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1 Track 1: The Content, Context and Future of STI-Policy: Towards a new Framing?

Track 1 was organized by Laur Kanger and Chux Daniels, both from SPRU (Science Policy Research Unit), University of Sussex, and included four Sessions.

The world is in transition. Many interlocking environmental, technological, economic, political and cultural trends such as resource depletion, population growth, industrialization, urbanization, inequality or individualization are creating collective challenges (United Nations, 2015) that exceed the ability of any single country, body of governance or scientific discipline to manage them. Our innovation engine is faltering with the fruits of creative destruction increasingly morphing into destructive creation (Soete, 2013). It is amply clear that traditional Science, Technology and Innovation (STI) policy has not delivered on these challenges nor are there good reasons to expect that it would do so in the future. Socio-technical systems need to be significantly reconfigured and STI policies re-invented to rise to the grand challenges. What is needed is not just the improvement of existing STI policy but adding a whole new set of rationales and instruments which would amount to a truly transformative innovation policy.

This diagnosis and respective solutions have recently begun to be articulated under many different labels, for example, Responsible Research and Innovation (Stilgoe et al., 2013), inclusive innovation (Agola and Hunter, 2016), social innovation (Joly, 2016) or the goverance of sustainability transitions (Grin et al., 2010). While differing in many aspects the basic themes of these approaches seem to be recurrent: attention to alternative futures and the co-production of science, technology and society, emphasis on the non-neutral nature of technology, focus on disruptive socio-technical systems change in addressing societal and environmental challenges, stress on the transformative potential of civil society and attentiveness to the needs and wants of users and non-users alike. This has led to a suggestion that we might be witnessing the emergence of a new framing of STI policy (Weber and Rohracher, 2012; Schot and Steinmueller, 2016), one markedly different from traditional approaches to STI policy-making that have focused on boosting R&D, promoting entrepreneurship or building innovation systems. The research session is therefore devoted to the exploration the context, content and future of transformative innovation policies.

More specifically, the papers in the session are called to reflect on the following questions:

- What are the implications of changing societal and global context for STI policy? How might broader social and environmental changes facilitate or hinder the potential renewal of STI policy towards transformative change?
- How has STI policy reacted to these changes until now and how are STI policies likely to react/adapt in the future? Which transformative policies and governance arrangements would be useful for addressing the world in transition?

We are interested in theoretical as well as empirical papers: however, all papers should contribute to the debate on how STI policy for transformative change could be articulated and evaluated. The possible topics include (but are not limited to) the following:

- The possible impact of major long-term landscape changes (e.g. the crisis of neoliberalism, the increasing financialization of world economy) or short-term shocks (e.g. financial crisis, Brexit) on STI policy, including its transformative potential
- Innovative approaches that do not only aim to reduce inputs or overall consumption but try to reconfigure the relations between consumers, investors and/or markets (e.g. Freecycle, benefit corporations)
- Stimulating and managing conflict in implementing policies directed towards the achievement of disruptive socio-technical systems change

- Ways of challenging environmentally harmful industrial sectors and socio-technical systems while addressing the possibly accompanying adverse impacts on local economies (e.g. unemployment, decreased energy security, skill mismatch etc.)
- Building multi-level policy mixes (supporting niches, destabilizing regimes, tilting the international playing field), balancing new policy mixes with existing policies
- The challenges and possible futures of STI policy in the context of permanent slow-growth economy or the slowdown in technological progress (Gordon, 2016)?

Empirical research can include individual in-depth case studies, comparative case studies or broader survey-based approaches. We are looking for research at the international, national, regional and local level, and contributions from outside Europe too. The expected outcome of the sessions within this theme is a better articulated overview and analysis of the current situation as outlined above and suggestions for STI policies of the future.

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1.1 Session 1.1

1.1.1 Enacting Transformative Innovation Policy: A Comparative Study

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The world is in transition. Many interlocking environmental, technological, economic, political and cultural trends such as resource depletion, population growth, industrialization, urbanization, inequality or individualization are creating collective challenges (United Nations, 2015) that exceed the ability of any single country, body of governance or scientific discipline to manage them. Our innovation engine is faltering with the fruits of creative destruction increasingly morphing into destructive creation (Soete, 2013). It is amply clear that traditional STI policy has not delivered on these challenges nor are there good reasons to expect that it would do so in the future. Socio-technical systems need to be significantly reconfigured and STI policies re-invented to rise to the grand challenges. What is needed is not just the improvement of existing STI policy but adding a whole new set of rationales and instruments which would amount to a truly transformative innovation policy.

This diagnosis and respective solutions have recently begun to be articulated under many different labels, for example, Responsible Research and Innovation (Stilgoe et al., 2013), inclusive innovation (Agola and Hunter, 2016), social innovation (Joly, 2016) or the governance of sustainability transitions (Grin et al., 2010). While differing in many aspects the basic themes of these approaches seem to be recurrent: attention to alternative futures and the co-production of science, technology and society, emphasis on the non-neutral nature of technology, focus on disruptive socio-technical systems change in addressing societal and environmental challenges, stress on the transformative potential of civil society and attentiveness to the needs and wants of users and non-users alike. This has led to a suggestion that we might be witnessing the emergence of a new framing of STI policy (Weber and Rohracher, 2012; Schot and Steinmueller, 2016), one markedly different from traditional approaches to STI policy-making that have focused on boosting R&D, promoting entrepreneurship or building innovation systems.

While necessary, this shift in focus is also most challenging requiring new skills, new ways of participation, new capability-building, new ways of monitoring, new ways of assessing progress, new ways

of managing conflict between stakeholders and so forth. It is therefore informative to conduct an exploratory study on the enactment of transformative innovation policy initiatives. Therefore, the paper focuses on the following research questions:

1. How has the challenge of transformative innovation policy been interpreted in different countries? What kind of initiatives have been undertaken as a response?
2. What are the main opportunities for enacting transformative innovation policy? What are the main barriers?
3. How does the broader national and international context facilitate or hinder specific transformative innovation policy initiatives?

The empirical part of the research is based on case studies of transformative innovation policy initiatives in five different countries, each representing a member of the Transformative Innovation Policy Consortium – Norway, Colombia, South Africa, Sweden and Finland. Cases are selected according to the following principles: 1) directionality: focus on alternative futures associated with technological design choices; 2) goal: focus on grand environmental and/or social challenges; 3) impact: focus on socio-technical systems and system-level issues; 4) degree of learning and reflexivity: focus on second-order learning, problematization of operating routines of different actors and the creation of spaces for experimentation; 5) conflict: focus on disruptive change, possibly resulting in major disagreements between actors; 6) inclusiveness: focus on initiatives with a broad base of participation, including the consideration of non-users as potentially affected parties. The data is collected through semi-structured interviews, innovation history workshops and the analysis of policy documents. We present a comparison of different factors facilitating or hindering the evolution of transformative innovation policy initiatives, including the role of wider context (country-level and international developments) in shaping these dynamics.

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1.1.2 Transformative Research and Innovation Policy – Towards a Meta-Governance Frame

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Keywords: Transformative innovation policy, Responsible research and innovation, Meta-governance, Meso-level

The paper will develop a meta-governance framework facilitating transformative policy-making, with a particular focus on the meso-level of research and innovation systems (RIS). In our concept "governance" includes all related actors, their resources, interests and power, fora for debate and arenas for negotiation between actors, rules of the game, and policy instruments applied helping to achieve legitimate agreements (Kuhlmann 2001; Benz 2006). "Meta-governance" is about "organising the conditions of governance" (Jessop 2002, 242).

Why is this perspective relevant? The contexts and conditions for RIS are changing, placing more, new and multiple kinds of pressures, demands and requirements on science, technology and innovation (STI). These demands can be understood as increased legitimacy pressures on STI actors and RIS (e.g. Schot & Steinmueller 2016; Mulgan 2017). Since about 15 years STI policies have become geared towards addressing objectives reaching beyond an immediate economic focus on growth and competitiveness (Lindner et al. 2016). This "normative turn" is expressed in the strategic reorientation of national and supranational STI policies to address the "Grand Societal Challenges" such as health, demographic change, wellbeing and sustainability (Foray et al. 2012; Kallerud et al. 2013; Kuhlmann & Rip 2014). Well known examples for this ongoing paradigm shift are the European Union's Europe 2020 strategy, the US Strategy for American Innovation or Germany's Hightech Strategy. This is complemented and propelled forward by the recent discourse on "responsibility" in research and innovation.

Against this background the paper will address the following questions:

- What is needed to establish, ensure or regain legitimacy for STI policy? Can legitimacy be constructed pro-actively (c.f. Suchman 1995)? How and towards which ends do RIS and their meta-governance have to be transformed to achieve this?
- Which meta-governance frame (at the meso-level) can help to address the transformations called for, and eventually contribute to establishing legitimacy of STI?

The paper does not intend to deliver a “grand concept” to transform RIS, covering all levels and systems dimensions. Rather, the focus is on transformation of organisations and institutions at the meso-level (such as funding organisations; ministries; boards of universities and of companies; civil society organisations). This level is often forgotten, as analysis and prescription either target “the system”, policy or individuals, and if they target the meso-level, it is often very specificly tailored towards a certain category. However, our premise is that while there is a variety of different organisations in RIS, there are core structures and processes influencing responsiveness to external demands across all of them that need to be understood and addressed. Successful changes at the meso-level have a potential to contribute, in a legitimate way, to system-wide transformations.

A recent prominent attempt to (re-)establish legitimacy and provide normative orientation for STI policy and RIS is the above mentioned quest for “Responsible Research and Innovation (RRI)” (e.g. von Schomberg 2013). In essence, “RRI” aims at improving the alignment of the impacts of technology and innovation with societal demands and values as far as possible. The concept is inherently characterised by a high degree of normativity in order to provide necessary guidance as to what constitutes desired or “responsible” research and innovation (Randles et al. 2014; Lindner and Kuhlmann 2016). The prominent position of “RRI” in the European Union's research and innovation programme Horizon 2020 and the endorsement of the "Rome Declaration on RRI in Europe" by the European Council in 2014 indicate that “RRI” has been used as a legitimacy resource for policy, research funding and scientific communities. The quest for “RRI” can be interpreted as one of the current responses to the challenges raised by the broader changes and dynamics conditioning and structuring STI. The related “RRI discourse” is an attempt to question, revise and strategically re-stabilise the legitimacy of public investments in STI policies.

But such claims to increase the “responsibility” and “responsiveness” in RIS should not be equalled with a meta-governance frame. Therefore, in contrast to attempts to define what “RRI” should mean in substance (e.g. Stilgoe et al. 2013), in our paper we apply a genuine governance perspective. The intended meta-governance framework facilitating transformative, responsive and legitimate policy-making in RIS will have to cope with two basic challenges:

- “Responsibility” has always been subject to changing value choices (Arnaldi & Gorgoni 2017). Also the recent claim for “RRI” is an inherently normative concept. The concrete realization of these normative claims will be contested in the context of pluralistic societies. Instead of downplaying these tensions and potential conflicts, we acknowledge the need to identify conditions and viable mechanisms that facilitate the capacities and capabilities of relevant actors to engage in constructive and productive negotiations.
- Any effective governance approach needs to take into account the manifold, multi-layered incumbent governance arrangements in RIS and STI policy, and draw on them constructively.

These various, often well-established arrangements and mechanisms, as well as normative priorities of actors, represent what we consider as “RRI in the making” or the de facto governance (Rip 2010) of evolving “divisions of moral labour” (Rip 2017) between actors.

Consequently the paper builds on a research approach aiming to learn from “RRI in the making”, understood as a historically unfolding process, co-evolving with understandings of what it means to be responsible in any particular context. Here we are interested in those practices in which the participating actors work towards legitimate normative objectives and outcomes.

In order to identify “building blocks” for a meta-governance framework and given the heterogeneity and complexity of present research and innovation governance landscapes, a case study approach

was chosen to study "RRI in the making", aiming to generate deep insights into established arrangements, mechanisms and practices of governance across a range of different research and innovation situations and contexts. Consequently, an explorative rather than a representative approach was applied to select and conduct 26 very diverse empirical cases (Randles et al. 2016). A tailored model was developed to guide the empirical research (Walhout et al. 2016). The case study programme was be complemented by a continuous monitoring process of "RRI" trends and developments in 16 European countries (Mejlgaard & Griessler 2016). The empirical material was analysed in a 3-stage deductive-inductive research process, and we identified 13 transversal lessons for the governance of RRI, along procedural and substantive dimensions (Randles et al. 2016).

Against this background we developed in an abductive manner the rationale and ambitions of a meta-governance framework ("Responsibility Navigator", Kuhlmann et al. 2015). This orientating framework is meant to facilitate responsibility-related debates, strategic reflection and decision-making processes in meso-level RIS organisations. The framework builds on ten principles organised along the three dimensions of (1) Ensuring Quality of Interaction, (2) Positioning and Orchestration, and (3) Developing Supportive Environments. We claim a high degree of robustness of the suggested principles given a strong empirical foundation plus the fine-tuning and testing in an elaborated "co-construction process" with key meso-level stakeholders from RIS in Europe and beyond (Bryndum et al. 2016).

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1.1.3 The Design of Holistic Innovation Policy: Characterizing 22 Policy Problems

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This paper will be a draft of the concluding chapter in a book entitled "Holistic Innovation Policy: Theoretical Foundations, Policy Problems and Instrument Choices" to be published by Oxford University Press in late 2017.

Many governments (national, regional and local) have developed innovation policies aiming at promoting and fostering innovation in their economies and societies. However, the rich literature on innovation studies still lacks a well-defined and encompassing theoretical basis for public policy. Such a basis is necessary in order to provide a solid conceptual framework for identifying policy problems in the innovation system and designing policy intervention. Furthermore, it is necessary in order to provide specific guidance for the design and re-design of innovation policies. Such designs should be based on holistic (or systemic) problem-solving choices of policy instruments.

Innovation policies are normally designed in a partial rather than in a holistic way, as they only focus on few of the determinants of innovation system processes. There can be many different partial innovation policies, but most often innovation policies are based on a linear view of the innovation process, focusing strongly on the role of research – and therefore the policies themselves become linear. A linear innovation policy is a special case of partial innovation policies, and the most common one. Those partial and linear innovation policies fall far behind current studies of innovation systems and innovation processes.

The aim of this paper is to provide a theoretical and conceptual basis for the design of holistic innovation policy. This serves several purposes. Firstly, it serves to characterize a set of 22 different problems in innovation systems, which might require public policy intervention. This characterization recognizes the complex nature of those problems which often cut across several areas and sectors in the innovation system, and have important time and space-related dimensions.

Secondly, it allows a wider understanding of the strategic choices of policy instruments, which are combined in particular and idiosyncratic policy mixes. The choice of instruments and mixes are typically associated to specific problems. But the instruments tend to change through time according to many factors, namely, transformations in the formulation of goals and views about the nature of problems, the responsiveness of policy-makers and stakeholders to new opportunities, and the political strategies towards different aspects of innovation.

Thirdly, by understanding that policy action is part and parcel of the innovation system, it serves to identify a large series of possible unintended consequences of policy action itself, an issue which has traditionally been explored in a few specific areas (e.g. public support of private R&D investments), but is largely unexplored in other equally crucial problem of innovation policy activity (e.g. education or innovative entrepreneurship).

This paper proceeds as follows. Section 1 introduces the paper and states the purposes described above. Section 2 introduces the theme by presenting in a very succinct manner a specific approach on innovation system, based on ten activities or determinants of innovation processes. This approach is the authors' theorizing effort about innovation systems and their dynamics, which is done in the context of discovery and of a continuous development from previous theoretical work on innovation. Section 3 discusses the differences between partial innovation policies and holistic innovation policies, along the lines mentioned above. Section 4 defines what policy problems are, and defines the two preconditions for innovation policy (additionality and the organizational capacity of public intervention). This serves to indicate that not all issues related to innovation should automatically be subject to public intervention, and that the capacity of public intervention is a key factor for the design of innovation policy in order to be realistic and fine-tuned. There are two preconditions for innovation policy intervention:

- Private organizations must prove to be unwilling or unsuccessful to address bottlenecks and deficiencies in the innovation system; a policy problem must exist;
- The state (national, regional, local) and its public organizations must also have the ability and organizational capacity to solve or mitigate the problem, as well as to learn from past experience.

Section 5 focuses on the 'core model' of our approach, namely the three elements for the design of innovation policy. Those three elements are the specific identification of policy problems in a system, the choice of policy instruments that governments typically use to mitigate them, and the identification of the likely unintended consequences of policy intervention. By linking those three elements, this approach aims at providing a holistic approach and problem-based account of innovation policy design.

Section 6 substantiates this approach, reviewing the most significant 22 policy problems identified in the different chapters of the book. This section summarizes as well the most relevant 'families' of policy instruments that governments traditionally deploy in view of addressing policy problems. And it summarizes as well the typical unintended consequences that policy intervention tends to take.

The final section of the paper, section 7, concludes this paper by stating the main contributions of the book. This book puts forward the theoretical foundations of a holistic innovation policy approach. In so doing it addresses the "unfinished business" of the innovation system's literature, which did not provide specific and detailed theoretical foundations for holistic innovation policy design. Secondly, the book considers policy instruments as part and parcel of the innovation system, which can be part of the problems themselves. In so doing, it overcomes previous literature on innovation systems that omitted or simply ignored the innovation policy instruments in place and their possible positive or negative effects on performance. Last, but not least, the book has made an effort to cover different types of innovation systems in terms of socio-economic development; and the diversity of policy problems and policy instruments in the design of holistic innovation policies. The section concludes with a plea: Policy problems as well as the choice of policy instruments should be based (and be part and parcel) of the iteration between theory and empirical efforts.

1.2 Session 1.2

1.2.1 Future Scenarios for Research & Innovation Policies in Europe

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The world, it seems, is getting more complex and unpredictable. A confusing mix of positive and negative trends, constructive and destructive forces, attract – and distract - our attention every day. Yet universal values as they are share by the UN Sustainable Development Goals sketch a direction for policy making and for a better life for all. In the context of European STI policy making, the question is: What will be Europe's role in the world and can European STI-policy making make a difference?

Europe can show the way towards the SDGs, but cannot take the world there. And if the world diverges from the SDGs path, Europe needs to be strong to deal with the consequences. Europe's strength depends on the EU, on its ability to coordinate and lead the countries and peoples of Europe, on its shaping appropriate framework conditions for research and innovation, and on its levels and forms and priorities associated with its investment in research and innovation.

Looking at the future, the junction of the SDGs with megatrends provides a framework for identifying key transitions for the future, and challenges and opportunities associated with such transitions. Using this framework, our paper covers future scenarios (2030) from a European project on "Foresight in Support of the Preparation of the European Union's Future Policies in Research and Innovation". These scenarios are built around:

- Governance (Global social, economic and political developments)
- Social needs; (Heath and Security)
- The Biosphere (energy and climate, environment and ecosystem resources and services)
- Drivers of change (towards a world of cities and accelerating innovation: ICT and tech convergence)

In each of these areas, the paper sketches two scenarios: one strongly aligned with the SDGs, and one in which the world moves away from the SDGs.

Looking at the transitions towards the SDGs the following general observations can be made:

- Inclusiveness and fairness are key principles of transition processes and key objectives of transitions.
- Coordinated action between European, national and regional level is essential

- There are strong interconnections between the scenario areas.
- Governance is key for innovation and value creation.
- The city emerges as a key level of governance and social and economic organization.
- Experimentation, rapid prototyping and testing solutions need to become an important part of policy

The aim of developing these scenarios is to explore strategic options for Europe in a world where there are major shifts in political and economic structures taking place at the global scale. The key perspective underpinning the scenario approach is that the EU has the potential to magnify the importance of its citizens and its Member States in the world scene, while, as economic globalization advances, the global weight of the EU decreases[1].

The EU will be a smaller part of the world economy, population, emissions and so on.

The scenarios cover a broad ground of important domains where major changes are either needed or likely to happen. A central question arising from the different scenarios concerns the role of EU's STI policy in connection with the coming framework programmes. The ability to move onto a sustainable transition path requires Europe to be strong, go united and overcome fragmentation, and to reduce its social division and restore inclusive societies. These are the essential pre-conditions to fully exploit the potential of fostered investment in research and innovation as the means for creating new solutions to the world's challenges; solutions that at the same time would be at the heart of Europe's economic, political and social success.

To enable the vision for a strong and resilient Europe to materialize, an overarching strategy for change is needed; a strategy that addresses both wider socio-political dimensions as well as transitions at the level of key systems. Such a strategy must combine a pace-making role in the promotion of Sustainable Development Goals with leadership in selected fields of research and innovation.

Among the open questions still to be discussed are: What can be the role of a new EU STI policy? What are the option for formulating a funding programme to become lead investor in research and innovation? How can economic and social returns of this investment be harvested?

1 As President Juncker [Juncker (2016)] put it in his 2016 State of the Union Address "The facts are plain: The world is getting bigger. And we are getting smaller. Today we Europeans make up 8% of the world population – we will only represent 5% in 2050".

1.2.2 An expert-based participatory evaluation of public policies for sustainability transitions

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Keywords: Policy evaluation, Evaluation criteria, Innovation policy, Transition governance, Comparative policy evaluation

Overview

How can innovation policy mixes for sustainability transitions be compared between countries? This paper introduces a conceptual framework, a set of appraisal criteria and a participatory expert-based method for appraising country-level public policies for sustainability transitions. Our Sustainability Transition and Innovation Reviews (STIR) framework combines a methodological approach inspired by the Bertelsmann Transformation Index with existing theoretical frameworks on sustainability transitions, notably Technological Innovation Systems (TIS), Multi-Level Perspective (MLP) or Strategic Niche Management (SNM). In doing so, it seeks to provide an enhanced framework for comparative assessment of, and reflection on, the capacity of policy systems to enable and drive sustainability transitions.

Theoretical and conceptual background

There are several existing indicator systems and evaluation frameworks that are used to examine the performance of countries' efforts to foster a greener economy. Examples include Yale's 'Environmental Performance Index', the European Eco-Innovation Scoreboard, and the Global Green Growth Institute's 'Global Green Economy Index', and the OECD's 'Environmental policy stringency' indicator (Botta & Kozluk 2014). The approach presented in this paper differs from these efforts in both the focus (which is specifically on policies enabling transformative change towards sustainability) but more particularly in the process.

The framework presented here starts from the assumption that any attempt to provide a comparative assessment of country performances should be responsive and open to the divergent contexts and institutional capacities of the countries in question. Moreover, the uncertain and contested nature of many potential policies for sustainability transitions demand a framework that is reflexive and open to divergent perspectives, and that allows situated interpretation of relevant indicators. Unlike most other scoreboard exercises, our approach is based on both quantitative indicators and qualitative expert commentary on a country's performance. The choice of expert-based appraisal rests on the assumption that available quantitative data require an informed and situated interpretation to arrive at a useful appraisal of countries' performance.

The appraisal framework draws on well-known approaches in analysing innovation systems (notably TIS), research and innovation policy mix (policy consistency and coherence) as well as the sustainability transitions literature (MLP and SNM). The appraisal is broad in scope and ranges from analysing agenda centrality of sustainability transitions in the public debate to asking questions on effectiveness of policies in enabling and diffusing eco-innovations. The exercise also aims to take account of the main phases of policy cycle, including agenda setting, policy design, strategy and decision making, policy implementation, and policy evaluation.

The policy appraisal framework is structured around 12 criteria:

- **Agenda centrality** - the relative position of issues related to innovation for sustainability in the policy debate and policy agenda. The criterion draws on the role of stakeholder dialogue and engagement in governance and deliberative democracy as well as the engagement of stakeholders in the agenda in transition management.
- **Policy relevance** - the assessment of the extent to which policy vision and objectives are consistent and adequate for sustainability challenges. This criterion draws on the field of policy evaluation. Systemic relevance assesses whether and to what extent policy objectives respond to sustainability challenges.
- **Directionality** - the extent to which policy mix is oriented towards sustainability. While relevance focuses on objectives and vision, directionality focuses on the entire policy mix and implementation of policies on the ground. It draws on both the economics literature and role of environmental prices and regulations. It is also influenced by ‘guidance of search’ concepts in TIS; also draws on the relevance of directed technological change for environment from the economics literature (Acemoglu et al 2012).
- **Environmental policy stringency** - the extent to which policy protects environment by installing and enforcing regulations that protect the environment from overexploitation. The criterion draws on traditional environmental economics focus on regulatory-driven innovation (Ashford et al. 1985; Porter & van der Linde 1995)
- **Alignment** - the extent to which public policy facilities alignment of change agents for the vision of sustainability transition and transformative eco-innovation. The criterion draws on the MLP emphasis on alignment. It also resonates with the transition management literature in recognising the importance of ‘guiding visions’.
- **Legitimisation** - the extent to which policy choices on direction of transition pathways have democratic and social mandate. This criterion draws on governance and deliberative democracy literature as well as on the emphasis on legitimacy in TIS.
- **Demonstration** - the extent to which policy creates strategic arenas for experimentation and demonstration of transformative system innovation. This criterion resonates with the emphasis on lead market formation, entrepreneurial experimentation as well as the notion of niches in MLP.
- **Specialisation** - the extent to which policy encourages entrepreneurial and industrial specialisation in the areas taking into account their sustainability impact. This criterion echoes calls for prioritisation and ‘smart specialisation’ widely found in practical policy advice. Interestingly, the dimension of specialisation does not emerge in TIS or MLP literatures.
- **Policy Coherence** - the extent to which policy mix is consistent, coherent and comprehensive. This criterion is based on the policy design and policy mix literature indicating the role of policy coordination and coherence for delivering impactful public intervention.
- **Distributional impacts** - the extent to which policy redistributes costs and benefits of transition between societal groups and regions. Sustainability transition will create positive and negative impact for different businesses and societal groups. Recognition of varying destruction of impacts contributes to better policy design and implementation. This dimension is taken into account in political economy literature and in the practice of policy evaluation and strategic impact assessment.

- **Effectiveness** - the extent to which policy is effective in achieving transformative impact. This is a core evaluation criterion used in policy evaluation. In relation to sustainability transition it is assessed against sustainability goals which may or may not be reflected by policy objectives.
- **Policy evaluation and learning** - the extent to which policy is based on evidence and supported by learning environment. The role of evidence and learning in policy making is central for the evidence-based policy paradigm and is part of 'good governance' criteria.

The appraisal process includes not only assessment and scoring, but also mapping questions (which enable recording of policy practice) and analytic questions (which ask experts to provide analytic commentary and context for the policies applied). Thus the process is designed to reflect on context and the particularities of each country, rather than simply providing a quantitative scoreboard.

The STIR Methodology in brief

The appraisal process has followed the following stages:

- Recruitment of country experts based on transparent criteria.
- Lead authors are briefed and provided with supporting material by the Inno4SD coordinating team: the STIR toolkit includes annotated template, secondary data, glossary, examples of cover letters and (when at the later stages) examples of completed reviews.
- Lead authors gather data, through analysis of existing secondary data and literature and through interviews with selected experts and stakeholders in the country (including policy makers, academia, business, civil society and media).
- Lead authors conduct stakeholder workshop with a collective reflection on the appraisal criteria. Stakeholders are invited to provide commentary and suggested scores on each appraisal criterion, reflecting on the specific context and developments in a country.
- Lead authors suggest overall scores against criteria based on all gathered evidence. An example of the scoring guide for an appraisal criterion is shown in Figure 1.
- The reviews and scores are subject to peer review by selected country experts. When scores suggested by the author and reviewers are significantly different, a meeting or teleconference is arranged to discuss and record the reasons for discrepancies and, if possible, to agree on the final scores.

Figure 1. An example of annotated appraisal criterion: Environmental policy

Environmental policy stringency

Public policy protects the environment and enhances eco-system services

- 10 - 8: The country has a policy and regulatory framework ensuring the protection of nature and improvement of eco-system services. The framework is based on scientific evidence, and takes a full account of the state of local and global ecosystems. The policy goes beyond obligations stemming from international agreements. While eco-innovation is at the core of the transition policy, all public support for innovation has to recognise the importance of the precautionary principle in order to avoid pursuing innovation pathways that present a considerable environmental and social risks.
- 7 -5: The country has a policy and regulatory framework ensuring the protection of nature and eco-system services. The framework is based on scientific evidence. The policy complies with obligations stemming from international agreements. Precautionary principle is used in taking policy decisions, however, economic benefits are often considered a priority, and seen as an opportunity to compensate for possible negative environmental impacts.
- 4-2: The country runs environmental policy with formal objectives to ensure the protection of nature. The policy is largely reactionary and focuses on the acute environmental problems. There is limited use scientific evidence in designing the environmental policy. The policy formally complies with obligations stemming from international agreements, but their implementation is partial.
- 1: The country runs a rudimentary environmental policy with formal objectives to protect the nature. The country, however, does not provide a legally binding framework for environmental protection and lacks the implementation capacity.
- 0: N/A

Reference data

- SGI network indicators – environmental policy (http://www.sgi-network.org/2016 and http://www.sgi-network.org/docs/2016/thematic/SGI2016_Environment.pdf)
- OECD database on environmental policy (http://www2.oecd.org/ecoinst/queries);
- LSE Grantham's Global Climate Legislation Database (http://www.lse.ac.uk/GranthamInstitute/legislation/the-global-climate-legislation-database/)
- EUROSTAT data on implementation of environmental legislation (EU)

Preliminary findings and applications

The STIR process has developed a policy appraisal framework based on a synthesis of relevant literatures and established approaches to measuring green economy and eco-innovation. There are three main purposes:

- Policy evaluation and policy research – STIR is a systemic policy evaluation tool based on a mix of self-assessment and exert appraisal focused on individual countries.
- Public debate and policy learning – STIR is to contribute to a policy learning process providing a comprehensive policy appraisal framework for national debates and policy reflection on concrete steps to improve current policies.
- International collaboration – STIR aims to stimulate international debate and collaboration on the current and future role of public policy in enabling systemic changes in economies and societies towards sustainability.

The pilot country appraisals (South Africa, the UK and Turkey) will be completed by the end of October 2017. Initial reactions from policy stakeholders have been positive, with many expressing interest in the process and in particular in the balance that the process provides between a simple scoreboard approach based on indicators, and a richer analytic-reflexive perspective. In our initial consultations, policy stakeholders have confirmed that this provides value both because it enables understanding of relative performance and activity in light of national contexts, and also because the process helps to initiate or reframe a strategic dialogue about innovation policy.

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1.2.3 Innovation policy at stake: the emperor is naked

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Keywords: challenges to innovation policy, service economy, globalisation, new trends in use

Positioning the issue

Very harsh questions emerge on our cumulative knowledge on research and innovation policies. Put together they drive to ask whether past successes build a lock-in situation that forbids envisaging ‘breakthrough’ transformations.

My take on this debate can be summed up around 3 main questions

- The first is both historical and evaluative: there has not been much discussion about the gathering in one policy of ‘science’, ‘technology’ and ‘innovation’ policies. Is it still useful? Has it ever been effectively implemented as a sectoral policy and has it been performative? Should not we rather consider another grouping focused on capability building regrouping higher education and (academic) research (see for instance points developed by C. Edquist)?
- The second requires to delve again in history and the birth of S&T policies, which were mostly warranted by ‘mission oriented’ objectives. What has changed when discussing ‘societal’ challenges? What can we learn from them before proposing radical shifts (as does Johan Schott in his ‘innovation policy 3.0’)?
- The third question, probably the most problematic, deals with the underlying assumptions (linked to manufacturing industries) on which the portfolios and policy mixes for innovation policies are based. Can we go on, facing politicians, keep telling the same stories on portfolios of instruments and policy mixes as those that worked for manufacturing industries?

In this conference, I would like to focus my presentation on the third question, the relevance of present policies supporting innovation.

Most policies have focused on ‘technology-based’ innovation of manufacturing firms in what I characterise around 3 main types that often have also been phases in policy design: technical centres, collaborative programmes, focus on small firms innovation capacity and within it on the ecology for start-up firms.

I argue that we should heavily discuss this focus to take into account radical changes. The key words that characterise the new challenges R&I policies face, can be characterised by three ‘umbrella’ terms: (a) service economy (b) globalisation, (c) new ‘lifestyles’ and political consumption. There may be more but these three issues combined drive us to ask ourselves if there is not a completely new paradigm to consider for relevant public intervention.

Under these umbrella terms there are important transformations that question our assumptions on the rationales for policy intervention.

Let me here just say a few words on each. In services we know about manufacturing-like services and on KIBS. But the core of employment (and even more the core of employment growth) is linked to services focused on ‘individuals’ – from health to tourism, leisure and culture. Some colleagues in SPRU have even coined the term “hidden innovation” to speak about transformations in the health sector. Can the now fashionable answer about business models help better characterise innovation

processes, so that we can identify ways in which public authorities can accompany firm efforts and build an environment that is more conducive to innovation efforts?

Globalisation goes with concentration worldwide around a limited number of large firms in most industries. This drives to discuss our models of international trade built upon relative comparative advantages. We face now ‘absolute’ comparative advantages that drive to massive reallocations of productive activities and in many OECD countries to a deep structural change in the economic fabric.

This also goes with a greater and greater decoupling between production & consumption. When both were coupled in one country, citizens’ vote could ‘frame markets’; when three quarts of what they buy come from outside, new forms of involvement are required. Political consumption and the rise of ‘value-based’ NGOs with their certification mechanisms are the other facet of globalisation, that questions intergovernmental inability to frame markets.

There has been work on the shifting role of users in driving innovation (cf. Von Hippel plea for democratising innovation). They represent an entry point to a new phenomenon whereby in a knowledge-based society, the vast majority of users/consumers are themselves part of innovations processes in their work (or at least change processes). And this is fast developing in multiple directions that question us. Again here I select only a few developments that can be captured by simplifying keywords: (a) crowd sourcing, (b) political consumption and/or responsible innovation; (c) social innovation, (d) DIY and (e) sharing economy. Are these movements marginal, or do they, taken together, drive to a reconsideration of innovation dynamics as a permanent source for renewed and enlarged consumption? This may drive also to a paradigmatic change in the rationale, direction and content of innovation policies.

While there is a growing recognition of the breadth and depth of such changes, we remain quite poor at studying their potential implications for policies. Examining a number of advisory reports produced recently, we remain very shy in even mentioning them, and quite conservative in the recommendations made that remain in the traditional mould of manufacturing industries.

This is all the more problematic that we face a further transformation in policymaking. We see de facto a new balance between ‘procedural’ and ‘substantive’ or ‘horizontal’ and ‘vertical’ policies. This drives to raise a simple question that I do not often see discussed but is everyday more visible in Europe at large (from Brexit to immigration policies): ‘who is the policymaker’, and if there is no single policymaker, what are ‘operational forms ‘ of collaborative governance (rather than multi-level). We could also well think, as many cities in the US, that global problems at better handled ‘locally’ than waiting on the emergence of a problematic ‘global’ governance. This gives de facto a different role to global organisations (in a recent conference on development, Y. Nugruho from Indonesia, one of the rapporteurs of the new Millenium SDGs, argued that their primary role was to influence national/local agendas).

My feeling is that we are at a turning point, and that we should be proactive in discussing what should be the next generation of innovation policies seen as policies anticipating coming structural changes. My ambition is thus to participate in an open discussion about the redefinition of the research agenda of the field.

1.2.4 Complexity and Governance: Towards more agile STI Governance?

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Keywords: Governance, STI system, New Public Management, Complex adaptive systems, Resilience

The paper aims to discuss on the governance modes of the STI by utilizing ideas from the theory of complex adaptive systems (CAS). As a concrete example is used Finnish STI system and its recent challenges. The major claim made in the paper is that from the perspective of complex systems theory, the governance of the STI is based too much on centralized linear steering from "top-down" while in a rapidly changing complex system the necessary agility of the system is maintained by relying on decentralized structures and the self-organization of the actors. The paper asks what kind of consequences the adoption of this perspective would have on the current governance ideas of the STI system. It is suggested that it emphasizes at least the role of strategic steering as a wide collective process, constant experimentation in new situations and less detailed performance based steering. The paper is based on on-going work.

Current governance paradigm and its problems

It can be claimed that the predominant ideas of governance are currently based on the idea of machine like organizations and systems (Morgan (1977). In this view organizations are entities which can be rationally and efficiently steered. Various functions have their own units and division of labour supports the targets of the organization. The development of the organization is based on the idea that it can always be adjusted and tuned to be more effective.

The image of organizations as machines is deeply inscribed in the ideas New Public Management forming the mainstream of governance ideas (Hood 1995; Lane 2002) also in the STI. In a nutshell the NPM includes the idea that public management should be based on market-like mechanisms in order to increase the effectiveness and efficiency of the system. Steering is based on detailed performance targets, productivity measurements and evaluation. For instance, Finnish universities are currently steered with performance agreements and a funding formula which is very detailed including e.g. number of degrees, publications and internationalization. Altogether 75% of the public funding is based on performance and additional 20 % on specific strategic targets and functions. The activities of funding organizations are also steered with detailed performance targets. For instance, the steering of the Finnish Funding Agency for Innovation (Tekes) is based on thematic targets which are concretized by using dozens of quantitative targets and their follow-up (TEKES 2015). Relatively strong top-down steering is also visible in the fact that a substantial share of public research funding is allocated by using programs with predefined themes or problems. For instance, in 2015 approximately 46% of the research project funding of the research councils (Academy of Finland) was tied to various programs and strategic themes (Academy of Finland 2015) and in the Finnish Funding Agency for Innovation (Tekes) practically almost all research funding is somehow tied to thematic programs.

However, at the same time there are number of increasing problems in the system including, for instance, such issues as the weakness of the overall coordination of the system, inability to address large societal challenges and horizontal issues that cut across administrative borders (Lehenkari et al. 2016), weaknesses related to the societal impacts and the commercial utilisation of research, and following from this, diminishing legitimization of the STI system, which has become manifested in the cuttings of public R&D investments, and in the termination of major innovation programmes (Loikkanen et. al 2017).

Number of recent reforms of the university and research institute sector and in research funding have been attempts to resolve these challenges. It seems, however, that these structural reforms have not been able to address the major challenges. For instance, the recent evaluation of the university reform indicates that major targets of the reform were not reached (in a nutshell increasing flexibility and effectiveness) and the working conditions were even weaker than earlier (Ministry of Education 2016). Likewise recent studies and evaluations on the utilization of knowledge-based capital and policy coordination of the STI system indicate persistent problems in system coordination and steering (Lehenkari et al. 2016; Pelkonen et al. 2014). The on-going OECD evaluation of the Finnish innovation system has also paid attention to the aforementioned problems (Hutschenreiter 2017).

Increasing complexity

At the same time the operational environment of STI policy-making has become increasingly complex and difficult to manage. In a nutshell the operational environment is volatile, uncertain, complex and ambiguous (VUCA, Lawrence 2013). There are number of reasons for the emergence of such environment including, for instance (Nieminen & Hyytinen 2015), facts that we are globally networked and interlinked by economy, politics and new technologies; the inter-linkages between various human and natural systems, countries and administrational sectors increase systemic risks (e.g. Grand Challenges); and the technological development has intertwined profoundly with social and economic development and it may have far-reaching impacts on e.g. biodiversity and human identity.

In this context organizations and their operational environment can be seen as complex adaptive systems (CAS) characterized by multi-level and multi-directional interaction of various actors and system elements creating unanticipated and nonlinear developments and impacts in the system. (e.g. Mitleton-Kelly 2007; Holland 1995). As this interaction involves numerous people, processes and development paths which cannot be fully identified or controlled, organizations and wider systems they form in many cases “co-evolve” with their environment. In this view development is usually based on self-organized learning and interaction and organizations are “organisms” or “systems of change and flux” (Morgan 1977) embedded in a wider system of other organizations and institutions. Centralized control and governance of all the factors and developments become more or less difficult due to the simple fact that there are too many issues to be controlled and if controlled, operations may become slow and rigid. Therefore, the governance of the system requires new kinds of ideas and instruments.

Need for a new ideas of governance

Thus, one possible explanation for the increasing and persistent problems of the Finnish STI system is the fact that the governance mode is not compatible with the increasingly complex, volatile and ambiguous environment. As a result the development of the system has become slow, one-sided and bureaucratic.

According to many researchers, instead of control, governance of complex systems should create opportunities and options for system development, facilitate creativity, interaction and heterogeneity of the system, and support decentralized structures. This should lead to dynamic self-organization and continuous learning within system. Decision-making should be “lean” and engaging and solutions co-created. (e.g. Uhl-Bien et al., 2007; Biggs & Schulter, 2012; Clarke 2013) For resilient organizations in a complex environment it is necessary to accept the need for continuous change, to be able to study and experiment alternative operational models, to be able to reallocate resources to new openings, and to be able to tolerate “slack” or “inefficiency” which is necessary for creating new ideas and operational models. In highly efficient systems there is little room for developing new openings and for experimenting. (Hamel & Välikangas 2003, Välikangas 2010; Walker & Salt 2006).

On the basis of this, and keeping an eye on the Finnish developments, at least the following hypotheses can be suggested on the characters of more “agile” governance of the STI system.

1. Detailed performance targets and monitoring combined with funding steers activities one-sidedly. Rapid change of targets is difficult as foreseeable continuity in the funding principles is required. In addition, the complexity of the environment combined with the need to support meaningful change in the organizations leads to increasing number of targets, which gives little room for self-organization at the organization level and flexible reactions to emerging requirements. The sensibility of the performance based funding and steering should be re-thought. Governance should allow more room for independent action.
2. The current system is largely based on sector policies and existing administrative silos making coordination of the system challenging. There is no shared research and innovation strategy albeit there has been various attempts for a wider coordination. While distributing responsibility hierarchically and horizontally increases opportunities to react meaningfully to complexity and ambiguity, as a prerequisite is, however, that all the actors have a shared idea of strategic targets. Therefore strategic leadership as a shared process and dialogic development should be emphasized as a fundamental principle of governance. There is little hope of sensible “policy mixes” if there is no sufficiently detailed idea of common targets and measures of research and innovation policy. In addition, strategies should be flexible and iterative processes in the context of change.
3. In a constantly changing environment “steady-state” governance becomes increasingly difficult. More emphasis should be given to experimentation activity aiming at new operational modes and organizational arrangements. Experimentation gives swiftly feed-back on the functionality of planned reforms or operations and does not lead to immediate difficulties to change operations when the environmental conditions change. In addition, governance should tolerate heterogeneity in operational models as the diversity of the system increases its resilience and adaptability to changing conditions.

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1.3 Session 1.3

1.3.1 Changing frames of health research and innovation

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Introduction

Public policies arise from understandings of past experience with actions, reflections on contemporary challenges, and perceptions of future need and potential for action. These understandings are often placed into frameworks to aid analysis and guide learning. These frameworks evolve and change, as one framework becomes perceived as inadequate to current circumstances. Practice often precedes new frameworks and theory. In health research and innovation, existing literature shows that new conceptual approaches are built on experiments and experiences of those who forge new patterns of interaction between physical technologies and the organisational and institutional infrastructures to which they relate (Nelson and Sampat, 2001 and Chataway, et al, 2010). New socio-technical systems arise as concepts and inform scale-up and institutionalisation (Schot and Kanger, 2016).

This paper draws on the developing conceptual thinking arising from Schot and Steinmueller's (2016) new 'Transformative Innovation Policy' conceptual approach, pertaining to the evolution of innovation policy frameworks and the need for new approaches to meet current social and economic challenges. We aim to contribute to its explanatory power by applying it to the specific case of health innovation policy, specifically the evolution of key institutional initiatives in UK health research and innovation. Towards this, and building on Schot and Steinmueller (2016), we review three key framings of research and innovation policy and introduce how each frame can be seen through the case of UK health research and innovation policy.

Frame 1: R&D leads to innovation

The conceptualisation of the relationship between R&D and innovation is that research leads to innovation - the key challenge is to spend money on research in an enabling way. This frame emerges out the 2nd World War and in the aftermath of the scientific milestones that occurred as a result of significant investment in R&D. An early proponent, Vannevar Bush, argued that spending on science was essential to achieving peace and prosperity in the post-war years (Bush, 1945). For Bush, the social and economic progress that science and technology would drive was the best hope for achieving progress on what he called the 'war on disease', national security, and societal prosperity.

The frame provides a rationale for why the state needs to fund basic science and research. The main justification for spending money on research revolves around market failure. It was argued that the inability of the private sector to recoup investment in basic research led to a 'tragedy of the commons', where no one entity from the private sector will invest in the public good of knowledge. In response, governments began to expand the research funding architecture. The decades that follow expanded investments to witness a rapid growth in new technologies and economic growth, along with the expansion of sectors and industries such as agriculture, aviation and transport and health.

The implications of this approach resulted in the dominance of a ‘linear model’ of innovation. While we now appreciate that the rhetoric of such a linear model never captured the complexity of the innovation process (Chataway, et al, 2012), it prevailed in policy circles for some time.

The emphasis of many research initiatives working within this frame begin with a focus on R&D and assume effective translation into innovations, and their uptake. In the UK, prior to 2006, and broadly speaking, health research was funded by either research councils (through the Biotechnology and Biological Sciences Research Council or the Medical Research Council) or through NHS R&D budgets which were distributed by the Department of Health, but locally controlled and spent in variable ways across the country. These two funding models resulted in two tiers of health R&D funding (Cooksey, 2006). Peer-reviewed, research council or medical research charity funding, which was more ‘basic’ in nature, was seen as the gold standard and was where the lion’s share of money was allocated (consistent with the linear model). However, there was widespread recognition that a large translational gap existed between this basic research and new healthcare innovations (Cooksey, 2006). His report marked the beginning of a shift from the rationale for intervention in frame 1 resting mainly on market failure, to frames 2 and 3 where the rationale looks to understand institutional failure.

Frame 2: Innovation Systems

During the 1970s and 1980s, increased economic pressures and international competition began to expose the limitations of the first policy framework. Differences in individual country’s ability to withstand economic shocks became more apparent and the lack of substantial progress in bridging the gap between the poorest and richest countries in the world caused concern.

Amongst others, Richard Nelson’s work highlighted that research does not flow freely (Nelson 1993). Knowledge is ‘sticky’, tacit, and difficult to translate. It is bound in complex ways with the institutions that produce it. The concept of ‘absorptive capacities’, developed by Cohen and Leventhal, underscores the importance of capacity building to use knowledge (Cohen and Levinthal 1990). In addition, the varying nature of technological progress in different settings came to be recognised. Paul David, Giovanni Dosi and others began to write about the importance of path dependence in innovation –arguing that it is very difficult to break from established routines and practice (Dosi, 1982).

Recognising the complexities, scholars began to talk about an innovation ‘system’ (e.g. Lundvall, 1992, Nelson, 1993 and Freeman, 2008), highlighting that the nature of relationships between organisations and institutions in any ‘system’, be it national, regional or sectoral, deeply impacts the rate, direction and nature of research and innovation.

This approach shifts attention from those who are creating and diffusing research, to consideration of those who sit in the institutions and organisations who provide the context and the demand for research and innovation. It is the *interaction* between different system actors which emerges as critical.

This highly-influential frame and the language of ‘systems’ and ‘networks’ it promoted have impacted on how science and technology is funded, managed, governed and regulated today. In this non-linear frame, iteration between supply-push and demand-pull for research is highlighted.

In the UK, we see this influence through the creation of the National Institute for Health Research. The NIHR was created in April 2006 under the government’s health research strategy, *Best Research for Best Health*. The strategy outlined the direction that NHS R&D should take in order to deliver the NIHR’s vision ‘to improve the health and wealth of the nation through research’. The ambition of the NIHR was to create an environment that valued clinical research as highly as basic research and that maximised opportunities for patient benefit.

A few cases from the early days of NIHR illustrate these attempts to tackle the wider system of health research. First, Biomedical Research Centres and Biomedical Research Units were established as university-hospital trust collaborations to address the first research gap between basic and applied research. The centres conduct early translational research and provide infrastructure and opportunities for research and clinical personnel to develop multidisciplinary skills to address the first translational research gap (Woolf, 2008 and Trochim, et al, 2011).

Second, the NIHR made a major investment into Collaborations for Leadership in Applied Health Research and Care (CLAHRCs), also university-NHS partnerships, but focused on the second translation gap – applied research to uptake by health services. The aim is to increase capacity to produce and implement research evidence through sustained interactions between academics and services, ultimately for improve patient outcomes.

However, an issue still emerges in that there is an explicit assumption with both of these kinds of initiatives that there is a gap that needs to be bridged. We propose, though, that in health research it is not about gaps, but about two-way, dynamic interfaces which jointly influence supply, demand, and translation pathways. This brings us to Frame 3.

Frame 3: Transformative innovation policy

The relationship between research and innovation in this frame is not so much about pace as it is about direction – with more emphasis than in frame 2 on social impacts and the diversity of forces and stakeholders underpinning those impacts.

The view of research and innovation as socially-relevant in interdependent ways, as well as being economically-beneficial, has led to increasing recognition that the first two policy frames are not well suited for analysis in this context. Neither conceives of research and innovation in ways targeted to the scale of transformation that is needed. In frame 1 the challenge is to overcome market failure, and in frame 2 it is to which enable the institutional relationships for translation and impact. In frame 3, the challenge is to make sure that research links to innovation in such a way that the underlying dynamics associated with social and technical systems that perpetuate social, economic and environmental challenges are addressed. This means engagement of a wider range of stakeholders across all stages of research and innovation pathways and a stronger shift to a culture of co-production of research funding decisions, agendas, implementation, and impact.

This calls for reorienting health research and innovation systems to revisit the, iterative relationships between supply and demand. Academic Health Science Networks (AHSNs) are one such move in that direction. They seek to align education research, innovation and service delivery and are characterised by more variability and experimentation than other NIHR initiatives. They are concerned with creating the structural, behavioural and network conditions to support progression of research and innovation across the entire pathway; recognising the importance of links between regions and 'the centre' and of links between health, voluntary and social care actors. They try to inform and match supply and demand in more stakeholder-inclusive ways than in frame 2. Priority Setting Partnerships like the James Lind Alliance, which seeks to involve the public in setting priorities for research, are yet another example of efforts to shift towards more user-led approaches (Morgan Jones, et al, 2016).

Another example is the Vanguards (new models of care), which explicitly consider interdependencies between the health system as something which is embedded in wider societal systems. They have an integrated approach to service transformation and service-model innovation, embracing links between health, social and community care systems and between and between low-tech, high-tech and social innovations.

Frame 3 however is in its infancy and raises difficult questions about what constitutes value and impact from research and innovation, new power-hierarchies, and lines of responsibility and accountability. It may also introduce an even more normative dimension to decisions about investment.

Discussion and conclusions

In looking at the evolving policy frames in relation to UK health research and innovation, we see several shifts. First, there is a shift in the focus on economic and sector performance[2] towards wider social benefits driving research and innovation priorities, with the third frame most focused on balancing that equilibrium. Second, and related, there is a gradual shift in the conceptualization of what impact means and on the balance of energy on outputs versus impacts. In the third frame, we see the most concern about impacts on ultimate end users and society at large, as evidenced by an increasing focus on end user perspectives in shaping research priorities.

Third, there is a shift in emphasis on the pursuit of structural versus behavioral policy interventions, with progressively more attention on the behavioural in frame 3. Alongside this, a greater recognition of the interdependencies between sectors emerges in frame 3, and with this comes the need for more interdisciplinary research across the frames and mechanisms to support this. As frame 3 recognises at its core that specific impacts require contributions from multiple sectors (e.g. health and social care for ageing-related innovations) it is more likely to place emphasis on interdisciplinary interdependencies in the policy framing and thinking.

Finally, power dynamics are also seen to move across the frames. Initiatives such as new models of care (i.e. the Vanguards) are deliberately pursuing more joined up governance, planning and accountability for health outcomes and impacts between sectors (e.g. health and social care), between parts of healthcare pathways (primary, acute, and community care), all of which changes who has influence on what. While frame 2 may give more consideration to power hierarchies within sectors, frame 3 examples illustrate a greater concern with cross-sector power relations. In addition, more power, influence, and capacity-building is given to the end user, eg patients and the public, in frame 3 thinking, which provides greater scope to bring in new actors, particularly those who are marginalised or underrepresented.

What is clear looking across the frames is a series of implications for how we think about the co-production of R&D and the policies that govern it. Analytically, we expect that a shift towards frame 3 thinking in the development of policy will have a series of implications, perhaps allowing for greater recognition of socially-relevant, as well as economically-beneficial, research and innovation, more so than in the market-oriented and systemic approaches in frames 1 and 2. This is not to say that these analytical frameworks are irrelevant, nor that either inhibits consideration of social and economic benefits. It is that frame 3 offers more nuance and scope for end users to play central, influential and diverse roles in policy development. The analytical lens used in this paper raises important questions for the future of innovation policy thinking, and the iterative and reflexive relationship between intellectual policy framing and its application in practice.

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2 E.g. NHS quality of care, productivity, cost-effectiveness

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1.3.2 How deployment policies affect complementary technologies - evidence from the power sector transition

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Keywords: complementary technologies, deployment policies, diffusion, clean technologies

1. Introduction

The political consensus to mitigate climate change requires profound innovation in clean technologies. To this end, numerous policies for clean technology deployment have been implemented over the last decades. A common approach to foster the deployment of clean technologies is to establish niches in which clean technologies are shielded from competition with established technologies (Kemp et al., 1998).

Due to the high cost and the simultaneous importance of deployment policies, there has been a lot of research on the effect of these policies on technology diffusion as well as innovation in general. Thereby, deployment policies have been investigated from mainly two perspectives. One perspective uses the policy instrument as main predictor for policy effectiveness (Nemet, 2009; Requate, 2005), while the other highlights the importance of policy characteristics or design features for clean technology innovation (Kemp and Pontoglio, 2011).

Besides deployment policies, complementary technologies can support the development of focal technologies since they increase the value of the former (Pistorius and Utterback, 1997; Sandén and Hillman, 2011). The importance of complementary technologies drastically increases once focal technologies outgrow their niches. Fostering the diffusion of complementary technologies is therefore deemed crucial for managing the transition of socio-technical systems towards sustainability (Kemp and Volpi, 2008).

Doing so, however, is not straightforward since (1) more than one technology may have complementary characteristics to the focal technology, and (2) the further evolution of the socio-technical system and therefore the future need for complementary technologies is highly uncertain. In practice, this leads policy makers to either refrain from policy interference in support of complementary technologies or to support different complementary technologies across-the-board.

In order to solve this dilemma, it is important to better understand drivers of the diffusion of complementary technologies. Thereby, we argue, that deployment policies for focal technologies play an important role for two reasons: (1) they have had a tremendous effect on the diffusion of focal technologies and are therefore likely to have spill-overs to complementary technologies and (2) they constitute important and adjustable levers for interfering in existing technological systems. Therefore, we aim to answer the question how do deployment policies for focal technologies affect the diffusion of complementary technologies?

To answer this question we investigate the cases of battery storage and pumped storage hydro power as complementary technologies for variable renewable energy technologies, namely solar photovoltaics and wind. We follow an inductive approach and derive propositions based on semi-structured interviews with corporate managers of firms active in Germany and California. Our findings are complemented by expert interviews and the analysis of archival data from press articles.

2. Literature Review

Deployment policies and their effect on technology diffusion

The effect of deployment policy instruments on technology diffusion has been analyzed by scholars of neo-classical (Jaffe et al., 2002; Jänicke and Lindemann, 2010) and quasi-evolutionary tradition (Faber and Frenken, 2009; Nill and Kemp, 2009). Despite differences in their epistemological concepts both literature streams acknowledge the positive influence of deployment policy instruments on focal technology diffusion.

Besides the analysis on an instrument level, there are several studies that identify deployment policy characteristics as important predictor for technology diffusion or innovation in general (Kemp and Pontoglio, 2011; Norberg-Bohm, 1999). These characteristics are mainly abstract and differ among studies. Rogge and Reichardt (2016) list six characteristics that they deem important in the context of clean technology deployment: stringency, flexibility, level of support, predictability, differentiation and depth.

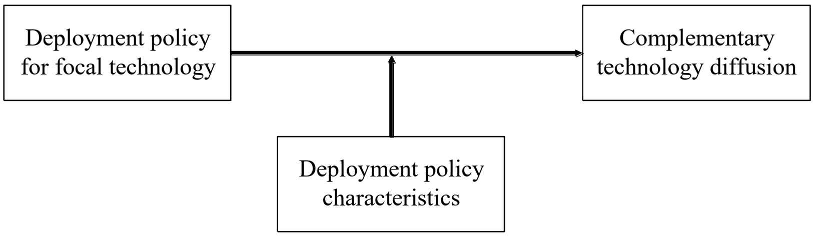
Diffusion of complementary technologies under policy influence

Within the literature on technology diffusion only few studies investigate the diffusion of complementary technologies (Colombo and Mosconi, 1995; Lissoni and Metcalfe, 1994). There are studies in which (1) policy interference does not play a role like in the diffusion of laser scanners and bar codes (Bucklin and Sengupta, 1993), (2) there is only one major complementary technology as in the case of hydrogen powered cars and the hydrogen supply infrastructure (Gnann and Plötz, 2015; Meyer and Winebrake, 2009) or (3) the complementary technology is located within the value chain of the focal technology (Choi and Anadón, 2014; Fabrizio and Hawn, 2013).

Summary & initial research framework

Summing up, the extant literature has not looked at the diffusion of complementary technologies under policy influence. Thereby, policy characteristics are likely to play a significant role since (1) the effect of the policy instrument choice on complementary technologies will be attenuated and (2) policy characteristics comprise information that goes beyond their effect on the focal technology, as e.g. in the case of the predictability of deployment policies. Figure 1 summarizes our research framework.

Figure 1. Initial research framework.



Investigating such a case is important since the diffusion of complementary technologies is (1) often critical for the performance of socio-technical systems and (2) likely governed by different mechanisms than the diffusion of focal technologies (Kemp and Volpi, 2008).

3. Research Case

We chose to study battery storage and pumped storage hydro power as complementary technologies to variable renewable energy technologies, i.e. wind and solar photovoltaics. Variable renewable energy technologies as focal technologies, on the one hand, are specifically well suited for our analysis since (1) wind and solar photovoltaics have experienced significant policy support over the last decades (Saidur et al., 2010; Solangi et al., 2011) and (2) both technologies have a strong impact on

the functioning of the overall power system (Mueller et al., 2014). Battery storage and pumped storage hydro power, on the other, are deemed highly complementary to the focal technologies (Kassakian et al., 2011; Sinsel et al., 2017) and are therefore a good fit for our endeavor.

Policies are country specific - therefore we chose to focus on Germany and California for the purpose of our study. The share of wind and solar photovoltaics have drastically increased in both countries over the last decades. At the same time, pumped storage hydro power is more prevalent in Germany as opposed to battery storage which features increasing diffusion levels in California. We therefore chose to study the diffusion of pumped storage hydro power in Germany and the diffusion of battery storage in California.

4. Method & Sampling

Our study follows a qualitative case study approach (Eisenhardt, 1989; Yin, 2009). Thereby, we proceeded in three steps. First, we scanned archival data to find out more on (1) the development of deployment policies in both countries, (2) the relevant corporate actors and (3) on factors that support or stall the diffusion of the chosen complementary technologies. Second, we conducted a number of exploratory interviews with industry experts. Third, we conducted semi-structured interviews with a sample of managers from firms involved in the sale or use of battery storage and pumped storage hydro power plants in either of the two countries.

5. Results

We first present our findings for the main effect, i.e. the influence of deployment policies on complementary technology diffusion, then we address the moderating effect of deployment policy characteristics.

Main effect

In general, we find a positive influence of deployment policy instruments on complementary technology diffusion. This is mainly due to positive expectations for the future demand of complementary technologies that is generated through deployment policies. Future demand is thereby either created via a technical need for complementary technologies, through market forces or through future regulation that is expected to be introduced in favor of complementary technologies. These positive expectations lead firms to increase technological learning by acquiring new resources and investing in demonstration plants, partly also in absence of a positive business case for the commercial operation of the complementary technology.

Summing up, we put forward the following proposition:
P1: Deployment policies for focal technologies increase the diffusion of complementary technologies.

Moderating effect

We find that policy characteristics have an ambivalent role when it comes to the diffusion of complementary technologies. A deployment policy with a high level of support, i.e. providing a high deployment incentive for focal technologies, hinders the diffusion of complementary technologies since they shield focal technologies from the market and therefore reduce the profitability of complementary technologies. Lowering the level of support e.g. by shifting the operational risk from society to focal technology users is likely to have a positive impact on complementary technology diffusion.

This leads us to suggest the following proposition:
P2: Policy characteristics moderate the effect of deployment policies for focal technology on the diffusion of complementary technologies.

6. Contributions

Implications for the existing literature

Our study makes contributions to two literature streams. First, we make a contribution to the literature on deployment policies by uncovering adverse effects on complementary technologies. Second, we contribute to the literature on the diffusion of complementary technologies by including policy as relevant driver and uncovering mechanisms that underlie complementary technology diffusion.

Implications for policy makers

Deployment policies for focal technologies have an ambivalent role when it comes to the diffusion of complementary technologies. One the one hand, deployment policies for focal technologies create positive expectations for the demand of complementary technologies which fosters their development and diffusion. On the other hand, deployment policies for focal technologies also hinder the diffusion of complementary technologies since their characteristics may shield focal technologies from the market. Therefore, it is important to adjust deployment policies over time in order to account for (1) the increased diffusion of focal technologies and (2) the simultaneous development of complementary technologies.

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1.3.3 Policy Entrepreneurship and Agenda Setting: Comparing and Contrasting the Origins of the European Research Programmes for Security and Defense

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Keywords: Policy entrepreneurship, European Commission, European Union science and technology policy, Security research, Defence research

The emergence of a security and defence dimension to European Union science and technology policy should be a source of fascination (and perhaps concern) to the academic community that studies science and technology policy. Paradoxically, given its potentially significant implications, the topic has been more or less ignored by that community and it has been left to students of European integration and security policy to examine these developments. They are clearly important since defence and security has until relatively recently been separate from the supranational mainstream of European integration, including European Union science and technology policy. The European Security Research Programme (ESRP) moved European Union science and technology policy into a field once regarded as strictly of Member States competence. The idea of a European Defence Research Programme (EDRP) is an even more dramatic shift in compentencies which has been argued by some advocates to be a “game changer” for the European Union and Member States (Fiott and Bellais, 2016).

This paper focuses on the origin of these policies since the origin of a policy can have a profound impact on its shape, scope and objectives. Nonetheless, public policy analysis all too often ignores why issues emerge as policy “problems”, the timing of their emergence, the representation of the “problem” and its acceptance by politicians and policy makers (Edler and James, 2015). The paper compares and constrasts the emergence of the European Security Research Programme (ESRP) which was established as a new research theme under the Seventh Framework Programme (2007-2013) and the European Defence Research Programme (EDRP) which is currently being proposed.

The paper makes three contributions. First, it mobilises the political science literature as a conceptual lens to help us compare and contrast the emergence of the two programmes and emphasises in particular the crucial role in both programmes of the European Commission as policy entrepreneur. Second, it introduces the idea of "serial policy entrepreneurship" to explain the important role of the same mid ranking European Commission official in identifying and utilising political windows of opportunity to get both programmes onto the policy agenda. Third, it emphasises the importance of ambiguity as a key feature in the process of framing and mobilisation that underpinned both programmes and broaden and deepens the discussion of ambiguity begun in an earlier paper (Edler and James, 2015).

The paper is structured as follows. It starts by developing our conceptual framework, building on the literature on policy entrepreneurship and agenda setting at the EU level. Section 3 discusses the origins of the European Security Research Programme, emphasising the important policy entrepreneurship role of mid ranking European Commission officials, the way that they identified a window of opportunity, framed the idea of the ESRP and mobilised an interest coalition in support of that idea as well as the important role in the agenda setting process of ambiguity in the definition of “security”. Section 4 compares and contrasts the origins of the European Defence Research Programme (EDRP) with that of the ESRP and finds important similarities in the process by which it emerged not least in the role of middle ranking officials (one of whom is characterised as a “serial policy entrepreneur” since he was involved in the emergence of both programmes) as well as the importance of ambiguity in getting the programme onto the policy agenda. Section 5 concludes with an expanded discussion of the nature of serial policy entrepreneurship and the importance of ambiguity in the agenda setting process.

1.3.4 Development of new policy solutions for Innovation in services: the role of multiple streams and policy entrepreneurs in small countries

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Keywords: Innovation in services, Innovation policy evolution, Policy entrepreneurship, Advocacy coalitions

Introduction

Innovation has long been associated with technological development and informed by manufacturing-centred theories and concepts such as research and development, new product and process development (Gallouj and Savona, 2009). This understanding has been challenged in recent years by scholars seeking to develop a broader understanding of innovation. In this context, innovation in services has received substantial interest from researchers and policy makers alike (Gallouj and Djellal, 2008; Toivonen, 2007). Much of this work has been driven by the growing importance of services in most developed economies, but also the blurring distinction between manufacturing and services (Miles, 2000). The topic of innovation in services has been addressed by a range of different academic literatures, including management theory and innovation studies, with more than 1,000 studies identified in a recent literature review (Snyder et al., 2016). This has seen much effort given to exploring the foundations of innovation in services, its distinctiveness to product innovation, and its sectoral attributes.

In recent years, policy and practitioners have recognised the potential to widen the focus of innovation policy by examining the potential to support innovation in services and sectors such as knowledge intensive business services (Kuusisto, 2012). Gaining impetus in the late 1990s, this has seen a sustained period of policy reflection in Europe and beyond. Academics have played an important role in undertaking policy research, and have been prominent members of policy forums established by organisations such as the OECD (2005) and the European Commission (Expert Group on Innovation in Services, 2007). Yet, despite this flurry of policy discourse, the practical implementation of new policies and policy instruments for innovation in services has been patchy. Indeed, the European Commission, itself, has recognised the challenges of implementing policy and instruments targeting innovation in services (European Commission, 2009).

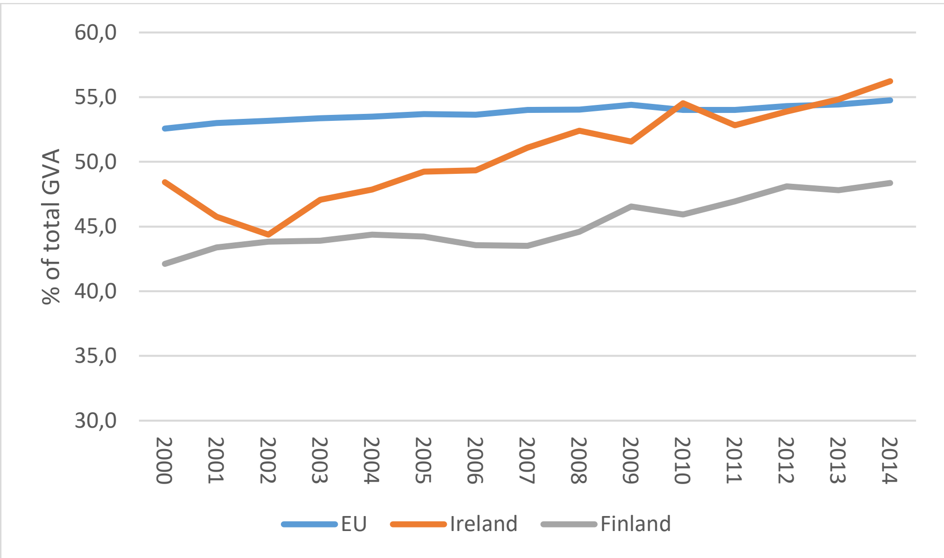
Drawing on case-study evidence, the research makes use of insights from public policy and innovation theories to explore the development of innovation in services policy in two countries – Finland and Ireland. Both have been at the forefront of policy development for innovation in services, and have sought to introduce new policy instruments. Based on interviews with policy makers, academics and documentary analysis the research examines how innovation in services policy ideas reached the policy agenda in each country, and subsequently progressed to implementation. Using the conceptual framework of the multiple streams approach (MSA), first developed by John Kingdon (1984/2003), it explores the role of *problems*, *politics*, and *policy* in the introduction of new policy ideas. This approach adopts the concept of a policy window, in which issues reach the policy agenda when policy entrepreneurs are able to join the separate streams of problems, politics and policies by mobilising enthusiasm, criticism or both (Baumgartner et al, 2006). This process, however, is characterised by ambiguity and constraints, and not all ideas will reach the policy agenda (Zahariadis, 2014). Such entrepreneurs can be policy makers within government, or individuals from the wider policy community, including academics, consultants, NGOs. Mintrom and Norman (2009) suggest that they are characterised by perceptiveness, clarity in defining a problem and team, and credibility. From this perspective, the development of new policy represents a process of trial and error learning, and one that is non-linear in character (Cairney, 2012). Following recent developments in MSA, the research recognises the potential for the strength and focus of the streams to evolve as policy solutions move towards implementation (Howlett et al., 2016).

In addition to MSA, the research draws on a second strand of theory – research on the nature and concepts of innovation in services. Miles (1993), for example, provides an overview of the characteristics of services, highlighting the intangibility of services, the close relationship between the producers and customer, and their perishability. Taken together, these factors imply that it is difficult to distinguish between production and delivery in the same way that is possible for a manufactured product. It can also present difficulties in determining what a service innovation is (Drejer, 2004), and measuring its output and effects (Djellal et al., 2013). The focus of this research is on innovation policy for market services (those that can be traded).

Results

Finland and Ireland are small countries, with populations of 5.5 million and 4.7 million respectively (Eurostat, 2016). Like many other countries the origins of innovation policy can be traced back to earlier science, technology and research policies. Both have faced economic challenges that have informed their broader policy responses to enterprise and innovation policy. Ireland, for example, was one of Europe's poorer economies for a large part of the post-war period. Its strategy of promoting inward investment, backed by skills development and favourable tax incentives, however, enabled it to become one of the fastest growing economies by the 1990s (O'Hearn, 2003). Policy makers in Ireland turned to innovation as a means of ensuring the continued development of the economy (Forfás, 2000). Finland, on the other hand, faced a particularly strong recession in the early 1990s, associated with the wider recessionary pressures and the end of the Soviet Union – a major trading partner. Innovation and technological development were identified as a key part of its strategy, resulting in rapid recovery, and R&D spending amongst the highest in Europe (Husso and Raento, 2002). In both countries, the contribution of services has grown in recent years.

Figure 1: Market services sector as a % of total Gross Value Added – 2000-2014



Source: Eurostat National Accounts (including GDP) database (nama_10_a10), Accessed 31st March 2017

The context for new policy approaches to innovation in services was the emergence of concepts such as regional and national systems of innovation, and a greater focus on innovation as an interactive process. These ideas challenged the linear model of innovation, and the pre-eminence of R&D and technology development. This broadening out the concept of innovation helped provide a supportive environment in which new policy thinking could emerge.

The research finds that the problem and policy streams were by far the most significant in understanding the emergence services policy ideas. Here, the identification of a problem – the lack of provision of support for innovation in services businesses - was largely driven by policy makers' interest

in developing new concepts in support of the emerging broader innovation agenda. This is not to say that policy makers did not respond to the wider trends of service sector growth, but that there was little evidence of over lobbying, or a wider 'national mood' evident (cf. politics stream). This is linked to the technical nature of the subject matter, and its niche position within the wider policy agenda. The findings do, however, highlight the role of policy entrepreneurs in helping to frame the new idea and align it to problems and potential solutions. In both countries the policy entrepreneurs were principally policy research and advisory officials (in Tekes – Finland's technology and innovation agency, and Forfás – Ireland's policy advisory body). These policy entrepreneurs were charged, in both country, with exploring a wide range of new policy ideas and ensuring that policy supported enterprise development. This role saw them develop a 'policy case' over several years, based on inputs from research and the wide policy communities of each country (and internationally). The policy entrepreneurs identified in both country shared the characteristics of persistence and commitment, in seeking to promote this new policy idea, within a context in which traditional technological innovation was still important. The outcome of the work of policy entrepreneurs was to raise the profile of innovation in services and introduce it in national strategic documents. In the case of Finland this resulted in strategic statements by the national Government (Lipponen II cabinet statement, quoted in Kuusisto and Kotala, 2004; p.12) and subsequent TEKES strategies. In Ireland, it led to the adoption of several policy statements (Forfás, 2008; DJEI, 2015).

While the work of policy entrepreneurs in Finland and Ireland helped to open a policy window for innovation in services, it was not sufficient to secure the implementation of innovation policy instruments. The key implementation agencies in both countries had significant discretion about how to implement the policy ideas in practice. As a consequence this required further development and feasibility testing by staff within the implementation agencies, thus introducing a new type of policy actor in both cases. The implementation phase took on a different form of confluence in which implementation came to dominate the policies stream. This did not mean that politics and problems had disappeared, rather they were not to the fore. While Finland was able to progress relatively smoothly to implementation of *Serve* (Tekes, n.d.) – a discrete programme supporting innovation in services, Ireland's initial policy development was limited by the financial crisis in 2007/08 to incorporating services eligibility into existing technological policy instruments. In the subsequent rebuilding of the Irish economy, however, innovation in services returned to the policy agenda, with the National Research Prioritisation Exercise (DJEI, 2012). Driven by a different rationale (smart specialisation) and personnel (primary business support agencies - Tekes, Enterprise Ireland, IDA Ireland and Science Foundation Ireland), this has led to current experimentation with policy instruments.

While experiments with 'demarcated' policy instruments were the initial goal of policy entrepreneurs in Finland and Ireland, the major focus of implementation in both countries has been one of integration within existing programmes. This owes more to an 'assimilation' approach, and reflects a process of mainstreaming of services across the innovation policy agenda. In Finland, the *Serve* programme was studied widely by other countries, without significant policy transfer. The final evaluation (Oosi et al., 2016), however, found that it had succeed in promoting new research in this area, and strengthening Finland as a centre of expertise in innovation in services. In contrast, the Irish policy instruments are in the early stages of implementation. Initial results, however, point to an unanticipated aspect of the policy challenge – namely lack of awareness and demand-side capacity. This seen limited numbers of successful applications for the service R&D grant funding established. While this may reflect the novel nature of the research topic in Ireland, it highlights the challenge of - 'technical feasibility' – that of stimulating both the supply and demand-side of policy for innovation in services.

Summary and conclusions

The research findings illustrate the important role of problems, policies and (to a lesser extent) politics in the development of innovation in services policy. While the experience of Finland and Ireland imply that a confluence of the multiple streams is important in creating a policy window, these streams are not necessarily distinct (particularly the problem and policies stream in these cases) and that the strength of the streams varies according to stage in the policy cycle. Policies (solutions), are

the predominant stream in the implementation stage in both cases, with politics and problems playing a much smaller role than in the earlier stages of policy development.

The research further points to the important role of policy entrepreneurs in helping to frame innovation in services and secure its position on the policy agenda. These individuals were initially senior members of the state (or semi-state in the case of Ireland) with responsibility for policy research and development. Unlike Kingdon's notion of the lone, calculating policy entrepreneur waiting for an opportunity to introduce their own idea, these individuals were tasked with exploring new policy ideas. Furthermore, while linked to individual staff roles, they were reliant on the support of senior staff, often at board level within organisations.

Finally the results give some confirmation to the messy and non-linear nature of new policy development. The processes described in these case studies have evolved over 10 years or more. In this time policy entrepreneurs and policy makers have come and gone, and rationales reshaped to fit the current narrative (e.g. prioritisation in Ireland). It also suggests that substantial ambiguity is still present in the policy development process in both countries, as reflected in Ireland's experimental approach towards implementation, and Finland's continued policy research into innovation in services options.

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1.4 Session 1.4

1.4.1 Evaluating the Impact of Convergence – Towards a Guidance Framework for Future Policy Assessment

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Keywords: technology assessment, policy assessment, convergence, new production revolution, social sciences and humanities, responsible research and innovation

Introduction

This paper describes the background motivation of the OECD Working Party on Biotechnology, Nanotechnology and Converging Technologies (BNCT) to develop and conduct a project on 'Harnessing Convergence for the Next Production Revolution'. The paper outlines the development of the BNCT approach for the impact assessment of emerging technologies and their policies.

Having commenced in January 2017, the BNCT project and the approach developed within it will undergo a proof-of-concept as part of the conduct of the two-year project. The oucomes of the project will be evaluated against the objectives of the project and the milestones of the approach.

Background

The concepts of 'Convergence' and the 'Next Production Revolution' (NPR) (AKA 4th Industrial Revolution, Industry 4.0, Next Generation Manufacturing) help signify a number of key technological developments with far-reaching social implications. These include the harnessing of machine learning algorithms for industrial production, the exploitation of bio-engineered resources and bio-inspired processes in large-scale industrial processes, and the co-ordination of increasingly complex activities across physical and digital systems. The advancement of the 'internet of things' (AKA cyber-physical systems (CPS)), the use of Big Data into diagnostic machine-learning algorithms, as well as the increasing use of behavioural and social data patterns in CPS (known as CPS2), for example, are likely to exert a deep influence on the patterns not just of production but of everyday life. The potential societal, economic and environmental impacts are recognised to be far reaching.

The OECD BNCT role in conducting analyses of national policies and inconvening discussions between national policy makers plays an important part in the preparation of governments for the advent of the convergence and NPR: as policies dedicated to fostering convergence and CPS2 proliferate, there is value in comparing frameworks used in different countries to ensure that sustainability, privacy and well-being (including economic well-being) are optimized.

Methodology - Policy Assessment of Emerging Technologies

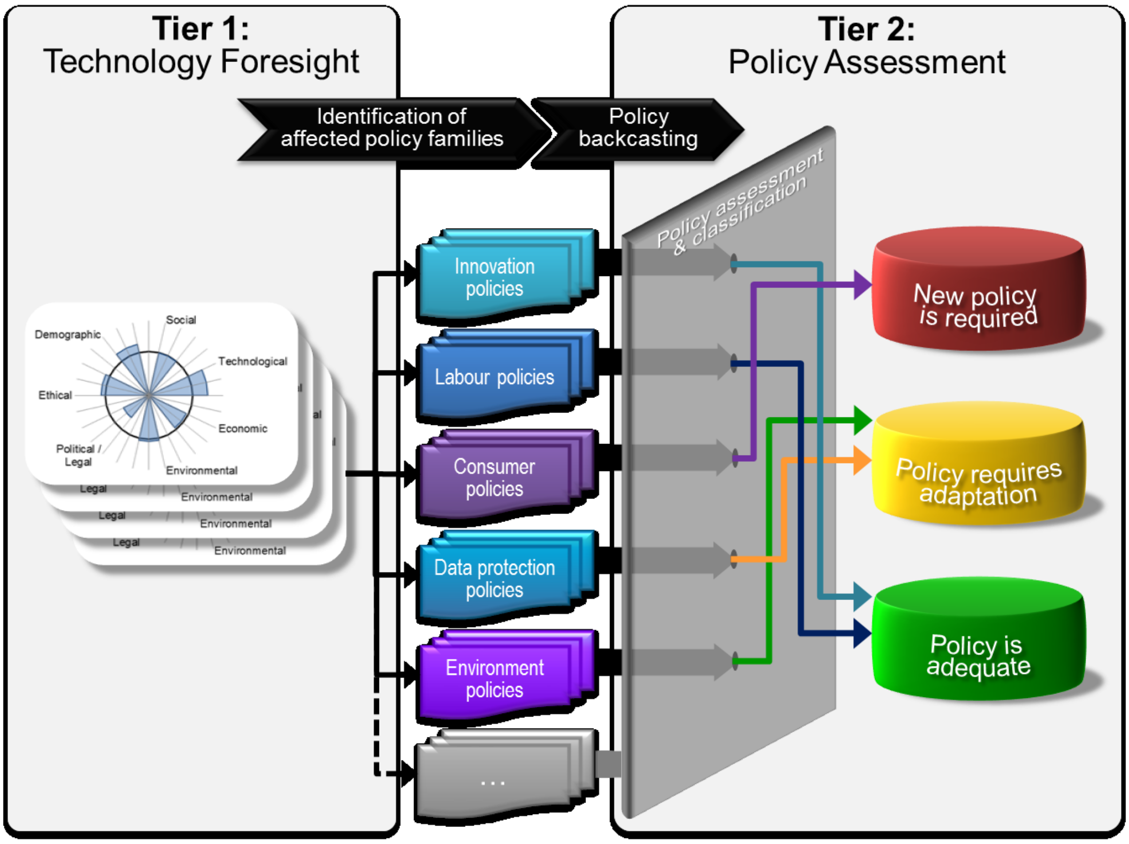
In its project on 'Harnessing Convergence for the Next Production Revolution', the OECD BNCT has now set out, in order to assess both the impact of technologies undergoing a convergence and the impact of policies affecting those technologies.

A two-Tier Approach for the Impact Assessment of Technologies and their Policies

In order to assess both the impact of technologies undergoing a convergence and the impact of policies affecting those technologies, a two-tier approach has been developed. In both tiers, the need for non- traditional approaches of assessment coming from the social sciences and humanities (SSH) and the concepts of responsible research and innovation (RRI) is given specific consideration.

Figure illustrates the overall structure of the BNCT two-tier approach for impact assessment of technologies and their policies.

Figure1. Illustration of the BNCT two-tier approach for the impact assessment of technologies and their policies.



(Source: authors'own creation)

Tier 1: This stage of the project is centred around **Project Workshop 1**, where a technology foresight exercise will be conducted, which combines elements of Technology Assessment (TA) (i.e. in particular the elements of "Scenario Workshops" and "Co-operative Discourse" (Decker and Ladikas, 2004), during which experts of humanities and social science will be asked to conduct critical reviews). This step follows the "Scientific Foresight" approach developed by the European Parliament Research Services (EPRS) (EPRS, 2015), in order to identify expected impacts of each one of the three concrete Technology Application Case -Studies, especially regarding, economic, social, environmental aspects.

Tier 2: This stage of the project is centred around **Project Workshop 2**, where a policy assessment will be conducted, based on the findings of Tier 1. The main policy families concerning the impacted sectors and stakeholder groups identified in Tier 1 are assessed with regard to their applicability to an increasingly complex and converging technology landscape. A detailed policy assessment is conducted on each one of the three technology cases, with a view to evaluating if a generic policy family is adequate, or if adaptations are likely to be required, or if a new policy needs to be developed, in order to cover the advent of convergence. In order to sufficiently illustrate the Case-Studies policies, specific jurisdictions may be selected.

The ultimate outcome of the assessment will be a guidance framework for a future policy assessment that is sufficiently flexible to accommodate rapid technological advances.

Conduct - Policy Assessment Tier 1: Technology Foresight

As a first step of the BNCT's approach for policy assessment of emerging technologies, a technology foresight is conducted, in order to identify those aspects that will be impacted by the technology in question, in order to subsequently ascertain the policies that are governing the relevant areas.

The technology foresight exercise proposed for this purpose builds on the "Scientific Foresight" approach developed by the European Parliament Research Services (EPRS) (EPRS, 2015). In order to include aspects of social sciences and humanities (SSH) and the concepts of responsible research and innovation (RRI), which are often missing in traditional assessment approaches, the exercise has been combined with elements of Technology Assessment (TA). In particular, this approach draws on the elements of "Scenario Workshops" and "Co-operative Discourse" (Decker and Ladikas, 2004), during which experts of humanities and social science will be asked to conduct critical reviews.

The methodologies of "Horizon Scanning" and "360° Envisioning", proposed by EPRS in 2015, have been further developed, in order to provide a comparative technology foresight exercise: the original guiding framework of STEEPED (Social – Technological – Economical – Environmental – Political/Legal – Ethical – Demographic) aspects has been detailed by a number of attributes assigned to each aspect. Table 1 lists the original descriptions and newly assigned attributes of the STEEPED aspects.

Table 1. Original description of STEEPED aspects (according to EPRS, 2015) and detailing attributes assigned to each aspect.

Description of STEEPED aspects	Attributes detailing each aspect
Social aspects cover changes in social and cultural values and lifestyles.	Inclusivity (intra-national) Inclusivity (inter-national) Network effect Privacy Social capital / community engagement Equality Behavioural changes Lifestyle
Technological aspects include how, and in which directions, technology is developing and the diversification of the use of techno-scientific devices.	Innovativity Problem-oriented Accessibility Single-use only (i.e. non-abusability) Efficacy
Economic aspects cover issues related to conjuncture, production systems, different distribution and trade systems, and consumption of goods and services.	Jobs / job creation Value creation Infrastructure independence Skills transferability Affordability Equality within countries

Description of STEEPED aspects	Attributes detailing each aspect
	Equality across nations
Environmental aspects embrace interactions with our natural habitat and our biophysical environment which is our planet. This category also includes the availability of natural resources.	Resource efficiency Energy efficiency Water efficiency Recyclability Product safety Process safety Environmental quality
Political/legal aspects describe developments or changes in various policy-making and legislative systems or forms of governance.	Market liberty Market coordination Competition Cooperation Democracy / collective choice Liability Individual rights
Ethical aspects cover individual preferences about the diverse values embedded in the broader society.	Autonomy / individual freedoms Access to technology Individuality (incl. disability) Distributive justice Respect for persons Respect for the environment Collective well-being
Demographic aspects entail various aspects of society, looking at the society as a collection of a varied set of social groups based upon parameters such as age, gender, religion, origin, profession, education, income level, etc.	Age Gender Origin / ethnicity Religion Education Profession (Dis)abilities Income level Skills

During the technology foresight exercise conducted at **Project Workshop 1**, experts will be asked to judge, whether an aspect attribute is likely to be impacted by a specific technology application in question, and, if so, whether the impact is likely to be positive or negative compared to the current status of the attribute.

Three concrete Technology Application Case-Studies

In order to allow focused discussions during thetechnology foresight exercise at **Project Workshop 1**, three concrete Technology Application Case-Studies have been selected and a detailed application scenario has been described for each one of them. These three concrete **Technology Application Case-Studies** have been chosen to cover different technology-readiness-levels (TRLs) from (a) starting to be deployed (high-TRL: 5-10 years), to (b) still undergoing tests but about to be widely applied (medium TRL: 10-15 years), to (c) technological feasible and widely deployable in the long term (low-TRL: >15 years):

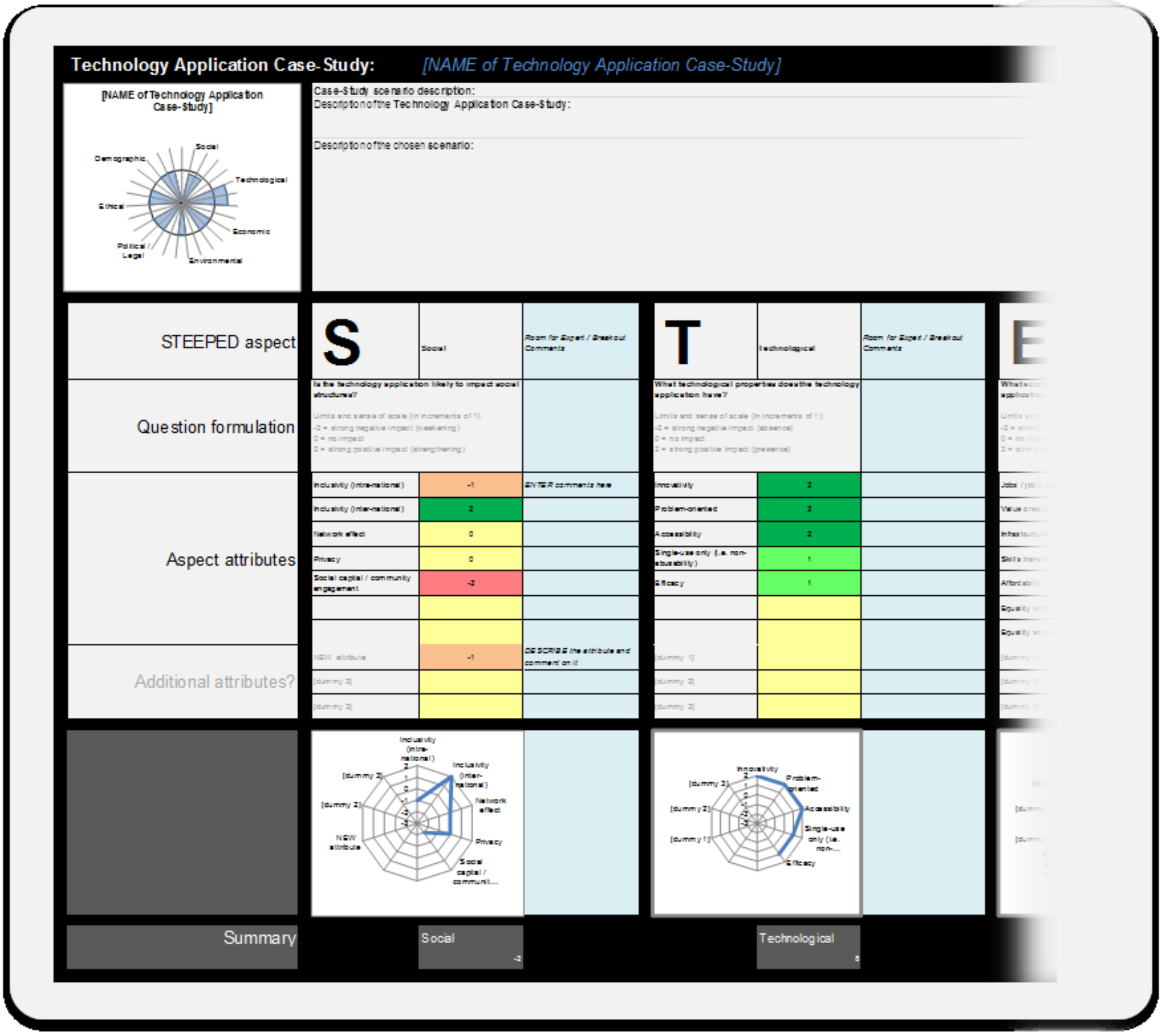
- **Robots in consumer-goods manufacturing** as a high TRL example of automation and robotics in the manufacturing environment) (e.g. sensors, autonomous systems, machine learning algorithms): these technologies are already widely used in industry, but they are also continuously advancing through technology convergence, and their applications are increasingly widened to new application areas of NPR),
- **Autonomous vehicles** as a medium TRL example of Cyber-Physical and Social Systems (CPS2) (e.g. a technology or service that is based on digital algorithms and that makes increasing use of individual data on behavioural and social patterns), and
- **Cyborgs** (i.e. human cogno-info implants) as a low TRL example of functional human-machine interfaces (e.g. personalised regenerative engineering, chip-implants, human enhancement, etc.).

Ahead of the workshop, each case-study will be prepared by the invited experts; each expert will be asked to complete a technology foresight matrix, which lists all STEEPED aspects and attributes, and allows the expert to assign a value between -2.0 and +2.0 (in step-sizes of 0.5) to each attribute, automatically generating radial ('spider net') diagrams for each aspect and a summary diagram for the entire Technology Application Case-Study.

This semi-quantitative approach to technology foresight allows workshop participants of varying backgrounds and expertise to discuss and compare their findings and opinions on the Case-Study during the scenario breakout group at the co-operative discourse workshop.

Figure below shows an excerpt of the technology foresight matrix, which all workshop experts are asked to complete for their assigned Technology Application Case-Study prior to the meeting, with a view to discuss and refine their findings and opinions during dedicated breaskout sessions at Project Workshop 1.

Figure 2. Excerpt of the technology foresight matrix. (NOTE the excerpt shown has been completed with an example case-study of '3D Organ Printing' (low TRL) for illustration purposes.)



Preparations of Tier 2: Draft Policy Identification and Initiation of the Policy Backcasting

In order to facilitate the transition from technology foresight to policy analysis, breakout-groups are asked to complete a 'Policy Identification Exercise', if all of the above tasks have been completed and breakout session time allows.

The exercise asks for a listing of those policies (or policy families) within the relevant STEEPED aspect that may be affected by the technology application case.

Experts are asked to enter a descriptive name of the policy (family) into the relevant cell, and to subsequently give a qualitative judgement (by choosing from a drop-down list in the yellow cells) (see below), if

- '**no action'** is required, because the policy is adequate to cover the implementation of the technology application case, or if
- policy '**adaptation**' is required, because the existing policy is not adequate to cover the implementation of the technology application case, or if

- the ‘**NEW development**’ of a policy is required, because the relevant STEEPED aspect or attribute is currently not covered by a policy.

Figure shows an example of the Policy Identification Exercise, which participants of Project Workshop 1 are asked to conduct (if breakout session time allows).

Figure 3. Excerpt of the policy identification exercise. (NOTE the excerpt shown has been completed with an example case-study of ‘3D Organ Printing’ (low TRL) for illustration purposes.)

Additional Task (if breakout session time allows): Policy Identification Exercise

Please list existing policies or policy families that may be affected by the Technology Application Case and indicate (by chosing the relevant quantification setting from a drop-down list in the yellow cells), if these policies are fit to cover the Technology Application Case, or if they need to be adapted. PLEASE ALSO indicate, if an entirely new policy is required.

Policy (family)	Quantification	potential comments	Policy (family)
privacy laws	adaptation	need to be widened to cover this new technology application	
community rights	adaptation	community rights need to be strengthened	
development policies	NEW development	development policies need to be created for this technology area	

Qualification
Policy (family) is adequate
Policy (family) needs to be adapted
NEW policy needs to be developed

(Source: authors’own creation)

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1.4.2 Framing STI policy in changing landscapes of science: a global perspective

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Keywords: STI policy for transformation, evolving systems, complexities and uncertainties, complexity-based approach, global perspective

In discussing the future of STI policy we should address the issue in terms of pluralities. This means that the new framing of STI policy has to be based on the interconnections/interplays of changes, including the changes in the geopolitics of science, related to the pluralities of contexts, contents and futures of STI policy at national, regional and global level. Traditional STI policy design principles and process have limited capabilities when applied to complex interrelated challenges. Integrated STI policies are needed in response to the interconnected problems. The future of STI policies is about making decision within ‘evolving systems’ and processes of continual change and evolution as well as interactions between knowledge, values, institutions, systems and people in the context of complexities and uncertainties.

We are at a turning point for a complexity-based approach, systems approaches to frame STI for a new global vision of the scientific endeavours and related science policies, based on interconnections, interfaces, participation, discussion, consultation, cooperation, and coordination of perspectives at national and global level. The challenge is how redefine the science policy agendas in a coherent way in order to ensure” no one is left behind” which means for the full benefit of all individuals but all countries.

How to respect national policy space for sustained, inclusive and sustainable economic growth, in particular for developing states, while remaining consistent with relevant international rules and commitments (Agenda 2030, the Sendai Framework for disaster risk reduction, the Addis Ababa Action Agenda, the Climate Change agreements)?

How to translate in action the universality principle embedded in the SDGs taking into account different national realities, capacities and levels of development and respecting national STI policies and priorities. The 2030 Agenda represents an opportunity and an obligation to change to way STI policies are designed.

The transformative dimension of the Agenda calls for different and disruptive approaches. Based on a more comprehensive vision of development, the implementation of the Agenda 2030 requires innovative integrated (overcoming the “silo” approach) STI policies, informed by solid evidence, that are transversal under the imperative of sustainability. Inclusive policy processes, based on new forms of participation and partnership and multilevel governance reforms will be needed A well-integrated and coherent STI policy design and implementation will require a solid framework of mechanisms and instruments to inform policy and ensure accountability. This will require intensified efforts to address the deficiencies that exist in many developing countries, particularly LDCs and SIDS. Data is critical to make the right decisions, develop adequate policies ensure their success, continuously review progress, and evaluate results and to draw lessons learned.

The 2030 Agenda for Sustainable Development underscored that data is key for effective policymaking and decision-making, as well as for reviewing progress towards the Sustainable Development Goals (SDGs) and for ensuring that no one is left behind. It called for ensuring that data is of high quality, accessible, timely, reliable and disaggregated. To better reflect the role of STI in achieving the 2030 Agenda, there is therefore a need for a fuller set of information than currently included in the core set of global SDG indicators. UNESCO, through the UNESCO Institute for Statistics (UIS), mandated to collect STI statistics and will lead the process to develop the thematic set of STI indicators for the SDGs. Such a thematic set would provide an integrated approach covering all aspects of STI, provide a means of advocacy for STI and raise its visibility, give information to policy makers on where to focus their efforts to achieve the SDGs, and point to areas where there is the greatest need for capacity building.

A thematic set of STI indicators for the SDGs should provide broader and more detailed information on the STI components of the SDGs and targets as well as on the STI commitments made in the Addis Ababa Action Agenda. This is in line with the commitment expressed in the the 2030 Agenda by all countries "support developing countries, particularly African countries, LDCs, SIDS and LDCs, in strengthening the capacity of national statistical offices and data systems to ensure access to high-quality, timely, reliable and disaggregated data". UNESCO is well positioned to contribute to the discussion about the future of STI by sharing/presenting its experience in science policy both at national and global levels. In fact, UNESCO contributes to the overall implementation of Sustainable Development Goals by providing policy assistance to support developing countries in strengthening their scientific and technological capacity, and to help Member States design effective policies, based on the best available knowledge, including local and indigenous knowledge systems.

At global level UNESCO, through the UNESCO Science Reports, provides a global comprehensive picture of the many facets of science in an increasingly complex world – including trends in innovation and mobility, issues relating to big data and the contribution of indigenous and local knowledge to addressing global challenges. Furthermore the Organization is part of the major STI global initiatives (UN Secretary-General's Scientific Advisory Board, Agenda 2030, United Nations Inter-agency Task Team leading the global Technology Facilitation Mechanism (TFM), etc). By virtue of its universal mandate, actions and competencies in STI policy, UNESCO may provide some insight in practically addressing the issues of "The Context, Content and Future of STI-Policy: Towards a New Framing" by providing the perspective from both developed and developing countries, particularly Africa and SIDS.

How to build a broad –based approach towards an effective and coherent governance of STI in Africa? What kind of policies and institutions have to be formulated for a better governance of STI in Africa, particularly with regard to the 2030 Agenda for sustainable development in Africa In conclusion, how to create new sources of dynamism in STI policy framing to catalyse positive transformation for the benefit of all and to find new solutions that are effective, just and inclusive, to eradicate poverty, to stimulate sustainable growth, to strengthen social cohesion? This is the fundamental questions that need to be addressed when discussing the future of STI policy.

1.4.3 Effective Country Adaptation to Threats/Challenges and Opportunities: A Strategic Innovation Policy & National and Government Strategy Perspective

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Keywords: CA-'Intertemporal' Country Adaptation or simply 'Country Adaptation; ONG-Overarching National Goal; N&GS-National and Government Strategy or National and Government Strategic Priorities; N&GS-"K" – Knowledge component of N&GS; N&GS-"I" - Implementation component of N&GS; NGOs-Non Governmental Organizations; SF-System Failure; SIP-Strategic Innovation Policy [SIP I-directed to 'market forces'; SIP II-directed to 'empowerment' of individuals and civil society; SIP III-directed to the Restructuring and/or Re-invention of Government (Structure and/or Operations) and/or the State; AI-Artificial Intelligence; BS-Business Sector; SMEs-Small and Medium Sized Enterprises; NIS-National Innovation System

Background

New threats & shocks (and Opportunities) in their Global and Domestic Environment increasingly pose significant Challenges for countries to adapt to. Examples are Disruptive Technologies (Christiansen 2002) such as Artificial Intelligence, Deep Learning, Robotics and 3D Printing with negative implications concerning continued Unemployment, Income Inequality (Picketty 2014, 2015), Inclusiveness & Social Resilience and even Personal Security; Climate Change; wars + new lethal weapons +Data Security/Cyber vulnerability; new health threats/challenges, "System Failures" derived from enhanced complexity of economic, social, political and legal systems and associated difficulties (both in ascertaining and applying adequate regulatory systems); weak & ineffective government systems due to 'short termism' and 'politics' or weak capabilities and/or out-of-date policy perspectives or misplaced 'objectives', etc.

The above Threats plus the enhanced importance of Radical/Type 2 Uncertainty (Taleb 2007) pose new strategic challenges which countries (and Governments) find difficult to adapt to i.e. the outcome being "weak CA".

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Country Adaptation (CA) and the CA System

Effective Country Adaptation to such (and other) changes is necessary and even key for the steady & sustainable well-being of its inhabitants. It involves *much more* than reasonable performance today in areas such as GDP/growth, Aggregate Investment, Inflation, Debt Reduction and Productivity; and is likely to be a much more complex affair than an effort which strongly focuses on Macro-Economic policies while underestimating the criticality of an evolving set of specific/structural investments and other 'Government actions' which are of 'strategic importance' for effectively confronting the above-mentioned Threats and Challenges in the short, medium and long term (including potential future reductions in GDB and citizen welfare)[3]. It follows that –over and beyond Macro-Economic objectives, a Country Adaptation approach should consider other Overarching National Goals (ONGs) [and associated Priorities/Priority areas] such as (or related to) *'Employment'*, *'Inclusiveness and Social Resilience'; 'A Flexible Government/Political System'* who supports *'Liberal Values' &'Justice for all Citizens'; 'Climate Change', 'Minimizing the impact of Floods & Draughts'* and *'Avoiding & Confronting Famine'; 'Avoiding/Dealing with New Conflicts and Data/Cyber Security'; 'Confronting New/Existing*

3 For an extreme example of investments and other actions directed to avoid such inter-temporal System Failures, see Finland's policies with respect to nuclear waste in "To the next ice age and beyond ", The Economist, April 15th, 2017]

Health Hazards', 'Updated Education and Training'; etc- some of which might not be easily measurable.

In the paper I refer to a CA function and a CA system and aspects of their links with 'Global Adaptation'. I argue here that effective "Country Adaptation" to Threats /Challenges/Opportunities should involve or should consider the following -

- Country Vision and a related set of *frequently inter-linked* Overarching National Goals (ONGs), which determine *the CA-function and CA System*;
- Such ONGs and their relative weights in the above function & system are likely to change when the country is confronted with new Threats/Challenges/Opportunities;
- Each ONG should be linked 'downstream' to one or more knowledge-intensive & policy relevant Strategic Priorities (belonging to an evolving set of N&GS);
- A Strategic Priority [whether 'National' or 'Government', and in contrast to a simplistic and not fully developed 'Nominal' Priority] is a Body of Knowledge involving Background, Narrative & Past Events, Forecasts & Future Scenarios; Links with other Strategic Priorities; the Implementation Profile (including key issues and decision points), and the associated Recommendations and 'General Policy Objectives' ; and,

for each Government Priority within the above set,

- 'Downstream' Policy Design and Implementation on the Ground by policy makers-- which should be consistent with the above-mentioned *General Policy Objectives* and *Implementation Profile* (a fact requiring close priority-policy coordination).

Throughout a distinction should be made between i) N&GS-"K" (the 'Knowledge Component' of a N&GS resulting from 'upstream' priority formulation or priority setting in what could be termed the country's 'Strategy and Policy' System, and the ii) N&GS-"I" (the 'downstream' priority 'Implementation Component' in terms of policies-including Strategic Innovation Policy(SIP)- on the ground').

Dynamic Sequence 1: Creation of a Simplified CA System[4]

Threats/Challenges/Opportunities-→ Identifying a relevant set of ONGs→

→Autonomous Formulation of a N&GS-"K" by priority setters →

General Policy Objectives (for each Government Strategic Priority)--→ -→

-→Priority-Policy Coordination + mutual feedback (Pri. Setters and Pol. Makers) →

-→(Specific Policy Design & Implementation on the Ground [N&GS-:I"]→

→Country Adaptation

The above sequence describes-in a very simplified way- 'creation' of a CA System in response to a particular set of new Threats/Challenges/Opportunities. A related sequence would describe the Stra-

4 For expositional reasons the Dynamic Sequence that follows ignores feedback effects and other non-linearities as well as the impact of 'exogenous' events such as new Threats/Opportunities (some of these will appear in the full paper). It also ignores the possible links with SIP as well as interactions with the political process (which also appear in the text).

tegic Re-orientation which follows important New Threats/Challenges/Opportunities (actual or expected/forecasted), the outcome being a 'modified' CA system. It is likely that both (but especially the former) require at least a measure of 'Re-invention of Government'.

Close interaction and coordination between (autonomous) priority setters on the one hand and policy makers on the other; as well as good inter-Ministerial coordination --are key both for creation of a N&GS and for any 'Strategic Re-Orientation'. Moreover, creation of a N&GS and its implementation on the ground require Government to re-invent itself (similarly with significant 'Strategic Re-Orientation' situations triggered by important changes in the set of Threats/Opportunities). While a 'Flexible Political System' would be an asset it should be complemented by another ONG entitled "A Strategic and Entrepreneurial Government (and/or State)" [5]. Implementing such re-orientation 'on the ground' might require an important set of new and coordinated policies e.g. Strategic Innovation Policy (SIP) and new patterns of 'policy interconnectedness'.

Priority-Related System Failures (SFs)

From the perspective of this paper, Venezuela and Argentina might be examples of significant CA-related System Failures[6] the outcome both of 'failed policies' (which to some extent did not respond to the requirements for effective Country Adaptation in the presence of new Threats/Challenges/Opportunities) and from weaknesses in their social, economic, and political systems.[7] Other countries including some in Europe might also have experienced CA-related System Failures. A System Failure in Israel relates to its political un-willingness to significantly improve and extend Education and Training (especially to and for the poor who represent a high proportion of overall population by OECD standards). Another is its failed response to new opportunities for achieving peace (see among others the seminal articles in Israel's 'prime' newspaper, 'Haaretz' during 2014 & 2015, by the-or one of the-leading political scientists of that country, Professor Y. Dror).

This paper will focus on-and provide between ten and twenty examples of- 'priority-related' ['Strategic']System Failures spanning a number of countries and areas.

Note that this paper's view of System Failures derives from policy systems which—due to 'politics', non-awareness of the new requirements for policy making, 'corruption' or 'rigidities in the Government/Political Systems'--are not 'strategic' or 'strategic enough' (see N&GS-"K" and N&GS-"I" mentioned above). One aspect of such a deficiency is not seriously considering (i) Inter-Priority links ('upstream in the country's 'Strategy and Policy System') *nor* ii) 'policy' inter-connectedness patterns and links ('downstream' in such a System).

This paper also argues that frequently, an important component of a 'friendly' CA system is a shift to Strategic Innovation Policy (SIP).

Policy Inter-connectedness and its contribution to Country Adaptation

Searching for and implementing effective policy inter-connectedness patterns may be critical nowadays e.g. as part of the response to the growing Unemployment resulting (or which may in the future result from) AI, outsourcing, and other factors such as changes in the competitive advantages of key industries or sectors. Over and beyond traditional policies such as wage flexibility and lowering the cost of employing and firing workers [and some Vocational Training, which is not always sufficiently

5 This links with a key ONG related to the Entrepreneurial State of the literature (Mazzucato 2012, Bonvillian several articles). This paper's approach is that the Government and State must be both Strategic and Entrepreneurial, especially in periods characterized by frequent & violent changes in the Threats/Challenges and Opportunities facing the country concerned. Moreover, and related to this, I also contend that Strategic Innovation Policy (SIP) could play important roles (both 'direct' and 'indirect') in the above processes e.g. by reducing the risks of CA-unfriendly 'political fragmentation.

6 At least in relation to the general conceptual framework of this paper and even from the point of view of the 'specifics' of Dynamic Sequences 1 and 2.

7 Other countries or 'countries in the making' which seem to be in or close to a Valley of Death (which-due to Path Dependence, may be very difficult to overcome), will be mentioned in the main text of the paper (not that such a Valley of Death may be the outcome of continued non CA behavior).

updated], a 'policy inter-connectedness' view will also consider other policies which overall enhance 'Inclusiveness and Social Resilience' including through positive impacts on Employment. Thus side by side with policies which directly focus on creating new jobs, other indirect impacts may result from continuously updated 'Vocational Training Policies', 'Industrial & Innovation Policies' directed to upgrade existing (or create new) sectors/industries; enlightened 'support of SMEs and entrepreneurship'; 'Pre-school learning and improved Educational methods' (including personalized learning and adaptation to different ethnicities), etc. And last but not least, 'Empowerment of the less fortunate members of society', including the poor and immigrants (SIP II). Needless to say their success might contribute to creating the political conditions for the continuation of CA policies in the future.

A key issue is the political feasibility, willingness and capacity of Governments to undertake the CA policies mentioned above (as well as others that have not been mentioned) such as policies associated with 'Health', 'Housing', 'Personal Security,'etc.

SIP II deals with 'innovative' & integrated provision of Government Services (preferably without intermediaries) in numerous areas such as Health, Education, Subsidies/Loans & Advice, etc. Such services would be specifically directed to a variety of different socio/economic/ethnic groups including Immigrants (where their *easy & integrated* access could-in certain circumstances-make such services more effective from an immigrant absorption point of view). Their CA role may also be indirect since--by dealing with Unemployment and thereby contribution to avoiding the 'Political Fragmentation' that may follow new shocks/threats it might set the base both for continued Strategic Re-Orientation and for the steady implementation of CA friendly policies.

More on Strategic Innovation Policy (SIP)[8]

Over and beyond Traditional Innovation Policy which focuses on supporting 'technological innovation' undertaken largely by and for market forces in the presence of Market Failure[9], Strategic Innovation Policy also supports 'social/services' innovations by and/or for other agents (including individuals & civil society organizations such as NGOs) directed to empower the less fortunate members of society(SIP II) as well as Strategy & Policy/services innovations –including organizational and institutional innovations--by and/or for public sector agents or organizations including the Government itself (SIP III).

A small sample of Types of innovation and Areas supported by SIPII and SIP III follows:

(i) 'Creating the Institutional and organizational underpinnings for an autonomous, knowledge-intensive process of setting National and Government Priorities by newly formed entities without (or with minor) 'political interference (including likely "Strategic Re-Orientations" dictated by new Threats/Challenges/Opportunities)'(Type);
(ii) Innovation support directed to facility the process of priority setting as well as identification of patterns of inter-priority links (Area);
(iii) Innovations in Management, Organization and Institutional set-ups both of/for firms & market forces & for Government entities such as Secretariats/Ministries/ Policy Agencies (Area);
(iv) Enhanced access, enrichment and overall coordination of Government services tailored & directed to individuals & socio-economic/ethnic groups as well as to civil society organizations(Area)
(v) Promoting Visualization, 'Qualitative' Pattern identification, Super-forecasting (see Tetlock and Gardner 2015) and Scenario Building & analysis of alternative futures (Type);

8 I focus on SIP II and SIP III only, since these seemed to have been least 'recognized' by what could be termed 'Traditional Innovation Policy".

9 While Market Failure was typically associated with business R&D there were other technology-related functionalities associated with MF such as engineering, design and startup of new process equipment

(vi) Techniques and procedures for 'robust' policymaking under conditions of strong and even Radical/Type 2 uncertainty, see Lempert 2013 (Type) (Area); etc
(vii) Innovations supporting Focused Search, Identification, Classification and Updating of inter-priority links and policy inter-connectedness patterns (Area); etc.

Most if not all the 'Social/Services' innovation types are either non-physical or the non-physical part is key. They include e.g. information, various types of "routines" (see Nelson and Winter 1982), and Algorithms & Software among others. These and other innovative 'technologies/techniques' underlying SIP and SIP Types could (or might increasingly) rely on Big Data, Artificial Intelligence(AI), Deep Learning, Neural Networks, Augmented Reality, etc.

Note that a very important user of SIP would be the Government who would be 'providing (through SIP II) & 'receiving' (through SIP III) innovative services' in the context of Re-inventing itself with the aim of enhancing its role in continued CA (SIP III).

Dynamic sequence 2 which follows complements Dynamic Sequence I by focusing on the possible roles of SIP II and SIP III on effective CA.

Dynamic Sequence 2: Impacts of SIP II and SIP III on CA/Strategic Re-Orientation[10]

New Threats/Challenges-→SIP II→"Improved CA-friendly Political Conditions"

*SIP III *: Institutional & Organizational Changes →SIP III a→*

→N & GS-"K" ('Strategic Re-orientation -knowledge component) →

*-→ SIP III **: Institutional & Organizational Changes-→ SIP III b*

Inter-connected 'Downstream' Policies (& associated organizational and institutional changes)

→ Continued CA

Symbols

SIP III *- Innovative Support of Institutional and other Pre-Conditions ['autonomy' in setting most stragic priorities without political interference)for a continuously updated N&GS;

SIP III a- Innovative Support of 'Knowledge Creation' in upstream Strategy formulation;

SIP III **- Innovative Support of changes in the institutional, organizational & behavioral underpinnings of the policy formulation and implementation process;

SIP III b- Innovative support of Policy Implementation on the ground

10 Future work will enrich the type and impacts associated with Dynamic Sequences 1 and 2 by considering feedbacks, exogenous changes and calendar time.

Final Remarks

This paper focuses on the notion of *Sustainable* Country *Adaptation (CA)* to a continuously changing set of new Threats/Challenges and Opportunities facing it *and* on its response in terms of the 'upstream' and 'downstream' components of its 'Strategy and Policy System'. The 'upstream' component comprises a National & Government Strategy (N&GS, or set of National and Government Strategic Priorities, each one involving a continuously updated *Body of Knowledge);* and a 'downstream' policy making on the ground component. Each Government Strategic Priority includes a *General Policy Recommendation* which policy makers must in principle comply with when formulating their *Specific Policy Design and Implementation* on the ground.

Further work will make explicit the nature of the CA function and of a broader CA system (which will also link each ONG of the function to the specific Threats/Challenges and Opportunities facing the country).

Over and beyond the enhancement of Traditional Innovation Policy (SIP I), Strategic Innovation Policy (SIP) includes two important components-SIP II and SIP III. Both play very important roles in the dynamics of CA as reflected in Dynamic Sequences 1 and 2. SIP II deals with *Empowerment* – through the provision of sophisticated, integrated and personalized *services* directed to the less fortunate members of society; while SIP III-supports innovations concerning the institutional, organizational and managerial aspects underpinning both *Creation* of a N&GS and *Strategic Re-Orientation* (of an existing N&GS) *and* 'downstream policy making on the ground.

The paper emphasizes the importance of avoiding political fragmentation when confronted with new Shocks/Threats and the emergence of CA-un-friendly Governments. Otherwise they risk entering a Valley of Death which could make it very difficult 'to get out of' (Note that sustainable CA involves much more the focusing on Macro-Economic policies).

Future work will incorporate feedback effects, learning and exogenous events into existing Dynamic Sequences; while also presenting new sequences (maybe by incorporating different types of System Failures originating both on new Threats/Challenges and on weak domestic responses).

The paper includes both a relatively extensive analysis of what a National and Government Strategy is all about and a number of additional Dynamic Sequences (future work will be more specific in creating –through an analysis of feedbacks, etc-a number of 'stylized' Dynamic Sequences -each one adapted to a particular country type). Together with future work, it will also summarize and justify the 'qualitative orientation' of the methodology utilized, particularly for situations where the global system is undergoing a process of 'Paradigmatic Change'. I will also speculate how, in these troubled times, the paper's framework of analysis might be useful to individual countries searching for new approaches to strategy and policy making. Presumably there may also be some implications for Global Adaptation.

1.4.4 Do scientists know best? Limitations and opportunities for STI policies to shape cross-border research collaborations in Europe

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Keywords: STI policies, international research collaboration, Self-organization of scientific community, European research policy, EU Framework programme projects

International research collaboration is one of traditional and increasingly important forms for organization of research and production and knowledge. While scientists have already for centuries exchanged information and interacted across borders in networks known as 'invisible colleges' (Wagner, 2008), today international research collaboration is intensifying. One of typical indicators of international research collaboration, namely international co-authorships have increased from 10% of the Web of Science articles in 1990 to 25% in 2011 (Wagner, Park and Leydesdorff, 2015). A number of reasons internal and external to science are usually invoked to explain growth of international research collaboration including increasing specialization of science, escalating costs of equipment, development of information and communication technologies, and need to address cross-border challenges.

Support for international research collaboration has also been on agenda of international organizations, European Union institutions, national governments, and private foundations that see international research collaboration as one of the ways to address so called Grand Challenges, i.e. major socio-economic problems in areas such as energy, health and environment (Ulnicane, 2016). However, a message emerging from some of the main contributions to (international) research collaboration studies is quite sceptical about the role of public policy. A number of key authors on this topic (Engels and Ruschenburg, 2008; Melin, 2000; Wagner, 2008; Wagner and Leydesdorff, 2005) suggest that successful research collaborations result from self-organization of scientists who know best with whom to collaborate and how to organize their collaborations, while public policy play a limited or even counter-productive role facilitating emergence of 'artificial networks' lacking coherence and ability to produce high quality research.

Against this background, this paper analyses long-term international collaborations in nano S&T in Europe to study, firstly, if and what role do public policy play in shaping these collaborations and, secondly, how does self-organization of scientists and role of public policy interact in these collaborations. The seven international research collaborations studied have lasted for more than 10 and some even 20 years and have included informal collaboration outside common externally funded projects as well as a number of common projects funded either by bilateral or diverse European funding schemes (FET, Marie Curie training networks, European Science Foundation projects, etc).

The seven longitudinal case studies integrate multiple data sources including publication, project, organizational and CV data, interviews with 61 collaborating scientists and site visits to 31 leading nano S&T institutes in Germany, Netherlands, France, Belgium and United Kingdom (Ulnicane, 2015). Data collection in particular focused on continuity and change in long-term collaborations, namely if and how externally funded projects within these collaborations influence choice of topics, partners and forms of interaction. A specific method of individual research trails was used to study continuity and change of topics of collaborating scientists. Individual research trails (Glaser and Laudel, 2015) study bibliographic coupling (understood as common references) among publications of a scientist; combined with analysis of acknowledgments in these publications, it allows to analyse if a new externally funded project leads to a change of research topic.

Evidence from the case studies suggests that in successful long-term collaborations self-organization of collaborating scientists and influence of policy are not always conflicting forces in tension with one

other but often reinforcing processes. Strong self-organization dynamics typically explain emergence of collaboration when core partners decide to start common research as a result of initial interaction during research visits, conferences, etc. Then very quickly self-organization begin to interact with policy when key collaborators choose which policy scheme they are going to apply for common externally funded projects that best fit their research agendas and strategies. Requirements of different funding schemes for international collaboration (e.g. different schemes supported by the EU Framework Programmes) vary considerably in terms of aims, thematic guidance, type of research, partners and forms of interaction, as well as size of projects supported. While previous studies have suggested that specific requirements of funding programmes might lead to counter-productive 'artificial collaborations', evidence in this study indicates that key collaborators very carefully choose among diverse funding schemes to find the one that would provide the best opportunities to do exactly kind of research that they want to do – for some networks that mean applying for a funding scheme supporting applied research on a pre-defined topic they have collaborated before, while for other scientists it mean applying for a research training network scheme allowing to do fundamental research on a topic of their own choice. Although collaborators might find some funding scheme requirements – on interdisciplinarity, heterogeneous partners, and accountability – challenging, they also appreciate long-term benefits of learning about other disciplines and extending their networks. Moreover, self-organization can also have problematic side when it facilitates narrow networks where inclusion/exclusion is based on gender and national stereotypes, which policy attempts to counter-act.

The proposed topic on relationship between the role of policy and self-organization in international research collaboration is highly relevant for the topic of the conference 'The future of STI – The future of STI policy. New practices and models of research and innovation as a challenge for STI policy'. As international research collaboration is increasing and as STI policies are increasingly concerned with supporting research tackling cross-border social and economic challenges, it is important to understand not only opportunities for future STI policies but also their limitations and interactions with other processes such as self-organization of the research community that can be an important factor for success of policies. This paper takes an innovative approach to study the role of STI policies because it does not start with a specific funding scheme and then assess its affects but it rather starts with successful international collaborations lasting over 10 and 20 years and leading to diverse scientific outcomes and outputs and then carefully traces if and how policies – in particular funding schemes – have influenced these collaborations. The paper uses a number of innovative methods such as longitudinal case studies and individual research trails of collaborating scientists to do that. It provides important lessons on the role of self-organization and bottom-up processes for success of STI funding schemes which are particularly relevant in times when policy-makers prioritize top-down initiatives as the main way to support research tackling societal challenges.

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2 Track 2: The Impact of STI-Policies on the Organization of Research and Production of Knowledge

Track 2 was organized by Siri Brorstad Borlaug (R-QUEST and NIFU Nordic Institute for Studies in Innovation, Research and Education) and Merle L. Jacob (Department of Business Administration, School of Economics and Management, Lund University) and included five Sessions.

This session is devoted to understanding how new developments in the governance of science, technology and innovation create impacts at the level of the organization and production of knowledge. The combined effect of EU and national funding practices have led to a significant number of changes at the level of how research is organized and conducted in individual European member states (e.g. Edler et al. 2012; Nedeva 2013). Previously an intensely national effort, STI policies have been incrementally nudged towards a common set of objectives and practices. While debate rages on the degree of isomorphism created by the multi-level governance initiatives that characterize policymaking in the EU member states, the last ten years have witnessed a change in the direction of coordination to include coordination of the systems for governance in and of themselves. This is evidenced in among other things, the increased focus on collaborative priority setting in STI policy and the introduction of joint programming at the EU and national levels.

Further examination of different national efforts in key areas such as funding instruments and evaluation practices would however reveal that the curtain of sameness often disguises significant differences at the level of implementation, reception by target communities and policy design (Lepori, B. 2011; Borlaug 2015; Whitley 2003). Noteworthy examples of areas where these effects may be observed include the popularity of Centre of Excellence initiatives and the overriding policy consensus that grand societal challenges constitute the appropriate priority setting mechanism for all member states. Likewise, the frequency with which member states ape the European Research Council's Starting and Advanced Investigator Awards suggests that the rhetoric of path breaking research is also a key element in the increasing convergence of policy instruments. Other areas may be indicators for performance-based funding, which have attracted a great deal of attention both from scholars and stakeholders, but the impact of which is nevertheless under explored (Gläser and Laudel, 2016; Aagaard and Schneider, 2015).

The session seeks to attract papers which will enhance our knowledge on the impact of STI policies on the organization and production of knowledge. This session invites conceptual and empirical papers that focus, on among other things, the impact of funding structures and the distribution of funding on the strategic capabilities of public research organizations and research performance; the role of collaborative governance initiatives; changes in the governance of funding streams and new models of research and innovation, e.g. stronger involvement of social actors, responsible research and interdisciplinary research. We invite papers on questions such as:

- In what ways may policies for excellence affect the strategic capabilities of public research organizations?
- How do different funding structures and streams impact the production of scientific knowledge?
- How do collaborative governance initiatives and the inclusion of other social stakeholders impact the organization of research and research content?
- What is the role of governance in promoting new fields of research and innovation?

Several scholars have examined questions similar to the above using neo institutional or rational choice frameworks. There is also a significant number of historical studies which provide rich material for using the past to provide more fine-grained understanding and analyses of the effects of different governance initiatives on the evolution of national research systems. We welcome papers based on all types of research methodologies and theoretical frameworks as diversity is an important prerequisite for furthering the frontier of knowledge.

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2.1 Session 2.1

2.1.1 Competition for large research grants – impact on universities' strategies and strategic capabilities

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Keywords: Universities, strategic capabilities, large funding schemes

1. Background and relevance

This paper investigates universities' strategies and strategic capabilities in the process of supporting and obtaining large research grants. The latter decades have seen an increase in large funding schemes, such as Centres of Excellence, with the purpose of concentrating resources on to the best research groups and to contribute to a structural change in the universities and the broader (national) research landscape (OECD, 2014; Langfeldt et al. 2013). While research on large funding schemes has contributed to enhance our knowledge on how such grants may affect researchers' behaviours (Bloch et al., 2014; Laudel & Gläser, 2014), the issue of how and to what extent universities adapt to these policies remains relatively underexplored.

We seek to illuminate the demands posed on the universities in the competition for large grants, and their strategies in responding to these, through a study of the Swiss scheme for National Centres of Competence in Research (NCCR). This is a key funding scheme for long-term collaborative efforts for cutting-edge research in Switzerland, expected to have substantial structural effects on the research at the home institutions and the Swiss research landscape. The centres are selected based on open calls for proposals and an extensive review process. Four calls for NCCR proposals have been issued by the Swiss National Science Foundation (SNSF) since the start (1999).

2. Theoretical framework and research questions

Universities are increasingly subjected to demanding performance requirements, broadening functions/missions and efficiency pressures, and they have to compete nationally and internationally against each other for prestige, resources and staff (Edler et al. 2014). As a consequence, many universities (and other PROs) attempt to manage research activities – through supporting effective research portfolios, and establish structures and processes that are attractive for excellent researchers of all career stages. The cumulative effects of changes – in amongst others financing and policy, and increased globalisation and competition – have thus mitigated the role of the universities and their strategic capabilities (Berman and Paradeise, 2016).

Studies of impact of large funding grants on universities argue that, while they provide prestige, reputation and money and as such being attractive to the universities, the grants do not enhance organisational capabilities as they bind up resources, strengthen fields of research that might not have been built within the strategic planning of the university and as such reduce universities strategic capabilities (Edler et al. 2014). In the same vain, some argue that the declining role of institutional funding and conversely the increase in external funding has posed a shift in the authority relation from the research organisation's top management to the research group leader. Less dependence on institutional funding could mean that the research organisations lose their ability to influence research groups top-down (Verbree et al. 2015; Whitley & Gläser, 2014). This poses challenges for university managers.

In the paper, we address these challenges and tension by asking: What are universities' strategies in obtaining large research grants and how do they adapt to the demands of these funding schemes?

To investigate this further we apply resource dependency theory (RDT) as analytical frameworks. The key elements of RDT are the organisation's capability to make strategic choices and the adaptive capability to ensure a sufficient flow of resources to the organisation (Pfeffer & Salancik 1978).

3. Methods and empirical material:

The paper builds upon a study of the selection of NCCR grants, including the requirements, review criteria and demands of the schemes, and the applicants' and universities' response to these criteria, requirements and demands (Langfeldt and Borlaug 2016). The data include documentation of the funding scheme's requirements and selection process (Terms of Reference, guidelines and procedure descriptions, application and review data) from the two last NCCR calls, a survey to the applicants participating in these two calls, interviews institutional leaders at selected universities which had applied (potential home institutions of NCCRs) and interviews with selected applicants and other stakeholders (funding agency representatives and reviewers).

The interviews with the potential home institutions included questions on their strategies for the internal pre-selection of applicants and their views on the requirements and selection criteria of the NCCR scheme. Leaders at five of the 11 universities which participated in the last call for NCCR proposals were interviewed. The survey to the applicants (potential NCCR directors) addressed their university's pre-selection process as well as a number of questions on their experiences with the application and selection process organised by the SNSF. In total 58 of the 113 applicants in the two last calls filled in the questionnaire (51% response rate). In addition to their survey response, five respondents took part in individual interviews elaborating their replies.

The aims and demands of the NCCR scheme:

The NCCR are prestigious and large both in terms of funding (3-5 million CHF per year over a 12 year-period) and in size as the centres involve different research partners with one "host institution". Although the scheme offers a large grant, it also requires considerable co-funding and entails large expectations to the contribution from the host institution. Moreover, a main goal of the schemes is to enable structural change at the home institutions, facilitating interdisciplinarity/new approaches and concentration of efforts. The combination of large co-funding and structural change, imply that the potential home institutions are expected to take actively part in the selection process. Both for the pre-proposals and the full proposals the applicants need a letter from their home institutions pledging support thought the 12 year period in terms of personnel, funding and implementation of necessary structural measures. The home institutions may initiate and encourage ideas for NCCRs, organise internal preselection of the pre-proposals to be submitted to the SNSF, as well as screening for the full proposal stage. Hence, the applicants are reliant upon support of their home institutions in order to succeed in the competition for the grant, implying an inherent tension in the scheme as the process is supposed to be bottom-up and research driven.

In selecting the proposals to support, and in formulating their support letters, the home institutions need to take into consideration a broad range of NCCR selection criteria in order to enhance the chances of obtaining these large grants. In addition to the scientific aspects of the proposals, the NCCR call lists a broad set of structural criteria for the SNSF's assessment of the proposals: the significance of the topic for Swiss research, goals with respect to knowledge and technology transfer, the advancement of young researchers and women, the budget and the suitability and support of the home institution. Moreover, another aspect of the NCCR selection process may entail tensions and concealed priorities within the universities: as part of the selection process, the funding agency and state secretariat has a formal meeting with each of the applicant institutions, in which the results of the pre-proposal stage are explained and questions regarding the university's commitments are discussed. In these meetings the institutional leadership participates, whereas the applicants/potential NCCR directors are not invited.

4. Preliminary findings

Our preliminary findings suggest that the small universities have an explicit and transparent strategy for selecting and supporting NCCR applications. The large universities, on the other hand, seem to apply a more implicit strategy in the sense that all may apply, but that the universities express their support to specific grants in their direct communication with the SNSF, or more indirectly in differentiating formulations in the support letters for their different proposals. This has obviously some negative effects. Concealed priorities (as well as explicit ones) create frustrations and tensions within the universities. With concealed priorities also comes the loss of time spent on preparing applications that are not given priority by the university.

Furthermore, the universities commit resources and support in the application process, sometimes without knowing if the resources will be realised, as this depends upon the opinion and support of other stakeholders such as the university board or the cantonal authorities. They also have different risk strategies: Some support more proposals than they can afford in terms of co-funding, calculating that not all proposal will be successful. Others only support the number they can afford.

The different strategies will be discussed from a resource dependency perspective.

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2.1.2 Varieties of Science Systems

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Keywords: convergence, science, globalization, specialization, portfolio analysis

Introduction

It is generally accepted that the production and accumulation of knowledge is central to innovation and economic performance (Arrow, 1962; Asheim et al., 2006). The potential for new knowledge development is increasing rapidly. The stock of available scientific knowledge is growing, there are many more researchers and engineers, in more locations around the world than ever before, and much more money is spent on research (UNESCO, 2010). Furthermore, existing scientific developments apply positive feedback to knowledge production since successful knowledge resulting from one stage of evolutionary progress can potentially be used to create the next stage (Arthur, 2007). Moreover, codified information is more easily transferable across geographical space through the Internet, digital databases, scientific journals, international conferences, mobility of researchers and through foreign direct investment by multinational corporations (David & Foray, 2002; Heimeriks & Vasileiadou, 2008). New opportunities for increasingly complex knowledge developments are opening up based on this expanding global stock of knowledge.

Nevertheless, knowledge production and accumulation remain very unevenly distributed over countries (Florida, 2005), and many countries struggle to replicate the levels of productivity and innovativeness in knowledge production achieved in leading regions (Heimeriks & Balland, 2015). Catching up of lagging countries is determined by their ability to absorb ideas and knowledge from the research frontier, which requires a long-term learning perspective. Policies in which governments intervene in the allocation of resources among fields of research can help lagging regions to learn. Learning may be more marked in some fields than in others, and the benefits of that learning, including the institutional development required for success, may spill over to other activities (Arrow, 1962; Stiglitz, 1999). While it is obvious for governments to invest in knowledge production (OECD, 1998), it can be difficult for policymakers to provide the right institutional settings for a range of leading-edge science and technology fields, especially in regions that are not at the forefront of any specific field. Convergence among countries is anything but automatic. It is conditional on specific policies and institutional arrangements that have proved hard to identify and implement. Indeed, the recipes seem to vary from context to context (Tödtling & Trippl, 2005). Consequently, there is no uniform relationship between research and macroeconomic productivity growth (Van Elk, Verspagen, Ter Weel, Van der Wiel, & Wouterse, 2015). There do appear to be country-specific effects, which suggests that institutional arrangements and policy have an effect on the relative performance of countries.

Science operates in a wide variety of national institutional settings. The lack of convergence toward a single type of science system gives rise to a number of challenging questions: What are the different kinds of science systems that exist around the world today? Why has convergence not occurred, and what explains the contemporary variation in the ability of countries to create economic growth and address societal challenges that crucially depend on new knowledge? Where do ‘good’ institutions come from?

The variety of science systems remains underexplored. The weak performance of European science in the upper tail of scientific quality, in fast moving scientific fields, and in new fields that follow a proliferation pattern of growth, or divergent search regime requires a dynamic comparative analysis of deep institutional features of scientific systems (Bonaccorsi & Thoma, 2007).

In this paper, we address the changing patterns of global science with respect to geography and fields. We examine to what extent the globalisation of science is accompanied by convergence in the level and structure of scientific output. Our contribution is both theoretical and empirical. Theoretically, we develop a framework for understanding how different institutions enable and constrain the ability to produce new knowledge among countries and fields. Empirically, we use time series publication data from Scopus to investigate these patterns. The results will show under which conditions knowledge developments fail or succeed. In a broader context, this research will help uncover the institutions underlying knowledge-intensive societies and economies and provide insights in the policy options for successfully expanding the knowledgebase of countries.

Background Theory

From a geographical perspective, many view science as an outstanding example of globalisation. The dynamics of scientific research is global in nature (Heimeriks & Boschma, 2012). Science has become a global community in which researchers produce for a worldwide commons. There remain vast differences in S&T performance among the world's nations. Studies in economic geography show that regions and countries tend to expand into research activities that are closely related to their existing capabilities (Cohen & Levinthal, 1990). Knowledge production results from locally available skills, tacit knowledge, resources and infrastructures that both enable and constrain the local evolution of knowledge. Knowledge production is therefore subject to place dependencies (Boschma, 2005; Heimeriks & Boschma, 2014).

Countries differ in composition, as well as in quantity of knowledge production. Furthermore, they also vary in the complexity of their knowledge base. Some countries are capable of contributing to a wide range of fields (Nomaler, Frenken, & Heimeriks, 2014). Others are esoteric, producing idiosyncratic knowledge that few other regions can make. In analogy with the production of goods (Hausmann and Hidalgo, 2009; Hidalgo et al., 2007), it can be expected that sophisticated countries are capable of contributing to complex topics that few other countries can develop.

From the perspective of different fields the patterns of change are also very diverse. The amount of scientific and technological knowledge keeps growing rapidly (Alkemade, Heimeriks, Schoen, Villard, & Laurens, 2015; Bornmann & Mutz, 2015). However, codified knowledge developments are very unevenly distributed among topics and their aggregates in fields. Since 1970 new knowledge has been primarily develop in a limited number of fields having to do with entertainment, communications and the collection and processing of information. Researchers in science and technology studies (STS) and information science argue that the evolution of codified knowledge is characterised by a path-dependent process of branching; new knowledge is developed from recombinations of existing knowledge. The existing body of codified knowledge thus enables and constrains the production of new knowledge. Knowledge production is therefore subject to path dependencies (Arthur, 2007).

Fields of knowledge develop in widely different ways (Whitley, 2000). Fields differ in the extent to which the codified body of knowledge is accumulative or divergent (Bonaccorsi, 2008) and differ in the importance of learning processes, the socialisation of experience, task uncertainty and the recombination of available information (Heimeriks, Van den Besselaar, & Frenken, 2008; Malerba & Orsenigo, 1996; Whitley, 2000). Moreover, some fields and topics are much more related to other fields and topics than others. These highly related fields have the potential to extend the research front of many other fields, and provide more than average opportunity for diversification. This is a vital issue because it determines the ability to accumulate new knowledge.

Bonaccorsi (2008) further shows that the dynamics of different sciences, in particular of new sciences born in twentieth century and developed after the Second World War (information science,

materials science, life science) thrive in specific institutional contexts, most prominently in the USA. Recognition of the role of the development of technological knowledge opens the door to seeing a wide range of institutions that can co-evolve with new technologies and fields of research.

Data and Methods

In this paper, we examine if the globalisation of science is accompanied by convergence in the level and structure of scientific output. Extending previous work by (Horlings & Van Den Besselaar, 2013), we use Scopus data (from www.scimagojr.com) on the volume and citation impact of scientific output of c. 200 countries between 1996 and 2015, distinguished by subject category.

Results

We find evidence of convergence in levels of scientific output, particularly after 2000. The per capita scientific output of smaller countries grows faster than that of larger countries. In addition, all countries show a decrease in the overall degree of specialisation. The scientific output of nations may follow a common growth trajectory, but there is no common development trajectory for science portfolios.

Additional analysis is expected to show different types of growth patterns. Furthermore, we expect to see that growth is concentrated in specific fields.

Figure 1. Field-normalised citation scores of national output for 237 countries and dependencies in Scopus, 2013-2015 (USA=1)

Source: Scimago Journal Ranking (www.scimagojr.com)
Note: Citations per citable document, excluding self-citations.

Policy implications and Conclusion

From a policy perspective, it has been long recognised that governments have an important role in promoting knowledge production. However, they do not know how different countries can reap the benefits of new knowledge developments in a knowledge-based and globalizing economy. It becomes a pressing issue what country- and field specific strategies are available for governments to capture the economic benefits of new knowledge developments and to address new societal developments. The results of this study will open up new lines of research in understanding the geographical and field specific possibilities of knowledge production and innovation. This can help policy makers to make decisions tailored to specific institutional arrangements in relation to different regions and fields. Within Europe, our findings may support the development of the European Research Area.

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2.1.3 The Change Quadrant: National Research Evaluation Systems and the Core of the University

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Keywords: Research evaluation systems, Universities, Science policy, United Kingdom, Research Excellence Framework (REF)

"Does science policy change science?" is a question that has been asked in various different contexts. Naturally, the answers vary depending on the analytical framework that has been applied. However analysis inevitably suffers from methodological issues around identifying and measuring change, and attributing it back to a specific science policy.

In this paper we experiment with an alternative framework to tackle this question which, we believe, bypasses the most acute issues with the study of policy impact and change of the public science system.

The framework we propose draws on two dimensions of the interactions between science policy, implementation and public research organizations. First, we explore the level of alignment between the 'ideology' of the science policy and the 'ideology' of the public research organization subjected to the policy. Second, we look at the level of efficiency of the implementation mechanisms of the policy.

Taking these two dimensions into account produces a matrix of the following possibilities in terms of change: 1. Ideology overlap and efficient implementation, leading to no change; 2. Ideology overlap and inefficient implementation, also leading to no change; 3. Ideology distance and inefficient implementation, leading to unpredictable change effects; and 4. Ideology distance and efficient implementation – a case we refer to as 'the change quadrant'.

In this paper we apply this ideology/implementation policy impact framework to analyze the effects of a specific national research evaluation system – the UK's Research Excellence Framework (REF) framework – on UK universities. For this we will use existing analysis and other empirical data.

2.1.4 Framing Global Competition in Higher Education: The Shanghai Ranking and its Impact

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Keywords: Innovation governance, Academic ranking of world universities (ARWU), Global university ranking, Measuring performance

The first Academic Ranking of World Universities (ARWU) or Shanghai ranking came out in 2003. It was an innovation, intended to measure the performance of the best universities in the world. In this paper, I will explore the criteria that the Shanghai ranking set and the forms global competition have taken in higher education since its inception. Its impact has been twofold. First, the Shanghai ranking gave the starting shot for a global competition between universities. Today, this competition is taken for granted. Second, it defined the rules that this competition would follow: quantification of excellence, focus on universities, on the hard sciences, and on English-language production. Ruled out were qualitative evaluation, research institutions, the soft sciences, and non-English language scientific production. These criteria have had a powerful impact on innovation governance, the strategies of universities to cope in an increasingly interconnected and competitive world, the global ranking industry of academic performance, national strategic goal setting and funding decisions, the criteria of self-evaluation of academics, etc.

2.2 Session 2.2

2.2.1 The effect of excellence funding on academic research practices: comparing 16 Dutch research groups

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Keywords: Excellence funding, Research practices, Excellence policies

In the last 25 years academic research in The Netherlands has seen a rise of excellence oriented research policy instruments. These excellence funding schemes aim to selectively support high-performing and high-potential individuals or organizations, in order to increase differentiation within the science system. The Netherlands is not the only western country that has witnessed a rise of excellence funding instruments. Almost all OECD countries have implemented policies to foster research excellence (OECD 2014). In Scandinavian countries excellent collaborating groups of researchers are funded in Centers of Excellence. In Germany, the Exzellenzinitiative was introduced as new funding scheme for the best universities, research clusters and research schools. At the European level the European Research Council (ERC) has implemented several excellence grants since 2007.

So far, scholars have identified a number of effects of excellence policies at the institutional level or the science system level (Langfeldt et al. 2015; Borlaug 2015), or have focused on the effects of one specific policy instrument (European Research Council 2012). However, there is limited understanding of the effects of combined excellence policies on the organization and production of knowledge at group level. This paper aims to fill that gap. It builds on our previous analysis of the influence of excellence policies on excellent groups (Hessels et al. 2016), i.e. groups that have accumulated excellence funding. In this paper we complement this analysis with an analysis of the effects of excellence policies on research groups that have not acquired excellence funding, and it deepens our understanding of the effects of excellence policies considerably.

Excellence policies are affecting research within academic institutions. Academic careers are increasingly dependent on a researcher's success in the excellence funding schemes (Van Arensbergen 2014). The tendency to quantify the notion of excellence has led to research evaluation practices based on criteria such as the number of published articles, the journal impact factor, the number of citations and the amount of grants received (O'Connor & O'Hagan 2015)). Furthermore, the temporal character of excellence funding favors a project based organization of performing research, and research institutions adjust their allocation models to stimulate researchers to attract external funding (Koier et al. 2016). The authors of the EURECIA-report on the effects of the ERC conclude that the grant scheme has impact on the research of a grantee, on the symbolic capital and the career (European Research Council 2012).

Scholars have expressed a number of concerns about the fundamental ideas underlying the excellence policies, i.e. creating differentiation in the science system through competition and selection. They argue that excellence policies may create a system where the 'winner takes all', that the focus on competition may hinder cooperation (Müller 2014), or that the quality of education and broader impact recede into the background (Stilgoe 2014).

In our paper we focus on the practices of researchers and research groups and we analyze the interplay between excellence funding and institutional policies on the one hand and academic research practices on the other. More specifically we explore the consequences of excellence policies for a broad range of research groups: from those that have gathered a number of excellence grants and prizes, to those that lack this type of finance at all. Further, we study the effects of excellence policies and excellence funding on the relationships between research groups and their institutional context. Finally, we explore the influence of excellence funding on epistemic choices of researchers.

We conceptualise the research practices of research groups in terms of the 'credibility cycle' as introduced by Latour and Woolgar (1986). This quasi-economic model explains the behavior of individual scientists by their need for credibility. We translate this model to the group level and explore the effects of excellence funding on the incentives and rewards structuring the work of an academic research group. The original credibility cycle is concerned with gaining credit within a community of peers. We add an institutional aspect since multiple elements of the cycle (recognition, money, staff and equipment) can also be influenced by the research institution of a research group.

We performed an analysis of sixteen research groups at Dutch academic institutions. Four of these research groups were identified as 'excellent'. They have shown the ability to collect large amounts of excellence funding from governmental funding bodies on the basis of their 'excellent' reputation and high-quality research proposals. We studied the four excellent research groups in detail by carrying out approximately ten interviews per group supplemented by a document analysis (self-evaluations, policy documents, financial accounts, etc.). The results of the four excellent research groups are then compared to interviews with twelve group leaders of 'non-excellent research groups', again supplemented by a document analysis. Non-excellent groups are, in this paper, defined as groups that have not collected (large amounts of) excellence funding, regardless of the reasons for this situation and regardless of their academic quality.

The sixteen cases were selected, in addition to their status as 'excellent' or 'non-excellent', by using two dimensions: the degree of strategic task uncertainty (Whitley, 1984) and the degree of collaboration. We expect these dimensions to influence the interplay between excellence funding and academic research practices. For every resulting quadrant we selected four cases: one excellent research group and three non-excellent research groups. This enabled us to make a systematic comparison between research groups within each quadrant.

We observe that the concept of excellence and the excellence policies are ever present in the research practices of both excellent and non-excellent groups. Every group needs to relate to and take part in the 'game' for excellence and excellence funding. Some non-excellent groups are connected to excellence policies only through the institutional pressure they feel to (reluctantly) take part in the competition for excellence funding. Some excellent groups, on the other hand, associate strongly with the excellence policy. Other groups are positioned somewhere in between. We have seen no group that could operate completely isolated from the excellence policies.

Furthermore, excellent groups experience more autonomy than their non-excellent counterparts in deciding on their staff, their budget and research topics. The non-excellent groups have less leverage in the negotiations with their organizational superiors. The external recognition that comes with obtaining excellence funds is important for internal (institutional) recognition and autonomy.

We further observe an epistemic relation between types of funding and research practices. Since the room for funding research questions through direct block funding is strongly diminished, external

funding is a necessary condition to start new research projects. Of all available external funding options, the excellence funding schemes tend to give the grantees the most space to follow their own research interests. Other external (non-excellence) funding possibilities are more restraining in terms of deliverables, accountability, social relevance and arrangements with (international) consortia. This may explain why non-excellent groups feel more restrained in their choice of research topics and adjust their research agenda to diverse funding organizations, whereas excellent groups experience more autonomy to set their own agenda.

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2.2.2 The European Research Area, scientific mobility and research careers

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A key initiative designed to reorganize research and innovation (R&I) in Europe is the European Research Area (ERA). Based in the Lisbon Treaty, the ERA promotes very deep and broad goals, including improving national science and technology (S&T) bases, enhancing regional and national competitiveness, and advancing the coordination of Member States (MS) in addressing grand societal challenges. Whilst based on the Internal Market, the ERA should also be open to the world, particularly in relation to multidimensional flows of knowledge, technology and human resources. Progress toward implementation of this European level policy initiative is largely the responsibility of national governments, exposing tensions between the objectives of frictionless cooperation and harmonization and the divergent realities of national institutional and regulatory contexts.

The conceptualization of the ERA (European Commission 2000) included 'more abundant and more mobile human resources' as one of its foundational aspects. Four core elements of the European-level organization of human resources for science and technology (HRST) were identified: greater mobility of researchers in Europe; a European dimension of science careers; greater place for and role of women in R&I; and stimulating the attractiveness of research careers among the young. While mobility was acknowledged to already be having a substantial impact on research training, improved knowledge and technology transfer, more inter-sectoral mobility of researchers, and the smoothing of administrative procedures and regulatory barriers were described as achievable objectives of the ERA. Opening up national recruitment and evaluation processes to European candidates was seen as essential to facilitate these objectives. Raising the horizontal and vertical participation of women in R&I, including via improving the overall taste for research careers of young people through better science learning and education strategies for school students, are objectives that should both enlarge and diversify the HRST talent pool.

This paper focuses on the implementation of the ERA across the first three of these four aspects. In particular, it focuses on the interrelationships between ERA and national policy frames, researcher mobility, and scientific careers. The paper starts by reviewing progress to date in the implementation of the ERA with a focus on the priority 'an open labour market for researchers' but also with attention to significantly overlapping priorities such as gender equality and open science (European Commission 2012, 2017). A number of key initiatives are described and discussed, including variation in the uptake of EURAXESS services in different national systems, grant portability, and the introduction of a European level pension fund for research (RESAVER). ERA implementation is compared across MS for these aspects. Intersecting policies such as the Scientific Visa package and the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers (European Commission 2005) are also introduced.

The paper then turns its attention to research on scientific mobility. "Scientific mobility" is defined by Mahroum (2000, p. 367) as "cross-border physical and geographic movement that comprises a stay in another country of no less than one year." Mahroum argues that such scientific mobility "goes through channels of institutions that enjoy a high reputation for excellence and expertise" (2000, p. 367). We adopt Mahroum's definition, but without the temporal limitation, as the role of short-term mobility has also been shown to be important in some disciplines and disproportionately for women (Cañibano et al. 2011; Jöns 2011). Studies of scientific mobility have highlighted its contribution to

building trans-national networks that sustain productive international collaborations (Woolley et al 2008) and to accessing key postdoctoral labour market entry points (Melin 2004). Stephan and colleagues (2014) examine the factors contributing to decisions to do postgraduate studies abroad. The most highly rated factors are scientific factors (benefit career, faculty, prestige, networks, infrastructure and funds), whilst non-scientific factors (lifestyle, life quality, family, fringe benefits) are less highly rated. The decision to do PhDs and Postdocs abroad are often linked to a desire to establish a research career in the destination country subsequent to training. Franzoni and colleagues (2013) found that migrant scientists who had been mobile for work or study outperformed their domestic colleagues, suggesting a productivity dividend for mobility that may benefit careers. However, another study of researcher mobility, productivity and tenure in Spain found there was no return to careers from mobility – at least in terms of rate of progress to achieving a tenured position (Cruz-Castro and Sanz-Menendez 2010). There is also wide variation in the academic labour market rules, hiring and career development approaches that impact on the degree and character of mobility into different national systems (Stephan (2008), Fitzenberger & Schulze (2013), Lissoni et al. (2011)).

However, recent reviews of mobility and globally networked science (Flanagan 2013; Jacob & Meek 2013) highlight the still fragmented nature of research on scientific mobility and the flow-on uncertainty of the policy terrain. The mixed, fragmented and mainly snap-shot research evidence that is available on scientific mobility limits its usefulness in relation to policy development (Flanagan 2013). It also makes it more difficult to evaluate the impact of existing policies and specific policy reforms outside of very general arguments about facilitating knowledge diffusion and networking. We argue that one important gap in the existing scholarship is the failure to create systematic linkages between scientific mobility and models of research careers. Whilst studies of scientific mobility often consider how it contributes to the development of research careers, this research tends to lack an overall framework of research careers to deepen understanding of this crucial connection. To try and fill this gap the European Commission established the MORE series of studies (IDEA Consult 2013), which link mobility to a model of career stages (European Commission 2011). Whilst these studies have produced some useful empirical evidence (Børing et al. 2013), a more comprehensive understanding of how mobility fits into, and functions within, existing models of science research careers is required.

The third section of the paper makes a step toward addressing this problem by reviewing available models of research careers. The aim of this review is to enable us to answer the research question: how does scientific mobility function in specific models of research careers? Addressing this question will then allow us to view mobility policies and incentives, such as those supporting the ERA, with a more systematic understanding of their potential effects not just on organizing mobility but on the organization and structuring of research careers. The three models reviewed are those developed by Grit Laudel and Jochen Gläser (Gläser 2001; Laudel & Gläser 2008), by Paula Stephan and colleagues (Stephan et al. 2014; Stephan and Levin 2001), and by Barry Bozeman and colleagues (Bozeman & Corley 2004; Bozeman et al. 2001; Bozeman & Gaugan 2007; Dietz & Bozeman 2005). Each of these models has different disciplinary characteristics and privileges certain assumptions about individuals, institutions and organizations. The section compares these three models in terms of how they define research careers, understand career progress and frame empirical investigations. A comparison is then made of how scientific mobility functions within each of these models.

The final Discussion section of the paper draws together the elements of the previous sections. It proposes a series of general principles for policy-making regarding researcher mobility and research careers derived from the conceptual models reviewed. The current mobility policies supporting the ERA are considered in light of these proposed principles. The paper contends that future efforts to organize R&I in Europe should systematically link scientific mobility and research careers in policy development processes. Better alignment between ERA and national level policies may eventuate from embedding this approach to policy development. Such an approach can pay dividends for the organization of knowledge production, not least by reducing the loss or under-deployment of highly skilled human capital at different stages of (career) development, due to spatially, institutionally or administratively produced mismatches between the supply of, and demand for, specialized knowledge and capability in specific R&I contexts. The paper ends with an outline of a future research agenda and how this can better serve future policy development.

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2.2.3 Constituting research quality and public research organisations: Some individual and organizational tensions in the UK

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Introduction

Discussions around the nature of 'research quality' and how malleable it is to research policy, funding, strategy and other interventions have become prominent in academic literature in the past few years (e.g. Aagaard 2015, Langfeldt et al 2015). Studies have been carried out to explore 'research quality' in the contexts of, for instance, effective research evaluation designs and practices, the performance of national and trans-national research funding arrangements, roles for research governance and management, and the quality of national research systems in the face of global competition and collaboration dynamics (e.g. Glaser et al 2016).

Research quality as a notion has been increasingly regarded in academic debate not as some objective parameter of scientific research results or outputs, but as a normative and value-laden concept. The way quality of research is defined can instead vary across scientific fields depending on the characteristics of the empirical study matter and types of knowledge produced (Nelson, 2016). In addition, the way 'excellent' quality research is defined and promoted has been incresingly affected by external pressures from outside simply the academic community (Watermeyer and Olssen, 2016)

The extent to which organisational and institutional actors have an impact on notions of research quality has also not been sufficiently recognised. Some work recognizes the shaping influence of, for instance the 'mission orientation' of science (Kuhlman and Rip 2014) or the impact of various sources and conditions of research funding on the resultant epistemic properties of knowledge produced (Laudel and Glaser 2014).

Examination of notions of 'research quality' has variously been used as an entry point to achieve a more nuanced understanding of the social and intellectual conditions of research, or to provide definitions (indicators, metrics) of 'excellent' quality research. In this paper we will instead focus on generative mechanisms through which notions of research quality are negotiated and how they are dynamically constituted in a number of organisational environments. We call these environments 'sites' where research quality notions are constituted by various actors.

We will also outline specific tensions at these 'sites' where research quality notions are constituted within the public science system. We propose that values, attitudes, practices and interests of stakeholders, such as academics, university managers, policymakers and funding agencies regarding notions around research quality clash in these sites. Compromises are negotiated to alleviate these

tensions. We use the concepts of interacting 'research fields' and 'research spaces' to explain why and how these tensions emerge in the constitution of research quality notions.

In this paper we specifically focus on dynamic tensions resulting from interactions about notions of 'research quality' at two particular 'sites', namely individual academic researchers and research-related organizational elites in administration, management and strategy roles within public research organisations (universities and research institutes). To illustrate some of these tensions, we use examples from UK universities, set in the context of the UK's panel peer review-based, performance-based funding system, the Research Excellence Framework (REF).

Research quality, research fields and research spaces

The tradition of defining research quality is long-standing and has involved contributions from authors such as Michael Polanyi, who outlined standards of scientific merit concerned with plausibility, scientific value and originality of knowledge claims (Polanyi 1962). The established research tradition on valuing science mostly looked at how research quality is assessed in a collegial manner via peer reviews and the accumulation of reputation within meritocratic communities (Whitley 2000; Gulbrandsen 2000). Criteria of merit considered in these studies relate to the significance of knowledge claims, use of sound methodologies, originality, and conformity with dominant parsadigms and with societal values (Bazeley 2010; Lamont 2009; Lee 2015).

Additionally literature has been noted that research quality assessed 'internally' by academic communities may differ from external assessements by administrative constituencies within public research organisations, external research funders and governments (Hammarfelt and De Rijcke 2015). However, such literature would appear to have limited power in explaining why, despite the apparent clarity of the criteria, research quality notions can be so dynamic, local and organisation-dependent. We therefore use the concepts of intersecting 'research fields' and 'research spaces' to explain such inherent variances in judgements around rearch quality.

We take 'research fields' to be the 'reputational units of research work organisation which reward innovative contributions to collective intellectual goals; control material rewards through public reputations; combine collegiality with competition; and direct research to achieving intellectual influence' (Whitley 2000, p.34). They feature knowledge communities hosted in particular research organisations, and converge around consistent bodies of knowledge, and interact by exchanging information and knowledge (Knorr-Cetina 1999, Crane 1972). Research fields have knowledge networks that integrate around trans-organizational and (typically) trans-national 'cyrstallising agents' (journals, conferences, research equipment and facilities, and research training) and (re)produce 'research quality' notions concerning research topic selection (problems, methods etc.) and complex processes for legitimation of knowledge (Lukkonen and Nedeva 2010).

'Research spaces' are where essential relationships and exchanges play out between state/government organizations, research active charities and foundations, research-related industry and commerce organizations, on the one hand, and research-performing organizations. Here the key exchange is generally 'funding for knowledge', as embodied in science artefacts (articles, books, reports, datasets, equipmentfacilities, methods, new materials) or scientists themselves (capacity, competencies). This 'funding for knowledge' is also framed around notions of the 'utility' of knowledge, typically defined by the politically most powerful actor in the 'research space'. These 'utility notions' can include the desired social and/or economic 'impact' of produced knowledge (e.g. utility for quality of life, utility for wealth creation), the desired immediacy of this impact (e.g. short-term within current political cycles), and so forth.

Over the past few decades in European and many OECD countries there has been a gradual, cumulative shift from notions of 'research quality' being predominantly constituted in 'research fields' to them also becoming constituted in 'research spaces'. Notions around the usefulness and validity of research have also tended to differ in research fields and research spaces. Tensions therefore arise in the constitution of research quality notions when the two encounter interact at certain 'sites' or key

points where the ‘research space’ element of the science system interacts with the ‘research field’ element of the science system (Nedeva 2013).

Five sites to constitute research quality notions

Taking into account this fields/spaces composition of the public science system leads us to five ‘sites’ that we propose are key in complex interactions leading to constituting notions of research quality:

- Individual researchers (whether organized alone or in groups of various kinds) and their research work content;
- Public research organizations (PROs, such as universities, research institutes, that bridge ‘research spaces’ and ‘research fields’, and host academic researchers);
- Knowledge communities (visible as knowledge networks in the ‘research field’);
- Research funding agencies (RFAs, and related intermediaries in the ‘research space’); and
- High policy/political levels (typically from the national ‘research space’).

We recognise that these five sites will perform different roles, and may often have unequal status in constituting notions of research quality. Tensions over research quality notions at each site will also depend on the ‘research field’ in question, as well as on nation-specific arrangements to the ‘research space’.

Research quality tensions at two key sites

Located at the intersection of ‘research spaces’ and ‘research fields’, research organizations, such as universities, are a particular point where research quality notions coming from the research space (policy and funding agencies) and notions from the ‘research field’ are very likely to collide.

The tensions over the constitution of notions of research quality indicate instances where the ‘research space’ and the ‘research field’ are likely misaligned. In this section, we use two examples from the UK university system, and its Research Excellence Framework exercise, to illustrate these tensions (refer to Table 1 for a summary).

Table 1 An overview of some sites, tensions and research quality constitutions

Site	Tension	Research quality constitutions
Individual researchers	Research quality defined by host university as publication in a narrow set of ‘high-ranked’ journals VS epistemic expectations of academic’s research field	Game-playing: Saturated targeting of high-ranked journals
		Game-playing: Strategic citing of authors already published in high-ranked journals
		Game-playing: Changes to research topic selection, methods selection, conference attendance selection etc.
		Career strategy: Satisfy research quality notions of the ‘research space’ versus those of the ‘research field’ (if they differ)
Research organizations	Expectation from RFAs for university to improve the research quality of its research environment	Game-playing: Short-term acquisition of research academic ‘stars’ instead of long-term development of existing academics
		Research strategy: University administration elites use journal rankings as a proxy for research quality that can be ‘managed’

Source: Authors.

The ‘university’ as a site to constitute research quality

We take the specific case of the UK and its relatively long-standing, periodic Research Excellence Framework (REF) as an instance where research quality notions have differed between individuals and groups of academics within universities, and research-related adminsitrators and managers within universities (see Watermeyer and Olssen 2016, Mingers and Willmott 2013, Nedeva et al 2012, Nedeva and Boden 2006).

One intended aim of the UK’s successive REFs (and predecessor Research Assessment Exercises, RAEs) has been to encourage universities in the long-term to create research environments to enable their hosted academics to perform at the highest levels – i.e. producing published research ‘[q]uality that is world-leading in terms of originality, significance and rigour’ (Mingers and Willmott 2013, p.1058). However in some instances (e.g. see Nedeva and Boden 2006) instead universities have chosen a ‘short cut’ of buying-in ‘star’ academics from other UK universities or from overseas (Nedeva et al 2012). This head-hunting, transfer market university strategy (Elton 2000) represents a short-term constitution of ‘research quality’ – a way to ‘beat the system’. In other words it shows a tension regarding the long-term constitution of research quality.

‘Individual researchers’ as a site

Another example relates to controversies around the use of journal ranking lists as a proxy for ‘research quality’ by universities in internal evaluation practices, and by external panels (Nedeva et al 2012, Watermeyer and Olssen 2016, Mingers and Willmott 2013; see also Sauder and Espeland 2009). There is an underlying tension here between the university notion of research quality as ‘published in a high-ranked journal’ and the individual academic notion of research quality perhaps of being recognized for their intellectual contributions in their knowledge community, say for pioneering new theories, methods, data, materials and so forth. This is essentially a tension between the academic’s organizational career and their career in their ‘research field’ (or between their organizational career and their and their knowledge community career, in the language of Glaser and Laudel 2015).

The university’s desire to achieve high places in ranking lists by increasing its researchers’ publication activity in highly rated publication outlets creates tensions with academic’ individual research strategies and desire to converse with their peers in relevant outlets, especially when research fields are interdisciplinary or emerging, and cutting-edge research may not (yet) be recognised by mainstream publication outlets that tend to have higher ‘impact factors’.

This tension can be resolved in multiple ways. First, if universities mobilize their performance monitoring and evaluation machinery – for example anchored to such processes as probation, mentoring and promotions – to an expectation for academics to publish in high-ranked journals then academics may pursue individual game-playing by submitting all their outputs to such journals, in the hope that something gets through. Second, academics may pursue individual game-playing by citing authors already in high-ranked journals as a way to prove their outputs are of sufficient quality to win a home in these journals.

Third, being expected to publish primarily – or only – in particular journals may also (negatively) affect an academic’s research topic selection, methods selection, and conference attendance selection. Such influences on topic selection may affect the novelty and originality of the research academics produce (see Luukkonen and Thomas 2016).

Discussion of examples

In the examples above, academics are essentially in a state of dynamic tension in being expected to choose – through their research content development and research publication behaviours – between notions of research quality from the research space, as constituted by how their host university translates these expectations around them, and perhaps quite different notions of research quality from their research field with corresponding rewards and penalties for both.

How this tension plays out for the career of the academic is likely to be specific to particular research fields. It is also likely to be affected by the mechanisms in place within universities whereby administrative and managerial elites in the university to exercise power. These can include mechanisms for 'rationalization', such as internal strategies for 'discrimination, selection, and the efficient allocation of resources' and tools for 'credentialization' to police these strategies (e.g. internal peer review quality ranking and score systems) whereby 'quality is measured by those with power to define the terms' (Sousa and Hendriks 2007, 270; see also Sauder and Espeland 2009 on power and internalization of quality rankings).

Systems such as the REF which feature unit of assessment panels from the 'research field' to undertake peer review of research outputs from universities can lead to tensions between notions of research quality promoted by research manager/administrator elites in universities – such as coercive use of journal rankings – and the notions of 'research field' elites. This kind of 'battle of the elites' to constitute research quality can be possible in current UK universities where university research administrators have become decoupled from research field elites. These organizational elites may attempt to judge the quality of research content from which they have significant epistemic distance on the basis of tools such as journal rankings.

Whether these elites manage to constitute the notion of research quality or whether this is done by the 'research field' elites will depend on the relative power balance. For example in the run-up to the 2014 UK REF 'research field' elites managed to get organizational elites to agree not to use journal rankings as research quality proxies (see Nedeva et al 2012). However the 'proliferation of a new professionalied cadre of non-academic managers, with signiciant power and autonomy' who 'have paradoxically become the new power-players within the Academy' (Watermeyer and Olssen 2016, 204) means that this tension remains dynamic, not static, going forward.

Conclusion and Next Steps

This approach to looking at sites and notions of research quality, rather than take for granted that research quality emerges out of a static judgement process from a particular instance of peer review or similar, enables us to look at the dynamic mechanisms whereby research quality is constituted and re-constitued over time. It also enables us to consider power asymmetries in the behaviours of elements of 'research spaces' and of 'research fields' as they interact in the public science system.

Our contribution is therefore twofold. First, while many current studies, some of which we have cited in this paper, recognise the existence of tensions between knowledge communities (c.f. 'research fields') and organisations that employ researchers, fund research and set research priorities, the model we have presented approaches tensions systematically and frames them as a part of ongoing dynamic constitution of researchquality notions in institutionalised sites. Second, we acknowledge the role of a variety of actors that have voice in these sites. The strength of this voice varies from specific site to specific site, just as the nature and strength of the resultant tensions may vary.

For now we have only reviewed some tensions in two of our five proposed sites whewre notions of research quality are constituted. Using illustrative examples and related literature contributions, we have briefly shown that notions of research quality can differ among various stakeholder groups, thus influencing research processes, research outcomes and the nature of published knowledge claims. Our further research will examine research quality tensions in the other sites, including exploration of specific research field examples within the broad areas of physics and economics in the UK and several other countries.

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2.2.4 The changing behaviour of European universities in Horizon 2020

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The introduction of the eight EU Framework Programme for Research and Innovation, Horizon 2020 (H2020) is claimed to have changed the focus of European research funding markedly from excellence in research, basic research and technology development towards innovation and commercialization. H2020 consists of three pillars: 1) Excellent Science, 2) Industrial Leadership and 3) Societal Challenges. The *excellence* pillar, clearly allows for investigator-driven frontier research (LERU, 2016). The other two pillars, by contrast, contain pre-defined broad themes, with strong emphasis in the calls for societal impact of the projects. Calls for research programmes here often stipulate *technology readiness levels* (TRLs). According to a recent analysis made by the League of European Universities (LERU), funding decisions are disproportionally skewed towards projects with high TRLs, which is described as a major limitation to collaborative discovery research. From 2014-2015 to 2016-2017, the emphasis on high TRLs in the working programmes has increased, and surprisingly, even more so in the Societal challenges pillar compared to the one addressing Industrial Leadership. LERU concludes that a “natural consequence of this bias towards higher TRLs is that a very large fraction of research that is not yet on technology tracks is explicitly excluded, regardless of its potential societal or technological relevance or impact” (LERU, 2016, p.7).

Against this background, concerns have been raised about the reduced interest and involvement of the universities in H2020 activities beyond the excellence pillar. It has been argued that a reduced engagement of universities in pillars with high TRLs demands, will have consequences on the ability to find solutions to many societal challenges for which the engagement and involvement of institutions having the basic knowledge required is fundamental (Elverhøj, 2016).

There are many reasons why we might expect that universities are less inclined to search funding from the large pillars of *Industrial Leadership* and *Societal Challenges* in H2020, but rather to increase their attention towards the excellence programmes instead (*The European Research Council (ERC), Future and Emerging Technologies (FET), Marie Sklodowska-Curie-activities (MSCA)* and the programme for *Infrastructures*). These are more oriented towards basic research, with less requirements for broad consortia formation, and being less strict with regards to immediate impact and commercialization. For the most prestigious universities, achieving funding from the Excellence programmes may imply that the university is an institution involved in excellent research, compared to other programmes in H2020 where research institutes, industry/private companies and universities with a more applied profile are more present.

The aim of our study is to investigate to what extent universities have changed their application profile in H2020. We hypothesize that the transition from the seventh framework programme (FP7) to H2020 has led to a stronger concentration of applications from universities in the excellence pillar, and that the increased concentration is higher among the most prestigious universities.

Using data from the European Commission’s data warehouse ECORDA, connected with university data from the Shanghai-ranking (ARWU), we study the universities’ application profiles in FP7 and H2020. We do not use project data, because the applications, more than funded projects, tell us about the intent of the universities; projects rather tell us about the successful applications, which is not only dependent upon quality, but also on the magnitude of competition in the calls. Institutional reputation and size has been documented to be important determinants for the participation of universities in EU’s framework programmes (Lepori et al., 2015), but to the best of our knowledge, no

study has ever analysed the applications in the framework programmes, partly due to the lack of standardized institution names in the ECORDA database.

Methods

The main data source in this study is application data in ECORDA, covering FP7 and the early phase of Horizon 2020 (we have used the November 2015 edition of ECORDA, which means that our FP7 data are complete, whereas the analysis of Horizon 2020 is restricted to only the early results of that framework programme). At NIFU, a complete standardization of all institutions in ECORDA, involving 1.1 million institution names (all applicants and grant receivers), has been conducted. In our standardized version of ECORDA (see more details in Piro, Scordato & Aksnes, 2016), we have identified 4,959 unique higher education institutions worldwide (universities, university colleges and academies, but excluding university hospitals and academies of science, especially in Eastern European countries), coming from 172 countries. In total, these institutions have made 344,168 contributions to applications (participating in 151,642 unique applications). Du to legal restrictions on the use of the application data in ECORDA we are not allowed to identify any institutions by name; all analyses must be performed at an aggregated level where single institutions cannot be identified.

The application profiles of all universities have been matched with ranking scores in the Shanghai-ranking (ARWU). The relevance and quality of university rankings are highly disputable (Piro & Sivertsen, 2016), but few would disagree that the universities ranked at the top in these rankings are outstanding institutions. In our study, each university featuring in ARWU has been assigned a mean value of its rank position in the years 2003-2014 (Harvard University is ranked first with a mean value of 1.0, followed by Stanford University at 2.2). Most universities in the world, however, are not included in ARWU, but are included in a separate category in our analysis.

Since the research question of this paper is to investigate whether there has been a shift in behaviour of universities towards the Excellence programme in H2020, it gives little meaning to include institutions from outside Europe, since these to a limited degree apply to ERC. Therefore, a large number of the universities have been excluded. In our final sample, we have included all EU nations and associated EU partners. Switzerland has been removed from the analysis, following its rapid decline in applications to H2020.

The changing behaviour of the universities will be investigated by comparing the volume of applications submitted to the programmes for *Excellence* compared to all other programmes. We define the following programmes as *Excellence*: European Research Council (45,541 application contributions) and Future and Emerging Technologies (5,689 application contributions). Marie Sklodowska-Curie Actions/Marie-Curie Actions (89,063 application contributions) and Research Infrastructures (5,787 application contributions) have been left out of the analysis.

Results

We have categorized the universities in seven groups, based on their mean ARWU position, see groupings in Table 1. In the first group, we find universities with average ARWU position in the range 4.1 to 122. In the other groups the ranking distribution is 125-216 (group 2), 216-297 (group 3), 297-389 (group 4), 389-565 (group 5), 600 (group 6), while group 7 includes universities that are not included in ARWU. In total 2,524 universities are included in the final analysis.

The most prestigious, highly ranked universities (group 1) have both the highest shares of applications to the Excellence programmes (30,5 per cent in FP7 and 34.4 per cent in H2020), and the highest number of applications. There is no perfect correlation between rank position and propensity to apply ERC/FET, but all university groups have increased their shares towards these schemes from FP7 to H2020, with the increase being markedly higher in the groups 1-3, compared to groups 4-6, and with group 7, which contains the largest number of universities, having only a minimal increase.

Table 1: Percentage of applications to Excellence programmes by seven university groups

	1	2	3	4	5	6	7
FP7	30.5	27.1	19.6	22.0	17.7	16.7	13.6
Horizon 2020	34.4	32.6	24.3	24.8	20.8	20.0	14.7
Change	3.9	5.5	4.7	2.8	3.1	3.3	1.1
Universities (N)	36	39	41	41	42	101	2224
Applications to Excellence programmes (N)	11896	7533	5093	4639	3243	5314	7312
Applications to Other programmes	20016	16218	17282	14262	13189	21867	31247

Source: NIFU and EU Commission/ECORDA.

Another aspect of changing pattern can be a reduced willingness to take on the coordinating role in applications. Excluding the excellence programmes, we now look at the percentage of applications coordinated by the universities in FP7 and H2020 in the other programmes.

Table 2: Percentage of coordinator roles in universities' applications to other programmes by seven university groups

	1	2	3	4	5	6	7
FP7	15.1	15.2	16.0	16.5	15.9	16.2	14.4
Horizon 2020	18.3	19.7	18.9	19.0	21.1	21.8	18.0
Change	3.2	4.5	2.9	2.5	5.1	5.6	3.6

Source: NIFU and EU Commission/ECORDA.

The results in Table 2 do not indicate that the universities in general are less willing to take up the coordinator role in H2020 compared to FP7. Contrary, the percentage of applications coordinated by the universities have increased in all university groups from FP7 to H2020. However, the increased propensity to coordinate an application is generally higher in the lowest ranked university groups, especially among the universities ranked 389-600 in ARWU.

Conclusions

The findings of this study indicate that less prestigious universities play a more active role in H2020 compared to FP7 in the pillars Industrial Leadership and Societal Challenges. In general, the universities have oriented themselves more towards the Excellence pillar compared to what they did in FP7, and this reorientation seem strongest among the highest ranked universities.

The results presented here may change when our full paper is finalized. This is due to two conditions. First, while we have complete FP7 data, our H2020 data are from that programs' early phase, where the universities' application behaviour may be more "Post FP7" driven than well-adapted to H2020 where many key actors struggled in the beginning to adapt to the new rules of H2020. In June, the new edition of ECORDA is released and we will be able to update our results.

Second, we have used ARWU to group the universities. There are many ways to categorize universities, and in our full paper we will compare different groupings based on data from the Leiden ranking: university size (number of publications), university impact (citation indicators) and university profile (percentage of collaboration with industry).

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2.3 Session 2.3

2.3.1 Engagement with industry and re-composition of the academic research agenda: Evidence from Germany

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Outline

Academic engagement with the private sector is an increasingly prominent part of the scientific profession (Etzkowitz, 1998; Geuna and Nesta, 2009). Scientists are encouraged to commercialize their research findings through patenting or entrepreneurial ventures and to collaborate with industrial partners in formal and informal ways. The establishment of third part funding as a performance measure and the recent economic crisis are stressing the role of industry sponsorship in funding academic research (Hornbostel, 2001).

Strengthening science-industry links seems to play an important role in translating scientific results into economic growth (Feller, 1990; Florida and Cohen, 1999). However, scholars are concerned that this might also substitute scientists' time away from scientific goals towards short-term industrial gain (Dosi et al., 2006; Pavitt, 2001; Perkmann and Walsh, 2009; Owen-Smith and Powell, 2002). Extant empirical research on the potential tradeoff on has led to inconclusive results (Perkmann et al., 2013).

We examine the relation between engagement with industry and the direction of scientific research. Most of the research on the impact of engagement on research has limited itself to correlating the (quality-adjusted) volume of scientific output with engagement. However, academic engagement might have a more subtle impact on the production of knowledge by on the one hand serving as a source of ideas and by on the other hand providing an incentives for scientists to pursue issues for which funding is more plentiful (Rosenberg and Nelson, 1994; Rosenberg, 1998; Cohen et al. 1998; Lee, 2000; Rosenberg and Steinmueller, 2013). Such shifts could happen within the scientific context and hence be difficult to identify through conventional productivity measures. Empirical evidence on whether industry funding leads academic scientists to do science differently is scant, but developing (Blumenthal et al., 1996; Godin and Gingras, 2000; Gulbrandsen and Smeby, 2005; Boardman and Corley, 2008; Hottenrott and Lawson, 2014, 2017).

Innovativeness and relevance of the paper

We contribute to the literature by assessing to which extent engagement with industry relates to the orientation of scientists' agenda. Do scientists who interact with industry often typically have a different research focus than scientists who do not? If this is the case, then policy makers should consider the possibility that increasing expectations about industry engagement of the scientific workforce might coincide with a broader (i.e. outside the scope of the expected interactions) shift towards industrially oriented research. This aspect has been largely omitted from prior literature, which in the first place has correlated industry engagement with measures of scientific productivity. We argue that a shift towards industry might occur *within* scientific knowledge production, and might hence not be detectable through classic measures of productivity.

Methods and empirical material

The analysis is based on 1539 respondents to an online survey conducted in Germany in 2011, carried out by the Center for European Economic Research and commissioned by the German federal ministry for Research and Innovation. The survey was sent to professors in German universities and applied sciences universities and covered a broad range of topics. Among these were a set of questions relating to the nature and determinants of their research agendas, as well as the orientation of their research activities in terms of knowledge transfer between 2008 and 2010. We only consider responses by professors active in STEM fields for this analysis, disregarding social sciences and humanities. The data have been complemented with publication data from Web of Science.

We use the share of external funding stemming from industry as a proxy for engagement. We characterize scientists' orientation through three measures. First, whether or not the scientist considers applied research to be an important part of their work. Second, whether the scientist believes industry is an important user of his work. Third, whether the scientist considers potential for knowledge transfer to be an important factor in deciding his future research agenda. We also examine the relation between the scientist's commercial orientation on their average publication and citation outputs. The analysis is based on linear and binary regression analysis, controlling for a range of personal and professional attributes, such as career age and gender. We also control for professional attributes, such as teaching load, number of Ph.D. students, and field.

Results

Our results confirm the unclear relation between orientation towards commercialization and research productivity described in the literature. However, we show a clear correlation between industry engagement and the industrial orientation of the scientist's research. The study thus shows that engagement with industry covaries with the nature of the research done by the scientist. Even if industry engagement does not impact scientific productivity, our results thus indicate that academics face trade-offs in composing their agenda when they engage with industry. This is not reflected in general productivity estimation and requires a specific approach to do so. Taken together, our results suggest that industry engagement does not compromise scientific productivity in the short run. However, enlarging the scope of research towards distant topics or very applied topics in function of industry engagement may have long term consequences for the development of scientific knowledge.

Conclusions

While indirect and correlative, our analysis provides evidences for a reorientation of academics' research agenda in the light of the entrepreneurial university. Compared to previous contributions focusing on the volume and quality of scientific outputs, or engagement in academic patenting, we provide a more nuanced perspective: industry-oriented scientists also re-orientate their scientific activities to those issues which are in demand among firms. On the one hand, scientific research might gain in short-term relevance when there are private actors willing to fund research activities. On the other hand, however, this approach might jeopardize long-term scientific progress. This last aspect is reinforced by the observation that there is some degree of incompability between the use of results by industrial vs academic actors, and between commercial and personal (scientific) interest in the choice of research topics to pursue. The different dimensions linked to the orientation of commercialization leads to a discussion about the implications of institutional arrangements to promote technological transfer on academic research.

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2.3.2 Innovation for rare diseases – co-creation in innovation ecosystems in the Netherlands

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Keywords: grand societal challenges, market failure, innovation systems, rare diseases, orphan drugs

Introduction, relation to innovation policy and conceptual approach

Rare diseases are life-threatening or chronically-debilitating illnesses with a low prevalence. Small patient pools mean that pharmaceutical companies struggle to recoup their substantial investments (Meekings et al, 2012). Small patient populations are also not associated with high reputational gains to be won by scientists. Still, although prevalence of individual diseases are low, the total number of patients having a rare disease is substantial given that there are 4,000-8,000 rare diseases (Seoane-Vazquez et al, 2008). Moreover, for most rare diseases there are no cures available, indicating an area of healthcare with high unmet medical needs.

The limited attention for research and development activities in the rare diseases area combined with a significant societal pressure to act indicates a situation of market failure. The rarity of the diseases means that scientists are often not well connected, physicians are unaware of clinical best-practices and patients are not easily identified and brought together for e.g. clinical trials. Moreover, there is a general reliance on 'generic' therapies for common diseases, while tailor-made solutions for rare diseases are often lacking. All this implies an ill-functioning innovation system and related systemic failures.

Market and systemic failures in the context of rare diseases have been recognized for over two decades in the European Union (Boon & Moors, 2008). The introduction of the Orphan Drug Act in 2000, following the example from the US, made it possible for companies to enjoy benefits when developing and marketing drugs for rare diseases, i.e. orphan drugs. Prime examples of such benefits are a ten-year market exclusivity period for any orphan drug and the possibility to enter the market based on less complete clinical data than would be normally required.

Reviews of the pharmaceutical sector seem to suggest that the orphan drug legislation has had a beneficial impact on the development of orphan drugs (Brabers et al, 2011). The number of so-called

orphan drug designations has risen over the years, indicating many new drugs entering clinical development (Braun et al, 2010). Also the number of approved orphan drugs has grown (Heemstra et al, 2008). Success of orphan drugs on the market however also revealed a downside: pharmaceutical companies ask high prices for their products, putting pressure on healthcare budgets.

The success of orphan drug development and marketing in some disease areas overshadow diseases for which no cures are on the horizon. In terms of innovation dynamics and innovation policy this reveals a significant and as yet not investigated question: why is orphan drug development in some rare disease areas more successful than in others?

We address this question by focusing on the creation of interactions and complementarities between research, development and the provision of high-quality care in local innovation eco-systems. We approach these interactions as part of an innovation system that is dedicated to the development of therapeutic products for specific diseases. As such technologies are put central which, combined with the dynamic perspective we emphasize, points at taking the concept of technological innovation system as a theoretical starting point (Hekkert et al, 2007). We are interested to what extent actors from different institutional backgrounds (research, commercial development, care) collaborate and create self-reinforcing innovation 'motors' (Suurs, 2009). For example, does world-leading research lead to spin-off companies and the creation of clinical expert centers? Co-creation between universities, academic and non-academic hospitals, research institutes, pharmaceutical and biotech companies and patient associations could produce such a 'motor'. Are there distinct motors to be recognized, indicating different innovation models, e.g. the ones in which clinical researchers are in the lead and those that have companies as primal movers? Lastly, as rare disease R&D often functions as a model for more common disease models (Van Weely & Leufkens, 2004) we are also able to investigate complementarities and cross-overs between rare and common diseases. By taking the technological innovation system as a conceptual starting point, we specifically focused on the seven functions that highlight the interactions between research, development and care.

Methods

The European Union mandated their members to produce a national plan for rare diseases that stipulates how countries are going to facilitate and stimulate rare disease care and innovation. As part of these plans, member states are asked to appoint centers of expertise: clinical organizations that provide top-level care and research in a specific rare disease. The Netherlands recently completed the inventory of these centers. We took the list of the centers as a starting point for our data collection. The centers covered 631 rare diseases. We matched these disease names with MeshIDs and IDs from the Orphanet database which is a specialized EU database on rare diseases including a classification system of all described rare diseases in the medical literature. This exercise required in-depth understanding of the rare disease names as well as choices that had to be made regarding the level of aggregation that was chosen. We performed this exercise with three independent coders.

The resulting list of disease codes were used to search for data for the four abovementioned functions. We focused on two major disease categories: 'inborn errors of the metabolism' and 'neurological diseases', because they are traditionally regarded as typical of rare disease dynamics. So far we have operationalized four functions of the technological innovation system covering the Netherlands from period 1995 (just before the introduction of the orphan drug act in Europe) to 2015. We did this as follows:

Knowledge development was measured by using bibliographic data. This data was collected by searching for articles with the disease Mesh terms in Thomson Reuters Web of Science. The bibliographic data was cleaned to link publications to institutes, countries, diseases and publication year. Publications were categorized in non-clinical publications and those addressing clinical development (Mesh terms related to clinical trials).

Entrepreneurial activities were measured by using the complete lists of EU orphan drug designations and drug approvals, and code for all products from which the applications originate from the

Netherlands. The resulting list of companies was reviewed and augmented by a representative of the Dutch sector association.

For each disease, resource mobilization was measured by creating an exhaustive list of funding agencies listed on the publications as well as overviews of all Dutch and EU research programs on rare diseases.

The support from advocacy coalitions was measured by indicating for which diseases a specific patient association was active.

The analysis consists of two parts. First, we performed a benchmark of Dutch output on the four functions as compared to EU, US and rest of the world. Second, for each rare disease we identified patterns in how research, development, healthcare and patient advocacy strengths were combined. These interactions serve as indicator for specific types of innovation models.

We validated the data analysis by discussing the findings with five experts in the field of rare diseases coming from academic medicine, drug regulation, innovative pharmaceutical companies, and the Dutch Steering Committee on orphan drugs.

Results and conclusions

We found that the share of Dutch publications on rare diseases remains steady against a backdrop of growing global publications and an increasing share of non-EU and non-US publications. Dutch research groups seem to perform well in disease areas that have a relative low number of total publications. This indicates that they focus on diseases that attract little attention.

In terms of interactions between research, development, care provision and patient advocacy we found in general two types of innovation models. The first innovation model revolves around the center of expertise in an academic hospital. A group of medical specialists with a strong research focus treat most patients in the Netherlands of a particular disease and performs research on the disease, including basic research and small-scale clinical trials. Frequent and intimate interactions with patient organizations lead to effective research performance, e.g. in terms of patient recruitment and even co-founding of natural history registries. The second innovation model has companies as the major players. The companies often start drug discovery from a rational, science-driven approach and during clinical development coordinate and subcontract studies in academic hospitals. These models resonate with governance models for post-marketing studies we found earlier (Boon et al, 2015).

These findings have broader repercussions for innovation policy since they align with recent discussions on alternative business models for pharmaceutical R&D, in particular in fields like rare diseases and areas associated with high unmet medical needs (Moors et al, 2014; Munos & Orloff, 2016). Examples of such alternatives include innovation models that emphasize the role of academic research centers (Kirkegaard & Valentin, 2014; Workman et al, 2017) and those models that explicitly aim to develop new therapies for low prices. The study also sheds more light on the balance between public and private involvement in pharmaceutical innovation processes. Medical researchers (Light & Lexchin, 2012) and innovation policy scholars (Mazzucato, 2013) have used the case of orphan drugs to call for a sensible distribution of risks and rewards for innovation, which should lead to a more efficient overcoming of market and systemic failures in the field of rare diseases. The models of alternative collaborations and cross-overs among technologies, actors and institutions highlighted in this study, provide more insight in the variety of approaches policy makers can use to fine-tune policy measures to better meet progress in medical innovations.

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2.3.3 The Science Base of Clean Technology

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Introduction

Nations worldwide recently formally agreed to reduce carbon gas emissions in a number of international treaties, the most noteworthy perhaps the COP21 in Paris. Clean technologies (cleantech) are indeed on the rise yet are not widely adopted for various reasons (IRENA 2017) and many countries have science, technology, - and innovation policies in place to stimulate its development. For such policies to be successful a deep understanding of the technological systems, the underlying scientific knowledge base and their interaction is required. Technological development relies heavily on a two-way interaction with science (Freeman 1994, Rosenberg 1982). Also, this interaction may be very different for each field of technology (Verbeek 2003). Energy technology is characterized as a heterogeneous field itself, both in the sense that it builds on diverse other technologies (Nemet 2012) as well as in the sense it is built on by diverse other technologies (Popp et al. 2012). This heterogeneous nature further challenges the development of a deep understanding. In this paper the main question is therefore: what is the scientific knowledge base of energy technology?

In a previous attempt to explore the science base of “environmental“ technology from 2000-2007, the OECD found a broad dependence on scientific disciplines (OECD 2010). Our contribution will go into more detail, working with more recent observations and attempt to interpret the findings in a broader context. More specifically, we address the science base differences between fossil fuel based energy technology and renewables (henceforth respectively dirty and clean technology). Once specific scientific disciplinces which are relevant to clean technology (and not necessarily to dirty technology) are identified, stimulating the activity in these fields can be the basis of a fundamental and long term policy for accelerating cleantech development. The distinction between basic and applied science can additionally be useful for the purpose of policy implementation. If a strong influence of basic science is found, policy stimulating effective transfer of basic science to technology may form an important stimulus to an economy. There are various examples of basic science transfer policies which some governments have already in place or are experimenting with. In this context of interacting government, universities and industries the triple helix model by Etzkowitz et al. (1995) forms an important basis to understand this interaction.

Theory

Technological change can be understood in terms of technological paradigms and trajectories (Dosi 1982). The natural sciences play a key role determining the content of technological paradigms and in the transition from one paradigm to another, for a better understanding of energy technology it therefore makes sense to look at its science base.

Science and technology consist of many, sometimes overlapping disciplines or fields. On top of that energy technology is heterogeneous itself and a large complexity for its science base can therefore be expected. Within energy technology this broad dependence may however be different for clean and dirty technology, as we know clean technologies produce far more spillovers to a greater variety of technological fields than dirty energy technologies (Dechezlepretre et al. 2014). The variety differences may not be surprising given that clean technologies exploit a far greater variety of phenomena than dirty technogologies. Where incremental innovation is mostly but not exclusively associated with dirty energy technology, radical innovation is mostly associated with clean energy. In the context of energy technology, incremental innovation is linked to large technological systems, characterized by

slow innovation and path dependent development. The second is characterized by fast and radical innovation mainly developing in niches (Markard et al. 2006). Radical innovation is understood to have closer ties with scientific developments. Given the radical and incremental association therefore, a stronger knowledge base can be expect for cleantech then for the more established dirty energy technologies.

For the purpose of identifying a science base, disciplines and classes can be defined in a number of ways. A useful criterion distinguishes between applied and basic science. Where the first concerns research into achieving some practical application, the second is more concerned with solving some fundamental theoretical problem. In terms of time development, basic science can be expected to precede applied science and technology which builds on it. The time lags between basic science and technology building on it can also be expected to be longer than the lags with applied science. Basic science is mainly produced by universities and is expected to be related to the product diversity (Nelson 1959) and absorptive capacity (Cohen et al. 1990) of firms. A strong emphasis of basic science in the science base of cleantech would therefore lead to an identification of specific relevant organizations.

Authors have argued the knowledge dynamics of technological change varies greatly amongst economic sectors too. Pavitt (1984) argues that knowledge picture of innovating firms supposing a 'generally available and applicable pool of knowledge' from which firms can freely and beneficially draw rather than add to is not realistic. Knowledge flows through the system in a complicated structure of interdependencies between firms which can on that basis be grouped into a taxonomy. The groups of innovating firms differ with respect to extent in which they build on scientific knowledge. Knowledge of scientific base of the energy technology is therefore essential to understand how the innovative activities from firms can be stimulated.

Methodology

In this research the representation of technology through patents is used. The science base of a technology can then be determined following citations to Non Patent Literature. First we will identify a patent dataset for clean and dirty technology, then the journal and keyword distributions will be determined and finally the time dependence of these science bases is studied. These steps are more thoroughly explained in the following paragraphs.

References to Non Patent Literature in Patents

In this contribution we choose to observe technology by looking at patent application data (henceforth shortly 'patents'). Patents provide the rare opportunity to empirically study technological content in quantitative manner. Received citations (forward citations) have been associated with relevant economic value parameters (Trajtenberg 1990) and are considered a measure for economic spillovers. Measuring technology through patents one is also confronted with some limitations, as not all technology is patented. Citations are only an indirect sign of spillovers and their relevance should therefore not be overstated (Meyer 2000).

For the purpose of identifying the science base of a technology, an especially useful aspect of patents are the references to Non Patent Literature (NPL) by the inventor and/or examiner. The majority of these references are to scientific literature, signaling which science was relevant to the invention. (Van Vianen et al. 1990 and Callaert et al. 2006). Narin reported a general trend of increasing dependence at the end of the 20th century and specifically on public science produced in universities (Narin et al. 1992). A general increase in the referencing magnitudes may also be the result of the implementation of better or automated methods for finding prior art. Because of the interpretational difficulties of the dependence strength, next to determining the strength of the science dependence, we will identify the specific science fields of the dependence.

Variety of science dependence

In their studies of the science base of biotechnology and nanotechnology, respectively McMillan et al. (2000) and Leydesdorff et al. (2006) identified the core scientific journals which were cited by patents. The different 'research areas' of Web Of Science (WOS) allow for a detailed disciplinary classification of journals and for a rough destinction between applied and basic science. Hence knowledge of the journal citations in patents can be used to identify the science base. The patent data is taken from the patstat autumn 2016 version. As there are generally many ways to write and abbreviate a journal's name, it is challenging to obtain high degree matches. We are therefore anticipating the patstat spring 2017 version, which has an improved recording of NPL references.

An easier approach consists of using keywords to identify scientific disciplines. A preliminary broad selection of keywords is narrowed down using a ranking in both scientific specificity and technological relevance. The scientific specificity of a keyword to a given scientific discipline can be determined by dividing the occurrence of that keyword in scientific papers of a specific field by the overall occurrence of that keyword in all papers. The technological relevance of a keyword can be determined by simply counting its occurrence in the patent NPL references.

Time dynamics of the science base

Filing dates of patents allow for detailed information on the time development of a technology and the number of NPL references per patent. Next, using the information in the citations themselves, the times from which the cited NPL stems are used to identify relevant periods of scientific development. The time development of the science base becomes especially interesting calculating the time lag with the citing technology, which signifies the speed of the knowledge transfer and the closeness of the science and technology interaction. The development of the lag itself in time can signify when shrinking the acceleration or when increasing a deceleration of the science and technology coevolution. Finally, using the citations of patents to patents, the conditional probability for a patent to refer to NPL given that a cited patent refers to NPL signifies the continuity of the science dependence.

Distinguishing clean and dirty technology

To distinguish clean technology we will use the classification scheme Y02 introduced by the Cooperative Patent Classification (CPC), which signals the application characteristic of enabling or stimulating climate change mitigation (Veefkind et al. 2012). More specifically, we consider all United States patents applications which have at least one classification in the Y02E subclass, which mainly concerns different energy technologies. The Y02E10/5 and Y02E10/7 subgroups, respectively involved with photovoltaics and wind turbines receive detailed attention. To distinguish dirty technology, we will largely follow the list put together by Dechezleprêtre et al. (2014). He also distinguishes an intermediate category, 'grey tech' which is still based on dirty technology yet focused on making it more energy efficient and cleaner.

(Preliminary) Results & conclusions

Here follows a brief discussion of some preliminary results, both because of limited space and the fact that this is work in progress. We see steady increases in the number of patents from clean, grey and dirty technologies, yet the increase of cleantech is strongest. We see an overall increase of number of NPL references per patent, yet the increase for cleantech is roughly a factor 1.5 - 2 times stronger. Additionally, the patents which are both classified in Y02E and dirty energy classes generally have less references to NPL then average patents in these dirty classes. We see a general increase in the number of backward citations per patent through the years and this increase is not significantly different for clean, grey or dirty energy patents. The number of backward citations appears to correlate with the number of references to NPL for all considered types of energy technology and stronger for clean technology then for grey and dirty, in agreement with the previously mentioned stronger increase in references to NPL per patent for cleantech. These findings however requires further careful analysis. These preliminary results indeed point in the direction of a stronger science base dependence for clean- than for dirty technology.

Averaged over all patent classes the time lag in years between cited NPL and a general US patent is on average 7.1 years, where it is first averaged over the patents in a certain year and then over the years. This lag was approximately 10 years end 1960s, slowly decreasing towards the year 2000 to 5 years and then increasing steadily to approximately 8 years around 2010. The time lags in the different dirty, grey and clean patent classes follow far a more fluctuating development, it is however clear that the average time lags of clean technology are shorter than the dirty technologies and far shorter than the average of 7.1 years, (the lag for solar being only 4.7 years for example). Some dirty technologies have also shorter time lags then average, time lags of technology related to combustion processes for example being 5.9 years. We conclude therefore that although the knowledge transfer between science and technology appears faster in clean technology it is not particularly slow for dirty technology either.

As the conditional probability for a patent to refer to NPL given that a cited patent refers to NPL, no significant differences appear to exist between clean and dirty techology. The probabilities for both only increase a small percentage given that a cited patent cites NPL. The continuity of the science bases appears therefore comparable between clean and dirty energy technology. A first quick identification of the scientific disciplines in the science base of cleantech on the basis of keywords appears consistent with previous work by the OECD (OECD 2010). These findings however require further analysis.

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2.3.4 The ‘newly emerging techno-sciences’ and the contemporary funding regime

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Keywords: funding regime, newly emerging techno-sciences, technoscience, academia, epistemic cultures

This paper combines sociological, ethnographic and hermeneutic approaches to appraise the quality and quantity of the impact of the contemporary STI funding regime on academic research practices, communities and identities. It raises the question how this regime led to the phenomenon of ‘newly emerging techno-sciences’ and what kind of change within academia this phenomenon denotes. An empirical analysis of the emergence and institutionalisation of the field of systems biology in different (trans)national contexts serves as a starting point for further discussion.

Getting a grip on newly emerging technosciences

STS scholars have been struggling for a while now with how to conceive of new phenomena such as systems biology and synthetic biology, often labelled as ‘newly emerging techno-sciences’ or NESTs: Do these represent ‘empty signifiers’, ‘buzzwords’, ‘emerging research fields’ or new (sub-)disciplines? The project ‘(Techno)epistemic cultures in 21st century life sciences’ addresses this very question with a focus on changing epistemic cultures, community constellations and identity constructions. It builds upon case studies of the emergence and institutionalisation of systems biology in the UK, Germany and Austria (for the latter, see Kastenhofer et al. 2012), including semi-structured interviews with scientists (both, dedicated systems biologists and other life scientists; contemporary scientists and representatives of earlier generations of scientists) as well as experts from the respective national STI governance systems (52 interviews in total).

The presentation starts with a twofold empirical inquiry: firstly, do systems and synthetic biology represent areas of research, research approaches, communities and identities that are distinct from other areas of research (synchronic distinctness), and secondly, do they represent a fundamentally new mode of practicing and representing science (diachronic distinctness). When combining these two analytical dimensions, four different extreme poles result:

(a) NESTs can be interpreted as further manifestations of modern differentiation within academia: systems biology and synthetic biology simply represent recent additions to an existing list of comparable research areas (that we for instance tick of when completing a research proposal’s standard form).

(b) NESTs can be understood as ‘empty signifiers’ – distinct only in their labelling: Wullweber (2008) exemplarily discusses whether nanotechnology should best be understood (and handled) as an ‘empty signifier’ that pays tribute to a specific “techno-socio-economical innovation strategy” (ultimately an ‘old wine in new bottles’ thesis, that holds only provided that wine and bottle are fundamentally distinct, see below).
(c) NESTs can be referred to as illustration of a fundamental epochal break that affects all contemporary research (and to some extent even suspends modern differentiation): this thesis – the thesis of an epochal break from science to technoscience – has been put forward and critically examined within philosophy of technology (cp. for instance Nordmann et al. 2011).

(d) NESTs can finally be interpreted as manifestations of a hybrid situation, combining a modern-like differentiation with fundamental historical change (for want of a label, I represent this by the German art historian Pinder’s formulation "simultaneity of the non-simultaneous" / “Gleichzeitigkeit des Un-

gleichzeitigen", later taken up by Mannheim and others): systems biology can be added to (and distinguished from) a list of other research areas, but is also seen as different in kind; precursors of such an interpretation are to be found in the historical analysis that biological sub-disciplines were differentiated along different classes of organisms (botany, zoology, microbiology) in a first historical phase of biology, later along different levels of complexity (molecular biology, cell biology, organismal biology, population biology, …) and recently along specific multi-disciplinary, engineering inspired ambitions (systems biology, synthetic biology, nanotechnology; including a possible link to overarching theories of scientific development, like the finalisation thesis put forward by Böhme et al. 1973). Today, results of all three logics of differentiation persist.

From science to technoscience

In the second part of my paper, I will illustrate with empirical material stemming from the presented research project that these four options are best to be understood as extreme poles (or ideal types) – the empirical examples combine aspects of all the options sketched. This situation can be explained along two superimposed rationales:

(1) From an institutional perspective, we observe that various aspects of national and transnational STI systems effectuate different phenomena of stabilisation and change. Among such potent 'game changers' national and transnational funding regimes and their historical reconfigurations certainly count as one of the presently most influential forces and their far-reaching influence has yet to be discovered in its full breadth. In February 2017, an international workshop dedicated to the analysis of changes in community constellations and identity configurations in fields such as systems biology, synthetic biology, nanotechnology, biofuel engineering or molecular chemistry ('Community and Identity in Contemporary Techno-Sciences', organised by STS Austria), resulted in the joint appraisal, that current funding practices leave essential traces in scientific communities and identities, even though some intentional moves of STI actors to change academic communities and identities via tailor made funding initiatives (e.g., towards 'responsible research and innovation', towards a primary orientation towards 'solving grand challenges') are rejected by academia, warded off by playing the game without succumbing to the 'external' influence. What sticks eventually is a perceived necessity to play certain (new) games and a selection of individuals who are willing and capable to do so. But the influence of national and transnational STI systems would not be that strong, were there not other supportive parameters of the STI systems at place, partly directly or indirectly connected to the funding regimes, partly rather co-incidental phenomena.

(2) From a hermeneutic perspective, we observe that competing definitions of what (techno)science is 'in its core' or 'fundamentally' and along which dimensions 'fundamental' change or stability thus manifest themselves result in a blurring of categories: can we legitimately speak of a new technoscientific era if the most visible change is a new kind of framing science in the media and in the funding discourse? Does this 'fundamentally' change what science is, i. e., what science is 'in its core'? Hacking (1983) famously negates this question; others tend to react differently. Nordmann (2011) points towards a situation, where an epochal break from science to technoscience can only be perceived from a point of view that is typical for a *scientific* era and (self)understanding, whereas from a *technoscientific* standpoint the shift is imperceptible; in other words, what gets lost in a turn from science to technoscience is held dear by those who are devoted to science and the loss hence gets noticed, whereas those devoted to a technoscientific ideal do not count the allegedly lost aspects as part of the core of what (techno)science is about and therefore see no fundamental change.

How funding regimes shape the technoscientific milieu

For the case study at hand – the establishment of systems biology in academia – the impact of the national and transnational funding regime(s) can be summarized as follows:

External funding has outranked the influence of traditional institutions on academia to a considerable extent in the wake of a veritable upheaval of the academic milieu at continental European universities like the University of Vienna around 2000.

The general trend within the transnational funding regime to opt for ‚label-oriented‘ funding programmes results in an explosion of new labels within science. Other than bottom-up or mission-oriented research funding, this strategy targets specific research fields or approaches that get discursively linked to societal missions. The U.S. National Nanotechnology Initiative may serve as a prominent example. The relating labels are propagated by specific groups and the relating approaches need to be demarcated from other research to decide who deserves to be funded within a relating programme (whereas bottom-up research funding is based solely on a demarcation of excellent research, and mission-oriented funding on an evaluation of feasibility). As a result, new labels prosper in academia (as does their critique), they embellish new journals, new chairs and new institutes. As label-oriented funding programmes come with an expiration date, so do the relating labels. ISI Web of Science reports 4 papers with the topic of systems biology in 2000, a peak with 1566 papers in 2012 and a slow decrease ever since (N = 1376 in 2015, N = 1374 in 2016). In the UK, the systems biology funding initiative has now been succeeded by a synthetic biology funding initiative.

Within label-oriented research, national funding agencies seem to be more influential then transnational ones, resulting in different national patterns of establishment. In the US and the UK, systems biology was established between 2000 and 2010 mainly in the form of big, multidisciplinary centres, in Germany mainly in the form of big networks, in Austria a kind of ‘small systems biology’ popped up in a much more dispersed mode in the absence of any major funding initiative (Kastenhofer et al. 2012; for synthetic biology, Molyneux-Hodgson / Meyer 2009 and Meyer / Molyneux-Hodgson 2016). Overall, the result is a kind of re-nationalisation of research communities and a re-localisation of research capacities with an increased dependence on costly local infrastructures within Big Science (albeit an unceasing internationalisation of research via collaborative projects and of identities via multinational careers).

As mentioned above, individual criteria of success have also changed drastically. External funding relies on verifiable criteria, mostly publication output and amount of funds raised during a certain recent period, plus a network of potential collaborators and, with label-oriented funding, the capability to pick up new trends in time. A long-term identification with a specific discipline, theme, approach or local tradition is out of the picture as is a major orientation towards teaching or popular science. Only very few scientists identify themselves as systems biologists (mostly those of the core group lobbying for corresponding funding initiatives), some concede *doing* systems biology (in correlation with their involvement in systems biology initiatives), many do systems biology among other things. Within the interviews, it accordingly proved difficult to name other systems biologists. If not for lobbying work, scientists seemed more engaged in their multidisciplinary collaborations providing them with complementary expertise, skills and equipment than in building up and maintaining homogeneous disciplinary communities. Those who do identify with systems biology are mostly of a specific generational cohort – mostly young PIs in their post-doc phase when the label emerged. Thus, a label-oriented funding regime that relies mostly on temporary funding initiatives produces not only different labels but also different generations of scientists, who, along Mannheims conception of generations (Generationszusammenhang), share distinct experiences and circumstances (in his words, a distinct fate). All in all, these processes point towards a shift from disciplinary community and subdisciplinary differentiation of science to further fragmentation (along labels, paradigms, generations, cp. also Kastenhofer 2013), accompanied by new modes of integration (multidisciplinary collaboration and lobbying groups as modes of strategic partnership).

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2.4 Session 2.4

2.4.1 Experiment, organizational change and programmatic work

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Keywords: organizational change, experimental systems, social movements, cancer research, genomics

Gläser and Laudel (2016) have recently called for closer integration of science ethnography, organizational studies and innovation policy studies. These authors rightfully point out that organizing and scientific work has often been considered to be mutually exclusive terms in the sociology of science. Scientists would simply be too autonomous and individual for organizational analysis to be relevant. Yet, science, technology and society (STS) scholars have often followed the axiom that the work of organizing science is itself a scientific activity. This means that much micro –level work on research practices will in fact capture organizational and policy dimensions. Often, scientists and policy actors are treated “flatly” without clear distinctions between scientific and policy work. This is exemplified for example by Fujimura’s uses of the concept of “articulation work”. More recently, some STS scholars have started to engage with organizational literature more explicitly. For example, Parker and Hackett have examined how collaborations are sustained in ecology. Keating and Cambrosio (2012) have highlighted how epistemic and organizational changes have been closely interdependent in the constitution of the US clinical research enterprise. Shostak (2013) and Panofsky (2014) have deployed Bourdieusian approaches to disciplinary organization and institution building to understand scientific change. Castel and colleagues have emphasized the work of change entrepreneurs against a backdrop of institutional constraints and professional gatekeeping in healthcare systems (Bergeron et al 2014; Vézian 2014). It should also be noted that theories of policy- and organization-making themselves have recently moved towards the study of coordination and steering activities in flat networks and that are quite similar to the kinds of organizational practices found in scientific sectors (Borrás and Edler 2014).

With this presentation, I propose the concept of “programmatic work” as a useful analytical tool for understanding how the organization of research activities is produced jointly by both scientific and policy actors. Research programmes are commonly understood as policy-designed mission statements assorted with funding and other resources. Shove (2003) has shown such expectations to be idealistic at best and that scientists commonly “hijack” programmes to advance their own interests and objectives. Yet, deviance from preordained objectives need not be seen as problematic. In fact, this might be perceived as a sign of the productivity of programmes. In this, steering processes need not be perceived as the exclusive province of policy-makers. Constructing a position for one’s project (in the sense of Felt et al 2013) necessarily entails managing peers’ evaluations of what is worthwhile science. My notion of programmatic work highlights the fact that programmes are commonly used by scientists themselves to mobilize resources, coordinate with colleagues and articulate dispersed efforts by elaborating shared models of innovation.

On the organizational side, programmatic work contributes to the building of networks and collaborations; shapes the reputation of institutions; proposes divisions of intellectual and technical labor among groups; and generates qualification tools and therefore participates in the maintenance of authority. Certain research programmes can lay the groundwork for bona fide intellectual movements (in the sense of Frickel and Gross 2005) that aim to reform research fields or institutions at a deep level. Certain scientists and policy-makers may even develop into full-time “programmatic elites” (Hassenteufel et al 2008). Nonetheless, programmatic work is almost always collective and heterogeneous – policy-makers and researchers are linked together through programmatic work in invisible colleges or

virtual coalitions. Because the attention capacity of scientists, much like other publics, is limited (Hilgartner and Bosk 1988), different programmatic proposals tend to be in competition with one another, even as their respective advocates may remain on perfectly friendly terms with one another.

I substantiate the concept of programmatic work via empirical engagement with a case study of the reform of cancer clinical research. US cancer trials with innovative drugs have been reworked with the introduction of genomic sequencing technologies. Over the same period, elite oncology researchers together with policy makers have called for a reform of clinical research. They have advocated (and often themselves implemented) trials with a more explicit experimental bend (in apparent contradiction of their regulatory role), design parameters that facilitate the introduction of new treatment technologies and new forms of collaborations. Trials have explicitly been launched to provoke organizational change as much as to evaluate new drugs. Some trials act as initiatives of mass technology transfer that provide access to genomic diagnostic capacity to thousands of community practices that would otherwise have no access to this cutting edge technology. I analyse these new trial projects as instances of programmatic work, experiments that simultaneously aim to produce knowledge about cancer biopathology but also to convince cancer researchers to adopt certain models of knowledge production and innovation. This qualitative case study has been conducted by extensive documentary analysis of the specialized cancer literature and through more than 50 interviews with policy-makers, regulators, and leaders of specific trial initiatives.

The outcomes of this work is a model where change in the content of STI activities and in STI policy is effected through organizational work. Programmatic work sets fluid guidelines for organizations that appear transient in the face of more durable scientific institutions, but nonetheless constitute the bulk of mundane scientific activity. Programmatic work connects together both policy wishes and experimental constraints and opportunities. The question is which programmes, and therefore which experimental and organizational issues, are perceived as important targets for individual and collective action to scientists and policy-makers. A relational analysis of programmes in a given sector, either over time or at a given time, provides a mapping of opportunities for and constraints to socio-technical change available to actors in that sector.

In terms of lessons for policy practice, these results highlight the inescapable partiality of much policy-making for STI. Policy-makers that are better aware of the broader alliances in which they evolve may be in a better position to identify blind spots in their own designs and interpretations. At the same time, these results destabilize any easy diagnostic of inefficiency sometimes assigned to STI policy-making. STI policies are systematically mobilized in producing change at the experimental and organizational levels, but the ramifications of policies are rarely straightforward and linear.

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2.4.2 Policy instrument affordances: A framework for analysis of research policy

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Keywords: policy instruments, affordances, policy design, research policy, impact

The purpose of this paper is to provide a theoretical framework for understanding how characteristics of policy instruments limit or extend policy action. The paper develops the notion of 'policy instrument affordance' to account for how policy instruments influence their targets. Policy instruments promote or inhibit certain types of actions depending on the context and the actors on which the instrument operates. Instruments have intended and unintended consequences as well as overt and latent functions. One of the functions of policy theory is to elucidate the ways in which instruments drive action and under what conditions. Programme theory, logic or effect models in turn assume certain mechanisms of influence from intervention, to actions to impacts and so forth. The actual mechanisms operating in the interface(s) between an instrument and the target community have normally been intuited on folk psychological grounds and not conceived of from the point of view of a coherent theory of how such influence occurs. In order to conduct this type of analysis one needs a concept of the causal efficacy of instruments, that is able to capture the mutual shaping of instrument, context and actor, without sacrificing conceptual clarity and cohesion.

This paper draws on previous research on affordances of objects and technical artefacts to offer a theoretical framework for analyzing policy instruments from this perspective. We posit that by conceptualising policy instruments as technologies of governance, one could successfully extend the concept of technology or object affordances to achieve a deeper understanding of how policy instruments work. This understanding can improve policy learning by allowing policymakers to get a better grasp of how specific contextual circumstances influence the performance of an instrument. We take as a premise that the impact(s) created by a given instrument are the results of the combination of (i) the properties of the instrument, (ii) the context of the target community to which the instrument is addressed, and (iii) the target community's own propensities to act in particular ways (e.g. given certain desires, beliefs and opportunities that they may have). Although the reach of an instrument is mediated by the properties of the context and the target community, the instrument itself can be said to drive action in a certain way, because of its constitutive qualities, which are activated and circumscribed by context and actor responses. The concept of instrument affordances can be used to explicate these constitutive qualities. There are several aspects of our approach that are reminiscent of early discussions about the transfer/diffusion of technologies of production (Fu, et al. 2011; Hoekman, et al 2004). However, while there is a wealth of research about technology diffusion and some general frameworks of explanation (Arrow, 1969; Keller, 2004), work on the transfer of technologies of governance has given rise to few attempts at generalised frameworks of analysis (Hood, 2007; Howlett, 1991).

The paper takes research policy practice as its primary empirical referent, although policy instruments may be found in all public sector endeavors. Research policy is particularly interesting as a reference point because governments are currently seeking and finding new socio-economic uses for science. Additionally, policy learning and networks for facilitating learning are now more prevalent than ever in research policy as a result of increasing internationalization and multilevel governance (Henriques and Laredo, 2013). Governments' increasing determination to harness the benefits of science to promote economic growth has, in almost all countries, issued into instruments designed to steer the sector in various directions ranging from national evaluations such as the UK's Research Excellence Framework to ubiquitous schemes for promoting excellence. Due to its current experimental mode of operating, and the relative ease with which to circumscribe its target (the science system), research policy is emerging as a sector par excellence for illustrating the issues described above.

2.4.3 Impact and outcomes of the ERA-NET in the 7th Framework Programme: Some observations from survey data

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Keywords: Transnational Research Programmes, ERA-NET in FP7, Impact and Outcomes, Alignment, Coordination, Monitoring and Evaluation, Training

Introduction

Research and scientific endeavour have always been international in nature. Transnational research is becoming the norm in large (big) science projects and it is also increasingly used as a science policy tool (Georghiou, 1998). In this respect, in the 6th Framework Programme the European Commission launched the ERA-NET scheme (2002) in support of coordination of the various national research programmes in the European Research Area. In the 7th Framework Programme the ERA-NET was further extended while a complementary scheme, ERA-NET Plus, was launched rewarding the networks that proceeded into launching calls with a top-up contribution from the EC. In Horizon 2020 the scheme was further revised and finalised in the format of the ERA-NET Cofund.

The scope of the ERA-NET in the 7th Framework Programme was that of developing and strengthening the coordination of national public research programmes through the implementation of public partnership for developing joint research activities through transnational proposals.

'Owners' of the programmes are the participating national and regional authorities and/or the programme managers. These include Ministries and regional authorities for setting up the agenda and research councils or other public research organisations to manage the programme and provide funding.

The aim of the paper is to highlight how the objectives of the ERA-NET transcend the basic characteristics of scientific endeavour in terms of research excellence whilst they are ground on fostering the exchange of good practices, define and implement common research activities and funding transnational research. Therefore the main focus will be on those behavioural impact and outcomes of the scheme that tend to improve intra-ERA science cooperation through opening up national systems to transnational cooperation, increase the overall 'quality' of research projects, introduce new common research areas and involve new researchers in the process.

Insights from the literature

Leydesdorff and Wagner (2005) argue that international research collaboration seem to be a self-organising process that is determined by individual scientists collaborating with each other. However, this type of collaborations can be strengthened through institutional support by establishing, for example, large-scale big-science projects or facilities, or team and interpersonal collaborations (Wagner, 2002).

There are two main forces at play during transnational research collaborations. Nedeva (2013) highlights that challenges emerge from trying to alleviate the tension between inherently global research fields and nationally bound research spaces. The globalisation of research can be identified through the increased level of international collaboration in research, cross-country co-publishing and citations, the proliferation of international research associations, international conferences, international journals and international facilities and organisations. At the same time, research spaces are national and share significant differences in relation to levels and modes of financial support, in terms of organisational set-ups, and accountability and evaluation systems. Studying the types of structures, interactions and coordination modes amongst research systems, funders and performers, Lepori (2011) highlights challenges in coordinating the organisation of research at the national level. In a transnational setting Nedeva (2013) notes that the level of alignment of national research spaces frames the extent to which the establishment of European level organisations with a clear identity would be possible. In other words, a European Science system may be emerging when the various national research systems would eventually align in terms of overarching organisational structures and funding.

Studies in these areas are pointing towards a complex intertwining of issues with regards to integration of national joint programmes (Lepori et al, 2014), openness of national research systems to transnational cooperation (Primeri et al, 2014) and the intrinsic characteristics of the various research systems in fostering openness (Cuntz and Peuckert, 2015). Here we take a practical approach to examine which activities conducted through transnational collaborative networks organised under the ERA-NET scheme may support openness to transnational projects, integration of national programmes, higher 'quality' research and researchers according to the experience of participating organisations.

The data

The study is based on a dataset obtained by collating different sources. The main set consists in the survey data conducted by the JRC – Growth and Innovation (IPTS), the 'NETwatch Survey' (Doussineau et al, 2014). Survey data have been integrated with information on the Networks, Organisations, and the Calls launched by each Network.

Our investigation concerned with the benefits realised by the respondent organisations participating to the ERA-NET in terms of:

1. Support to transnational projects;
2. Opening up to transnational cooperation of national programmes in existing or new research areas;
3. Higher quality projects funded at the national level
4. New types of research projects funded
5. Researchers with no prior international or European experience benefiting from joint activities.

The variables used to evaluate the benefits in participating in ERA-NET are linked to 1) strategic planning; 2) coordination 3) monitoring and evaluation and 4) training. These variables are related directly to the benefits accrued by the organisation, the independent variables instead concern i) activities undertaken by the organisation within the ERA-NET and ii) Activities undertaken by the ERA-NET. The Idea is to assess whether the organisation benefits from participating to the ERA-

NET on the basis of the activities conducted (ORG-ORG) and/or they accrue benefits from participating to the ERA-NET independently on whether the organisation was directly involved in such activities or not (ORG-NTW).

A number of co-variates were also included. These include the size of the networks in terms of budget and number of participating organisations and number of countries, the activities of the networks in terms of time in operation, calls issued, proposals received and proposals selected.

The model used for the estimates is the proportional odd model (ordinal regression) since the dependent variables are ordinal. The link function used is logit (main effect).

Preliminary findings

We look at the 'origin' of these benefits and the factors that have contributed to achieve them in the opinion and experience of the respondents. To do so, we ran 5 ordinal regression models in order to look at which factors (activities carried out by the organisation within the ERA-NET) affect the realised benefits (ORG-ORG models). We then compared the results with the relative ordinal regressions considering the factors that have been undertaken within (or by) the ERA-NET but not necessarily by the organisation (ORG – NTW models).

Support to transnational projects

(ORG-ORG) Controlling for the average number of proposals funded per each call, organisations entertaining activities of 1) establishment of common multinational proposal evaluation procedures; 2) development of common funding rules for transnational projects and 3) joint monitoring of transnational projects within the network increases the cumulative odds of scoring higher achieved benefits from participating in the ERA-NET by 2.555, 1.950 and 3.721 respectively.

(ORG – NTW) Controlling for the same covariate, the benefits perceived by the organisations is sensitive on whether the activities are undertaken by the organisation within the network or by the network. In fact, the first two variables are not significant. Monitoring of transnational projects is however statistically significant (at the 5% level) and the odd ratio is 2.421.

Opening up to transnational cooperation of national programmes in existing or new research areas;

(ORG-ORG) Having controlled for the number of countries participating in the ERA-NET, organisations participating to design and implementation of 1) schemes for joint training activities and 2) specific cooperation agreements or arrangements between participating programmes increases the cumulative odds of scoring higher achieved benefits from participating in the ERA-NET by 2.654. Moreover, organisations operating in countries where the national programme is complemented by the ERANET, increases the cumulative odds of scoring higher achieved benefits from participating in the ERA-NET by 3.040.

(ORG – NTW) Evaluating the benefit accrued by the organisation on the basis of the activities carried out by the ERA-NET (independently on whether the organisation undertake such activities or not) it emerges that 2) specific cooperation agreements or arrangements between participating programmes contribute to the likelihood of cumulative higher scores for benefits perceived by the organisations (p-value <0.05 and Odd ratio of 2.050)

Higher quality projects funded at the national level

(ORG-ORG) Having controlled for the duration of the ERA-NET, organisations participating to design and implementation of 1) Schemes for personnel exchange; and 2) Development of common funding rules for transnational projects increases the cumulative odds of scoring higher achieved benefits from participating in the ERA-NET by 2.225 and 3.320 respectively.

(ORG – NTW) Evaluating the benefit accrued by the organisation on the basis of the activities carried out by the ERA-NET (independently on whether the organisation undertake such activities or not) it emerges that 1) Schemes for personnel exchange; and 2) Development of Common Funding Rules for Transnational Projects contribute to the likelihood of cumulative higher scores for benefits perceived by the organisations with Odd ratio of 2.136 (p-value <0.05) and Odd Ratio of 2.291 (p-value<0.01) respectively.

New types of research projects funded

(ORG-ORG) Having controlled for the Number of Proposals funded per call, organisations participating to the establishment of common, multinational proposal evaluation procedures; increases the cumulative odds of scoring higher achieved benefits from participating in the ERA-NET by 2.212. Moreover, organisations operating in countries where the national programme is complemented by the ERA-NET, increase the cumulative odds of scoring higher achieved benefits from participating in the ERA-NET by 2.790.

(ORG – NTW) Evaluating the benefit accrued by the organisation on the basis of the activities carried out by the ERA-NET (independently on whether the organisation undertake such activities or not) it emerges that the Establishment of common, multinational proposal evaluation procedures contributes to the likelihood of cumulative higher scores for benefits perceived by the organisations with Odd ratio of 2.048 (p-value <0.05).

Researchers with no prior international or European experience benefiting from joint activities

(ORG-ORG) Having controlled for the average number of proposals funded per call through the ERA-NET, organisations participating to design and implementation of 1) Action plan taking up common strategic issues / preparing joint activities; and 2) joint monitoring of transnational projects increases the cumulative odds of scoring higher achieved benefits from participating in the ERA-NET by 2.883 and 2.872 respectively. Organisations having larger experience in ERA-NET (in the 6th Framework programme and/or through ERANET+) increase the likelihood of cumulative higher score for benefits by an odd ratio of 3.130 (p-value<0.01). Moreover, synergy between research activities conducted within the ERA-NET and through national research programmes increases the cumulative odds of scoring higher achieved benefits by an odd ratio of 3.737 (for low synergy) and 3.861 (for some synergy) relative to the highest level of synergy taken as a reference category.

(ORG – NTW) Evaluating the benefit accrued by the organisation on the basis of the activities carried out by the ERA-NET (independently on whether the organisation undertake such activities or not) it emerges that Joint Monitoring of transnational projects contribute to the likelihood of cumulative higher scores for benefits perceived by the organisations with Odd ratio of 4.195 (p-value<0.01).

Some considerations

Overall, in the 5 areas considered, participating to the activities of the network contributes to the realisation of higher benefits for the organisation. This means that the majority of the benefits accrued by the organisations towards the objectives of the ERA-NET in the 7th FP may be dependent from the direct involvement of these in the specific activities carried out within the network. These activities involve the establishment of common multinational proposal evaluation procedures; development of common funding rules; joint monitoring; schemes for joint training activities; specific cooperation agreements or arrangements between participating programmes.

In some cases and only by a limited extent, participating organisations can achieve some form of benefits only by virtue of being part of the network i.e. limiting their activities to 'ratifying' the decisions, plans or processes established by the network.

These observations hold across the various thematic areas of the ERA-NET. No substantial/significant differences were found.

From the survey data it emerges also that a ‘learning effect’ may be at play providing additional benefits to the organisations involved in the networks; however, the results were not clear and therefore we did not report them in this abstract. This is likely due to the nature of the data since it would be difficult to find a consistent effect on organisational learning from the analysis of a cross-section. Therefore, further investigations are warranted in this area.

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2.5 Session 2.5

2.5.1 Social science research in the field of environmentally friendly energy – the importance of dedicated funding streams for knowledge production

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Keywords: Research funding; Environmentally friendly energy; Methodological approaches; Research policy; Research content

This paper analyses the importance of dedicated funding streams for scientific knowledge production in the field of social science energy research in Norway – addressing *environmentally friendly energy* issues in particular.

Background

Addressing climate change is one of the grand societal challenges of our time. The transformation of our energy system towards more sustainability can contribute to tackling climate change.

Energy studies in general have been central in many parts of the Norwegian research system, but mainly technological studies and to a limited extend in social sciences, including economics. The limited attention by social science is rather peculiar since Norwegian social science research is rather well developed also in an international comparison. However, the importance of energy issues in other fields of the research system such as technology studies can be explained by two major features of the Norwegian economy: Firstly, the dominating position of renewable electricity production via hydropower over many decades for the Norwegian economy, allowing rather low electricity prices but also preparing the ground for energy-intensive industries, such as aluminium processing industry or solar photovoltaic industry. Secondly, the oil and gas sector has provided through income from exports of the fossil resources but also through export of services a major financial source for the Norwegian welfare state.

With the transformation from a fossil-based society towards a sustainable economy this oil and gas sector is declining and new fields of economic activity have to be developed, building on the existing strength of the Norwegian society, including competencies and energy production and distribution. Here policy is required to set the direction of the transformation process, going much further than traditional policy of market failure fixing (Mazzucato 2016) or structural system failures (Klein Woolthuis, Lankhuizen, and Gilsing 2005). Such a transformation requires clear guidance and political prioritisation, showing the direction of the envisioned transformation and setting priorities for this development, understanding demand-side developments, the need for policy coordination and reflexivity (Weber and Rohracher 2012).

Social science research can contribute to such processes. Covering human and societal aspects of energy issues was raised in a number of broad policy processes and agreements, for instance in the OECD Green Growth Strategy from 2011 (OECD, 2011) and in the Lund Declaration from 2015. These concerns regarding the role of social sciences in energy research have also been raised in connection with Norwegian policy processes.

Research focus

In our paper, we want to analyse the development of a growing research field in the light of research policy funding schemes over the 1999-2014 period.

The following policy oriented research questions will be addressed:

I. Why have the funding agencies prioritised social science for environmentally friendly energy and how has this changed over time?
II. How important are national and international research grants for the development of social science research groups specialised in environmentally friendly energy in Norway?
    a. Importance of *priority shifts* in the funding agencies for shifts of the content of the research groups
    b. Importance for *shifts of collaboration pattern*s
    c. Importance for *disciplinary or interdisciplinary research*

The paper will contribute to the debate on social science energy research and relevant methodology for this (Sovacool 2014; Sovacool et al. 2012; Gläser and Laudel 2016).

Methodology and data

The data for our paper has been gathered during two projects addressing social science research on sustainable energy resulting in two reports (Klitkou et al. 2010; Ramberg et al. 2016). For the purpose of this paper we have focus on the role of the changed funding policy for the observed changes of the research. Such changes encompass research collaboration patterns, the disciplinary background of the involved researchers and the focus of the published papers.

The paper is based on a mixed methods approach: beside quantitative methods like analysis of funding streams, bibliometric analysis, content analysis and social network analysis are combined with a qualitative approach based on interviews with central research actors and representatives from central funding agencies. One point of departure for this paper is Gläser & Laudels (2016) review of science policy studies and contributions of sociology of science to the study of How Science Policy Shapes Research Content. Their discussion of the state of the art points to “a need for revision of both methodologies and theories addressing the impact of specific practises and instruments of governance of research content”. They see the need for more collaboration between the two research fields above as well as with bibliometrics to analyse “the micro-macro link between individual knowledge production and the knowledge dynamics in scientific communities”.

The changes in the funding streams are analysed by tracing funding for social science research from national sources and international sources. In the analysis of funding streams we combine both R&D statistics, register and survey data. In a specially designed enquete to the researchers we also include disciplinary background in addition to the institutional affiliation in order to assess interdisciplinarity of the research.

The motivation for the changed priorities of the national and Nordic funding agencies are explored through document analysis and supplementary interviews.

We analyse *scientific knowledge production in this field by identifying relevant scientific publications* in the database for scientific publications Thomson Web of Knowledge, concentrating on a selection of journals, by analysing *the content of the published papers* and by analysing *the cooperation patterns behind these publications*. The analysis of cooperation patterns has been conducted with social network analysis. We identify the ten most central research organisations in this field and interview central researchers from these organisations.

Our current research of the content of the publications has both a more comprehensive and a more focussed mission than Sovacool, 2014, when we describe the content of the research in this emerging field, and at the same attempt analyse the micro-macro-link to the funding streams for the new research field in Norway.

Expected outcomes

For addressing the transformation of the energy system and in accordance with the so-called Climate Agreement in 2008 the Research Council of Norway established dedicated research programmes for environmentally friendly energy, Renergi and later Energix, centres for environmentally friendly energy (FME). The programmes explicitly encouraged also social science research and in 2011 three FME centres were established following the earlier eight technology focussed centres.

Our analysis indicates a clear expansion of the research activities within social science on environmentally friendly energy in Norway. Along with this expansion we also observe a higher degree of cooperation and a more mature network of collaborating institutions.

We find a marked growth in the number of articles published, from less than 50 articles in the 1999-2008 period to over 200 articles over the last period covering 2009-2014. This expansion seems to concur with the general increase in Norwegian investments in the field of renewable and environment friendly energy.

On an aggregate level, we find that approximately 25 per cent of total R&D spending in Norway is related to energy issues in general. Not surprisingly, petroleum related R&D stands out as the most important form of energy in this context, especially in industry, but also to a large extent in the research institute sector. R&D related to renewable energy is mostly conducted in the research institute sector.

If we focus on *R&D related to environmentally friendly energy*, we find that social science constitutes just 7 per cent of the energy-related R&D in the institute sector and 14 per cent in the higher education sector.

The scientific collaboration has evolved rapidly over the last fifteen years. From a very fragmented and more or less national scenery the Norwegian research organisations active in the field have developed both national and international linkages. The main explanation for this rapid change is networking through FME centres. Direct collaboration between the main Norwegian universities is less prominent, while a number of the most central research institutes collaborate with different Norwegian universities. The SNA shows also that involvement of business actors or other types of non-academic actors is much less prominent in social sciences on energy research. This remains an untapped resource for the Norwegian researchers.

NTNU stands out as the most important Norwegian institution in this field of research, followed by NMBU. A number of research institutes also play a central role, both individually and as important “bridges” in the national networks of collaboration.

Economics seems to be the sub-discipline of social science which is most frequently associated with energy research. This appears both from the bibliometric analysis and from the study based on R&D-statistics. The dominance of economics in the social science research on environmentally friendly research confirms findings of Sovacool (2014). Transformation studies on environmentally friendly energy are still less prominent in our sample. Hence the contribution to policy development is still limited.

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2.5.2 Funding Instruments and the Institutionalisation of new norms in research systems

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Keywords: Funding, cross-sectoral mobility, humanities, social science, corporate

The purpose of this paper is to analyse the contribution of funding to the institutionalisation of new norms or behaviours in research systems. The paper is a qualitative deep case study of a funding initiative directed at scholars in the HSS area and intended to persuade them to engage in collaborative research partnerships with corporate and other societal actors. The research is based on semi structural interviews with the funded researchers and with the funding agency. The paper finds that participation in this funding arrangement provided researchers with valuable experience in collaborative research while at the same time deepening their commitment to remain at the university. The paper provides additional qualitative insights into the factors that drive HSS-societal research collaborations.

2.5.3 External research funding instruments and novelty in university research - Findings from Finland

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Keywords: Research funding, Funding instruments, Novelty, Excellence, Ground-breaking research, Finland, Research policy

Recently societal expectations for university research have grown, one manifestation of which is the increasing call for scientific excellence: attainment of 'world-class excellence' and production of 'ground-breaking' or 'frontier research' (OECD 2014; Langfeldt et al. 2013). At the same time, university research has become ever more dependent on external funding sources. This change has taken place gradually during the last two or three decades across many countries (e.g. Bloch & Sorensen 2014).

Given the growing importance of external, project-based funding and the increasing stress on excellence or even ground-breaking research at universities, it is important to examine how university researchers are using different types of research funding sources and what kinds of conditions these sources provide for the researchers. To what extent to do the existing funding channels provide the means to attain 'frontier reseach'? Furthermore, as research funding agencies, instruments and schemes are often studied and assessed individually ("in isolation"), there is a lack of a more systemic understanding of what kind of an entity the different funding instruments form as a whole from the researchers' perspective. Morever, our understanding on the role of research councils and research funding agencies more generally in funding new research avenues in terms of highly innovative research is scarce (Heinze et al. 2009, 613).

This paper examines the use of external project-based research funding instruments by researchers at Finnish universities. The main focus here is on aspects of novelty and creativity in research and on how different research funding instruments promote these aspects. We seek to answer the following questions:

- What kinds of conditions different research funding instruments set and create for researchers to carry out research?
- How and to what extent do different research funding instruments enable, facilitate or encourage research that can lead to discoveries with important industrial, economic or social implications?
- To what extent are the studied funding instruments able to promote highly innovative ideas in research?

At present many research funding agencies aim at funding highly innovative, or even ground-breaking, research. However, it is a complex issue what kinds of funding instruments and related grant conditions actually provide researchers with such circumstances that are inclined to lead to excellence in terms of high-risk and path-breaking research (Bloch and Sorensen 2014; Laudel & Gläser 2014). Previous studies provide some insights into this question, suggesting elements that may be conducive to innovative research, such as:

- Leeway. Many studies suggest that freedom to define and pursue individual scientific interests is central for scientists to be "highly creative" (e.g. Heinze et al 2009, 616). For external project-based funding at universities that implies that researchers' ability to define the research question and problems of the project is highly significant in terms of its innovativeness. Furthermore, it has also been pointed out that ground-breaking research calls for freedom and flexibility also during

the project, so as to enable scientists to seize up-coming openings, and, if needed to chance original research plans (e.g. Zoller et al. 2014).

- Stability. Stability refers to the duration of the funding as well as to the possibility to renew the grant. Stability of funding has been found to be highly significant from the researchers' perspective as it allows continuity and enables concentration and absorption to the research topic and data at hand (e.g. Bloch et al. 2016; Baillou et al. 2002). Accordingly, long-term stable funding seems to be connected with high-impact, 'explorative mode' research while short-term funding is inclined to lead to more risk-averse, 'exploitation mode' research (Heinze 2008, 303).
- New research lines. Innovative, path-breaking research is by definition a risky endeavour the results and outcomes of which are not known beforehand and highly uncertain (Luukkonen 2012). In order to carry out such research, scientists need to have the possibility to open up completely new research lines in the field of study, formulate novel ideas that open up new cognitive frames, to adopt and develop novel approaches and methods as well as to take risks. Ground-breaking research is characterized by new openings and opportunities of paradigmatic shift or a revolutionary change but includes always a high degree of uncertainty. However, such risky research may be difficult to get supported through external funding as new ideas may simply be "too new" (Laudel 2006) and due to the inherent conservative bias of the peer-review system leading to the situation where innovative, path-breaking research is not accepted by peers and hence eliminated (Linton 2016).
- Moving to new field. This refers to the possibility to move to a new research field in which the researcher does not have previous activity (i.e. "field-hopping"). Heinze et al. (2009, 619) noted in their study that scientific breakthroughs often take place through scientists moving to a new field or through integration of new fields to their previous area of research. However, getting into a new field may prove particularly difficult through external project-based funding as agencies' funding criteria often require that a researcher has track-record the given field to prove his or her credibility to study the particular topic (Laudel 2006).

Through these four dimensions, the paper examines and analyses the principal Finnish research funding instruments and schemes. The principal data for this study consists of 59 thematic interviews with research group leaders at universities in Finland. Interviews were carried out in six research fields (computer science, chemistry, cancer research, urban studies, energy research and archaeology) and seven universities (Aalto University, University of Helsinki, University of Turku, University of Jyväskylä, University of Oulu, Lappeenranta University of Technology, University of Eastern Finland). When choosing the objects of study, the aim was to provide diversity of different science fields and organisations. In addition to the interviews with research group leaders, 20 interviews with representatives from research funding agencies, science policy administration and university administration were carried out in order to gain a deeper understanding of the research funding environment and changes therein as well as funding agencies' aims, funding criteria and requirements as well as procedures regarded funding they grant. Additionally statistical information and document material regarding the research funding system have been used in the analysis.

The study shows that the Finnish research funding system lacks a funder that would strongly encourage risk-taking and support novel approaches. Furthermore, there seems to be an overall increase of thematically predefined funding vis-à-vis free researcher-driven funding. In certain research fields and universities, it is felt practically impossible to obtain funding for "free", researcher-driven research. The paper also highlights that research at universities is practically only conducted through external funding. Research group leaders have to use increasing amounts of time and energy for securing funding for their groups. In some cases external research funding is also used to support teaching. This leads us ask whether this is situation sustainable and optimal from the perspective of research groups' possibility to carry out high-level, world-class research.

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3 Track 3: Policy Mixes and New Instruments for Transforming Innovation

Track 3 was organized by Karoline Rogge, University of Sussex, Florian Kern, University of Sussex, and Eva Buchinger, AIT Austrian Instiute of Technology, Center for Innovation Systems & Policy, and included four Sessions.

Within innovation studies, there has recently been an increasing interest in policy mixes with several contributions published in Research Policy (Flanagan et al. 2011; Magro and Wilson 2013; Quitzow 2015; Kivimaa and Kern 2016) and other innovation studies journals (Borrás and Edquist 2013; Reichardt and Rogge 2016; Reichardt et al. 2016; Uyarra et al. 2016). Policy mixes can be understood as “complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years” (Kern and Howlett 2009: 395). While it has long been acknowledged that a combination of technology push and demand pull instruments is required for stimulating innovation (e.g. Freeman 1987, OECD 1999, EC 2003, Aho et al 2006, Aschhoff and Sofka 2009), how such instruments interact and form policy mixes has only recently become of interest to the STI community (e.g. Nauwelaers et al. 2009, Flanagan et al. 2011). There is also an emerging discussion on the need for systemic instruments to address grand societal challenges (Wieczorek and Hekkert 2012, OECD 2015a) or the need for novel STI policies to foster transformative innovation (Schot and Steinmueller 2016, Edler and Yeow 2016).

It has been increasingly pointed out that today’s grand societal challenges, such as addressing health, climate change, and security, call for new approaches to design and combine policy instruments (Bason 2014, Carstenson and Bason 2012, Kimbell 2015, Tonurist, Kattel and Lember 2015). More specifically, it has been argued that policy mixes are required in order to address not only traditional market failures such as underinvestment in R&D or negative environmental externalities such as greenhouse gas emissions, but also structural and transformational system failures, such as institutional failures or failures regarding guiding the direction of a transformation process (Weber and Rohracher 2012). However, the majority of academic contributions so far focused on policy mixes as portfolios of instruments originating from various governance levels and policy fields, paying particular attention to interactions between instruments (del Rio 2014, Guerzoni and Raiteri 2016). Yet, in the context of transformations 2 (or what the OECD calls system innovation), a broader perspective on policy mixes has been proposed (Weber and Rohracher 2012; Flanagan et al 2011; Rogge and Reichardt 2016).

This has a number of implications for policy mix research in the context of transformative STI policy: First, the need for steering the direction of innovation is argued to require greater analytical attention to credible long-term policy strategies, such as the recent Paris Agreement on limiting global warming, and their role in redirecting corporate innovation strategies (Schmidt et al. 2012; Rogge et al 2011). Second, studies have argued for greater attention to the policy processes through which such policy strategies, targets and instruments come into being, both because of their explanatory power regarding the design of policy mixes and due to their direct influence on innovation processes (Boekholt 2010; Chung 2013; Williamson 2015). Third, attention has also shifted to the co-evolution of policy making and technological change and thus to dynamic changes in policy mixes (Hoppmann et al., 2014; Reichardt et al. 2016). Forth, there is also a critical appreciation that real-world policy mixes may never be completely consistent and coherent but that policy makers should strive for an increased coordination across policy levels and policy fields to improve the effectiveness of these mixes for stimulating innovation (Flanagan et al. 2011; Kern et al. 2017). Fifth, it has also been argued that in the context of grand societal challenges innovation policy mixes aiming at structural change within a sector such as energy, transport, and health may need to pursue simultaneously the ‘creation’ of new innovations as well as the ‘destruction’ of incumbent systems (Kivimaa and Kern 2016). Sixth, because of the inherently ‘experimental’ nature of STI policy new practices and models focusing on inclusive policy making and co-creation are seen as a promising new avenue to achieve robust innovation policy results for growth, jobs, and welfare (OECD 2015b; OECD 2016).

This research session aims to bring together papers which address such a broader policy mix perspective for transformative STI (including novel STI instruments) and as such specifically calls for contributions addressing the following topics:

- Conceptual improvements of policy mix thinking: How can we better conceptualise policy mixes for system innovation and go beyond an understanding which purely focusses on desired combinations of instruments?
- Policy mix characteristics: Which influence do broader characteristics of policy mixes, such as their consistency, comprehensiveness, credibility or coherence have on STI?
- Directionality of policy mixes: What is the role of long-term policy targets and their credibility for innovation processes? How can governments improve the perception of the credibility of policy signals by innovators? How do companies make sense of conflicting policy signals and how does this influence their innovation strategies?
- Co-evolutionary dynamics of policy mixes: How do policy mixes emerge over time, how do they impact on STI, and how do these impacts influence the further evolution of policy mixes?
- Next generation innovation policy instruments: Which new instruments could be utilized to consider the changing relationship between citizens, science, industry, and policy? What is the potential of demand-side measures such as innovation procurement, regulation and standards and how can demand-side and supply-side policies be integrated in an effective policy mix? How can co-creative and inclusive mechanisms such as innovation policy labs, sandboxes and incubators facilitate the match between supply and demand for innovative ideas?
- Assessment of instrument interactions: How to analyze the effects of simultaneously existing policy instruments and the feed-back loops between them in innovation ecosystems? How do next generation innovation policy instruments interact with other measures within the policy mix?
- Policy processes and policy mixes: What can STI scholars interested in policy mixes learn from the policy studies literature? How can we analyse the politics of policy mixes aimed at addressing transformative change? Which implications can be drawn for managing resistance to change?
- Institutional implications of policy mixes: Which implications result from the complexities arising from policy mixes for innovation for institutional designs, administrative capacities, and policy learning across multiple jurisdictions?
- Policy mixes for creative destruction: Which role do policies aimed at phasing out undesired technologies or practises play for innovation in competing alternatives?
- Methodological novelty in analysing policy mixes: Which research designs, novel qualitative and quantitative methods, new data sources and operationalisations of policy mixes are best suited to studying policy mixes and their role in transformative innovation processes? Which are useful approaches for boundary setting and establishing causal relationships between policy mixes and innovation?

We invite conceptual as well as empirical papers which address any of the questions raised above.

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3.1 Session 3.1

3.1.1 Co-evolutionary dynamics of policy and system development: the case of marine renewable energy technologies

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Keywords: Sociotechnical transitions, Policy mixes, Policy change, Niche development, Non-linearity, Renewable energies

The transition to a sustainable energy system is a major societal challenge requiring profound transformations in existing socio-technical systems (Markard et al, 2012). These processes have been addressed by the sociotechnical transitions literature that called the attention to the role played by radically new technologies, being developed in niches, which have strong transformative potential (Kemp et al, 1998; Schot and Geels, 2007). These technologies and the socio-technical systems developing around them often need temporary protection against the selection pressures of the established regimes (Smith and Raven, 2016); and supportive policies are a fundamental mode of protection (Kivimaa and Kern, 2016). In the case of sustainable energy technologies, policy support is further justified by the need to accelerate the transition process (which is usually a long term process), given the urgency of fighting against climate change (IPCC, 2014).

The process of sustainable energy transition has been characterised by the emergence of a variety of renewable energy technologies evolving at different paces (Ellaban et al, 2014), which co-exist but also compete for attention and resources (Verbong et al, 2008). This variety has implications for policy, since the definition of supportive policies involves decisions regarding the role played by different renewable technologies in a broader policy strategy, and regarding the definition of a mix of policy instruments that takes into consideration the specific requirements of individual technologies, but also accounts for the complementarities between them (Rogge and Reichardt, 2016). The outcome of these policy making processes has consequences for the development of the new socio-technical systems being built around the different technologies. Thus, in order to understand how policies can

contribute to the development and eventual take-off of sustainable energy technologies, it is necessary to gain a better grasp of the processes that influence the definition and change of the policy mixes addressing them.

The innovation policy literature has increasingly pointed out that policy making is influenced by a variety of factors and shaped by a multiplicity of actors, internal and external to the policy space (Flanagan and Uyarra, 2016). Given the emergent nature of the technologies (and of the policies supporting them) policy making is also a dynamic and potentially non-linear process, where changes in actors' expectations/perceptions about the technologies (Bakker and Budde, 2012) or actual changes in technology/niche trajectories (Geels and Raven, 2006), can have important impacts upon decisions regarding (modes of) policy support.

Against this background the paper proposes that an understanding of the process of policy definition and change will require examining three interrelated dynamics: i) the impact of policies on the conduction of the socio-technical processes that can drive niche development and breakout (Rothmans et al, 2001); ii) the impact of niche-level processes on policy making - either directly through niche actors purposive advocacy (Raven et al, 2016), or indirectly through the way niche trajectories affect policy makers perceptions of technologies' growth potential and/or contribution to broader economic and social goals (Normann, 2015); iii) the impact of "external shocks", e.g. events originating in parallel niches, in contiguous systems, or at the landscape level that may have unanticipated effects, inducing changes in system development trajectories and/or in policy makers views (Hoppman et al, 2014). In other words, it is necessary to address the co-evolution between policy making processes and system building processes and the ways they affect each other. However, while the co-evolution between policy making and technological change is increasingly referred in innovation policy research (cf. this call), empirical analyses that address such co-evolution and provide an understanding of the actual processes taking place and the type of factors that shape them, are still scarce (e.g. Hoppman et al, 2014; Reichardt et al, 2016; Matti et al, in press).

The paper addresses this gap. It analyses the process of formulation, implementation and change of a policy mix aiming at fostering the development and diffusion of marine renewable energies, focusing on the interplay between the processes that took place at policy level and the dynamics of the niche(s) where technologies were being developed. The objective is to investigate how such interplay can contribute to explain a cycle of policy support, policy divestment and policy re-orientation; and its impact on the non-linear development of a new socio-technical system. These processes are also positioned in an context characterised by the presence of other renewable technologies, discussing both the influence on policy formulation of previous experiences with a more mature technology, and the changes induced by the emergence of a new technology that share the same space.

In order to investigate the interplay between the policy making process and the building of the new socio-technical system, the paper combines theoretical contributions from socio-technical transitions and policy studies. Regarding the former the paper draws on the strategic niche management literature, in particular recent advances to this literature which address the processes that enable niche development and breakout (Geels and Raven, 2006; Smith and Raven, 2012; Kivimaa and Kern, 2016). Regarding the latter, the paper draws on broader conceptualisations of policy mix for sustainability transitions that integrate policy strategies, instrument mixes and policy processes (Rogge and Reichardt, 2016); as well as on critical approaches to innovation policy that highlight its emergent and complex nature (Flanagan and Uyarra, 2016). Following both streams, particular attention is given to policy processes and, in particular, the role played by a multiplicity of actors, with diverse interests and positioning, on the conduction of these processes. To strengthen this approach, we also draw on contributions from the policy studies literature that address actor roles in policy making and in policy change (e.g. the advocacy coalitions framework: Sabatier and Weible, 2007; Markard et al, 2016) and from the literature on expectations (Bakker et al, 2011; Bakker, 2014), as well as on insights from cognitive psychology on sense-making and creative adjustment processes (Perls et al, 1951).

The empirical research focuses on the processes that took place, over the past two decades, aiming at building an "ocean energy system" in Portugal. Adopting an historical perspective, it examines the process of policy mix formulation, implementation and change; and confronts it with the process of

construction of a wave energy technological niche (emergence, apparent take-off, hype, decline and slow recovery), and with the sudden emergence of a competing/complementary technology - floating offshore wind - and its subsequent take-off. The analysis of the policy making process is based on policy documents and interviews (conducted in 2015-2016). It examines: the early strategy definition; the design of a purportedly “systemic” instrument mix; the difficulties confronted with its implementation; the partial abandon of the “systemic” approach; and a substantial policy re-orientation. The analysis of the system dynamics draws on and extends previous research on the development trajectory of wave energy and offshore wind (Fontes et al, 2016; Bento and Fontes, 2017). The research identifies and attempts to explain key turning points, focusing on critical periods/events at policy and system levels, and on the behaviour of actors/coalitions of actors that had a role in policy definition and policy change.

The results show that the initial decision to support marine renewable energy technologies, the process of formulation and implementation of policy mixes, and the changes in level and modes of policy support were effectively subject to a variety of influences, internal and external to the “policy space”. They uncover a diversity of interactions between that “policy space” and the “socio-technical space” being built around the new technology, as well as between these and broader political or socio-economic developments. In particular, the research shows that policy processes “internal” to the policy space are in fact strongly influenced by processes taking place in the socio-technical space. These include the proactive behaviour of different groups of system actors (sometimes with divergent interests), who attempt to shape the policy making process by matching positive visions of future system development with broad policy goals; who act in answer to the announcement or the implementation of policies (or its lack) producing particular outcomes that may lead policy makers to adjust their perceptions on the (value of) the technology, or on the effectiveness of the policies; who attempt, over time, to capitalise on positive developments or to defuse the effects of the negative ones, including the impacts of “external shocks”, by interpreting and making sense of changing conditions, re-articulating expectations and lobbying towards the re-setting of policy agendas.

Overall, this case suggests that policy making to foster the development of new socio-technical systems is a more complex and non-linear process than it is sometimes assumed in the innovation policy literature. Not only policy level and system level processes are shown to be multifaceted and uncertain in their own right, but they also interact over time influencing (positively or negatively) each other dynamics. Moreover, the development of new socio-technical systems takes place in broader political and socio-economic spaces, which means that other dynamics and sudden external events can have unexpected effects on either policy making or system trajectory, introducing added complexity and non-linearity.

This paper adds to recent research that moves beyond the analysis of the impact of innovation policies on the development of new technologies, acknowledging that policies (both design and change) do not emerge from abstract processes, but are shaped by the interests and efforts a variety of actors from inside and outside the policy space. Thus, the paper answers to the call on the need to investigate “how do policy mixes emerge over time, how do they impact on STI, and how do these impacts influence the further evolution of policy mixes.” More generally, it adds to the broader debate on the co-evolution between policy making and technological change.

Finally, the paper brings into focus the frequently overlooked policy dilemmas associated with the presence of a variety of technologies that propose different paths in the process of sustainable transition, contributing to a discussion of how to integrate this variety into policy design.

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3.1.2 Mapping policy mix and innovation performance in energy efficiency for the residential sector: clusters and trajectories over the last twenty years in EU countries

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Conceptual framework

Energy efficiency is one of the core pillar of the EU energy and climate strategy. Accordingly, there is growing interest in understanding the role played by different combinations of the available policy instruments and innovation efforts in stimulating and directing technical change in this specific domain. In particular, the literature has recently focused on the role of policy mix, a concept that at its basics considers the combination of policies into a composite set, but that also includes the processes through which different instruments emerge and interact (Flanagan et al., 2011).

In the specific context of analyses of policy mix designed to promote eco-innovation, Rogge and Reichardt (2016) make an effort to clarify the meaning of the main characteristics of policy mix identified in previous literature, both with regard to policy processes and instruments combinations. In particular, regarding the instrument mix, they refer to its consistency when positive interactions between different instruments take place and to its comprehensiveness, defined as the degree to which the instrument mix addresses all the three policy purposes of technology-push, demand-pull and systemic concerns. These characteristics are expected to impact the performance of policy mix, though in a differentiated and context-specific way, depending on the features of each innovation system (Borras and Edquist, 2013).

Empirical studies that focus on the effects of policy mixes on innovation (Guerzoni and Raiteri, 2015) and in particular on eco-innovation performances (Reichardt and Rogge, 2016; Uyarra et al.,2016) represent a limited though rapidly expanding area of research. Following these contributions, here we propose a descriptive analysis based on a large sample of EU countries that aims to measure some significant characteristics of the policy mix and map European countries in terms of energy efficiency policy, trade and innovation dynamics over the past twenty years.

The empirical analysis we propose focuses on the case of energy efficiency (EE) technologies in the residential sector, which appears to be appropriate since a large number of different policies in several countries aims to enhance EE, especially by fostering the generation and diffusion of new technologies (IEA, 2015; Sovacool, 2009). In the examined case, the full range of demand-pull, technology-push, soft and systemic instruments are available and used in policy mix frameworks, allowing us to derive a comprehensive picture of the implemented policy mix across EU countries via the construction of ad hoc policy mix characteristics measures. Following Costantini et al. (2017), we first

focus our attention on the balance in the policy mix between demand-pull and technology-push instruments and, then, we move to the analysis of policy mix comprehensiveness in the policy domain of EE in the residential sector.

In particular, by applying a descriptive statistical tool as the cluster analysis, we map country groups according to several characteristics influencing energy efficiency dynamics. This clustering procedure is applied considering policy, trade, energy and innovation dynamics in the residential energy efficiency domain in order to investigate the co-evolution of policy mix and technological trajectories.

Furthermore, since the policy decisions adopted by other countries are likely to influence domestic innovation performance (Dechezleprêtre and Glachant, 2014; Peters et al., 2012), we map EU countries against similarity measures between domestic and foreign policy mixes. In this respect, the specific domain under scrutiny is particularly favourable in investigating also trade-related bilateral relationships since the standard SITC classification at 4 digits allows disentangling export flows of domestic electrical appliances that are subject to the policy mix here mapped.

Data and methodology

Data and indicators

The empirical analysis is carried out on a panel of 19 European countries[11] in the period 1990-2012. For all the considered countries, several variables representing the characteristics of national energy efficiency system have been included.

Innovation: following the contribution by Costantini et al. (2014), innovation in the EE domain is measured by the count of patent applications filed at the EPO by EU countries over the period 1990-2012 from OECD STATS. Accordingly, the patents included combine the technologies in the class Y02 of the Cooperative Patent Classification (CPC) with those relative to the residential EE appliances, thus including the following main technological domains: Insulation, High-efficiency boilers, Heat and cold distribution and CHP, Ventilation, Solar energy and other RES, Building materials, Climate control systems and Lighting. The selected patents applied to the EPO are classified by application date and assigned to the applicant’s country. When multiple assignee countries are present for a single patent, we have assigned a proportion of the considered patent to each country on the basis of the number of assignees for each country. Patents number is used to build different measures of technological comparative advantages (Archibugi and Pianta, 1996) and specialization (van Zeebroeck et al., 2006) in order to map the dynamics of EU technological trajectories over time.

Demand-pull policy: we consider the impact of energy taxation on the market price in energy demand for the residential sector as a price-based instrument. Data collected for such policy come from the Electricity and natural gas prices and taxes from EUROSTAT database for the residential sector and from the Electricity and natural gas consumption from EUROSTAT database. Since we are interested in capturing the role of this policy in affecting residential energy consumption and consequently favouring EE innovation, we calculate the average tax rate applied to energy consumption in the residential sector for each country and year as an ad valorem equivalent on energy market price.

Technology-push policy: this policy instrument is quantified by taking data on public R&D efforts in EE (expressed in million Euro at 2010 constant prices) taken from IEA Technology Statistics (IEA, online database) as stock of R&D expenditures according to the Perpetual Inventory Method with a 15% depreciation rate.

11 The 19 European countries included in the analysis are: Austria, Belgium, Czech Republic, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Slovakia, Sweden, United Kingdom.

EE policy instruments (including soft and systemic instruments): we collect information from the IEA database on Energy Efficiency Policy Online Database (IEA, 2016) in three sectors (buildings, lighting, residential appliances) for EU countries in the 1990-2012 period, classified in six types: Economic instruments; Information and education; Policy Support; Regulatory instruments; Research, development and deployment; Voluntary approaches. Considering the qualitative information of the IEA database, we have assigned value 1 if there is a policy for each country and year. The final measure is given by the sum of counts as the cumulative number of policy instruments in force at time t in country i. According to Johnstone et al. (2010), this modelling choice allows the whole range of policies still in force at time *t* in country i to be considered for each year and changes occurring to policies over time can also be accounted for.

Considering these information we build the following quantitative measures of policy mix characteristics:

Policy mix balance: the balance between demand-pull and technology-push instruments in the domestic policy mix is computed as the difference between these two policy domains.

Policy mix comprehensiveness: we proxy this policy mix characteristic by computing an aggregate stock of total policies for EE given by the sum of the stocks of policy instruments belonging to the whole range of policy types as obtained by the IEA EE policy database.

Bilateral export flows: country-pair trade relationships are taken from the UN-COMTRADE database and cover the class 775 of SITC Rev.3: Household-type electrical and non-electrical equipment, n.e.s. (Household-type laundry equipment, refrigerators and food freezers, Dishwashing machines, Shavers and hair clippers, Electromechanical and Electrothermic domestic appliances). Such data allow also building a set of trade-related measures according to the revealed comparative advantages approach as the Balassa indices, which could help shaping the dynamic clustering process of international economic competitiveness of selected countries.

Energy: we include several variables representing the energy country profile, such as national energy consumption, imports, energy efficiency measures and temperature. Furthermore, given the focus of the analysis, we also introduce specific information on the residential sector.

Finally, in order to analyse the intra-cluster relationships we build two further indicators: the intra-cluster policy balance similarity, which considers the policy balance distance between each *i-th* country and the other countries belonging to the same cluster, and the intra-cluster export share of energy commodities of each country.

Cluster analysis

We perform a cluster analysis applied to distinguished sets of indicators in order to group EU countries with respect to four main dimensions: policy mix, competitiveness, energy and innovation. Following the approach applied by Costantini et al. (2016), we perform a preliminary principal component analysis (PCA) to avoid potential correlations between variables. Then, each cluster analysis is conducted in two steps. The first one consists of a hierarchical cluster analysis that is needed to determine the optimal number of clusters. When the number of groups is defined, the second step consists of using the number of clusters to inform a non-hierarchical k-means clustering process (MacQueen, 1967) by imposing the number of clusters obtained in the first step. At the end of the process, the final composition of the cluster is achieved according to which we can map the EU countries based on different indicators and identify different country group characteristics. By graphically analyzing clusters in terms of countries belonging to groups obtained by a clustering process applied to different characteristics (e.g., policy mix features, technological specialization of international competitiveness) we shed lights on the co-evolution of policy mix and technological trajectories and the related energy and trade performances.

Results and policy implications

The empirical analysis is expected to provide different evidences that are capable of enhancing our knowledge on the characteristics and co-evolution of the energy efficiency system and map European countries in terms of four dimension (policy, trade, energy and innovation dynamics) over the past twenty years.

Firstly, the use of the aforementioned policy mix indicators allows us to identify the different characteristics of national policy mixes, highlighting that some countries are more technology-push oriented while, in others, the demand-pull component prevails. Considering that the balance between these two policy pillars emerged as a key characteristic to be addressed when designing policy mix (Costantini et al., 2017), this information appears to be relevant to evaluate the positioning of single countries with respect to this dimension. Similar conclusion also holds for the policy mix comprehensiveness indicator. However, there is a threshold level beyond which some negative interaction effects may occur as a result of policy fragmentation.

Furthermore, there is the evidence that there is not a direct relation between the degree of eco-innovation (in terms of EE patents) of a country and its degree of trade specialization in that field. This suggests the existence of value chains so that a part of Europe contributes to innovating and providing new technologies, while another part of Europe implements them to produce and export final commodities.

Finally, results appear to have interesting policy implications as positive spillover effects might arise between countries characterized by a similar policy balance and by a high level of bilateral trade. Indeed, when trade integration is coupled with a strong policy coordination, the effect of technological innovation patterns is not confined into the domestic borders but it reinforces among countries, due to the presence of knowledge spillovers.

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3.1.3 Governing the Evaluation of Policy Mixes in the Context of Smart Specialisation Strategies: Emerging Challenges

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Keywords: Policy-mixes, Smart Specialisation Strategies, Governance

While the policy mix concept has become popular in innovation policy literature as a result of new combinations of policy rationales and the corresponding broadening and deepening of innovation policy (Flanagan et al., 2011, Borrás, 2009), evaluating innovation policy mixes is a complex task (Magro and Wilson, 2013). Yet this complexity is more due to governance challenges than to specific technical issues related to the evaluation methods to be employed. As such one of the main challenges for evaluating policy mixes is to go beyond traditional (and often isolated) impact evaluations that search for optimum policies and by extension for an optimum policy mix. Indeed, an optimum policy mix is elusive precisely because it depends on the context in which the policies are embedded. That is to say, the behaviour of instruments and their impacts are conditioned by the context in which they are embedded, the policy framework and domains to which they are responding, and the specific place in which they impact. Above all, they are conditioned by the governance context through which policies emerge and evolve over time.

The importance of place and context for innovation policies can be appreciated in the shift in both literature and practice from spatially-blind innovation to place-based innovation policies (Barca, 2009; McCann y Ortega-Argilés, 2015). Place-based policies have been most clearly developed in the context of regions, in which the notion of geographical proximity is a key element in innovation processes as geographical closeness facilitates tacit knowledge-sharing (Moulaert and Sekia, 2003). Smart specialisation strategies can be considered the latest generation of regional innovation policies, having been widely spread among European regions with the impetus of the European Commission (and structural funding conditonality that insists all regions have a Research and Innovation Strategy for Smart Specialisation or RIS3). These strategies are rooted in previous place-based innovation policies but shift the focus towards the explicit prioritization of activities based on regional capabilities, and in many cases focused on the addressing of grand societal challenges. Indeed, in this sense they represent a coming together of science, technology and innovation (STI) policy with a new form of industrial policy (Aranguren et al., 2017).

A key feature of smart specialisation strategies is their treatment of research and innovation as transversal elements in each region, influenced by and impacting on government policy from the whole spectrum of government departments. Yet policy-mixes in this context have been considered more a set or portfolio of instruments than a policy setting that might affect the directionality of innovation. This is incongruent given the explicit aim of smart specialisation strategies to prioritise activities as a result of a complex governance process involving actors from the quadruple helix of government, business, research and civil society, each with vested interests.

These key features of smart specialisation strategies – their place-based nature, their orientation towards grand societal challenges, their transversality, and their complex governance context – make them extremely interesting laboratories for analysing policy mixes. In particular, we focus in this paper on the evaluation challenges that are emerging through the implementation of smart specialisation strategies. Evaluating territorial strategies poses some challenges to those that already exist around policy evaluation, as argued by Magro and Wilson (2015). It implies not only evaluating the

impact of the policy-mix, which itself is quite a complex task (Magro and Wilson, 2013), but also evaluating the directionality of those policy-mixes and their degree of adequacy or alignment to the strategy. The shift from evaluating policy-mixes isolated from their context or policy framework towards an evaluation of those instruments in their relation with a territorial strategy implies moving from policy learning towards strategic learning, and raises new questions around the governance of evaluation processes themselves.

Governance of evaluation is often neglected in the evaluation literature. Indeed, debates have traditionally been focused on the external/internal evaluator issue with little emphasis on the process of governance itself. Moving from individual policy evaluation to policy-mix evaluation or even to systemic evaluations as defined by some authors (Arnold, 2004; Molas-Gallart and Davies, 2006; Edler et al., 2008) poses new governance challenges. First of all, innovation policy mixes are normally designed and implemented by different government actors (either political or administrative actors) operating at different levels (Magro et al., 2014). Moreover, while some coordination in design and implementation can be (and often is) achieved, a systemic coordination of evaluation is a much more complex task, due in large part to the sensitivity characterising the notion of 'evaluating'. In the context of smart specialisation strategies these challenges are particularly acute given the multiple actors with a stake in research and innovation policy, both within government (in different departments and at different levels), and outside of government (in the other 'helixes' of business, research and civil society). In this new strategic approach actors are part of the entrepreneurial discovery process but also an object of evaluation, as is the public sector. That raises potential conflicts of interest, as strategy shapes actors behaviour and that behaviour needs to be monitored and evaluated for learning purposes.

This paper seeks to deepen our understanding of the governance of evaluation of innovation policy-mixes in the context of smart specialisation strategies. It does so by first dissecting the concept of innovation policy mix in the context of smart specialisation, where the issue of directionality raises specific issues. The paper then develops conceptual arguments around the governance of policy-mixes and their evaluation in a smart specialisation context. These arguments are illustrated and explored through the case of the Basque Country in Spain, providing insights on the different elements to be taken into account for establishing a strategic evaluation process in a complex setting of institutions and actors.

3.2 Session 3.2

3.2.1 The role of Institutional Entrepreneurship in transforming the National Innovation System of Transition Economy: the case study of Lithuania

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Keywords: national innovation system, transition economy, institutional entrepreneurship, institutional change, capabilities

The purpose of this paper is to identify the factors that influence the transformation of the national innovation system (NIS) in transition economies and to reveal internal causal mechanisms that reinforce this transformation. Economies in transition still lag behind despite full access to the European Union (EU) markets, investments in scientific knowledge and inflows of the EU funds. Prior research explains this so-called European periphery paradox by looking at growth enhancing policies (e.g. competition and education) that stimulate innovation (Radosevic and Kaderabkova, 2011), the role of the education sector (Grimes and Millea 2011, Urbanovic and Wilkins 2013, Karaulova et al. 2016), the relationship between businesses and universities (Inzelt 2004, Binkauskas 2014), and innovation policy (Smallbone and Welter 2012, Paliokaite et al. 2016). In sum, most approaches examine the key components of the NIS at the micro, meso, and macro level, and their interconnections, whilst overlooking the role of human agency within organizations, and in particular institutional entrepreneurship.

Theoretical background

We employ the theoretical lenses of the NIS and institutional theory in the context of transition economies. Firstly, we adapt a broad definition of NIS proposed by Lundvall et al. (2009) and Edquist (2005). NIS focuses on capabilities (e.g. Sen, 1999) rather than resource endowments as means to enhance social capital (Abramovitz, 1994). Knowledge and learning (Arocena and Sutz, 2005) play a key role in the catch-up process (Abramovitz, 1986). Institutions and policies are the main causes of development (Acemoglu et al. 2003) bringing structural changes (Kaldor, 1967). Secondly, we examine institutional theory and in particular, agency-induced institutional change (Meyer and Rowan 1977, Jepperson 1991, Scott 1995, Hoffman 1999). Institutional change is possible if actors are organized, motivated, entrepreneurial and able to exploit opportunities (DiMaggio, 1988). DiMaggio (1988) defines such initiative to shape and change institutions as institutional entrepreneurship. Beckert (1999) argues that institutional entrepreneurs are able to dis-embed themselves from existing institutional constrains in order to change existing or create new institutions. Garud et al. (2002) propose to look at institutional entrepreneurs as champions that lead and strategize collective actions that change innovative technology fields.

Method

The study is designed using critical realism approach and is based on 25 semi structured in depth interviews with major stakeholders of Lithuanian innovation system. Participants include representatives from universities, research centres, government institutions and non-profit private associations of local firms.

Findings

Based on the interviews we conclude that the NIS of Lithuania is still in transition due to various institutional inefficiencies of the public sector such as lack of relevant organizational, managerial and entrepreneurial capabilities. Transformation is a systemic change and government institutions should be the key moderators of this change. However, the interviews reveal that institutional inefficiencies

still exist due to individual (human agency) factors such as the old post-soviet mindset and low motivation to change. Further analysis of the interviews points to institutional entrepreneurship as a key mechanism that might stimulate institutional change and the overall transformation of a transition NIS. Current best practices reveal that institutional entrepreneurs may stimulate institutional change through various internal (within organization) and external pressures (policy level and internationalization).

Contribution

The study contributes to the NIS literature of transition economies by revealing importance of the human agency role and its relation to institutional change, better organizational, managerial and entreprenurial capabilities. The study reveals that institutional entrepreneurship might be the key mechanism in the overall transformation of a transition innovation system

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3.2.2 New Instruments for Transformative Innovation & their Functions: Product Development Partnerships for Neglected Diseases

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Abstract

With the growing attention to solve complex problems, a series of new forms of governance at national and international level have developed since the early 2000s. They are new because they address strategic long-term problems in a holistic manner, they set substantive output-oriented goals, and they are implemented through new organizational structures. Overall these new instruments seek to coordinate diverse actors through a series of ideational and organizational elements. In asking how these new instruments emerge and evolve, this paper takes a functionalist approach identifying empirically the different functions they fulfill and looking at how they mobilize the available resources to fulfill them (funding, organizational, knowledge and legitimacy resources). This approach is used in the study of product development partnerships for neglected diseases, a new type of transformative instrument that brings together different partners in order to develop affordable, effective and accessible medicines for the global poor. The paper examines in detail 4 emblematic cases of single- and multi-disease PDPs (DNDi, EVI, IAVI and MVI). The findings show that their functions have been evolving through time, as the PDPs are becoming more specialized and focused. However, their ability to mobilize the resources depends largely on their capability as agents to adapt to rapidly changing opportunity structures (scientific opportunities as well as institutional opportunities).

Extended Abstract

With the growing attention to solve complex problems, a series of new forms of governance at national and international spheres have developed since the early 2000s. They are new because they aim at addressing strategic long-term problems in a holistic manner, they set substantive output-oriented goals, and they are implemented through new organizational structures. At national level this is related to the raise of 'systemic instruments' to address grand societal challenges (Rogge and Reichardt 2016) (Chataway, Hanlin et al. 2014), and the growing directionality and mission-oriented nature of science technology and innovation STI policy mixes towards transformative innovation (Schot and Steinmueller 2016) (Wieczorek and Hekkert 2012). At the international level these new forms of governance are related to the emergence of international governance architectures which are strategic and directional initiatives on targeted issues (Borrás and Radaelli 2011) (Abbott, Genschel et al. 2014). Taken together, these new transformative instruments seek the coordination of a diversity of actors by means of a series of ideational and organizational elements.

Product development partnerships for neglected diseases are new forms of organizations which bring together different partners in order to develop affordable, effective and accessible medicines for the global poor. Operating across national borders and across very different types of partners, product development partnerships (PDPs) are relevant examples of new types of transformative instruments of research and innovation. Neglected diseases pose serious problems for poor countries' public health and development. Providing accessible medicines for these diseases are among the most enduring and difficult grand societal challenges, as they require advanced investments in R&D as well as expensive and long development and approval processes of those medicines. The low purchasing power of patients has created a market failure, limiting the investment levels from private firms in those markets. Likewise, public governments in developing countries lack the institutional capacities to develop such advanced and capital intensive R&D investments. Product development

partnerships (PDPs) seek to overcome this double market and state failure by bringing together national governments, international organizations, universities, private firms and large philanthropies, in the targeted effort to find suitable ways to prevent, treat and cure these diseases.

There are approximately two dozens of PDPs currently operating across borders. In many ways, these partnerships can be seen as a serious attempt of create new types of instruments for transformative governance, governing the change in the complex socio-technical systems of these diseases. However, in spite of sharing similar goals and overall expectations, these partnerships differ significantly in their structures, funding sources, knowledge expertise, regulatory strategies, and interaction with public health authorities.

Based on governance studies and recent developments in the field of innovation policy instruments (Flanagan, Uyarra et al. 2011) (Borrás and Edquist 2013) (Rogge and Reichardt 2016), the present paper develops an approach focusing on the different functions of these PDPs. Asking how these new instruments emerge and evolve, this paper identifies empirically the different functions they fulfill and looks at how they mobilize the available resources to fulfill them (funding, organizational, knowledge and legitimacy resources). The paper examines in detail 4 emblematic cases of single- and multi-disease PDPs (DNDi, EVI, IAVI, and MVI). The findings show that their functions have been evolving through time, as the PDPs are becoming more specialized and focused. However, their ability to mobilize the resources to fulfill these functions (funding, organizational, knowledge and legitimacy resources) depends largely on their capability as agents to adapt to changing opportunity structures (scientific as well as institutional).

The paper proceeds as follows. The next section reviews succinctly the literature on transformative governance and on new policy instruments. This will serve to contextualize the new instruments of transformative research and innovation in its broader context of changes in governance forms at national and international levels. The section after that will be devoted to develop a functionalist approach to the study of these instruments building further from recent approaches on the governance of socio-technical systems. Section 4 will review succinctly the nature of product development partnerships as new instruments of transformative innovation that have emerged since early 2000s in the field of neglected diseases. The paper will develop a typology of PDPs which will serve for the selection of 4 emblematic case studies. Sections 5 and 6 will be devoted to the analysis of the four cases selected. The final section will summarize the empirical findings and distill their theoretical and analytical contribution for future studies of transformative innovation instruments addressing grand social challenges.

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3.2.3 Public procurement and innovation dynamics: evidence from the World Input Output Tables

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1. Introduction

The term 'public procurement' (hereafter PP) is used to identify the direct purchase of goods and services by the public sector, which represent a relevant component of the overall economies. In 2011, public procurement has accounted for a share of about 13% of OECD countries GDP and almost 29% of their national public spending (OECD, 2011).

Considering its dimension PP has been used as a policy instrument aimed at achieving different goals: increasing aggregate demand, stimulating production and jobs, protecting domestic companies from global competition by encouraging investment and growth, increasing competitiveness of 'national champions' by fostering their innovative capacity and, finally, reducing regional disparities (Edquist and Hommen , 2000). Not less relevantly, public procurement is included among industrial and innovation policy tools. In fact, it can accelerate productive systems' upgrade encouraging the development of sectors characterized by greater technological intensity, creating new markets and stimulating demand-driven innovative investments (Rothwell, 1983; Weiss and Thurbon, 2006; Chang, 1994; Gerosky, 1990; Wade, 1990; Edquist et al., 2000, Mazzucato, 2013).

In recent years, an increasing attention has been posed on demand side policies to foster innovation (Edler and Gheorghiou, 2007; OECD, 2011) and PP has been identified as a key instrument of innovation policy in both developed and developing countries (Uyarra and Flanagan, 2010; Mazzucato et al., 2015; Edquist, 2015). The strategic role of PP appears to be particularly important in the current economic situation. The 2008 crisis has led to a sharp decline in the levels of economic activity and employment especially in manufacturing sectors. In Europe, the crisis has led to a growing polarization in terms of employment, competitiveness and industrial specialization (Simonazzi et al., 2013, Stoellinger et al., 2013; Cirillo and Guarascio, 2015). In this scenario, PP is seen as a useful tool to reverse the economic trend characterizing the majority of EU economies (Mazzucato et al., 2015). In fact, public demand for goods and services could play a crucial role in macroeconomic terms, supporting aggregate demand and employment, but also reviving those innovative investment that are essential for sustaining international competitiveness and economic growth in the long run. Moreover, orienting public demand towards specific areas and firms can contribute strengthening those regions and sectors more seriously harmed by the crisis. Public demand directed towards one or more specific production sectors, represents a key tool to promote the emergence or consolidation of production and markets that are characterized by high growth prospects (Pasinetti, 1981; Mazzucato et al. 2015; Pianta, 2015). This appears to be of particular relevance in high-tech industries, where the return of R&D investment are strongly uncertain. In this context, public procurement produces an exogenous increase in demand for high-tech goods and services, stimulating innovation activities carried out in order to capture these flows of demand (Pasinetti, 1981).

After the crisis, however, not all countries followed the same strategy. The United States included public procurement among their main countercyclical tools. Public investments have been directed towards the upgrade of the infrastructure network as well as to foster high-tech and green sectors. The

US have also maximized the impact of their government spending through a strategy focused on domestic purchases of products (the so-called ‘Buy American’ strategy according to which the government is allowed to purchase only domestically produced goods and services). On the contrary, the EU responded to the crisis adopting deflationary policies directed at consolidating member states public budgets. For these reasons, in many European countries there has been a reduction rather than an increase in the size of public procurement. Furthermore, EU institutions does not encouraged in any way the increase in domestic content of public procurement (i.e. no measures as the ‘Buy American’ have been adopted in Europe).

The aim of this work is to analyze the relevance of the demand-pull influence of public procurement on innovation activities as the sectoral level. Moreover, we investigate by means of panel data econometrics, if and to what extent import penetration on public procurement plays a moderating effect in shaping the relationship between PP and innovative activities of industries. In so doing, we will try to shed light on a possible trade-off between static and dynamic efficiency that should be taken into account in policy choices regarding PP strategies. The analysis takes advantage of a rich dataset providing industry-level information on economic performance, public procurement, international trade and production as well as on R&D expenditure and patents for all manufacturing industries – 2-digits Nace Rev. 1 – in 25 economies (Austria, Belgium, Czech Republic, Germany, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Japan, Korea, the Netherlands, Poland, Portugal, Romania, Russia, Sweden, Slovenia, Slovak Republic, Spain, Turkey and the US) over the period 1995-2011. In particular, sector level information on PP derive from the WIOD database that collects Input/Output tables for a large set of countries.

2. The dynamics of public procurement and import penetration

In the present analysis public demand is computed as the sum of goods and services - both intermediate and final – purchased by the public sector from a specific 2-digits sector. We follow the classification used by Messerlin and Mirodout (2012). We identify as public sector the aggregation of the following industries: ‘electricity, gas and water supply’ (100%), ‘post and telecommunications’ (50%), ‘public administrations and defence; compulsory social security’ (100%), ‘education’ (100%) and ‘health and social work’ (100%). For each sector i and country j, thus, the public procurement variable reports the value of goods and services purchased by the public sector of that country j.

In the considered period the relative weight of public procurement increases significantly in China, and to a lower extent in Japan. On the contrary, the EU27 public procurement share, in turn, slightly decreases between 1995 and 2000 while showing a moderate increase from 2000 onwards shrinking again following the 2008 crisis. A similar trend is registered in the US but the latter remains above EU27 both before and after the crisis. Remarkably, the strongest drop in the public procurement relative share between 2008 and 2011 is registered in the EU27.

As discussed, our key research question regards the impact of import penetration on the public procurement-innovation relationship. Import penetration is calculated as the share of (domestic) public procurement to sector j which is captured by foreign producers (Ramboll Report, 2011; Messerlin and Mirodout , 2012). For example, the share of import penetration of the Italian motor vehicles industry is equal to the share of government purchases of motor vehicles produced abroad over the total public procurement directed towards the motor vehicles industry. The same holds for all the manufacturing sectors of each country.

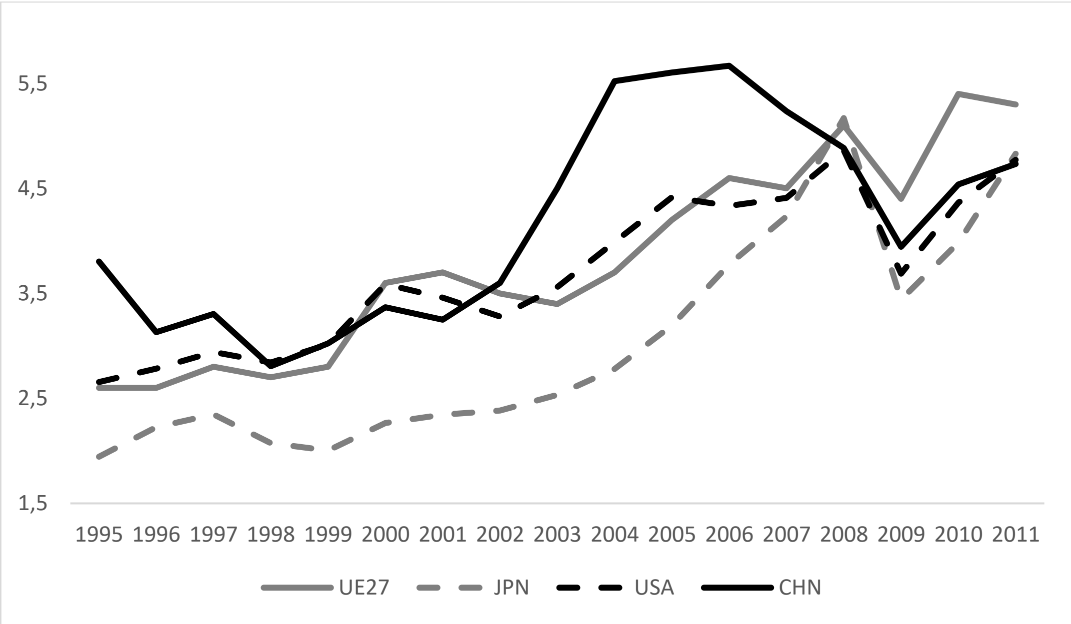
The import penetration indicator (1) is computed in the following way:

$$Imp\_pen_{ijt} = \frac{\sum_{ikt} Int_{import} + \sum_{ikt} Fin_{import}}{Tot\_pubproc_{ikt}} \quad (1)$$

where the numerator of (1) is the sum of intermediate and final goods imported by the government of country j from a certain sector i; the denominator is total public demand by the government of country

j directed towards sector i. Hence, (1) denotes the relative weight of imports in public procurement for each manufacturing sector. Figure 1 reports the evolution of import penetration on public procurement for selected countries.

Figure 1. Import penetration on public procurement in EU27, China, Japan and the US, 1995-2011



Source: our elaboration on WIOD data

The evolution of import penetration displays similar trends in the EU27and the US. After the crisis, however, the dynamics begins to diverge. While import penetration on EU27 public procurement continues to rise, in the US there has been a sharp fall that stops, with a gradual recovery, towards the end of 2009. During the crisis, thus, the degree of openness of public procurement in Europe and in the US starts to diverge substantially. This evidence can be associated with the effects of 'protectionist' measures – i.e. the 'Buy American' act - aimed at protecting public procurement and put forth in the US early after the crisis explosion. A reinforced 'buy American' would seem to explain, at least in part, the sudden divergence in the dynamics of import penetration US than Europe. The mounting import penetration on China's public procurement registered between 2000 and 2007, in turn, points to the fast internationalization of the Chinese economy occurring in that period. Finally, showing the lowest level of import penetration along the considered period, the Japanese economy displays a dynamics similar to the US one. In particular, even in Japan a significant contraction of import penetration intensity is detected from 2008 onwards.

3. Public procurement and innovation dynamics

Our econometric analysis is build on the hypothesis that aggregate demand and, particularly, public procurement is an important driver of technological change and innovation (Edquist, 2015; Mazzucato et al., 2015). First, we test whether public procurement is positively associated with industries innovativeness – measured in terms of patents stock– accounting for the all the other standard determinants of innovation (both technology push and demand pull elements). Secondly, we investigate if and to what extent a relatively more intense import penetration on public procurement can affect the relationship between the latter and industries innovativeness.

The econometric results confirm the importance of public demand in driving industries innovative performance. That is, a positive association between change in public procurement and industries innovativeness – measured in terms of patent dynamics– is detected across all the carried out estimations.

Moreover, it turns out that a greater openness of the public sector – identified by the share of import penetration on public procurement – negatively affects the 'pro-innovative' stance of public procurement. This result is robust to different specifications of the Model.

Our results are in line with those contributions which identify public procurement – among the demand-pull factors steering technological change and innovation - as a key driver of innovation in both industries and firms. However, it emerges how the positive impact of public procurement can be mitigated by the intensity of import penetration. This result suggests that when dynamic efficiency is considered instead of static efficiency 'too much openness' in public procurement policies can become detrimental for economies as it may harmper the strategic and 'pro-innovative' attitude of public procurement.

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3.3 Session 3.3

3.3.1 Guiding innovation policy mixes: focusing on structural change vs. upgrading

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Keywords: Innovation policy mix, Structural change, Structural upgrading, Innovation frontier

Motivation: a missing layer in innovation performance goals

Innovation is increasingly seen as the dominant policy to address both economic and societal objectives. Not least due to a burgeoning literature on various rationales for and effects of innovation policies, the range of policies available to policy makers has become so great that an own strand of the innovation policy literature is devoted to innovation policy mixes. The pursuit of the combination of policies most effectively addressing a country's specific innovation challenges is becoming ever more complex.

As a survey of the innovation policy literature in Janger et al., (2017a) shows, performance goals for innovation efforts are usually very general, framed as i) increasing the rate of innovation activities (boost either the generation, diffusion or use of innovations, or productivity) or ii) as changing the direction of innovation activities towards specific societal goals. Foray (2009) notes that goals of overarching technology policy are usually not discussed. By contrast, individual policy goals are usually not framed in economic or outcome terms, but as direct results or outputs of these policies, e.g. more R&D spending by firms is a goal of policies subsidising firm R&D efforts. We argue that there is a middle layer missing in the hierarchy of performance goals, a layer which connects bundles of individual policies and the overarching country-wide innovation or productivity performance.

Structural change vs upgrading as a focusing device for innovation policy

Recent research suggests that the economic effects of innovation, or innovation outcomes, must be reflected at the sectoral level in either structural change towards knowledge-intensive sectors or upgrading within sectors towards more knowledge-intensive segments within these same sectors (Janger et al., 2017b). Evidence shows that some countries such as Hungary do well in structural change, while other countries are better at upgrading, such as Italy or Austria (Janger et al., 2017b).

Focusing policies on either structural change or upgrading could present such a middle layer of performance goals which provides new directionality in efforts to improve overall innovation performance or the rate of innovative activity.[12] This is also relevant for achieving societal goals such as fighting climate change, as the rate of innovative activity in a certain direction determines the speed with which societal goals can be reached.

We propose to investigate whether this way of measuring innovation outcomes – which we call the innovation frontier (Janger et al., 2016) – is a suitable focusing device for innovation policy-making at the national or regional level which can guide appropriate policy mixes. More precisely, our research

12 On the directionality point, see also (Edler and Nowotny, 2015).

question is: can we empirically isolate determinants of the process of structural change which are different from determinants of structural upgrading?

Hypothesis-building as a basis for empirical analysis

Methodologically, we aim at first reviewing the following strands of the literature to build hypotheses as to which factors or policies drive structural change vs. upgrading:

- Evolutionary economics (Dosi and Nelson, 2010) stresses path dependence and the cumulative nature of technological change, which is informative for changing track (structural change) vs improving established industrial strongholds (upgrading)
- The literature on localised technological change and related diversification builds on this, e.g. Antonelli (1998) sees sunk costs as a major factor of switching costs for firms when they want to change the capital stock or the proportions in which it is used with other inputs
- The National Innovation System literature (e.g. Soete et al., 2010) is also relevant, as in addition to path dependence explained by capabilities of actors, path dependence is a result of linkages which have formed historically in a NIS and may foster certain innovation outcomes over others
- The *varieties of capitalism* literature maintains that “coordinated” market economies specialise in incremental innovation while “liberal” market economies specialise in radical innovation (Hall and Soskice, 2001)
- We also want to look at the history of STI policy strategies; Freeman and Soete (2007) juxtapose the success of the US in providing incentives for Schumpeter Mark I innovation processes (i.e. of creative destruction driven by new entrants) with the dominance of Schumpeter Mark II in Europe, characterized by large incumbent firms in search for innovation rents and defence of international competitiveness, whereas Berger and MIT Task Force on Production in the Innovation Economy (2013) look at the reasons behind the decline in US manufacturing and the strong German manufacturing.

These literatures identify factors related to structural change and upgrading. We group our hypotheses as to the factors driving the distinct performance layers in three broad categories: i) framework conditions for innovation activity, e.g. labour and product market regulation, institutional set-up of the economy (e.g., co-ordinated vs liberal market economy); ii) education system (vocational vs general skills, prevalence of tertiary skills), iii) R&D and innovation system, including the science system (intensity of industry-science cooperation, public funding of firm R&D and innovation, bottom-up vs thematic funding etc). To test whether policies can separately target these two innovation outcomes, we propose an empirical approach.

Empirical Analysis: factors driving structural change vs. upgrading

To identify performance in structural change, we use a composite of several indicators at the country level showing levels of the share of knowledge intensive sectors in total economic output, using industry data from the recently updated OECD STAN as well as from Eurostat SBS. To identify performance in structural upgrading, we use a composite of indicators on export quality (BACI database by CEPII) and on adjusted R&D-intensity (OECD STAN), mirroring position of countries on the quality ladder of industries (Janger et al., 2017b). Data will be available mostly for EU- and OECD-countries. Each composite works as the variable to be explained by a range of explanatory variables selected on the basis of our hypothesis building. Among these are:

- Framework conditions for innovation
    - Labour and Product market regulation (OECD indicators)
    - Start-up regulation (Doing Business indicators)
    - Dummy variables for institutional set-up (presence of employers association)
    - Density of industrial ecosystems (indicators on outsourcing vs offshoring)

- Characteristics of financial system (bank- vs market based)

- Data on education system
    - Vocational vs general skills (OECD education at a glance)
    - Prevalance of tertiary education, including distinguishing between short- and long-cycle tertiary education, and PhD training (OECD education at a glance)
    - Human Resources in Science and Technology (OECD)

- R&D and innovation system characteristics
    - Public funding of firm R&D (OECD MSTI)
    - R&D expenditure by firms, split into basic and applied research, as well as development
    - Tax vs direct subsidies (OECD MSTI)
    - Venture capital intensity (EVCA)
    - Employment in fast growing innovative firms (Eurostat)
    - Quality of science system (quality of publications; university performance in quality of publications)
    - Intensity of commercialisation of academic knowledge (data on university patents and spin-offs, licensing income)
    - Size of innovation system (number of researchers relative to country size, MSTI)
    - Industry-science links (co-publications, industry funding of science, innovation cooperation; Eurostat, OECD)
    - Size of public research sector (OECD MSTI, role of extra-university applied research institutes)

We try to tackle complementarities between these factors through interaction effects. Country- and industry-specific effects will be controlled for, including varying levels of development of countries as measured by their position relative to the economic frontier (GDP per capita). Our empirical strategy relies on panel data estimators which allows for addressing endogeneity concerns. Nevertheless, empirical work at such an aggregate level should be seen as a first step towards further investigations at more disaggregated levels. At the firm level, change and upgrading may also be conceived as specialisation vs diversification. Country performance with respect to structural change and upgrading may not just the result of recent policies and current framework conditions, but is bound to be the result of a “dynamic co-evolution of knowledge, innovations, organisations and institutions” (Soete et al., 2010, p. 23) over time, so that different constellations of policies, institutions and firm capabilities may lead to different effects of the same kind of initiative or policy in different countries.

Conclusions

In terms of outcomes of this research, if we can identify separate factors which drive structural change vs upgrading, this would speak in favour of using the dichotomy of change vs upgrading as an intermediate performance goal layer which can guide STI policy mixes, enabling a new directionality of innovation policy and potentially informing the future of STI policy.

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3.3.2 Evaluation of Policy mixes in practice: What prescriptions for tackling the problem of antimicrobial resistance?

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Keywords: Policy-mix, Antimicrobial resistance, innovation system, multi-criteria mapping.

Focus of the paper

This paper presents work in progress on the evaluation by stakeholders of new policy instruments and policy mixes for the management of antimicrobial resistance (AMR) in European countries. The paper considers the practical difficulties in implementing a set of policy measures to address grand societal challenges such as AMR. Drawing on recent policy documents from the countries studied it explores the extent to which proposed sets of policy measures are systematically designed and whether particular groups of policy instruments are welcomed or rejected by different stakeholder groups, and why.

AMR is a major emerging global problem posing a serious impact on modern medicine. Many advances in general medicine (simple acts of surgery, cancer treatment, organ transplantation and so on) rely on the ability to prevent and treat bacterial infections. However over the last decade, the increase of antibiotic resistance (CDC, 2013; ECDC, 2017; WHO, 2014), even to last-line antibiotics (ECDC, 2016), combined with the limited number of new antibiotics in development is leading to at least 700 000 death yearly, which could rise to 10 million in 2050 (O'Neill, 2016). AMR has been highlighted by the World Health Organisation (WHO) as a global health threat. In 2015, the WHO adopted a resolution to implement a global action plan on AMR in conjunction with national action plans in order to deliver consistent policies at national and international levels (WHO, 2015, 2016). The problem is presented as requiring transformative change in order to be able to maintain a sustainable health system against the AMR threat (Morel et al., 2016; O'Neill, 2016; WHO, 2015). The paper will focus on a specific area of policy aiming at limiting the use of current antibiotics through the development and use of diagnostics tests. This issue is of particular importance as research has shown that the overuse of antibiotics can lead to the outbreak of illnesses due to resistant bacteria (Dingle et al., 2017). Therefore the limitation of antibiotic use is of prime importance, and diagnostics are important tools in the better deployment of antibiotics, targeting the use of particular antibiotics to the patients that need them and avoiding use of these drugs where no bacterial infection is present.

Conceptual framing

Recent contributions in Innovation Studies call for use of innovation policies that do more than just fostering firms' innovativeness; they argue that innovation policy can be used to tackle grand challenges and transformative change (Fagerberg, 2016; Schot & Steinmueller, 2016; Weber & Rohracher, 2012). In this vein, a growing literature focuses on policies for technological change for sustainable development (Kern & Howlett, 2009; Quitzow, 2015; Rogge & Reichardt, 2016; Uyarra, Shapira, & Harding, 2016), building on literatures including innovation systems, transition management and policy mixes, in order to evaluate and advise on policy mixes that span the innovation system.

A practical problem in the design and optimisation of policy mixes is that they evolve in situations where often governance is dispersed among different levels and actors, and co-ordination is seen as impossible (Flanagan, Uyarra, & Laranja, 2011) with actors' constrained in their abilities to contribute to systemic solutions: 'actors are defined by their agency. This agency is of course enabled, shaped and constrained by behaviour and expectations of other actors and by institutions, which themselves have been shaped by earlier action and institutions' (ibid: 706).

While the evaluation of individual policy instruments (or small sets of these) is well established there are few examples of policy mixes being evaluated (Cunningham et al., 2013). This paper demonstrates a way to prospectively evaluate policy mixes for the development and use of diagnostics for the management of AMR – a complex context in which policy mixes are currently being developed and implemented.

The proposed prospective evaluation of policy mixes seeks to reveal tensions between the ideal policy design proposed by in the policy literature (e.g. ministerial reports on tackling AMR), and the view of the actors/ stakeholders from across the innovation system who will work in the context of these new policies or even take part in their implementation. The paper will explore the extent to which particular policy instruments are welcomed or even rejected by actors from different parts of the innovation system as well as determining the basis of their views.

The paper will provide a synthesis of instrument types based on various classifications (Borrás & Edquist, 2013; Hekkert, Suurs, Negro, Kuhlmann, & Smits, 2007; Steinmueller, 2010) to characterise the variety of measures proposed by different national efforts to manage AMR, facilitating comparisons. A set of policy options are presented to stakeholders, who explore their merits, limitations and potential challenges for implementation.

Methods

This paper will draw on secondary data and interviews. The secondary data comprises a corpus of policy documents, reports, academic articles, and policy briefs on the topic of tackling AMR with specific recommendations on the development and use of diagnostics.

The empirical analysis starts with the review of the AMR policy literature to identify policy instruments related to the development and use of new diagnostics tools to manage AMR. The AMR challenge has spurred a rapidly growing set of policy recommendations by academics and a wide range of policy makers involved in ministerial, national and international efforts. These authors provide policy options to tackle different aspects of the overall problem, including the development and use of new diagnostic tests (aspects such as the management of AMR through control of use of antibiotics in farming or development of new treatments are beyond the scope of this paper). The reports studied generally provide a number of policy imperatives and recommended instruments, but more rarely do they reflect on whether these different policies can work together effectively, or be used effectively with existing actions already implemented.

Literature is selected depending on the country of authorship for national policies or plan (our focus is the UK, France, Germany and Spain). France and the UK are selected due to their long standing national actions in this domain – since the beginning of the 2000s. Germany or Spain are more recent entrants into the policy literature on AMR - in the late 2000s and early 2010s.

In the second phase, interviews are conducted with stakeholders use multi-criteria mapping (MCM) (Stirling, 1997; Stirling & Mayer, 2001) to ensure that each set of policy instruments is discussed systematically. In MCM, each interviewee chooses the assessment criteria which they deem important to assess policy options. Both quantitative (scoring) and qualitative (comments about the scores given) aspects of the MCM interview provide data on the anticipated performance envelope of policy options (i.e. best and worst cases are discussed, including difficulties of implementation). This method can therefore reveal insights into policy instruments and mixes that stakeholders are united behind or divided on, within and across countries.

Interviews with stakeholders from the following groups are included: firms developing diagnostics, primary care physicians, pharmacists, hospital physicians, clinical laboratory staff, healthcare payors, policymakers and patients groups.

Anticipated outcomes

The research will contribute to an understanding of the policy mixes that would be favoured by different stakeholder groups in different countries as well as a detailed set of challenges for the implementation of these policy mixes. The paper will also reflect on the utility of MCM as a tool for prospective evaluation of policy mixes.

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3.3.3 The politics of policy mix evolution: Towards a conceptual framework of policy mix feedbacks in socio-technical transitions

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Keywords: Policy Mix, Politics, Policy Feedback, Socio-Technical Change, Co-evolution

Designers of policy mixes aiming to foster sustainable socio-technical transitions face significant challenges. Among which is having to account for uncertainty in a changing social, technical and economic context (Hoppmann et al., 2014; Rosenow 2013). Such changing conditions mean that revisions to policy mixes for socio-technical transitions are often necessary, and that there will be continued policy discussions involving multiple actors over the rate and direction of travel. Policy reformers can aim to foster transitions through supporting novel emergent technologies alongside the current configuration (Smith and Raven 2012) and more radical reforms reducing support for the status quo (Kivimaa and Kern 2016). Sustainability transitions are often politically contested (Smith and Stirling 2010), and commonly feature close relationships between state actors and incumbent industry actors who may lobby to oppose the new direction of travel (Unruh 2000; Walker 2000; Kern and Howlett 2009). Consequently, maintaining political support for transition policies over time is fundamental to enable socio-technical change which can take decades to unfold.

Understanding how politics and policy processes can influence the rate and direction at which socio-technical change occurs is an important, yet underexplored research agenda in the field of sustainability transitions. While some studies have sought to explain how individual policy instruments or new organisations influence politics, we argue that it is important to extend the scope of analysis to account for a range of policy instruments that make up an overarching policy mix. In our paper, we conceptualise these processes by building on insights from the literature of policy feedback (Pierson 1993), which draws attention to the continuous interactions between public policy, the outcomes in society, and how these outcomes affect policy actors in ways that influence subsequent policy making (Skocpol 1992; Patashnik and Zeilzer 2013).

At the broadest level, policy feedback refers to how policies affect politics over time (Beland 2010). Policies can create self re-enforcing effects (Pierson 1993, Beland 2010, Campbel 2012), which cause the costs of choosing policy alternates to increase markedly over time, creating lock-in and path dependency (Pierson 1993, 2000). We, however, follow a recent line of scholarship which has brought attention to instances where policy may fail to produce self re-enforcing effects (Patashnik and Zeilzer 2013), or may produce effects that may undermine the political support for the policy mix over time leading to policy revision or termination (Oberlander and Weaver 2015). We suggest this analytical focus offers insights to explain the dynamic and recursive nature of how policy mixes and the socio-technical system interact. In doing so, the contribution of the paper is to take a first step

towards better conceptualising the co-evolutionary dynamics between policy mixes and socio-technical change, by focusing on the processes which mediate this relationship.

The paper presents a novel conceptual framework for analysis which focuses on actors in the socio-technical system and their incentives to participate in policy making processes. The framework highlights that policy mixes aiming to foster transformative change need to be designed to create incentives for beneficiaries to mobilise support, while overcoming a number of prevailing challenges which may undermine political support over time. The proposed framework aims to explore how policy mixes for sustainability transitions generate feedback mechanisms that influence subsequent policymaking and the evolution of the mix, and how changing conditions to the socio-technical system strengthen or constrain policy feedback mechanisms.

We demonstrate the usefulness of the framework with an illustration of the zero carbon homes policy mix in the UK, representing an instance of ambitious policy reform which was unsuccessful in stimulating radical change. The paper links with the themes of the panel with a central focus on the design of policy mixes and the changing conditions which influence the co-evolutionary dynamics of policy mixes and socio-technical change. By better understanding these factors, policy makers can anticipate the challenges that policy reform may face and design policy mixes in ways that can lead to greater chances of reforms to become self-reinforcing and to facilitate transitions.

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3.4 Session 3.4

3.4.1 Policies for System Change: The Transition to the Bioeconomy

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Keywords: Sustainability transitions, Innovation system failures, Policy mixes, Bioeconomy, Nordic countries

Relevance

Over the past 10-15 years the bioeconomy has increased in importance and has been promoted as a possible contribution to address important societal challenges such as climate change, food security, and global health issues. It is argued that the development towards a circular bioeconomy can be characterised as a system change as it requires fundamental changes in both production and consumption systems (Coenen, Hansen, and Rekers 2015; Bugge, Hansen, and Klitkou 2016; Scordato, Bugge, and Fevolden 2017). However, even if governments in many countries have started to introduce policies addressing grand societal challenges, it remains unclear how policies can be implemented to achieve determined goals, and also how such policies can be understood in relation to existing policies (Kuhlmann and Rip 2014; OECD 2015; Schot and Steinmueller 2016). Still, we know very little about the extent to which policies are in fact giving sufficient importance to transformative failures (vis-à-vis market and structural failures). Also, to the extent that transformative failures are given attention in bioeconomy policies, we don't know whether this is consistent in the policy mix or only in terms of formulating visions.

In this paper, we therefore wish to investigate the occurrences and characteristics of policies for system change by i) exploring the rationales for policy intervention aimed at a transition to the bioeconomy; and ii) whether and how policy mixes for transition are combined and implemented differently in various national contexts.

Aims and research questions

The aim of the paper is to study how policies for system change towards a circular bioeconomy are formulated, and how they co-exist along other types of policy rationales. To our knowledge no studies have explicitly explored "real-world" bioeconomy policies from a socio-technical transition perspective. We hence believe that this study could contribute to filling this identified knowledge gap. The research questions guiding the study can be formulated as follows:

- How is policy legitimized to address the transition to a circular bioeconomy (market failures, structural system failures or transformational system failures)?
- How can the different policy strategies identified be interpreted as an expression of a policy mix across the three different policy rationales?
- What are the policy strategies, instruments and policy processes characterizing the policy mixes across the Nordic countries?

Theoretical framework

Over the past years, scholars within the field of innovation studies have increasingly been interested in understanding the complex features of policies addressing contemporary problems, such as climate change, loss of biodiversity, resource depletion, health and urbanisation. The solutions to these problems, commonly defined as grand societal problems due to their unpredictable, open-ended and complex nature, are seen as requiring broad systemic changes and novel approaches by innovation policies (Kuhlmann and Rip 2014; Schot and Steinmueller 2016). Concepts such as Innovation policy 3.0 and Deep Transitions have recently been introduced into the scholarly debate to indicate that it is time for innovation policy "to focus much more on the achievement of wide systems transformations, since optimization of existing systems will not be a sufficient answer" (Schot and Steinmueller 2016p. 17; Schot and Kanger 2016).

The importance of long-term strategic orientation in sustainability transitions is acknowledged as having a fundamental role in giving a direction to system changes. A key assumption is that policies play a key role for the redirection and acceleration of technological change, a central requirement for such transitions (Weber and Rohracher 2012; Rogge and Reichardt 2016). Innovation policies for system change, thus differs quite substantially from traditional innovation policy which is directed towards improving generic capacities of industries, regions, etc. with the main objective to create economic growth and employment. Policies aimed at system change can be understood as "a horizontal policy approach that mobilises technology, market mechanisms, regulations and social innovations to solve complex societal problems in a set of interacting or interdependent components that form a whole socio-technical system" (OECD 2015 p.7). Weber and Rohracher (2012) have identified four possible types of policy failures in transformative change; (a) directionality failure, (b) demand articulation failure, (c) policy coordination failure and (d) reflexivity failure. These add to previously identified structural innovation system failures, such as capabilities failures, infrastructural failures, network failures and institutional failures (Woolthuis, Lankhuizen, and Gilsing 2005) that are commonly used to legitimize and shape research and innovation policy. The different types of failures are summarized and illustrated in Table 1.

Table 1: Different kinds of failures and policy rationales in different analytical approaches: neo-classical, innovation systems and system innovation.

Market failures (neo-classical)	Structural system failure (innovation systems)	Transformational system failures (system innovation)
1) Too little investment in R&D, because of the public good character of knowledge (and leakage) and uncertainty about outcomes (which hinders cost benefits calculations)	1) Infrastructural failure: limited investment in physical infrastructure because of risks (large-scale investments and long-time horizons) and low return on investments.	1) Directionality failure: Transformation process will be hindered by: a) lack of shared vision regarding goal and direction, b) inability of collective coordination of distributed agents involved in shaping system change.
2) Negative externalities: private actors do not take negative consequences into account if they can externalize costs.	2) Institutional failures: Problems in formal institutions (laws, property rights, regulations) creates uncertainty that hinders investment and innovation. Informal institutions	2) Demand articulation failure: The exploration of new user patterns and opening up of new markets will be hindered by: a) insufficient spaces and opportunities to learn about user

	(norms, values, attitudes, trust, risk-taking) may also hinder innovation.	needs, b) absence of orienting signals from public demand (*e.g.* public procurement), c) lack of demand-articulation capabilities
3) Over-exploitation of commons, leading to over-use of public resources in the absence of regulations.	3) Interaction or network failure. Very strong cooperation may lead to lock-in and inward-looking behaviour. Too limited interaction hinders knowledge exchange and interactive learning.	3) Policy coordination failure: Transformation will be hindered by: a) lack of multi-level policy coordination (regional, national, European), b) lack of horizontal coordination between innovation policies and sectoral policies (transport, energy, agriculture), c) lack of vertical coordination (between Ministries and implementation agencies)
	4) Capabilities failure: Lack of appropriate competencies prevents access to new knowledge and inability to adapt and compete.	4) Reflexivity failure: Transformation will be hindered by a lack of monitoring, learning, open debate, adjustment, and reflection about direction and speed.

Source: adapted from Weber and Rohracher, 2012: 1045 in OECD 2015

Another related approach to study the policy complexities characterising societal challenges focuses on policy mixes. The concept of policy mixes, has been used narrowly by Borrás and Edquist (2013) to define “a set of different and complementary policy instruments to address the problems identified in a national or regional innovation system” (Borrás and Edquist 2013 p.1514). More broadly the concept also encompasses policy goals and rationales, processes of policy making and implementation (Rogge and Reichardt 2013; Flanagan, Uyarra, and Laranja 2011). In the context of sustainability transitions it is argued that policy mixes need to address a strategic component, associated policy processes and the characteristics of policy mixes (Rogge and Reichardt, 2016). Moreover, these three “building blocks” may be analysed in terms of their elements: 1) Policy strategy (including policy objectives and principal plans) 2) Instruments (including their types and purpose) and 3) policy processes (including policy learning and policy implementation aspects) (Rogge and Reichardt 2016). In the real world, each of the three “building blocks” will be motivated by certain policy rationales. Therefore, we may assume that changing policy rationales in the long run have effects on and require adjustments in policy mixes.

Methodology and analysis

Empirically we focus our attention upon government policies encouraging bioeconomy development in four Nordic countries (Norway, Denmark, Sweden and Finland). Like many other countries in the world these countries have over the past decade developed policy strategies which encourages the development of a bio-economy. In this sense, they share a strong interest in the bioeconomy with governments at different levels worldwide (German Bioeconomy Council 2015).

The data collection includes i) document analysis, which involves an analysis of key documents in relation to the building blocks of the extended policy mix framework described above and; ii) semi-structured interviews with policy makers and other relevant stakeholders across the selected countries.

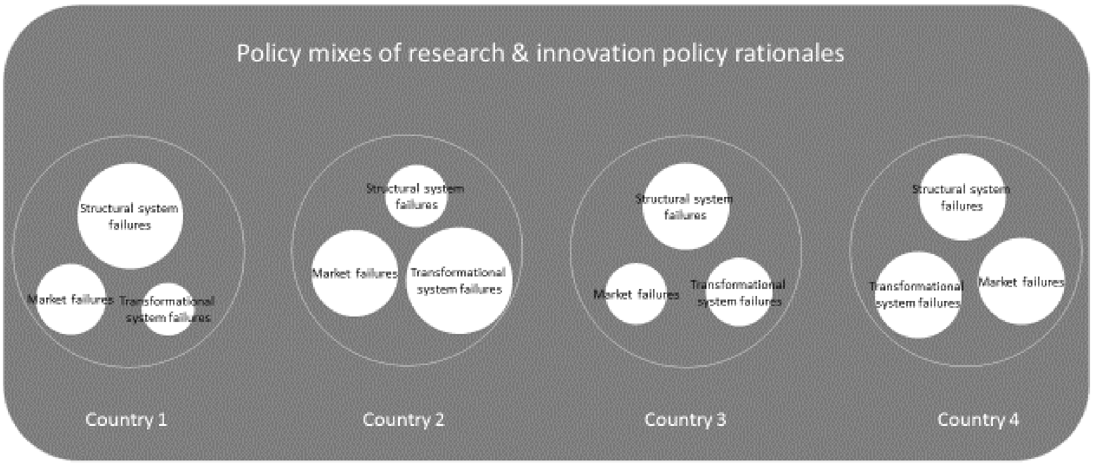
The document analysis covers official governmental documents or documents that are treated in the country itself as primary documents. Several sources have been used to identify the documents, such as from the Bioeconomy Observatory of the Joint Research Centre (JRC) and the overview of

national bioeconomy strategies from the German Bioeconomy Council. The document analysis is used to prepare the background for semi-structured interviews.

Expected outcomes

Reflecting the research questions posed the paper aims to investigate how policies addressing the bioeconomy is justified and legitimized in terms of the three policy rationales introduced. In comparing the balance between the three policy rationales across the Nordic countries the paper suggests that the use of different logics can be interpreted as a dimension of depth in the notion of policy mixes. Figure 1 below illustrates how the analysis is expected to provide insights on these parameters.

Figure 1: Illustration of the expected outcome



Source: the authors

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3.4.2 Introducing theory of change and impact pathways to the conceptual framework of policy mixes for sustainability transitions

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Keywords: policy mix, sustainability transitions, impact assessment, policy effectiveness, temporal coherence

1. Introduction

There is a need for a better understanding of effects of different policy mixes on sustainability transitions. There have been several recent contributions focused on the concept of policy mix in the context of sustainability (Kivimaa and Kern, 2016; Rogge and Reichardt, 2016; Uyarra et al., 2016). To date, however, there has been only a limited reflection on how to assess, let alone measure, actual and probable socio-economic and environmental impacts of policy mixes on sustainability (Cunningham et al, 2013; Smith et al., 2010). The concept of policy mix for sustainability transitions needs to be extended to allow for assessing effects of policy beyond shifts of technological regimes.

This paper postulates making the notion of theory of change and impact pathways an integral element of policy mix analysis. It presents an example of an analytical framework designed to assess environmental effects of individual policy instruments and policy mixes. The proposed framework – here referred to as the Cumulative Policy Impact Assessment (CPIA) - allows to qualitatively investigate how direct and indirect, intended and unintended effects of various policy instruments evolve and relate to one another over time. The overall logic of the approach draws on the theory-based evaluation approaches, including programme theory (Funnell and Rogers, 2011; Rogers, 2008), contribution analysis (Mayne, 2001; 2012), utilization-focused evaluation (Patton, 1997; 2011), and impact pathway evaluation (Douthwaite et al., 2003). It also benefits from the notion of systems evaluation of research and innovation policy (Arnold, 2004).

2. Using theory of change to analyse impacts of policy mixes

Policy evaluators have long wrestled with the systemic complexity and uncertainty of studying long-term effects of policy interventions. Theory-based evaluation approaches are considered suitable for analysing complex policy interventions (Blamey and MacKenzie, 2007; Funnell and Rogers, 2011; Mayne, 2011; Rogers, 2008; Patton, 2011). Rogers (2008, p.30) summarises theory-based evaluation as ‘a variety of ways of developing causal model linking programme inputs activities to a chain of intended or observed outcomes, and then using this model to guide evaluation’. The role of external determinants as drivers or barriers of policy effects are central to these models. Theory-based evaluation, and theory of change as its central component, appear particularly fit for studying complex policy mixes described as ‘complex arrangements of multiple goals and means’ (Kern and Howlett, 2009, p.395). The logic of theory of change with its emphasis on ‘chains of intended or observed outcomes’ allows to extend the boundary of policy mix concept to consider environmental and socio-economic impacts of public intervention.

The key evaluation question in the case of a policy mix for sustainability is to what extent effects of policy mix contribute to sustainability transition. If existing policy objectives were relevant and internally consistent, the assessment of effectiveness of policy mix could rely on the formal objectives. In reality, however, policy mixes are often heterogeneous and comprise inconsistent or even conflicting policy frameworks, which may or may not be conducive to sustainability. Evaluating effec-

tiveness and relevance of policy mix for sustainability transitions is, therefore, likely to require selecting or constructing a set of baseline objectives and impact pathways conducive to sustainability transitions.

Theory of change suggests that the success of policy mix depends on the external factors that enable or hamper the sequences of desired policy effects. This implies extending the understanding of policy coherence to account for alignment with external determinants (systemic coherence). Coherence has also a temporal dimension. Temporal coherence is 'ensuring that policies continue to be effective over time and that short-term decisions do not contradict longer-term commitments' (OECD, 2003). Theory of change allows for an analysis of time-lags and timing of sequences of outcomes and impacts of policy. Tracing impact pathways of various instruments over time may then uncover synergetic or conflicting relations between them.

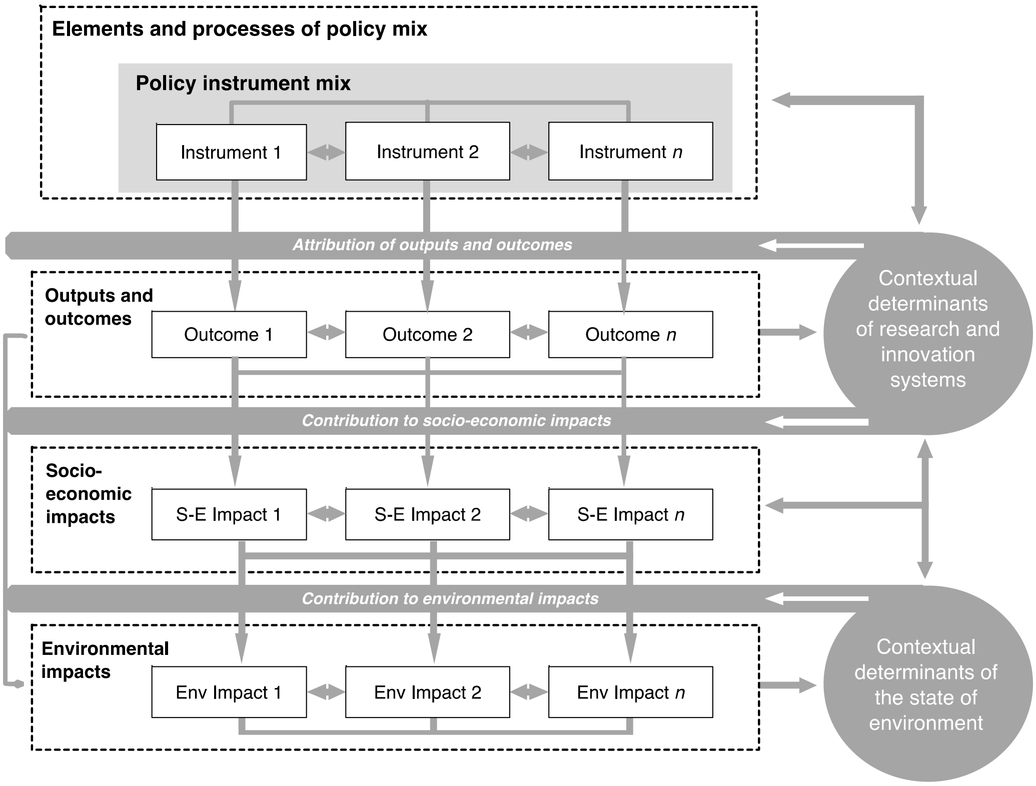
3. Towards a framework for assessing impacts of R&I policy mix

3.1. The scope of the proposed framework

This section introduces CPIA framework originally designed to support the process of assessing environmental impacts of the EU research and innovation (R&I) policy (Miedzinski et al., 2013). The central premise of CPIA is that any policy IA aiming at identifying environmental impacts of R&I policy needs to be based on a systemic understanding of the socio-economic effects of public intervention. CPIA proposes a systemic approach to constructing a systemic theory of change connecting R&I policy instruments (inputs) with their wider socio-economic and environmental outcomes and impacts.

Figure 1 introduces the key components of the CPIA logical framework indicating causal feedbacks between policy instruments, policy effects and the contextual determinants.

Figure 1. The logic of the CPIA framework



Source: Based on Miedzinski et al. (2013)

The instrument mix of CPIA originally featured selected instruments of EU R&I policy. It focused on EU-level supply side instrument mix. A number of relevant policy instruments deployed on the EU or national level (e.g. environmental regulations, fiscal instruments) were not the focus of the study, and were considered contextual determinants of R&I policy mix. The CPIA framework introduced stylised types of short-term outputs and outcomes of R&I instruments contributing to wider socio-economic impacts. Following the approach employed by the European Environmental Agency (EEA, 1999) the types of environmental effects differentiate between environmental pressures and impacts. Environmental pressures contribute to wider impacts on the state and functions of the environment (Sala et al., 2012). The overall framework was designed to trace intended and unintended sequences of effects of R&I instruments over time (impact pathways) while considering the role of contextual factors that enable or hamper desired effects. Figure 2 introduces the IA Canvas applying the CPIA framework to the EU R&I policy.

3.2. Theory of change and cumulative impact pathways

The CPIA framework is broadly in line with the main principles of theory-based evaluation. It regards public intervention as *one* of the driving forces of change, taking into account contextual determinants that enable or impede effects of policy. The context influences the scale and timeline of effects of policy instruments. The CPIA attempts to capture a policy-wide systemic theory of change comprising various policy instruments, and extending impact pathways to account for the wider socio-economic and environmental impacts.

The impact assessment (IA) canvas was designed to help in tracing multiple causal links (or impact pathways) between policy interventions and their direct and indirect socio-economic and environmental effects. The canvas can be used to visualise actual or probable impact pathways. Pathways can be represented as linear *n*-order causal connections or complex feedback loops with iterations between effects *and* the context (contextual determinants) in which they occur. By identifying direct and indirect effects of two (or more) instruments the canvas allows for a reflection on a temporal coherence of policy mix. While a perfect temporal coherence may be impossible to attain in practice (Carbone, 2008; Rogge and Reichardt, 2016), a systematic reflection on time-lags along impact pathways can contribute to emergence of a systemic theory of change and policy learning about intended and unintended effects of individual instruments and policy mix. A reflection on how theories of change of instruments align or diverge in time provides a valuable contribution to the policy design.

Figure 3 illustrates simplified cumulative impact pathways of two R&I policy instruments: basic research funding and direct support for product development for SMEs. The figure traces how pathways triggered by two policy instruments may unfold and interact to create cumulative effects over time. Letter A on the pathways stands for ‘attribution’ whereas the numbers (e.g. A1 or A2) indicate the order of attribution of effects to a policy instrument or instruments. For example, A1 stands for a direct attribution of effect (output) whereas A2 or A3 indicate second- or third-order effects of policy instruments. As in the case of theory-based evaluation, outcomes and impacts of policy mix can be explained by a combination of direct and indirect effects of various policy instruments, often deployed at different times *with or without* an intention to create synergy or dysergy. C stands for ‘cumulative’, and indicates how and when cumulative effects of policy mix may emerge. The cumulative effects are further enabled or hampered by various contextual determinants (D).

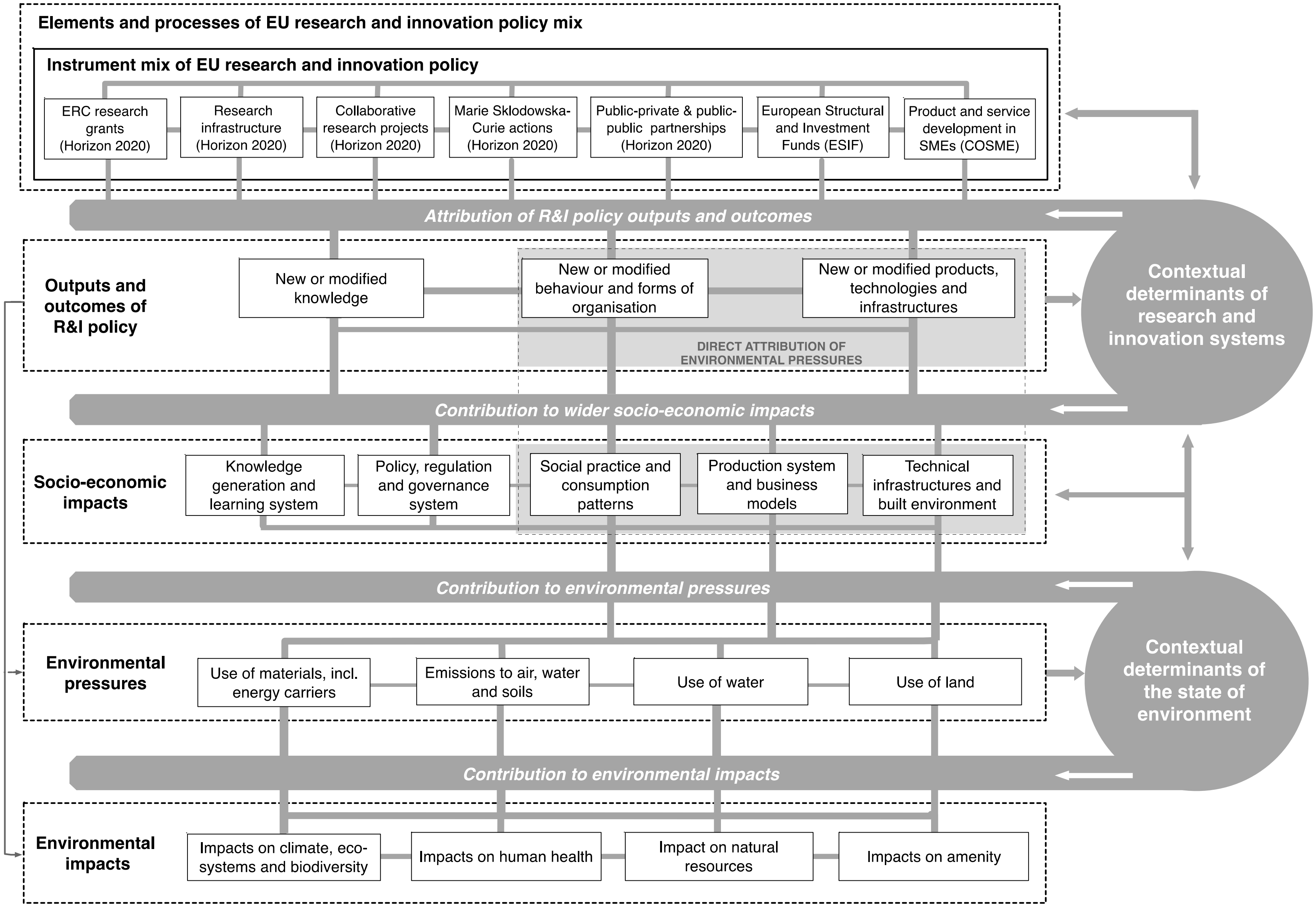
3.3. Challenges of assessing impacts of R&I policy mix

Constructing IA methodologies to analyse effects of R&I policy on environment is a complex task that requires connecting approaches used by social sciences with environmental assessment methods rooted in natural and physical sciences. The question is how to bridge frameworks used to collect and appraise evidence of effects of individual instruments and policy mix on research and innovation system and, on the other hand, frameworks and data used to assess environmental pressures and impacts. Micro-level indicators allowing to measure and assess environmental performance of tangible outputs of STI policy (e.g. new products or services) can be sourced via

monitoring and evaluation systems. This requires that monitoring data capture attributes and parameters of innovative products and services used in established methods assessing environmental impact.

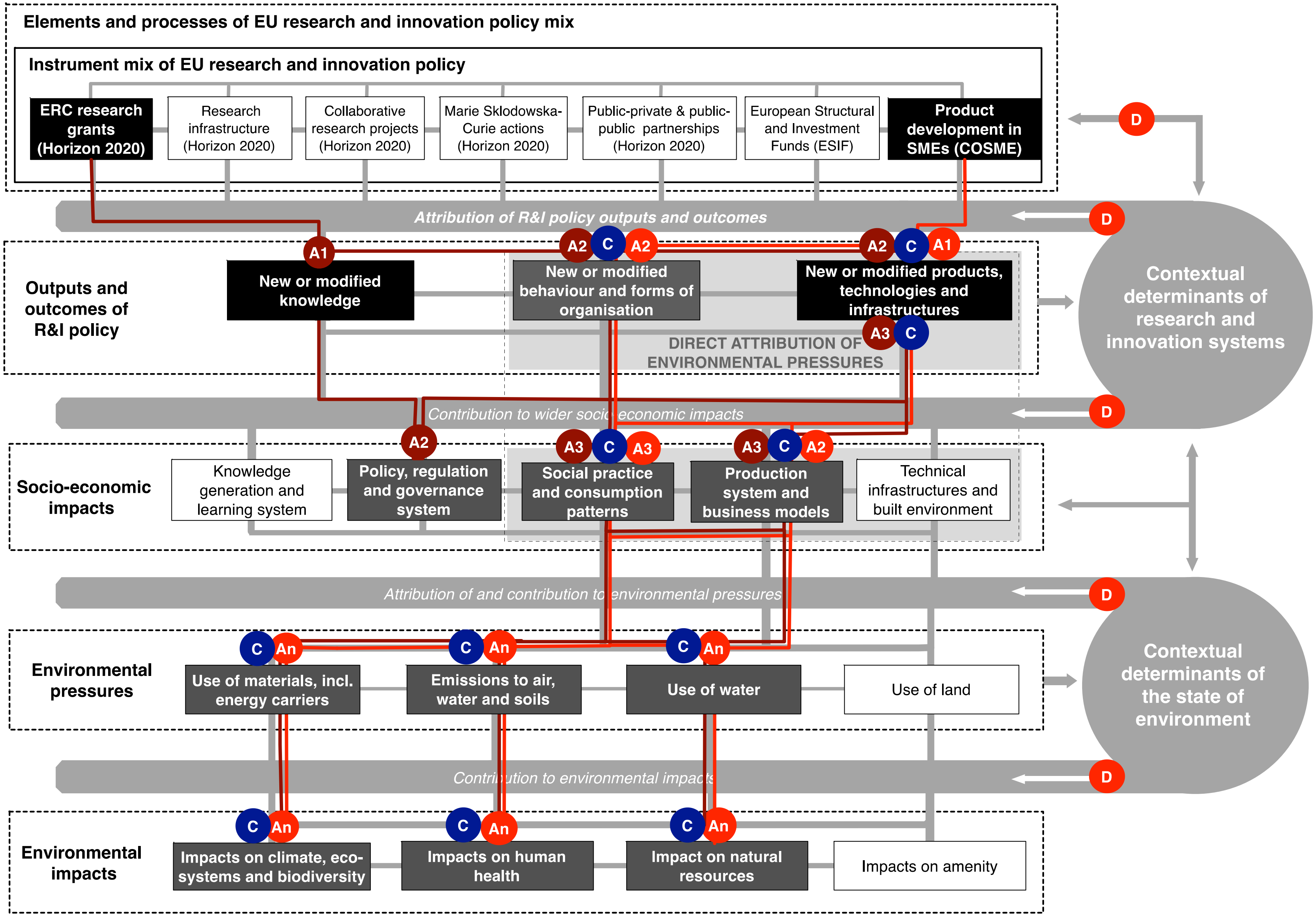
In order to yield useful insights on the meso- and macro-level of analysis, however, IA needs to analyse how outputs and short-term results of policy mixes (e.g. new products or technologies) co-evolve *with* their context. The lack of consideration of the role of context in enabling or hampering impacts may result in failing to recognise that the expected environmental benefits assumed based on the performance of individual products or processes may be offset by the way they are used or by other activities they indirectly trigger (see e.g. Font Vivanco et al., 2016). Tackling the risk of such rebound effects requires a policy mix perspective may be counteracted by deploying other policy instruments. In general, wider environmental impacts of research and innovation are uncertain. Therefore, policy mix assessments require interdisciplinary knowledge and expertise and a sufficient time for collective reflection on possible impact pathways.

Figure 2. CPIA's IA Canvas



Source: Based on Miedzinski et al. (2013)

Figure 3. Tracing cumulative impact pathways with the IA Canvas



Source: Based on Miedzinski et al. (2013)

4. Conclusions and lessons learnt

Introducing the notion of theory of change to policy mix analysis allows for considering interdependencies and time-lags of impact pathways of various instruments. The notion of *cumulative* impact allows to trace synergetic effects of policy mix pointing out that these synergies occur in specific periods of time. Studying cumulative effects requires long historical and prospective time horizons as synergies may occur between active and long-ended instruments.

Adding the notion of impact opens the possibility to reflect on effectiveness of policy mixes. Despite limitations in terms of performing quantitative assessments, the CPIA provides a qualitative model to relate policy effects to the goals of sustainability transition. Regarding coherence, the framework offers two important perspectives. First, it demonstrates that coherence of policy mix cannot be comprehensively assessed without a critical reflection on the theories of change and cumulative impact pathways of policy instruments. Without an analysis of *when and where* various instruments deliver results, we cannot make claims on their *temporal* coherence with other elements of the mix. Second, coherence depends not only on the internal interactions between instruments, but also on how contextual factors enable or inhibit achieving intended effects. CPIA proposes to view external determinants, notably those with an agency, as an integral element of policy mix analysis.

The experience of CPIA suggests the need to designing and testing interdisciplinary frameworks bridging concepts, methods, and quantitative and qualitative data of different nature. Complex system-level assessments need to include methods catered for dealing with fragmented (or missing) data and risk and uncertainty. Research designs should explicitly encourage interdisciplinary conversations and a considerable degree of exploration. When exploring prospective impact pathways, research designs may also include methods encouraging collective learning and creativity (e.g. scenarios and storylines).

One of the challenges of working in interdisciplinary teams is the lack of shared understanding of the unit of analysis and the absence of shared professional language to communicate. CPIA proved useful to create a common understanding of policy mix and its theory of change. IA canvas was designed to serve as a reference logical model visualising the extended R&I policy mix. This visual representation of theories of change was central to creating a shared language between experts and stakeholders.

Connecting the field of policy mix with policy evaluation brings it closer to addressing the challenges of policy design (Howlett and Lejano, 2012). The reflection on impact pathways can provide a basis for deliberation of future policy mix options based on envisioning alternative theories of change to achieve sustainability. CPIA can help to engage stakeholders to co-design of policy options, and create shared understanding on what is desirable, what is feasible, and what is risky and uncertain.

Acknowledgments

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3.4.3 How policy shapes the diffusion of renewable energy systems – An agent-based simulation of California’s energy transition

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3.4.4 Policy packaging or policy patching? The development of complex policy mixes

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Keywords: Policy mixes, Building energy efficiency, development of policy over time

Introduction

Within innovation studies, there has recently been an increasing interest in policy mixes with several contributions published in Research Policy (Flanagan et al. 2011; Magro and Wilson 2013; Quitzow 2015; Kivimaa and Kern 2016; Rogge and Reichardt 2016) and other innovation studies journals (Borrás and Edquist 2013; Reichardt et al. 2016; Uyarra et al. 2016). Policy mixes can be understood as “complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years” (Kern and Howlett 2009: 395). While it has long been acknowledged that a combination of technology push and demand pull instruments is required for stimulating innovation, how such instruments interact and form policy mixes has only recently become of significant interest to the STI community (e.g. Flanagan et al. 2011). There is also an emerging and related discussion on the need for systemic instruments needed to address grand societal challenges (Wieczorek and Hekkert 2012) or the need for STI policies to foster transformative innovation (Schot and Steinmueller 2016).

However, while the interest in policy mixes is relatively new in the field of STI, there is a significant literature already on policy mixes in the field of policy studies. We argue that the emerging research on policy mixes within the STI field would benefit from cross-fertilizations with related work in the policy studies literature (e.g. Rayner and Howlett 2009, Howlett and del Rio 2015). This literature focusses on assessing policy mixes against policy mix characteristics such as coherence and consistency, which has already been taken up in the context of low-carbon innovation (Kern and Howlett 2009). The potential ‘fit’ of proposed new policy programmes or instruments with their governance context is also considered important (Howlett and Rayner 2013). One of the key arguments in this literature is that new policy developments are almost always constrained by previous policy choices. For example, Howlett and Rayner (2007) argue that the degree to which institutionalisation has occurred is variable and that the implementation of new policy programmes and governance arrangements depends on a number of well-understood processes such as increasing returns and other kinds of positive feedback, sunk costs, and incremental policy learning. We argue that drawing on this line of research can help the innovation studies community to better conceptualize and analyse through which kinds of processes policy mixes develop over time and what the likely outputs and innovation impacts of such processes are, as well as better understanding the politics of such processes and the necessary skills required by policymakers.

One sector in which there already has been lots of policy attention to stimulating transformative change is the energy sector. Because of global climate change objectives, many policy makers have recognised the need to fundamentally restructure current energy systems towards lower carbon socio-technical systems (Verbong and Loorbach 2012). Stimulating energy efficiency is an important part of many policy strategies aimed at addressing energy and climate policy objectives, but many studies of energy transitions in the field of STI focus predominantly on supply side technologies and associated changes in practices, regulation, etc. However, according to the International Energy Agency (IEA), stimulating

energy efficiency of buildings has a number of potential benefits which include public expenditure savings of around €30-40b across Europe as well as improved occupant health and well-being (IEA 2014). As buildings account for a 40% share of energy use in Europe, there is much potential for reducing their energy use as a key contribution towards a broader low carbon transition.

While the existing literature on energy transitions acknowledges that public policy is key in terms of influencing the speed and the direction of these change processes, there is little explicit research on policy mixes for transformative change (exceptions include Kivimaa and Kern 2016, Rogge and Reichardt 2016 and Reichardt et al 2016). This paper fills this gap by conducting an empirical analysis of the development of the building-related energy efficiency policy mixes in Finland and the UK 2000 and 2014. The aims of the paper are: (1) to describe the development of the policy mixes in the two countries over time and (2) to analyse their emerging characteristics. Our novel insights relate to introducing a conceptual perspective on the evolution of policy mixes into STI policy debates and new empirical analysis regarding building energy efficiency policies in Finland and the United Kingdom (UK).

Analytical Framework and Methodology

Conceptually, the paper builds on the policy design literature which judges the potential effects of policy mixes on the basis of criteria such as consistency and coherence, and analyses why many existing policy mixes are sub-optional. Howlett and Rayner understand policy design as follows: “how specific types of policy tools or instruments are bundled or combined in a principled manner into policy 'portfolios' or 'mixes' in an effort to attain policy goals” (2013: 172). We draw on Howlett and Rayner (2013) who define consistency as “the ability of multiple policy tools to reinforce rather than undermine each other in the pursuit of policy goals” (p. 174). Coherence is the “ability of multiple policy goals to co-exist with each other and with instrument norms in a logical fashion” (p. 174). However, goals and instruments are added to and subtracted from the mix over time. Policy makers are not completely free in their choices as policy mixes are path-dependent and typically evolve through four processes: layering, drift, conversion and replacement (Howlett and Rayner 2007, 2013; Kern and Howlett 2009) (see Table 1).

Table 2: Relationship between policy development processes and the expected coherence and consistency of a policy mix

Instruments / Goals	Consistent	Inconsistent
Coherent	*Replacement*	*Conversion*
Incoherent	*Drift*	*Layering*

Source: Kern and Howlett 2009: 396

Howlett and Rayner (2013) note that empirically most existing policy mixes have developed through *layering, conversion* or *drift*, often resulting in inconsistent and incoherent policy mixes. Situations where new policy mixes are developed ‘from scratch’ are rare. This literature argues that studying the processes of how policy mixes evolve over time and the emerging overall policy mix characteristics in terms of consistency and coherence can be used as a proxy to assess likely policy outcomes ex ante.

We apply this framework to the case of building-related energy efficiency policies in the Finland and the UK. The data on which our analysis is based was collected from a number of sources, including a systematic review of national energy policy documents, reports, IEA documents, and a number of existing databases were used to identify building-related policy goals and instruments. This was complemented by 19 semi-structured interviews which were conducted with stakeholders who have expertise in energy efficiency in buildings, including representatives of the building industry, technical experts, energy agencies, civil servants and NGOs. An Excel spreadsheet and a timeline of policy instruments in place in late 2014 in each country was used to analyse the overall characteristics of the policy

mixes. The collected information was used to trace policy developments over time (see Figure 1 and 2).

Figure 1: The development of the Finnish policy instruments for building energy efficiency, 2000-2014

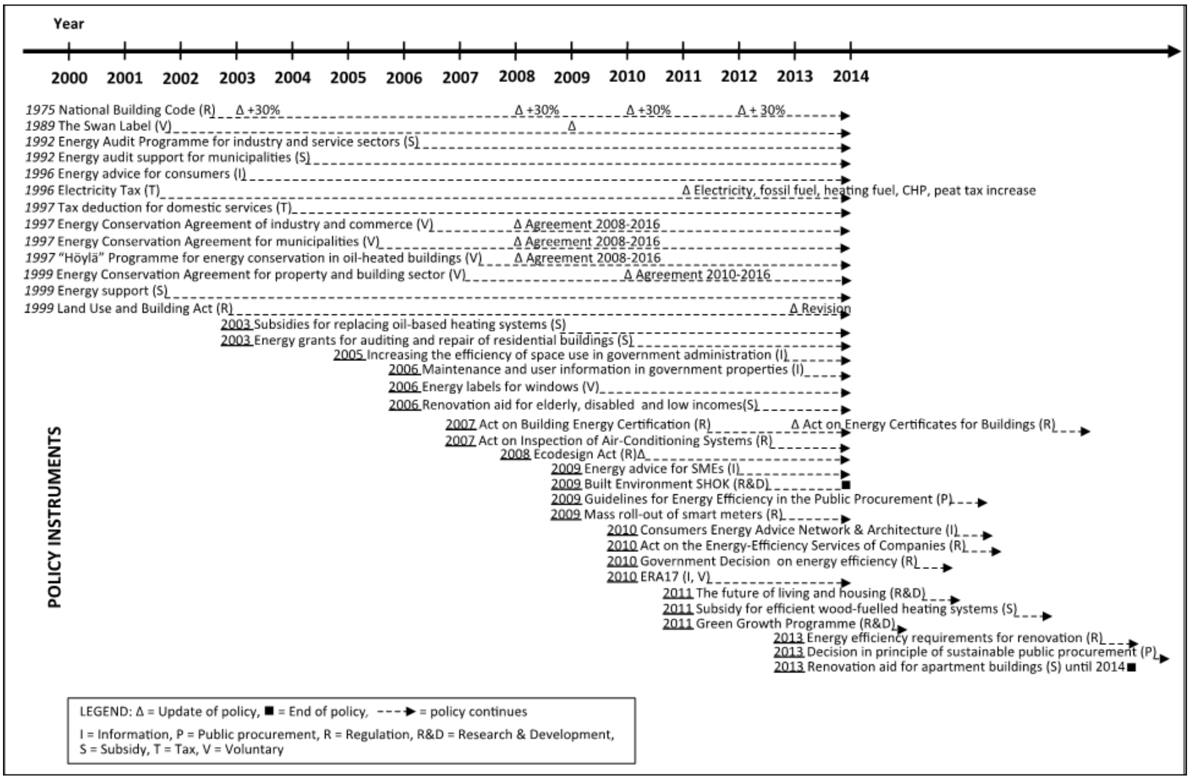
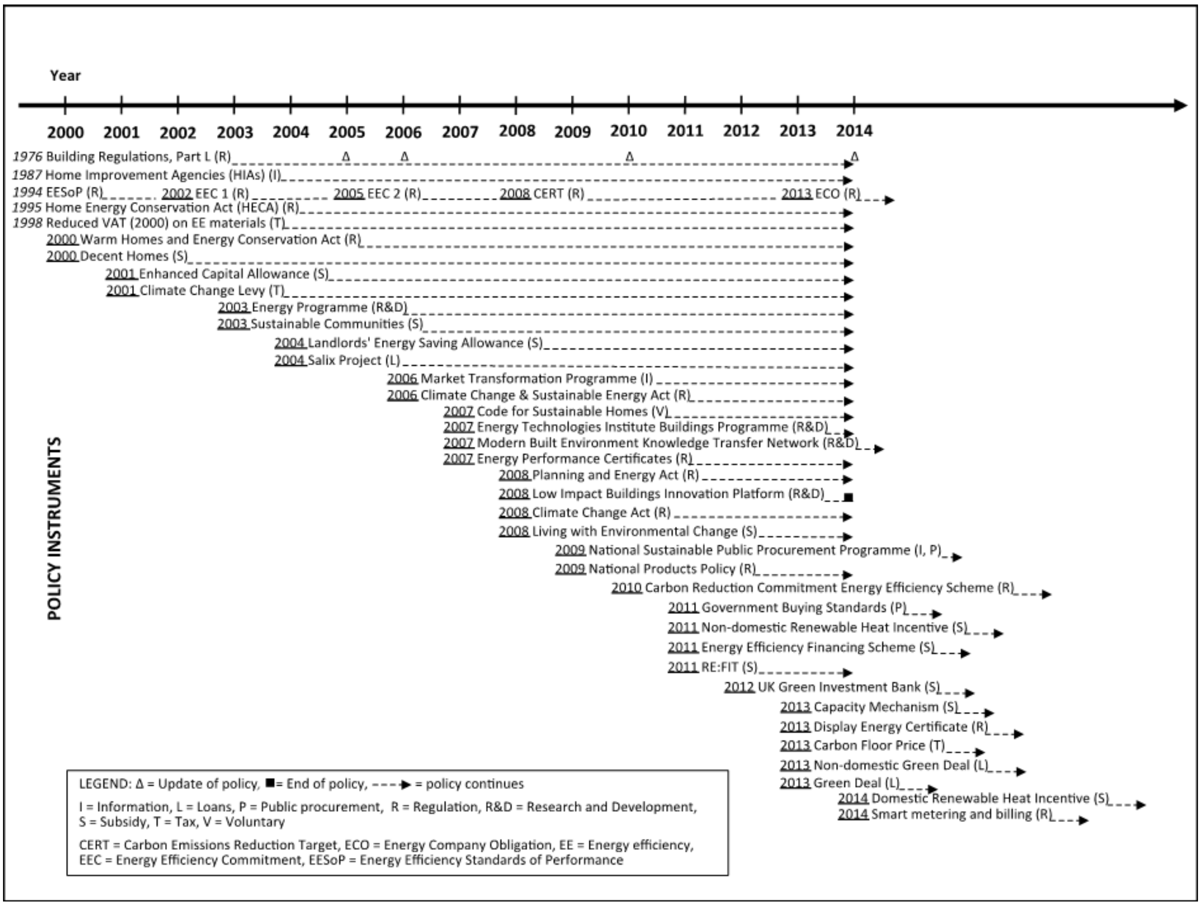


Figure 2: The development of the UK policy instruments for building energy efficiency, 2000-2014



Source: Kern et al 2017

Results

Our analysis finds that that both countries have increasingly complex policy mixes, encompassing a variety of goals and instruments and making use of a variety of different types of instruments (see Table 2) – creating challenges for both the design and evaluation of the policy mixes. The analysis shows that both countries make use of the ‘full toolbox’ of available instruments, including financial, regulatory as well as ‘soft’ instruments in a reasonably balanced way. This is important since in early policy design studies analysts often argued for implementing the least intrusive measures first and then ratcheting up the level of coercion. In contrast, Howlett and Rayner argue that “rather than assuming that a choice must be made between only a few alternatives such as regulation versus market tools” (2013, p. 175), policy makers are encouraged to use the full range of possible instruments. This is especially important for STI policy mixes aiming for transformative change we argue because of the number of system failures that need to be addressed (Weber and Rohracher 2012). We also argue that given the complexity of the mix, both countries should make an effort to start evaluating the overall impact of their policy mixes rather than evaluating individual instruments or selected bundles of instruments as is common practice.

Table 2: Summary of types of instruments in Finland and the UK in place in 2014

Types of instruments		Finland	UK
Economic instruments	Subsidy	8	11
	Loans	0	3
	Taxation	2	3
	Public procurement	2	2
	Research & Development	3	4
Regulatory instruments	Regulation	9	12
Soft instruments	Voluntary measures	7	1
	Information	6	3
	Total	***37***	***39***

NB: Because some instruments are classed under more than one type, the overall number does not match with the ones in section 4
Source: Kern et al 2017

While the Finnish mix evolution showed characteristics of a replacement process, it also displayed a degree of layering of new instruments and an approach of policy patching rather than a complete re-packaging that the literature associates with replacement. Nevertheless, the policy mix is seen to function relatively well and is likely to lead to positive outcomes at least in terms of incremental innovation. In contrast, the UK case is predominantly characterised by drift as partly incoherent policy goals have been combined with a relatively consistent and largely well targeted instrument mix with some gaps, which may undermine progress towards achieving the goals. Especially with regard to the existing building stock, energy efficiency has not improved as fast as is necessary to meet targets. Until 2014, the UK also showed a rapid accumulation of new instruments (layering) combined with a degree of policy packaging.

One contrast between the two cases is that while in the UK there has also been a lot of ‘churn’ in policy instruments, Finland has had a somewhat more stable policy environment, where the added policies have not as radically altered the mix. According to previous research, a rapidly fluctuating policy environment can slow innovation down as companies generally prefer stability for their investment decisions, particularly given that innovation processes can take decades (see Kemp and Pontoglio 2011 for a review of this research). This means that the UK policy context may in effect deter low energy innovations and their diffusion. In contrast, while the more stable Finnish approach is likely to support innovation and diffusion of building innovations such as heat pumps (cf. Heiskanen et al. 2014), insulation and ventilation systems, it is unlikely to lead to radical system innovation in zero carbon or passive houses (cf. Mlecnik 2013; Pässilä et al. 2015).

Conclusions

Our results support the claim by Howlett and Rayner (2013) that strategic policy patching (if done well) may be a more promising approach for policymakers than the creation of completely new policy packages from the perspective of achieving a coherent and consistent policy mix supporting transformative

innovation. We argue that the concept of patching is useful for policymakers as it chimes better with the reality of 'messy, real-world' policy making. Our analysis has identified ways in which such patching can be strategically used by policymakers in both countries to increase the chances of significant improvements in building energy efficiency. More generally, our analysis emphasises the importance of 1) a broad mix of different policy instruments to stimulate transformative innovation, 2) the need to evaluate portfolios rather than individual instruments, and 3) to manage the mix over time in a way which doesn't deter investment through unexpected changes or excessive 'churn' but at the same time incentivises progressively more radical changes in existing socio-technical configurations. These are important lessons also for STI policy makers interested in stimulating transformative change.

Conceptually, the UK case shows a different pattern compared to the way drift has previously been defined in the literature as occurring when new goals replace old ones while keeping the instruments similar (Kern and Howlett 2009). Instead in this case drift has occurred through the introduction of social and carbon reduction goals into traditional energy efficiency ambitions which led to a set of partly incoherent goals. The definition of drift should be extended in line with this finding and other studies should be used to corroborate whether this is a more common finding.

Note

This extended abstract is based on a paper which has been recently published as:
Kern, F., Kivimaa, P., & Martiskainen, M. (2017). Policy packaging or policy patching? The development of complex energy efficiency policy mixes. *Energy Research & Social Science*, *23*, 11-25. (available open access)

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3.5 Session 3.5

3.5.1 Innovation policy mix: evidence on complementarity between supply-side support and public procurement

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Keywords: Public procurement, Innovation policy, Policy mix

Introduction

In the public support of innovation, supply-side policy measures have traditionally overshadowed demand-side policy measures (Edler et al., 2012; Edquist et al., 2015; Uyarra and Flanagan, 2010). However, in recent years, EU and national policy makers have increasingly come to appreciate public procurement as potentially the most effective demand-side approach to stimulating innovation (Edler and Georghiou, 2007; OECD, 2011; Edquist and Zabala-Iturriagagoitia, 2012; Uyarra and Flanagan, 2010).

This study explores how traditional, supply-side policy measures jointly with public procurement affect innovation outputs. Nowadays scholars and international organizations, such as the OECD, recognize that supply-side and demand-side measures are complements and should be regarded as such (Aschhoff and Sofka, 2009; Edquist et al., 2015; Flanagan et al., 2011; Guerzoni and Raiteri, 2015; OECD, 2011). This argument is the motivation for this study, because the aim is to empirically test the hypothesised complementarity between public support and public procurement.

The main contribution of this study is to investigate the joint impact of public financial support for innovation and two types of public procurement (Edquist and Zabala-Iturriagagoitia, 2012; Uyarra and Flanagan, 2010): namely, regular public procurement, i.e. the purchase of ready-made products where contracts do not require any additional R&D or even broader innovative activities; and public procurement of innovation, i.e. when a public sector organisation purchases “innovative solutions” (products or services that demand innovation by a supplier, such as R&D activities) (Lember et al., 2011). This study is among the first to assess the joint effectiveness of public support and public procurement in stimulating two different kinds of innovation outputs: “operational”, denoting both technological and non-technological outputs (product innovation in goods and services as well as process, organisational and marketing innovation); and “commercial”, denoting the proportion of total sales accounted for by innovative goods and services (innovative sales).

Theory and hypothesis development

Since the 1950s, supply-side policy measures have been the dominant form of government intervention. Even though predominantly positive policy effects are reported, they are usually small (OECD, 2014). Consequently, the last decade or so has witnessed the resurrection of demand-side policy measures, in particular, public procurement. Although the complementarity between supply-side and demand-side innovation policy has long been recognized in theoretical work this notion has gained

traction among policy makers only in the last decade or so (Edler and Georghiou, 2007; OECD, 2011; Guerzoni and Raiteri, 2015). In the evaluation literature, this trend is reflected in the increasing number of studies assessing the effectiveness of innovation policy by taking into account the implementation of both supply-side and demand-side measures, in particular, public procurement. Aschhoff and Sofka (2009) find that both public procurement and knowledge spillovers from universities increase the market success of innovation (innovative sales). Second, Guerzoni and Raiteri (2015) explore how interactions between public procurement of innovation, R&D tax credits and R&D subsidies affect innovation expenditure. Their results suggest that public procurement of innovation has a positive impact on innovation input when this policy tool is considered separately, as well as when analysed in combination with R&D subsidies and R&D tax credits.

Based on the above theoretical considerations and previous empirical findings, we formulate the following hypotheses:

H1: Supply-side support and regular public procurement have a complementary effect on innovation output indicators.

H2: Supply-side support and public procurement of innovation have a complementary effect on innovation output indicators.

At the level of the economy as a whole, the potential of regular procurement to influence innovation may be enormous. Yet, firms engaging in regular procurement may or may not be induced to engage in more innovation, whereas firms engaged in procurement of innovation have to innovate. Hence, our final hypothesis:

H3: The firm-level effects of regular public procurement on innovation output indicators are smaller than the effects of public procurement of innovation.

Methodology

We use the Flash Eurobarometer 394 – "The role of public support in the commercialisation of innovations" survey – which includes firms from 28 EU Member States, Switzerland and the United States and covers the period from January 2011 to February 2014 (European Commission, 2014). The focus of this study is on the Average Treatment on the Treated (ATT) effects, where the outcomes of interest are innovation output indicators. Treatment assignment into both supply-side support and public procurement should be regarded as endogenous due to selection bias arising in the process of application and distribution of public measures, because either: a) firms self-select themselves into programmes; and/or b) programme agencies adopt a "picking-the-winner" strategy during the selection process (Cerulli 2010; David et al. 2000; Guerzoni and Raiteri, 2015). To take into account that firms may both benefit from supply-side innovation support and participate in public procurement, we estimate treatment effects in the multi-treatment context (Lechner, 2001).

Empirical results

The estimated ATTs for Model 1 (with regular procurement) are reported in Table 1. We find no evidence of complementarity between supply-side support and regular public procurement for any of the operational outputs (Column 3). In contrast, we report strong evidence of complementarity between supply-side support and regular public procurement for innovative sales. The joint effect is not only around three times as large as either effect in isolation, but these differences are statistically significant at the one percent level. In sum, the evidence generated by investigating Hypothesis 1 is more interesting than simple rejection/non-rejection. We find no evidence of complementarity between supply-side support and regular public procurement for technological and non-technological aspects of innovation. Yet for innovative sales we find strong evidence of complementarity between supply-side support and regular procurement. Therefore, whereas Hypothesis 1 is not supported for operational innovation outputs it is supported for the commercial success of innovation.

Table 1. The estimated Average Treatment Effects on the Treated (ATTs) for Model 1: supply-side support and regular public procurement.

Outcome variables	Average Estimated Treatment Effects on the Treated (ATTs)			No of obs.
	Supply-side support	**Regular public procurement**	**Both supply-side support and regular public procurement**	
Product innovation in goods	0.025 (0.038)	0.138** (0.024)	0.150*** (0.039)	2,054
Product innovation in services	0.054 (0.041)	0.136*** (0.024)	0.150*** (0.042)	2,073
Process innovation	-0.013 (0.040)	0.032 (0.025)	-0.010 (0.041)	2,068
Organizational innovation	0.015 (0.042)	0.043* (0.025)	0.004 (0.045)	2,072
Marketing innovation	0.037 (0.042)	0.063** (0.025)	0.044 (0.046)	2,069
Innovative sales	0.131** (0.058)	0.147*** (0.038)	0.404*** (0.072)	1,578

Notes: Robust standard errors in parentheses; ***p <0.01, **p<0.05; *p<0.1.

The estimated ATT effects for Model 2 (with public procurement of innovation) are reported in Table 2. The results for Hypothesis 2 are similar to those reported above for Hypothesis 1. We find no evidence of complementarity between supply-side support and public procurement of innovation in any of the operational outputs (Column 3). In contrast, for innovative sales we report strong evidence of complementarity between supply-side support and public procurement of innovation. Therefore, whereas Hypothesis 2 is not supported for operational innovation outputs it is supported for the commercial success of innovation.

Table 2. The estimated Average Treatment Effects on the Treated (ATTs) for Model 2: supply-side support and public procurement of innovation.

Outcome variables	Average Treatment Effects on the Treated (ATTs)			No of obs.
	Supply-side support	**Public procurement of innovation**	**Both supply-side support and public procurement of innovation**	
Product innovation in goods	0.030 (0.032)	0.127*** (0.025)	0.124*** (0.040)	2,295

Product innovation in services	0.038 (0.035)	0.098*** (0.024)	0.127*** (0.038)	2,314
Process innovation	0.016 (0.034)	0.073*** (0.026)	-0.019 (0.041)	2,314
Organizational innovation	0.014 (0.036)	0.077*** (0.026)	-0.005 (0.046)	2,318
Marketing innovation	0.048 (0.036)	0.070*** (0.026)	0.099** (0.046)	2,312
Innovative sales	0.158*** (0.053)	0.212*** (0.046)	0.422*** (0.082)	1,785

Notes: Robust standard errors in parentheses; ***p <0.01, **p<0.05; *p<0.1.

To test Hypothesis 3, we estimate two variants of a third model: in Model 3a, in which we exclude firms that received supply-side support, the treatment group comprises firms that participated in public procurement of innovation only while the comparison group comprises firms that participated in regular public procurement only; and Model 3b, in which we include firms that received supply-side support but maintain the same mutually exclusive treatment and comparison groups (see Table 3).

Table 3. Testing Hypothesis 3: the estimated Average Treatment Effects on the Treated (ATTs).

Outcome variables	Model 3a	No. of obs.	Model 3b	No of obs.
Product innovation in goods	0.074** (0.037)	1,866	-0.039 (0.061)	285
Product innovation in services	0.039 (0.036)	1,884	0.048 (0.066)	288
Process innovation	0.001 (0.038)	1,879	0.063 (0.066)	290
Organizational innovation	0.076* (0.039)	1,885	0.019 (0.070)	289
Marketing innovation	0.033 (0.040)	1,880	0.088 (0.064)	289
Innovative sales	0.106 (0.082)	1,415	0.015 (0.158)	254

Notes: Robust standard errors in parentheses; ***p <0.01, **p<0.05; *p<0.1.

In Model 3a, as expected, all of the ATTs are positive, which indicates that public procurement of innovation does more than regular procurement to stimulate innovation outputs. However, only two of these differences are statistically significant. As expected, public procurement of innovation gives rise to more product innovation in goods than does regular procurement which, in turn, may give rise

to differential organizational challenges. However, although the differential effect on innovative sales is large it is not statistically significant, which – we conjecture – may reflect the inability of cross-sectional data to capture effects that unfold over periods longer than those captured by the three-year survey period. Moreover, when we add firms that received supply-side support to the sample, although all but one of the estimated ATTs is positive they all lack statistical significance. Accordingly, Hypothesis 3 is – at best – partially supported.

Conclusions and policy implications

We test three hypotheses using six indicators of innovation output: five operational (product – in goods and services, process, organisational and marketing); and one commercial (innovative sales as a measure of the commercial success of innovation). Hypotheses 1 and 2 – on the complementarity between supply-side support measures and, respectively, regular public procurement and procurement of innovation – are both rejected for all of the operational outputs but are both confirmed for innovative sales. We conclude that the commercial success of innovative goods and services is most effectively promoted by supply-side support and public procurement in combination rather than by either in isolation. In this field of policy making our evidence thus contributes an argument for a "joined up" approach. In this vein, our study adds weight to the findings and conclusions from Guerzoni and Raiteri (2015), who found complementarity between supply-side support and public procurement of innovation with respect to innovation inputs.

Our third hypothesis is that at firm level the direct effects of public procurement of innovation should typically be larger than the indirect effects of regular public procurement. This hypothesis is partially supported by our findings; although public procurement of innovations gives rise to greater product innovation in goods and corresponding organisational innovation than does regular procurement, the differential effects on the other operational innovation categories and on innovation sales are positive but not statistically significant.

Our findings are also informative about the relative effects of supply-side support and both types of public procurement, even though we do not state corresponding hypotheses. Here, our findings are in line with Geroski (1990) and Guerzoni and Raiteri (2015), who argued that public procurement could be more effective than supply-side policy measures in increasing firms' innovation inputs. We extend these findings by providing evidence on the relative effects of supply-side support and procurement on innovation outputs. For each of the five categories of operational outputs, our estimates uniformly suggest no statistically significant effects from supply-side support measures in contrast to individually significant positive effects from both regular procurement and procurement of innovation. In contrast, for innovative sales there is no statistically significant difference between the individual effects of supply-side support and either type of public procurement. Accordingly, our findings are supportive of the earlier studies with respect to operational measure of innovation but not with respect to the commercial outcomes of innovation, which we find to be promoted from both the supply-side and the demand-side.

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3.5.2 Demanding innovation: A Policy lab approach for public procurement

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Keywords: Demand-side innovation policy, Public procurement, Policy intervention

Social systems theory

Demand-side instruments such as public procurement, regulation and standards became prominent within innovation policy. Together with supply-side instruments such as subsidies for research and development they should form an effective innovation policy mix (EC 2007/C/799; OECD 2011, 2014; SBIR-STTR-IPC 2014; Edquist et al. 2015; Edler and Georghiou 2007). Public procurement of innovation is presently the most prominent demand-side instruments because of its huge economic relevance (public procurement accounts for over 14% of European Union GDP) (EC 2016). Hopes are high that public procurement can provide a powerful lever for innovation. But procurement is in its nature conservative and risk-averse and the innovation stimulating purchasing power of public entities remains therefore somewhat unexploited. Thus, intervention is required and justified from an innovation policy perspective.

Austria, which belongs meanwhile to the group of advanced countries in this field (ERAC 2015; OECD 2016; Buchinger 2016), has been using a policy lab approach for the optimal design of a policy intervention under the label "Public Procurement Promoting Innovation (PPPI)". The PPPI Lab, its context, its rollout and its outcome will be discussed in this text. Before that the rationales of public procurement of innovation and the systems theoretical background will be outlined.

Rationale: Boosting innovation through procurement is not new. It has been done occasionally since decades to modernize public infrastructures. Examples are implementing e-health devices, demanding renewable energies, introducing intelligent mobility solutions, and modernizing safety & security facilities. New is the aim to achieve higher rates of innovation procurement in all areas. This aim follows a rational consisting of three strands of considerations. First, enhance public administration's effectiveness. Second, address societal challenges. Third, mobilize and direct resources for innovation. These three strands of consideration converge in the one overall rationale: capitalize on innovative solutions to modernize public services for the benefit of citizens' immediate and long-term well-being.

Systems theoretical background - intervening system and addressed system in PPPI: On the macro societal level, the intervening system of the PPPI initiative is politics and the addressed system is economy. On the organizational level the addressees are economic operators – i.e. enterprises or other forms of suppliers – which are expected to increase their innovation performance following the demand of public buyers. According to social systems theory, societal as well as organizational systems are complex 'operationally closed' entities. Operationally closed systems cannot be controlled from outside, i.e. being the intervention 'object' of an outside located intervention 'subject' (Luhmann 1997). But they are open to various kinds of signals from their environment and can be brought into resonance. Therefore they are called intervention 'addressees'. In the case of the PPPI initiative various actors can be identified performing a certain intervention role on the organizational level. Economic operators supplying innovative solutions upon public entities demands which in turn must receive intervention signals sent from innovation policy makers. These signals have to be tailored in a way which increases the probability that they are received by the public entities as information (and not as noise). In the terminology of social systems theory resonance is achieved whenever signals in the environment affect the system's self-referential operation mode.

First lab phase - learning and clarifying the context: Austria's innovation procurement initiative has been triggered by the European Commission, which has itself been inspired by the US procurement model SBIR. Various searching/learning activities resulted in the up-taking of the demand-side issue in the 'Austrian Strategy for Research, Technology and Innovation (RTI-Strategy)' (BKA et al. 2011).

Second lab phase - co-designing and deciding policy intervention: A stakeholder process was launched to co-design the intervention as crucial part of the development of the Austrian PPPI Action Plan. Process owners were (and still are) cooperatively the Ministry of Science, Research and Economy (BMWFW) and the Ministry for Transport, Innovation and Technology (BMVIT). Before the stakeholder process was launched, a stakeholder mapping took place. That is, a functional analysis was conducted to distinguish the various roles performed, identify thus the 'right' stakeholder and structure the process accordingly.

Third lab phase - intervention implementation and interim assessments: The implementation of the PPPI Action Plan started immediately after the government mandate was given. Up to date various interventions took place and indicating all together the third milestone of the PPPI lab. They include the installation of a comprehensive service-network, an online market place, awarding of vouchers and of grants, and the amendment of procurement law among others.

Fourth lab phase - outlook impact evaluation: Summarizing it can be said that PPPI is henceforth well institutionalized in Austria. Various lab mile-stones (M) have been achieved: M1 mandating the PPPI Action Plan by the Austrian government; M2 stakeholder co-design of the 'PPPI Action Plan' and its mandating by the government; M3 implementation of interventions such as the amendment of the procurement law, the inclusion of pro-curer needs in existing programs, the provision of a range of services and financial incentives resulting in concrete innovation procurements, and the initialization of an monitoring system. Nevertheless, much work has to be done. Generally, for the coming time it is necessary to transform the existing good practice 'elite' into a 'mass-movement' of innovation procurement and therefore the PPPI lab will continue and the 'Austrian Council for Research and Technology Development' recommended specific improvements. A comprising impact evaluation is scheduled for 2017/2018. It will show how much resonance has been achieved by the interventions of the PPPI initiative and what the next steps should be.

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3.5.3 Opening the black box of innovation policy instrument mix: A conceptual framework for impact evaluation and empirical application using panel data

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Keywords: Firm-level innovation, policy mix, instrument mix, temporal consistency, dynamic complementarities

Innovation policy studies literature increasingly recognises that policy complexity severely limits the explanatory power of traditional methods for policy evaluation (Laranja et al., 2008; Magro and Wilson, 2013; OECD, 2015b). The concept of 'policy mix' has emerged as a means of understanding and mitigating the limitations brought about by policy complexity (Flanagan et al., 2011). A cornerstone aspect of policy mix theory is to focus on the interactions, interdependencies and trade-offs between different innovation policies as they affect the extent to which policy outcomes are achieved (Flanagan et al., 2011; Rogge and Reichardt, 2016). The primary means of operationalising innovation policy is through policy instruments (Martin, 2016). Firms often receive multiple policy instruments simultaneously, meaning that the observed impact of innovation policy can depend crucially on interactions within this mix of policy instruments (Nauwelaers et al., 2009).

Individual policy instruments are characterised by distinct rationales, goals, and implementation modes (Flanagan et al., 2011). Depending on the degree of consistency between different policy instruments in terms of these characteristics, interaction effects can be complementary, substitutive, or neutral (Rogge and Reichardt, 2016; Lanahan and Feldman, 2015). Neutral effects will be the result of 'weak' consistency, which involves the simple absence of conflicts between policy instruments, while 'strong' consistency entails complementarity and requires policy instruments to mutually reinforce one another's impact (Howlett and del Rio, 2015). When different policy instruments actively hamper each other they are inconsistent (Kern and Howlett, 2009) and may substitute. Consistency in the instrument mix is therefore an important means of improving the performance of innovation policy, and a large part of the policymaker's role is to design and coordinate the policy instrument mix to achieve this (OECD, 2010; Borras and Edquist, 2013).

Beyond theory, policy instrument mixes are rarely designed, but rather emerge over time, are implemented across multiple levels of government, different policy domains, and geographical spaces (Flanagan et al., 2011). In this complex policy system, it seems unlikely that consistency will be achieved by simply layering one policy instrument on top of another over time (Howlett, 2014; Kern and Howlett, 2009; Howlett and Rayner, 2007). Therefore, evaluations of the policy instrument mix must take account of the important temporal dimension of instrument mix consistency (Flanagan and Uyarra, 2016; Kern et al., 2017). This requires analysis of the dynamics of how policy instrument mixes are arrived at, as well as the eventual impact these dynamics have on firms' innovation outcomes (Uyarra, 2010). However, to date empirical evaluations have tended to focus solely on the relative effectiveness of different combinations of policy instruments (e.g., Czarnitzki and Lopes-Bento, 2014; del Rio, 2014; Guerzoni and Raiteri, 2015), paying little attention to the crucial underlying role of consistency in moderating these interaction effects (Reichardt and Rogge, 2016; Rogge and

Reichardt, 2016). Therefore, the theoretical underpinnings of how policy instrument mixes function have not been translated as the basis upon which policy instrument mix evaluations are conducted in practise.

We fill this gap in the literature by asking: How does the temporal consistency of an innovation policy instrument mix effect its impact on firm-level innovation? In seeking to answer this question, we make three key contributions to the literature.

First, we establish a conceptual framework for the ex-ante and ex-post impact evaluation of policy instrument mixes. Drawing on policy mix theory, we place consistency between interacting policy instruments at the heart of this framework. We aim to ensure that the framework is truly dynamic by conceptualising feed-back loops between ex-post instrument interactions and policy outcomes with ex-ante policy instrument design. In addition to this, we broaden in a holistic manner the scope for policy impact to include social and political outcomes as well as the economic outcomes typically considered in the literature. Finally, we incorporate the notion that policy outcomes can be unintended as well as intended over the short, medium and long term (Edquist and Zabala-Iturriagagoitia, 2012). This progresses the literature towards a more holistic understanding of policy evaluation (Lenihan, 2011).

Second, we apply this conceptual framework using a novel econometric method that is uniquely suited to evaluating consistency in the policy instrument mix. We apply a direct statistical test for static and dynamic complementarity between policy instruments (Love et al., 2014). We do this first in static terms, by pooling all of the observations in our dataset (detailed below) and comparing them to one another in terms of the different policy instrument mix they are exposed to. Following this, we test for dynamic complementarity by conducting intra-firm comparisons of firms to themselves as they receive different mixes of policy instruments through time. Two different policy instruments are complementary if receiving a new instrument increases the additionality being achieved with an instrument the firm is already receiving (Mohnen and Röller, 2005; Cassiman and Veugelers, 2006). This method allows us to account for the fact that firm-level innovation additionality does not simply depend on what policy instrument(s) the firm is currently exposed to, but also on what policy instrument(s) the firm was exposed to in the past (Flanagan et al., 2011). Despite the applicability of this microeconometric procedure to the evaluation of the temporal consistency in the policy instrument mix, to the authors' knowledge, this is the first time it has been performed in the innovation policy evaluation literature. Applying policy mix theory using this method, we test the following hypotheses:

Hypothesis 1: When firms receive a combination of two different policy instruments simultaneously, there will be a complementary relationship between them in their impact on firm-level innovation.

Hypothesis 2: When firms receive a policy instrument in one year, and then switch to receiving a combination of the initial policy instrument and a new policy instrument in the next year, there will be a complementary relationship between them in their impact on firm-level innovation.

Testing these hypotheses calls for dynamic analysis, and so requires information on the mix of policy instruments a firm is exposed to through time (Love et al., 2014). This requirement leads to our third contribution: the construction of wholly novel panel dataset capturing all of the core innovation policy instruments available to firms in Ireland spanning the years 2006-2014. The Annual Business Survey of Economic Impact (ABSEI), collected by the Department of Jobs, Enterprise and Innovation (DJEI), is a rich source of firm-level panel data that captures whether firms received an R&D tax credit, as well as other crucial information. We combine the ABSEI with administrative data from Enterprise Ireland and IDA Ireland, the two primary public funding agencies of innovation in indigenous and foreign-owned firms respectively through direct innovation subsidies, and Science Foundation Ireland, the primary funding agency of applied and (oriented) basic research through Public-Private Research Collaborations (PPRCs). No other empirical setting we are aware of can facilitate an impact evaluation of changes to policy instrument mix over such a long time period, with such precise information on the underlying characteristics of each policy instrument.

The results of our analysis have important implications for policy. Empirically, our findings indicate no evidence of static complementarity between any of the different policy instrument combinations. However, when dynamic complementarities are considered, we find strong evidence that adding a direct innovation subsidy from Enterprise Ireland or IDA Ireland or a PPRC from Science Foundation Ireland to a firm already receiving an R&D tax credit is accompanied by an increase in firm-level innovation. In terms of the practise of policy evaluation, not only do these findings demonstrate the conceptual importance of consistency when conducting policy instrument mix evaluations, but they also make clear the key role temporal dynamics play policy instrument interactions. More broadly, by constructing a conceptual framework for the holistic ex-ante and ex-post evaluation of policy instrument mix, we lay a theory-based foundation upon which future empirical evaluations can be conducted. This moves the field beyond its current focus on the relative effectiveness of different instrument combinations to an understanding based on the interactions and trade-offs inherent in all policy mix relationships.

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3.6 Session 3.6

3.6.1 Innovation policy mix: conceptual and operational approach in the OECD STI Outlook 2012-2014-2016

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Introduction: Scope

The “policy mix” concept has gained popularity among innovation policy communities over the past two decades in a context of growing complexity and uncertainty. Its increasing use reflects two major science, technology and innovation (STI) policy trends: the increasing complexity of innovation policy that requires a more holistic approach in governance (and therefore a clear understanding of how the policy mix is composed), and the growing need to evaluate policies and support the design of evidence-based policies (and thus evidence that the components of the policy mix interact positively between each other).

The “policy mix” term could be understood as the set of and interactions among policy rationales, arrangements and instruments implemented to deliver public action in specific policy domains. The “policy mix” concept refers therefore to: 1) the composition of the “policy mix” and the relative balance between its components, and 2) the interactions between its components. More specifically in the innovation policy domain, there is no clearly stated definition of the concept (Flanagan et al., 2011) and discussions often question the normative features of the mix in terms of “coherence”, “consistency”, “coordination”, “efficiency”, “appropriateness”, “balance”, “stability”, “predictability”, “comprehensiveness”, “legitimacy”, “credibility” etc. (Guy et al., 2009; Nauwelaers et al., 2009 ; OECD, 2010; Flanagan et al., 2011 ; Bórras and Edquist, 2013 ; Cunningham et al., 2013 ; Rogge and Reichardt, 2016).

A growing bunch of policy analysis and academic literature, in the innovation policy area and beyond, has been advocating the need to expanding the scope of policy evaluation to go beyond an instrument approach (Bórras and Edquist, 2013; Cunningham et al., 2013; Edler et al., 2012; Flanagan et al., 2011; Kay, 2006), and to better capture the multidimensional interactions at stake in the policy mix.

The need has been more pressing as environmental and societal challenges require urgent policy action and prompt governments to re-think policy making in a more radical and transformative way (OECD, 2015; 2016a). System innovation, as an horizontal policy approach to systemic problems, provide new rationale for policy intervention and require combining new policy tools, changing the governance architecture, engaging more actors into policy making, building policy intelligence and sequencing policy action along the different phases of transition.

Several recent academic studies have contributed to reconceptualise the policy mix and have opened up avenues for practical approaches in evaluation (Kivimaa and Kern, 2016; Rogge and Reichardt, 2013; 2016; Magro and Wilson, 2013; Veugelers, 2015).

Yet, further operational developments have remained limited as comprehensive and broadly-shared concepts, appropriate and comparable policy data, and agile and adaptable data management systems lack (Cunningham et al., 2013 ; Flanagan et al., 2011 ; Kergroach, 2017; Rogge and Reichardt, 2016).

In 2009, the OECD Directorate for Science, Technology and Innovation (DSTI) initiated an exploratory work on the innovation policy mix with a view of operationalising a mapping and developing a new monitoring and evaluation system of innovation policies. This work led to a deep revision of the OECD Science, Technology and Innovation Outlook (STIO), its policy questionnaire and production process, and to the development of a new international database of national innovation policies, jointly managed by the European Commission (EC) and the OECD since 2015 (OECD, 2012a; 2012b; 2014; 2016b; EC/OECD, forthcoming). After three rounds of information collection, the **EC/OECD international database on Science, Technology and Innovation Policies (STIP)** –formerly the OECD STI Outlook Policy database- has become a major large-scale international exercise of policy mapping, covering all STI relevant policy domains (e.g. research, innovation, education, industry, environment, labour, finance/budget, and others) and gathering policy information for 54 countries, including emerging economies (e.g. Brazil, the People's Republic of China, India, Indonesia, the Russian Federation, and South Africa). Taken together, countries covered in the STIO/STIP database account for an estimated 98% of global R&D (OECD, 2016b).

The following abstract is a synthesis report of this work. It presents the conceptual foundations and operational developments of the STIO/STIP policy mix mapping.

Accounting for an increasing complexity

Background

Recent key trends in innovation policies have spurred a 'policy mix' demand. With the multiplication of policy objectives, arrangements, targets and instruments, innovation policies have reached an unprecedented level of complexity and uncertainty. New STI governance arrangements have emerged and reshuffled the STI policy landscape. At the same time, greater attention has been paid to assessing the impact of public investments, including in the innovation policy domain.

Conceptualising the innovation policy mix

Several conceptual principles and gaps in analysing policy mixes are discussed based on a review of the academic literature in the area. This presentation also explores the dimensions where interactions take place in the policy mix and recalls the need to integrate policy processes, as well as to account for a greater variety of actors and a broader toolbox in a policy mix evaluation (Cunningham et al., 2013; Borrás and Edquist, 2013; Edler et al., 2012; Flanagan et al., 2011; Kay, 2006; OECD, 2010; Hutschenreiter et al.; 2009; Rogge and Reichardt, 2016; Smits and Kuhlmann, 2004; and Vedung, E., 1998).

The idea of interaction between polices is central to the policy mix concept. Interaction may be intended or unintended. They may take the form of complementarities reinforcing the effectiveness of other policies in the mix, or trade-offs attenuating the impact of each policy. They may also be neutral. Interactions take place within one dimension of the policy mix or at the "boundary" between two or more dimensions.

Shedding the foundations of a policy mix mapping

This presentation exposes the results of a comparative analysis of major international mapping exercises (CAEU, 2017; CEPAL, 2007; EC, 2009, 2010; UNESCO, 2017). It then translates these elements, as well as the results of a small-scale mapping of the French and UK innovation policy mixes in the late 2000s, into practical lessons for operationalising a mapping (Kergroach, 2017). This exploratory work was conducted through a desk-based analysis of various international repositories of innovation policy initiatives and an extensive consultation of national documentation, administrative sources and government and official agencies websites. It gave the foundations of larger-scale operational developments.

The STIO/STIP database

The second part of this presentation describes the architecture of the STIO/STIP database and its operational features.

Structuring principles and architecture

The architecture of the STIO/STIP database reflects the areas of interaction in the policy mix as identified above. Operational specifications include identifying the unit of observation, defining the properties of an observation and quantifying or qualifying it.

- The unit of observation is the "major national policy initiative". There is a trade-off to find between capturing the completeness of a policy mix and preserving the simplicity –and feasibility- of an evaluation. In that respect, there is a common understanding among the innovation policy community on the need to focus evaluation on the "key", most "relevant", "meaningful" or "important" policy initiatives in the mix (Magro and Wilson, 2013, Veugelers, 2015; Kivimaa and Kern, 2016; Rogge and Reichardt, 2016).
- Each observation (or unit) – the major policy initiative- has several properties that reflect different areas of interaction in the policy mix.
- Policy initiatives are quantified as a single unit (not weighted), irrespective of their budget appropriations or their size in terms of input/output/outcome.

Descriptors and typologies

Policy information is structured along standardised descriptors and organised into operational typologies. The STIO/STIP typologies have been generated by grouping empirical observations, drawn from country responses to the STIP policy questionnaire, by semantic or conceptual proximity, or by associating free answers to usual standard classifications. Policy governance arrangements associated to each policy initiative are described as free text background information. The time dimension is encoded in three different ways as to allow tracking changes in the policy mix over time and chaining the sequencing of policies.

Ensuring sustainability

Three rounds of STIO/STIP data collection have helped gather historical series of country-specific policy information in a standardised way, build a national STI policy database and consolidate the initial conceptual framework and operational typologies. However, the process is extremely burdensome, and the STIO/STIP questionnaire is complex, both in terms of administration and content management.

Further developments have been constrained by resources and technology limitations so far. The needs for implementing an integrated information management system –from data collection and administration, to data analysis, to data dissemination and visualisation-, as well as the technical specifications of such a system, have been described in Kergroach (2015). Efforts are to be made on two functionalities in particular : i) updating information on a more regular basis and allowing ad hoc country submissions between two STIO/STIP survey rounds, as information become available; and ii) ensuring the dialogue and exchange of information between different information collection systems (i.e. different surveys, different repositories, different formats).

In addition, monitoring the policy mix requires adopting some statistical and measurement principles but it cannot be limited to a statistical exercise as most of the mix components and interactions are not quantifiable with the data currently available.

This presentation concludes that, as for ensuring the sustainability of the STIO/STIP exercise, three major improvements are required: a better coordination with similar national or international exercises, the adoption of standards and new IT developments.

Analytical perspectives on the STIO/STIP mapping

Finally this presentation explores possible uses of the STIO/STIP information for analytical purposes and discusses how recent shift in data management paradigm, through new semantic-based technologies, could further leverage our capacity to assess innovation policy mix (Kergroach et al., 2017).

Although the quality and comprehensiveness of the STIO/STIP information remains an issue, data exploration for analytical purposes is now possible. Furthermore, it is expected that this analytical exploration, from a user perspective, will provide incentives to improve data quality, strengthen coordination and encourage the adoption of common standards, prompt a shift towards a new data management model and help consolidate the IT environment of the STIO/STIP database.There are currently several layers of analysis that could be developed from the STIO/STIP mapping, from textual analysis, to the production of new set of indicators, to the use of new analytical and graphical tools.

Conclusions: expected Outcomes

The article aims to contribute to the debate and literature on evaluating the innovation policy mix. It aims to raise awareness among the international innovation policy community and gather expert feedback on the analytical potentialities offered by the EC/OECD STIP database.

The conceptual framework and structuring principles of the STIO/STIP mapping and early versions of the EC/OECD STIP database offer a foundational infrastructure for knowledge building and sharing and mutual learning. These developments are currently being carried forward with a view to developing a new “semantically enrich” generation of STIP database. In a joint project with the EC, the OECD is building a “controlled vocabulary” that describes the STI policy world and aims to significantly strengthen STIP analytical capabilities and the use of country information for research and policy analysis. The “controlled vocabulary” builds upon the work presented herein, for example, by incorporating typologies of policy instruments and policy target groups. The new STIP database will be launched in autumn 2017, while the “controlled vocabulary” will be publicly available for download and inspection (IPP, 2017).

Overall, this article seeks to ensure that future STIP developments are aligned with the needs of the policy community.

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3.6.2 An empirical exploration into the role of phase-out policies for lowcarbon energy transitions: the case of the German Energiewende

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Keywords: policy mix, creative destruction, discontinuation, credibility, energy transition

The energy sector plays a significant role in reaching the ambitious climate policy target of limiting the global temperature increase to well below 2°C, as agreed at COP21 in Paris (UNFCCC 2015). To this end, technological change has to be redirected and accelerated in the direction of zero-carbon solutions which calls for a policy mix including demand pull, technology push and systemic instruments (Rogge & Reichardt 2016). In addition, it has increasingly been pointed out that policy mixes should not only include instruments promoting green niche innovations, such as renewable energies (Smith & Raven 2012) but that in addition such mixes should also target the destabilization of established regimes (Kivimaa & Kern 2016).

The literature on sustainability transitions (Markard et al. 2012) has considered this ‘flip side’ to innovation in the form of ‘destabilisation’ of technological regimes (Turnheim & Geels 2012; 2013). More recently, attention has also been given to the ‘discontinuation’ processes aiming at the phaseout of certain technological trajectories (Longen et al. 2015; Stegmaier et al. 2014; Johnstone & Stirling 2015). In addition, literatures related to overcoming ‘lock in’ and incumbency in sociotechnical transitions have addressed this phenomena (Geels 2014; Hess 2015). These contributions are based on historical case studies analyzing the different influencing factors that lead up to a particular ‘window of opportunity’ where a discontinuation policy is realized, offering preliminary insights into the understudied areas of deliberate destabilization and technological discontinuation. Yet, the effect of such destabilization policies on the development and diffusion of green alternatives has received limited attention in empirical research so far.

In this paper we address this knowledge gap using the case of the transition of the German electricity generation system towards renewable energies – the so-called Energiewende (Strunz 2014; Agora Energiewende 2013). We have chosen this example because it represents a sustainability transition governed by a policy mix which not only includes policies supporting renewable energies but also desta-bilization policies – most prominently the nuclear phase-out policy until 2022 (Morris & Pehnt 2014; BMWi; BMU 2010; BMWi 2016a). Our socio-technical analysis adds to existing empirical studies which have focused on the economic and technical assessments of the impacts of the nuclear phase out for energy systems (Edberg & Tarasova 2016; Bruninx et al. 2013; Glomsrød et al. 2014; Liebmann et al. 2014; Bretschger & Zhang 2017; Guidolin & Guseo 2016; Malischek & Trüby 2016).

In order to explore the impact of destabilization policies on the development and diffusion of renewable energies we draw on the results of a survey of innovation activities of German manufacturers and suppliers in renewable power generation technologies conducted within the GRETCHEN project. The innovation survey was conducted by telephone in the summer of 2014 and achieved a response rate of ap-proximately 36% of all German companies active in the supply chain for manufacturing renewable power generation technologies (n=390). The sample includes both new entrants but also incumbent players having redirected their activities towards emerging green niche markets in solar PV, onshore wind, off-shore wind, biomass and biogas, geothermal, wave and tidal and hydro power.

In this paper, we combine insights from descriptive statistics (Rogge 2015) as well as factor and re-gres-sion analysis (Rogge & Schleich 2015; Rogge & Duetschke 2015) to explore the impact of the nuclear phase-out policy in technological change in renewable energies in Germany. Contrary to what is typically expected we find that companies believe the nuclear phase-out offers the strongest support for the future diffusion of renewable energies. In contrast, the EU Emissions Trading System – another destabi-lization policy – hardly seems to have had any effect, which, given its low allowance prices, is hardly surprising and in line with previous studies. Manufactures also did not think that the framework conditions for fossil power generation technologies – which did not foresee any specific phase-out policy at the time of the survey in 2014 – have any significant positive impact on the future expansion of renewable energies. Should Germany eventually overcome the strong resistance of incumbents to implement a coal phase-out – as strongly suggested by think tanks and environmental NGOs (Graichen et al. 2016; DIW 2014) –it seems likely that such a coal phase-out would – similarly to the nuclear phase-out policy – yield a positive impact on the diffusion of renewable energies.

Regarding the impact of the nuclear phase-out policy on innovation we find a positive link which seems to materialize through the effect of the existence of this policy on the overall credibility of the German policy mix for renewable energies. The findings suggest that manufacturers were most keenly aware of the political will to promote power generation from renewable energies at the time of the nuclear phase-out after Fukushima. However, companies think that this credibility of the policy mix has ebbed away since then. This is important as it is this credibility which was regarded by companies as almost as important a factor for determining their innovation activities as the political expansion targets and the German Renewable Energy Sources Act (EEG) and comparable foreign demand pull instruments, whereas the EU Emissions Trading System played hardly any role. This matters because regression analysis indicates that those companies which view the policy mix as more credible invest more in R&D in re-newable energies. Interestingly, not only the German feed-in tariffs for renewable energies determine the perceived credibility of the policy mix, but also other instruments, including the nuclear phase-out, but also the existence of the EU Emission Trading System. That is, destabilization policies are shown to positively contribute to companies' perceptions of the credibility of the overarching policy mix. And this, in turn, leads to higher investments in corporate R&D in renewable energies, therefore highlighting that the nuclear phase-out policy also had a positive innovation impact on these competing low-carbon technologies. In other words, while much attention has focused on 'creative destruction' what we find could be captured by 'destructive creation' in which discontinuation policy is supporting the creation of green alternatives by destructing the existing regime technologies, thereby providing a growth opportunity for green niches. Based on these findings we derive policy recommendations regarding phase out policies for nuclear and coal.

Our paper also speaks to building understandings of the role of destabilization and discontinuity in sus-tainability transitions more generally, a hitherto under-researched aspect of transitions study (Geels 2014). It adds to previous research on destabilization and discontinuity in technological systems (Stegmaier et al. 2014; Philip Johnstone & Stirling 2015; Longen et al. 2015; Levain et al. 2015) by high-lighting the impacts that discontinuation policies have once they are implemented, on the broader en-ergy sector. The credibility and importance of the phase out policy for manufacturers in the renewables sector gives some indication of how policies aimed at the regime level and nichesupporting policies interact within a policy mix. Such niche-regime interactions are an area requiring more attention (Hess 2015; Bui et al. 2016). In particular, research in sustainability transitions has recently tried to understand how processes of niche protection and empowerment can be achieved (Smith & Raven 2012; Raven et al. 2015). Despite turbulence in the German energy transition and on-going policy debates (Lütkenhorst & Pegels 2014), nuclear phase-out appears to play a key role in cementing the credibility to the overall policy mix enabling certainty in the face of challenging market conditions. As such, the German nuclear phase-out can be encapsulated as a process that assists in protecting, empowering and shielding niche developments through companies' confidence remaining high due in part to the clear overall direction of the German energy transition which the nuclear phase out makes clear.

4 Track 4: Next Generation Research Evaluation Governance - Enabling Creative and Responsive Knowledge Production

Track 4 was organized by Li Xiaoxuan, Management Innovation & Evaluation Research Center, Chinese Academy of Sciences and Stefan Kuhlmann, Science, Technology, and Policy Studies (STePS), University of Twente, and included five Sessions.

Creative research and knowledge production are required to address the so-called Grand Societal Challenges (Kuhlmann & Rip 2014). Research and innovation activities are supposed to become “responsive” to societal needs. This request has been put forward by the European Commission and in several EU Member States (see e.g. the “Rome Declaration on Responsible Research and Innovation in Europe” 2014), yet more recently also in emerging economies and their research and innovation systems, not at least in China. Governance approaches to research and innovation, in particular funding policies and performance incentives as well as related evaluation processes will have to reflect such ambitions – this is the focal concern of the suggested session (track).

Research evaluation and related performance measurement, in advanced and in emerging countries, have become increasingly professionalised in recent years. Yet most of the implemented measures are focussed on simplistic “excellence” criteria (Rip 2012). Where research “impact” criteria are used they are all too often defined in a quite mechanistic way (Spaapen & van Drooge 2011).

The professionalised research performance evaluation can be seen as a form of governance of research. In the last few years it has been provoking increasingly harsh criticisms from researcher communities (e.g. DORA, initiated by the American Society for Cell Biology, Way & Ahmad 2013) and sociologists of science (e.g. the “Leiden Manifesto for Research Metrics”, Hicks et al. 2015). The critics warn against a misfit between increasingly bureaucratised simplistic research performance evaluation governance and the need for incentives stimulating creative, risk taking research.

Meanwhile we have witnessed growing efforts, in advanced and emerging countries, to overcome this misfit. In 2015, UK HEFCE published a report titled “¬The Metric Tide Report of the Independent Review of the Role of Metrics in Research Assessment and Management” (Wilsdon et al. 2015), which proposed a framework for responsible metrics, and made a series of targeted recommendations based on fifteen months of evidence-gathering, analysis and consultation. These indicators and underlying data infrastructure developed are designed in the ways that support the diverse qualities and impacts of UK research.

Similarly in China, the blunt uses of metrics such as SCI publications, journal impact factors and grant income targets are worrying. The country’s leading academic institution for the natural sciences and the highest science and technology advisory body, the Chinese Academy of Sciences (CAS), so far, has experienced four phases of their institute evaluation system, reflecting the history of using metrics within the CAS and China. The latest reform of the system in 2010, also known as the major R&D outcome-oriented evaluation system, was proposed to encourage creative and original research work. Not only research institutes, but also Chinese universities, have already taken action to change the orientation of research evaluation towards creative and original knowledge production or real-problem solving, rather than counting publications.

Given the development of science, and the mission to address societal challenges, research drawing on multiple disciplines is more needed than ever. That is also why “convergence science” is becoming an emerging research paradigm (Bonaccorsi 2008). The eight research fields in CAS’s 13th Five-year plan also indicate the concept of convergence science. There is no doubt that evaluation of convergence science will be a new challenge in near future.

In this context, the proposed session will provide a forum to discuss new approaches on research evaluation, reflecting the required responsiveness of research and innovation and “responsive” governance principles and requirements (e.g. Kuhlmann et al. 2015).

- Guiding aspects to be addressed by session papers include:
- Trends of governance of and through research evaluation in an international perspective;
- Modes of responsive evaluation of different research paradigms, e.g. inter-disciplinary research, convergence research;
- New concepts and responsive practices of third-party evaluations, e.g. talents evaluation, programme evaluation, faculty or institute evaluation;
- Responsive assessment of mission-oriented research (Grand Challenges) and of societal impact.

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4.1 Session 4.1

4.1.1 "This large research infrastructure will benefit our region" But how?

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Keywords: impact assessment, narratives, theory of change, research infrastructures

Evidence relating to social returns is of vital importance to the sustainability of a large Research Infrastructure (RI). For scientists/users the value of an RI is generally self-evident. However, funders, politicians and policy makers need to justify their decision to spend substantive amounts of public funding on a single RI, knowing that the impact or return of investment will only be achieved in the far future. An indication of social return is increasingly requested, including for allocations of funds for fundamental research, as is the case with the large RIs. Examples include a bill of the House of Representative requesting to the National Science Foundation (USA) that every one of its research grants must advance "the national interest." Similarly, a cost benefit analysis was needed in order to be allowed to allocate EU structural funds to the construction of the EU international laser research infrastructure ELI. (ACCELERATE 2016).

RIs promise a wide range of impacts. They promise to contribute to the scientific knowledge base. The increased stock of fundamental knowledge can be used by firms as a source for innovation. They promise to contribute technical solutions. Hardware and software developed for use in the RI can be used outside of the RI. They promise to build capacity by training staff that works for the RIs: highly skilled technicians, scientists. They promise to have a positive effect on the employment opportunities in the region by creating jobs. Construction, maintenance and administrative staff is hired by the RI. They promise to have a positive influence on the economy in the region in general, due to the relocation of highly specialized staff and to visiting users. Etc.

In recent years, a number of studies have been published that describe a variety of impacts of large RIs (Mahieu et al 2014, Koopmans et al 2014, Van Lieshout et al 2013). These studies were performed by professional organisations, that use more or less sophisticated techniques and measures to capture actual and future impacts and effects: Technopolis, TNO, OECD.

However, management of RIs have indicated the urgent need to understand, monitor and actively contribute to impact *ad itinere*. This is required for the sustainable maintenance of the RIs. RIs typically use a variety of financial sources, with different requirements and interests: regional governments, national research councils, the European Union. Also, besides the formal rules of the financiers, several of their stakeholders have brought the issue of social impact on the table.

We are involved in the ACCELERATE[13] project in order to develop a socially robust social impact monitoring approach for the RIs involved. Socially robust in this particular case implies that it can be used by the RIs themselves and that it responds to the needs of the RIs, their financial sources and other relevant stakeholders. The intention is to bring the responsibility for impact creation and monitoring back to the RIs themselves. To enable them to take ownership. Impact creation and monitoring thus becomes an integral part of the governance of the RI. After all, social impact was a promise from the beginning. This differs considerably from the more common situation at present, where impact assessment or reporting on impact has become either symbolic and rather meaningless, or is taken out of the hands of the responsible organisation and performed by professional organisations.

We build on concepts and ideas introduced in recent decades. They seem to refer to far more complex modes of science, such as Mode 2 (Nowotny et al, 2001), innovation journeys (Van de Ven et al, 2008) challenge oriented research (Kuhlmann and Rip, 2015) or Responsible Research and Innovation (European Commission, 2013). An RI is at first sight a far simpler mode or situation of research. However, given the multitude of promises and impacts that go above and beyond the science of the RI, it makes sense to use these concepts and ideas. Moreover, the goal is to enable RIs to develop a realistic and substantiated view on their impacts and to enable or empower them to be responsible for the impact - not just accountable.

Key element is the theory of change. A theory of change (Rogers, 2014) explains how an impact is understood to come about. It is a shared narrative or a joint understanding of the causal relations between inputs, activities, outputs and impact. (Van Drooge and Deuten, 2016). Developing and using a theory of change can be regarded as a horizontal form of governance. From the theory of change, a number of evaluation or monitoring questions can be identified (Spaapen and Van Drooge, 2015).

Douthwaite (2007a, 2007b) has used the theory of change for planning and monitoring the impact of research for development projects. He introduces the idea of a limited number of “storylines” or “plot types” when it comes to impact narratives. In other words: there is but a limited number of impact journeys. When it comes to RIs, the most obvious one is the plot of developing a technology and adopting that technology. Another is that of capacity building, the plot with scientists and stakeholders learning to collaborate and developing the capacity to work together. (Douthwaite 2016)

Our approach is as follows:

- Identify a limited number of typical impact plots or storylines, based on
    - Academic literature on impact (such as Matt et al, 2017; Meagher and Martin, 2017)
    - Studies reporting on impact of RIs (Mahieu et al 2014, Koopmans et al 2014, Van Lieshout et al 2013)
    - Mission statements and other policy documents by the RIs (to identify promises made and impacts foreseen)
    - Requirements of the funders of the RIs
- Develop theories of change, together with the RIs and some of their stakeholders (i.e. funders) concerning each of the impact plots
    - Identify the promise of each of the plots – or the ultimate goal (such as “innovations”, “more employment in the region” or “improved scientific capacity”)
    - Understand and unpack the impact journey that leads towards these promises

13 ACCELERATE is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 731112

    - Identify who and what contribute to the realisation of the goal, and decide on whether this is within the influence of the RI, or not – and with whom to collaborate or share the responsibility
    - Understand how impact can be organised and embedded in the RI
- Identify relevant indicators of progress
    - Understand what serves as an indication of progress toward the goal or promise
    - Select a number of indicators, quantitative as well as qualitative for monitoring purposes
    - Organize the indicators and understand their order: whether they refer to structural properties of the RI, or to anecdotal evidence.

The result is a limited number of narratives, each relating to a specific storyline or impact journey. Each narrative provides insight into assumptions, causes and actors. And each is developed and will be enriched with quantitative and/or qualitative evidence. For instance, the "innovations" narrative can be enriched by specific anecdotes of specific innovations resulting from work done at the RI. The anecdotal evidence is thus embedded and can be understood as part of a bigger narrative.

This is a further development and is in contrast with the present situation, where anecdotal evidence or case studies are required as evidence of impact (REF2014, SEP 2015-2021), but the bigger story remains untold. Or with the evaluation of RIs where successful impacts are presented, that are then used to illustrate the importance of the RI (OECD 2014), but not used to understand how the RI has contributed to this specific impact.

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4.1.2 Monitoring and evaluation (M&E) system: An underestimated tool in reflexive governance of research evaluation in academia

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Introduction

Managerial university and New Public Management (NPM) have been criticised for, inter alia, indicatorism, quantification, metrification, economisation and “publish or perish” pressures (e.x. by Lorenz (2015)), in favor of reversing back the managerial trend during the last decades. While abandoning NPM in academia does not seem feasible, the present article attempts to weaponise new era of managerial university, and specifically responsible research and innovation (RRI), by state-of-the-art M&E systems and practices.

RRI has attracted considerable attention not only in academia by theorization and conceptualization, but also in recent high-level agenda and regulations such as the European Horizon 2020, and also at a more abstract level with on-going moral, societal and philosophical ascriptions. Based on Guston (2004), RRI could be characterized by four dimensions of anticipation, reflection, open debate and responsiveness/ flexibility. Governance of RRI, which acts as an umbrella over the whole RRI system, could be linked to above dimensions to yield anticipatory and reflexive governance of RRI. The governance itself lies within the paradigm of institutionalism and market failure, in which free-market is known as a failed mechanism for total management of so-called externalities of research and innovation, taking responsibility as an externality.

The present paper addresses application of monitoring and evaluation (M&E) systems into reflexive governance of research evaluation in academia to better achieve responsibility goals and RRI. In fact, instead of mere criticism of managerial university, the paper attempts to modify it by introduction of the application of state-of-the-art M&E systems into RRI reflexive governance and NPM. In contrast to other themes that are mostly of a priori (foresight) nature and tackled to some extent, such as anticipatory governance, risk assessment, impact assessment, societal impacts and soft law of RRI, the reflexive governance could encompass posterior and reflexive monitoring and evaluation as a tool to achieve accountability and responsibility goals.

While monitoring and evaluation (M&E) systems has traditionally been developed separately, it has recently been introduced to the concept of RRI within a development theme by the 2015 Conference on Monitoring and Evaluation for Responsible Innovation being held by Wageningen University. In contrast with the development theme, the present research suggests M&E system as a useful tool for reflexive governance of research evaluation in academia.

Methodology and research question

The present article is based on an ongoing evaluation project of the research centres of Sharif University of Technology since early 2016. Hypothesising that elements and processes of M&E systems are lacking, skinny or at best fragmented, several semi-structured interviews were held with managers and academic experts having experience in governance of research. The interviews were normatively oriented due to lack of M&E practices and processes, i.e. asking about should-be M&E practices that will result in better governance of research toward responsibility goals and reducing shortcomings of NPM related to its mechanistic view to research and science.

Practically, it was found that only normative research questions could be pursued, and not descriptive ones, due to lack of M&E practices and processes. Consequently, the research question was formulated as:

'How state-of-the-art approaches, processes and elements of M&E systems could achieve responsibility goals in research governance of academia?'

State-of-the-art M&E system

The 2015 Conference on 'Monitoring and Evaluation for Responsible Innovation', characterised a state-of-the art M&E system by suggesting retiring and elevating ideas in three complementary categories of 1) the roles and responsibilities, values and principles, competencies of M&E professionals; 2) process design, focus and approach; and 3) institutional changes needed to support. Since the three categories have considerable conceptual overlapping and dictate a heavy agenda for interviews, they were simplified by the authors as below eight questions to be asked by the interviewer, i.e. which below approaches and elements of M&E system are preferred and how could they positively affect responsibility goals in research governance:

1. Pursuing accountability or improvement goals?
2. Qualitative or quantitative evaluation?
3. Adopting participatory evaluation, external and independent evaluation, peer review or self-evaluation?
4. Using a centralised evaluation committee or a distributed specialised structure?
5. Adopting a uniform evaluation or a customised one?
6. Whether evaluation at individual, team, project or organisational level?
7. What evaluation indicators (output/ input/ process)? If capacities, capabilities, resources, output, outcome or impacts, strategic, managerial, etc. indicators should be adopted?
8. What evaluation model, e.x. SWOT, EFQM, input-output, balanced scorecard, etc.?

While answering each of the above questions requires a separate research stream and possibly contingent upon many situational factors, such as overall governance structure and mode (e.x., Molas-Gallart, 2012), culture, higher level policies, etc., the present research attempts to provide a preliminary general answer based on the case under study.

Case study

As part of a preliminary study for designing an M&E system for the research centres of Sharif University of Technology, the interviews revealed that there is no clear picture of the research output, outcome and impacts of the departments and the university as a whole. Not even the rudimentary elements of M&E systems were missing, feeling of such necessity was also absent. The absence of such necessity is well characterised in the widespread criticism of the overarching hierarchy mode of research governance and also the crippling growth of the network mode of research governance in the university by the hegemony of the faculties. The university was not even readily aware of its basic research financial measures, including total research income, total industry income, expenditures, or license

income. Not surprisingly, such conditions were found prevalent in other Iranian universities and also worldwide. Therefore, the questions outlined in the previous section were normatively asked in the interviews, i.e. based on non-practices and shortcomings perceived by the experts and should-be M&E solutions.

The first question outlined in the previous section was approached by the interviewees in favor of improvement-oriented evaluation, to clarify the current status of a research centre and accommodate the huge differences between them due to extremely different financial turnover and income, distinct publication and citation norms affected by the disciplines, life stage of centres, and their missions and strategies. But, it was also affirmed that such an orientation does not mean abandoning accountability approach, since accountability is an essential element in the bureaucratic hierarchical research governance of Iranian universities. It is supposed that improvement-oriented evaluation would be welcomed by managers and researchers due to long-lasting criticism regarding mechanistic view of top-down accountability-oriented evaluation which neglects organisational, discipline, mission, strategies and resources differences.

Regarding qualitative or quantitative evaluation, while quantitative one has overly been criticised by researchers and academics for its mechanistic view, it was predicted that application of qualitative evaluation methods in Iran would encounter serious challenges due to cultural issues. For example, peer review and interview were said to be not working properly based on current practice of peer review of journal articles, since peers (evaluators) would be solicitous about the results of evaluation and its possible negative impacts on others' career. Therefore, a mixed method is suggested in which the share of qualitative methods is gradually heightened as accultured.

In the third question, participatory evaluation has been stressed as a missing practice, which would yield considerable results in favor of higher acceptance of M&E systems due to taking organisational, resource, financial and strategic differences between research centres into account.

The answers to the fourth and fifth questions advocated specialised evaluation by a distributed structure and committees utilising customised evaluation indicators and processes based on different needs of each centre as an outcome of participatory evaluation.

Regarding the evaluation level, the respondents stressed on the necessity of evaluation at an organisational level, which is lacking now, to make stakeholders able to assess the current status and also trends and improvements towards goals. Of course, they valued other levels of evaluation such as team, project or individual levels complementary, to be followed on later.

Lastly, the interviewees did not prescribe any specific set of evaluation indicators or framework due to perceiving them contingent upon mission, conditions and goal of evaluation. Regarding indicators, they also suggested evolutionary approach for the sake of practicality, to first accommodate the most available and required indicators according to the mission, strategies, budget and time constraints, which would then gradually be completed by further indicators.

The case-study results were found generally consistent with the literature on research evaluation and governance (e.x. Frederiksen, Hansson, & Wenneberg, 2003; French Evaluation Agency for Research and Higher Education (AERES), 2013; The High Council for the Evaluation of Research and Higher Education (HCERES), 2014; Geuna & Martin, 2003; Gibbons & Georghiou, 1987; Gray, 2008; London School of Economics and Social Sciences (LSE), 2013; Netherlands Organization for Scientific Research (NWO), Association of Universities of The Netherlands (vsnu), & KNAW, 2010; OECD, 1997; Reinhardt, 2012; Van Den Besselaar, Inzelt, Reale, Turckheim, & Vercesi, 2012).

Conclusion, limitations and future avenues

To address the true concerns of academicians regarding mechanisation, economisation, quantification and indicatorism of academia due to the rise of managerial university, M&E systems are proposed to

be utilised in reflexive mode of research governance and for RRI goals, instead of theorising to reverse the managerial university back.

The case study of non-practices of the research centres of the top Iranian technology university suggested participatory, customised, distributed and specialised evaluation, and introduction of qualitative methods including interview, self-report, peer review, survey and site visit, in addition to current mere quantitative ones, under a paradigm of ongoing evaluative and systemic thinking. Focusing on impact and output indicators rather than just classic input ones, and continuous meta-evaluation was another result. Utilising sophisticated and highly-normalised bibliometric indicators was advocated instead of traditional simple ones. It was also predicted that how these changes may address current shortcomings and criticisms toward managerial university. In fact, a proper M&E system in a professional context like academia should be implemented bottom-up, with the true engagement of researchers and scholars from defining the mission, goals, objectives and criteria of evaluation, up to implementation and meta-evaluation heterogeneously across different units and departments based on their missions and strategies. Without an M&E system, university managers do not know much of the performance, effectiveness and efficacy of their subordinate units, as it was the case. Having a complete reflexive view of research in an academic organization by the aid of an M&E system let managers move towards accountability and responsibility more consciously, and simultaneously address current shortcomings of new public management at academia.

One may also ask about the distinction of the present paper (M&E system) and the evaluation research literature. In response, it should be said that in M&E systems, it is the ongoing evaluative and systemic thinking and implementation which make distinction compared with fragmented evaluation practices. This could be considered as an opening avenue, borrowed from M&E system literature, to recent empirical works on research evaluation systems (e.x., Gläser & Whitley (2007)). Reaching an overall trustable view of a responsible research organisation in a systemic and systematic approach is what an M&E system could deliver, if itself subject to continuous meta-evaluation and modifications according to stakeholders' inputs.

As a limitation, it should be noted that the present study adopted a normative and design approach due to scarcity of empirical evidences and practices, which of course should be complemented by descriptive studies based on state-of-the art M&E practices at academia. This normative view should be further combined with challenges of implementation of evaluation systems, such as the work of Molas-Gallart (2012) which indicates a fit between evaluation uses and national research governance structure. Furthermore, the interplay between research governance and evaluation system has been assumed linear and straightforward due to the focus of the paper, while it could be disentangled as feedback-looped reciprocal mechanisms, e.x. as Hanberger (2013).

Some interesting research avenues include historical reasons behind not adopting M&E practices in academia governance, impacts of M&E system application into research governance and more generally at managerial university and the mechanisms behind, and effective application of M&E system into academia and research governance for different purposes of RRI including accountability and responsibility.

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4.1.3 Towards original and responsive knowledge production: does CAS's research evaluation reform can lead to China's change?

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It is well known that the development of science and technology has become the crucial power to improve a nation's strength. China's ambition for science and technology has never decline. According to the latest statistical data provided by the National Bureau of Statistics of China, the total amount of R&D investment in 2015 has reached a new level of 1.4 trillion, which is 2.07% of GDP that year. New science and technology breakthroughs have been achieved at both investment scales and investment level. The increase in R&D investment has paid off. In 2016, China has made significant breakthroughs which amazed the world. For instance, the world's first quantum science experimental satellite "Mozi" has been successfully launched, and Shenzhou 11 spacecraft return capsule has successful landed and so on. With regard to the research performance in basic research, China has published more research papers than any country other than the United States, and there is about one Chinese researcher's name in every five high-cited papers in the world. According to the data released by the Organization for Economic Co-operation and Development (OECD) website, the number of tripartite patents owned by Chinese inventors in 2013 was 1897, accounting for 3.51% of the world's total number and ranked sixth in the world. Top Chinese research institutes are breaking into the world's best rankings, and China has built more and more magnificent research facilities.

On the other side, we notice that Chinese researchers are so busy with chasing for the number of papers, patents and so on, and limited efforts are made to produce original and responsive knowledge. It is a fact that there is still a long way to go for China to improve research quality. One shall ask about the reason that causes such consequence. Quantitative evaluations might be to blame. It is hardly to ignore the fact that nowadays quantitative evaluations have triggered a complex mixed effect in the domestic and international scientific community. The blunt use of quantitative indicators such as journal impact factors, h-indices and grant income targets to be reminded of the pitfalls. Too often, poorly designed evaluation criteria and qualitative indicators are "dominating minds, distorting behavior and determining careers (Lawrence, 2007)."

In this context, Chinese scientific community probably has been affected by qualitative evaluation more deeply. Recently, we surveyed approximately 3000 Chinese researchers from research institutes, universities and enterprises about their attitude on Chinese current research evaluation and rewarding system. 76.3% researchers think that qualitative indicators such as impact factors, SCI papers, and citations should not be over emphasized. 89.4% researchers think that the current

research evaluation has do more harm than benefit on original innovative research. Over 98% researchers support to reform current research evaluation system. We are wandering: how does research evaluation reform lead to China’s change?

The misuse or abuse of quantitative indicators has already raised international concerns. Recently, the San Francisco Declaration on Research Assessment (2013), the Leiden Manifesto (Hicks et al. 2015) and the Metric Tide (Wilsdon et al. 2015) have all invoked the use of quantitative indicators with discretion for evaluation purpose. Chinese Academy of Sciences(CAS) has also realized this issue a few years ago and has already reformed its research institute evaluation systems from quantitative orientation to true scientific contribution and real-life problem solving orientation. The principle of this evaluation system, also known as the major research outcome oriented evaluation system, is to encourage either frontier original research or responsive knowledge which aims to solve real-life problems. Particularly, CAS has identified six types of major innovation contributions and innovations, including original and responsive research works that solve major scientific problems, create new research fields, achieve breakthroughs in a key technology, provide a solution, achieve remarkable social or economic benefits and provide significant and influential advice. Further, CAS has explored the major research-outcome evaluation system to wider research management tasks such as project management, and talents selection and so on within CAS.

However, CAS’s research institute evaluation system may have limited impact outside CAS. In order to have a wider impact within the society, a better way may be to unite Chinese universities, especially the top universities to implement research evaluation reform from quantitative orientation to quality and impact orientation. In fact, some Chinese top universities are already taking steps. Nanjing University, and Shanghai Jiaotong University have walked in the forefront of research evaluation reforms. Recently, Nanjing University proposed the “Qian-Bai-Wan” project in its "13th Five-Year Plan", which encourages problem-oriented original research that is focused on the forefront of science and the major needs of the country. With regard to research evaluation, more focus is put on the breakthroughs of basic research and cutting-edge technology, problem-oriented research and combination of national major scientific research tasks, problem-oriented research and the cultivation of important scientific and technological platform and so on. Shanghai Jiao tong University, another Chinese top university in the world, has been exploring a way towards "comprehensive, research-oriented, international" world-class university goals. The president, Prof. Zhangjie believes that top universities should design and stick to its own research evaluation systems that is focused on the mission and vision. Prof. Zhangjie believes that Shanghai Jiao tong university’s international status and reputation has been improved these years, and he gives the credits to its internal research evaluation reforms, such as international assessment of scientific research staff which is undertaken every five years.

We are glad to see that more and more Chinese high-level research institutes and universities are working on its internal research evaluation reform, aiming to encourage original and responsive knowledge. Now let us back to the initial question: does CAS’s research evaluation reform can lead to China’s change? We argue that the flexible way would be to combine CAS and top universities’ strength to implement research evaluation reform towards original and responsive knowledge production. With this trend, more and more followers can be expected, and eventually we will see china’s transition in research evaluation from quantity to original and responsive knowledge production.

4.2 Session 4.2

4.2.1 What makes the evaluation of public procurement for innovation be different from other policy instruments? A preliminary framework

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Innovation policy can be understood as a compendium of elements (i.e. priorities, strategies, programs, instruments, etc.) undertaken by public organizations aiming at influencing innovation processes, i.e. actions that are conducive to innovation (Edquist, 2011; Knutsson and Thomasson, 2014). Innovation policy can play a key role in in the support of societal goals such as the respect for the environment, the mitigation of climate change and the challenges associated to it, while also improving employment, public health and social conditions (Hettne, 2013). One of the common goals shared by the multiple instruments that may be used within the broad field of innovation policy is thus to put innovativeness at the core of the intervention in such a way that it will be encouraged, or at least not disadvantaged.

Innovation policy has become an increasingly complex field due to the systemic nature it has adopted (Smits and Kuhlmann, 2004; Smits et al., 2010; Wieczorek and Hekkert, 2012). Three main reasons are the ones justifying the complexity of STI policy (Borrás, 2009; Edquist and Borrás, 2013; Flanagan et al., 2011; Magro and Wilson; 2013; Magro et al., 2014; OECD, 2011a): (i) the widening and deepening of innovation policy; (ii) the policy-mix concept; and (iii) multi-level governance.

In general terms, the instruments that are included in the articulation of the policy-mix in the innovation realm can be divided into supply and demand-side instruments (Edler and Georghiou, 2007). Supply-side policy instruments are those addressing the determinants that intend to increase the operative efficiency of markets and industries. In this sense, fiscal measures, support for training and mobility, grants for industrial R&D, information and brokerage support or networking measures would entail some examples of supply-side innovation policy instruments. On the other hand, demand-side innovation policies are defined as “a set of public measures to increase the demand for innovations, to improve the conditions for the uptake of innovations or to improve the articulation of demand in order to spur innovations and the diffusion of innovations” (Edler and Georghiou, 2007, p. 952). In this sense, systemic instruments such as cluster policies, the use of regulations and standards, public procurement, or the support of private demand can be regarded as examples of demand-side interventions.

Despite the role of demand as an enabler and source of innovation has been a topic in innovation studies and innovation policy for quite some time (Izsak and Edler, 2011), traditionally, innovation policy initiatives have mostly come from the supply side (Edquist et al., 2015). Countries and regions have actively implemented and used innovation policy instruments such as fiscal measures, support for training and mobility, public financing of R&D, information and brokerage support or networking measures, to mention a few. Discussions on the positive impacts of demand-side innovation policies took place as far back as the 1970s (Dalpé, 1994; Geroski, 1990; Mowery and Rosenberg, 1979; Rothwell and Zegveld, 1981). However, recent years have seen a resurgence of the interest in demand-side approaches to innovation policy, as the multiple books edited on this topic evidence (Eliasson, 2010; Yürek and Taylor, 2012; Rolfstam, 2013; Lember et al., 2014; Edquist et al., 2015).

The scope of this paper will be limited to the analysis of public procurement as an innovation policy tool, i.e. what we refer to as Public Procurement for Innovation (PPI). PPI occurs when a public organization places an order for the fulfillment of certain functions, which are not met at the moment of the order or call, but can potentially be met within a reasonable period of time through a new or improved product. Hence, the objective of PPI is not primarily to enhance the development of new products, but to target functions that satisfy human needs, solve societal problems or support agency missions/needs. Still, some form of innovation (new product or process) is necessary before delivery can take place.

Public procurement for innovation (PPI) constitutes an evolving field where different approaches, methods and criteria co-exist (Edquist et al., 2015). Different modes of PPI can be distinguished, each of them having different purposes and aiming at addressing different failures or needs. These multiple modes of procurement show a strong potential for cross-complementarity through their use in instrument-mixes, both regarding demand and supply-side policy instruments (Borrás and Edquist, 2013; Edler and Georghiou, 2007). However, despite the widely recognized potential of innovation procurement, to date there is a lack of evidence to form a basis for policy-making. We do not even know the extent of different kinds of PPI intervention in the Member States. This is partly because of the unavailability of a firm and structured conceptual basis that can form the basis for the creation and gathering of data.

Even if there is evidence from some countries having started to monitor and assess their procurement activities (e.g. Netherlands, UK, Austria, Sweden), we are still far from having consolidated a common strategic framework for the practice of PPI, not only at the national level, but also at the European and regional ones. In this regard, we are far from being in a sound context in terms of evaluation and monitoring, both methodologically and empirically. Some preliminary efforts have been done at the empirical level by evaluating some initiatives, particularly in the UK and in Sweden (Neij, 2001; Arnold et al., 2004). Something similar can be said at the conceptual and methodological level with the efforts carried out by Greenberg (2004) and Edler et al. (2012) being worth mentioning.

The goal of this paper is twofold. On the one hand we aim to discuss what makes the evaluation of public procurement for innovation be different from other policy instruments. On the other, but also built on the former, we aim to propose a preliminary framework that helps overcome some of the challenges associated to the evaluation of this particular demand-side innovation policy instrument. With it, we aim to set the basis for a comprehensive evaluation of procurement initiatives to enhance innovation.

To carry out this research, we first propose a conceptual framework that starts by distinguishing between these three concepts (i.e. monitoring, evaluation, impact). Second, we distinguish between the different types of additionality according to which an evaluation can be conducted (i.e. input, output and behavioural additionality). Finally, we apply our conceptual framework to the evaluation of PPI and compare it to the evaluation of other policy instruments such as R&D grants, innovation vouchers, or cluster policies to identify the different challenges that are to be faced in the evaluation of these different types of policy interventions.

4.2.2 Towards a strategic and comprehensive evaluation approach in the context of research and technology organisations (RTOs)

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Introduction

During the past 40 years, the most striking characteristics in the societal development have been the accelerated pace of technological and social changes and the increase of global interdependence (Lundvall, 2007). At the same time, it has become evident that major societal challenges – concerning for example environmental issues – are complex and systemic in nature (Harrisson et al., 2010; Kuhlmann & Rip, 2014). The role of innovations has been emphasised when tackling these problems. Because of their systemic nature, it is impossible to find solutions through individual product or service innovations only, but large scale changes are required (Rubalcaba et al., 2013). Prerequisites for these kinds of changes are combining technological innovations and service-based novelties with the social support and engagement of various stakeholders (Djellal & Gallouj, 2010, 2013). Further, developing innovations and disseminating them at the systemic level requires understanding about the whole socio-technical system, including the dynamics and interplay between parts of the system (Geels, 2010; Geels & Schot, 2007; Kemp & Rotmans, 2004; Kemp et al., 2009; Auvinen et al, 2015).

The viewpoints described above have significant implications to public policies. Novel approaches that support the development and implementation of innovations, strategic planning and evaluation have become necessary (Hartley, 2005; Lévesque, 2013; Smits & Kuhlmann, 2004; Kuhlmann et al., 2010). Services, which are often manifestations of the changes, are shaped through new types of governance mechanisms that include the rise of networks and partnerships, innovation as democratic practice, the development of 'choice', and co-production-based delivery models (Langergaard, 2011; Newman & Clarke, 2009; Sørensen, 2002). In practice, this necessitates new kinds of methods, which strengthen horizontal approaches and steering mechanisms and are adaptive and able to respond to the rapidly changing situations. A challenge is how to take into account the increasing complexity and pace of change in order to guarantee robust and real-time information in decision-making (Hyytinen, 2017; Hyytinen et al., 2014).

In the context of innovation, the evaluation of the outcomes is an essential task. However, current evaluation practices are largely based on the linear input-output-outcome-thinking, which does not correspond to today's complex development processes and the multiple relationships between the contributing actors (Arnold, 2004; Kuhlman, 2003; Patton, 2011; Rip, 2003). The increasing 'servitization of society' (Gebauer & Friedli, 2005; Neely et al., 2011) has created additional pressure to develop a more advanced and participatory approach to evaluation. Service studies, and specifically the studies on service innovation, have revealed the one-sidedly techno-economical nature of the indicators used in evaluation. These traditional evaluation tools and measures do not describe

properly the innovativeness, impacts and performance of services (Djellal & Gallouj, 2010, 2013a; Metcalfe & Miles, 2000; Sundbo, 1998). More generally, they are not able to capture the immaterial, interactive and systemic characteristics of innovations. Furthermore, organisational (including business model), governance, social and marketing innovations are not sufficiently recognised, understood or targeted by mainstream evaluation frameworks. However, this picture is now changing due to new efforts promoting the assessment and management of multiple types of innovations and related critical issues (e.g. CASI-F), thus paving the way for more strategic and comprehensive evaluation approaches (see Popper et al., 2017)

Another challenge in the context of R&D evaluation realtes to the emergence of ‘citizen-science’ and crowd-sourced research. These developments bring new challenges to the evaluation of R&I rationales, processes and outcomes: citizen science initiatives tend to target a variety of individual and collective social benefits and challenges, which require more flexible indicators, metrics and methods (Popper et al., 2015). To take into account these developments “smart” R&I evaluation has been suggested. Aim is to (1) reinforce the role of evidence and transparency in R&I policies; (2) assess R&I impacts more flexibly and comprehensively; (3) promote peer review in evaluation of excellence and relevance; and (4) evaluate and monitor citizen-science initiatives more sensitively (ibid.).

This paper aims to contribute to the above described need for a “smart” and more comprehensive evaluation approach. In the conceptual part, it sketches a new type of strategic and comprehensive evaluation approach to expand the traditional evaluation criteria and metrics towards multi-criteria evaluation including the contributions to broader societal transformations (cf. Djellal & Gallouj, 2010, 2013, Hyytinen, 2017; Popper et al., 2017). In the approach multi-criteria perspective is integrated in traditional strategy management practices (Kaplan & Norton, 1992, 1996) and organizational learning (Kallio, 2015; Saari & Kallio, 2011; Patton, 2011). In the empirical section, a new type of evaluation framework is developed and applied in the context of one context of Finnish research and technology organisation, VTT Technical Research Centre of Finland Ltd.

Towards a strategic and comprehensive evaluation approach

These above described challenges in measurement and evaluation in the systemic context intend to assess the impacts on the basis of a multidimensional approach (Djellal and Gallouj, 2010, 2013; Rubalcaba et al., 2013). In order to analyse impacts from more comprehensive and strategic perspective, we apply multi-criteria evaluation approach (Djellal & Gallouj, 2013; Poper et al., 2017). Approach describes the variety of impacts by giving insight to different societal spheres and their principles and values in the sens of Economics of Convention (Gadrey 2005; Djellal & Gallouj 2010, 2013). It identifies six different justification criteria that provide basis for the evaluation: *the industrial and technological, the market and financial, the relational and domestic, the civic, innovation, and the reputation* (Djellal & Gallouj, 2013). The impacts can then be evaluated from the perspective of different goals or target areas: besides the traditional technical and financial aspects, the complex societal challenges and the specific characteristics of services linked to quality and social value can be taken into account (Djellal & Gallouj, 2010, 2013a; cf. Rubalcaba et al., 2013).

Evaluation is a tool in strategic management: its purpose is to provide managers with feedback from the activities that they have initiated and supported. However, traditional evaluations have been made to legitimize their existence (Chelimsky, 1997; Rip, 2003). To direct the evaluations towards continuous development, stronger integration with strategy approaches and theories of organizational learning are beneficial. Currently, evaluation research searches new approaches to promote learning and development based on knowledge produced to ensure challenge-driven way of working and impacts at all levels of the organization (Kallio, 2015; Saari & Kallio, 2011).

In our framework, strategy approach is incorporated by linking the multi-criteria perspective to the idea of the balanced scorecard (BSC) which is a traditional strategy management framework in organisations. The BSC suggests to view an organisation from four perspectives: financial, customer, internal process and organizational capacity. The BSC developes objectives, measures (KPIs), targets, and initiatives (actions) of an organisation in relation to each of these points of view. It aligns a

measurement and monitor progress towards strategic targets and ensuress thate the day-to-day work that everyone is doing followst he strategy. (Kaplan & Norton, 1992, 1996)

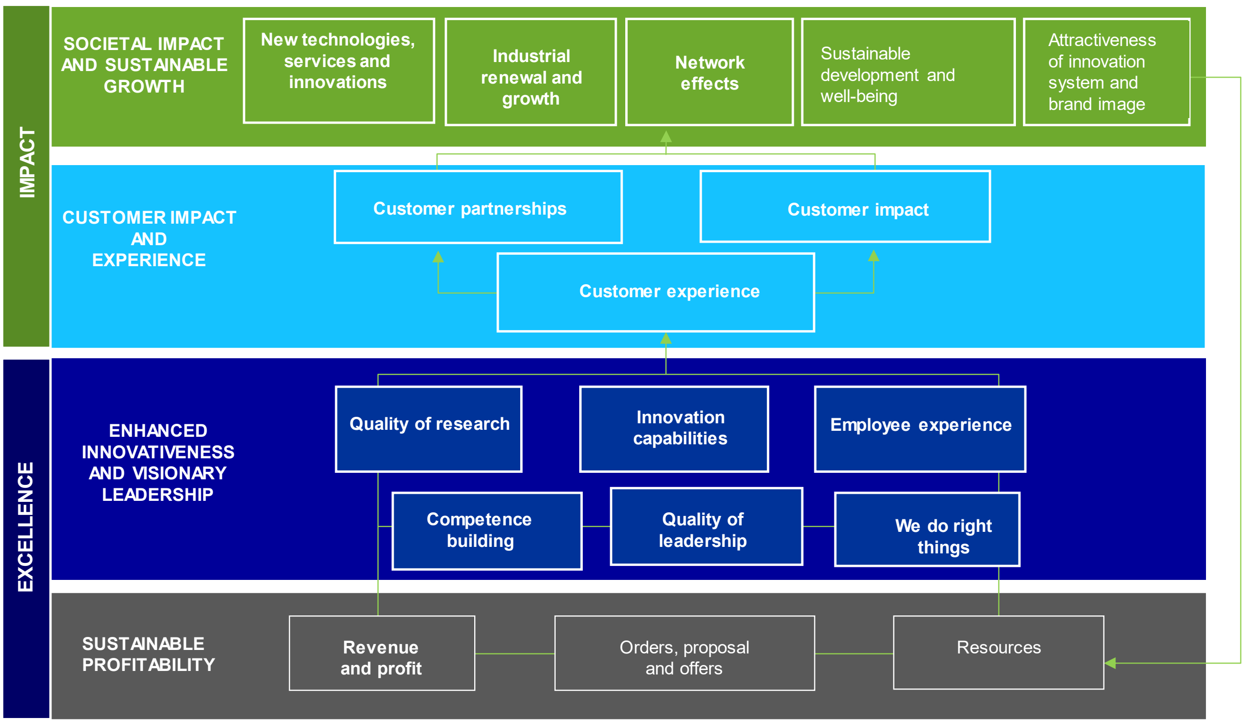
Organisational learing instead, is reflected in the approach by incorporating the idea of developmental evaluation (Kallio, 2015, Patton, 1994,1997, 2011; Saari & Kallio,2011). Its main aim is to make sense of what emerges under conditions of a complex system, and to provide real-time responses to adapt to new conditions in the face of changes. Developmental evaluation documents and interprets the dynamics, interaction and interdependencies; to do so, it considers both the top-down and bottom-up forces. The target is a system: by the means of anticipation, adjustment, reflection, multiple perspectives and continuous implementation, it increases understanding of the dynamics in the system, and helps to identify potential outcomes and implications in it. The information resulting from that type of evaluation is especially relevant in complex and dynamic situations to support strategy building, development and continuous learning.

Sketching new evaluation framework in the context of VTT

Empirically the paper develops the approach in the context of Finnish research and technology organisation, VTT Technical Research Centre of Finland Ltd. VTT is currently renewing its strategy: focus is on a challenge-driven way to solve the current and future challenges of customers and society through scientific and technological excellence. In accordance to new strategy, VTT's evaluation culture and indicators in been renewed and modernised. Cornerstones in the new evaluation culture is to strengthen challenge-driven way of working, and to support leading through substance: timely evaluation, learning and rewarding are related transparently to the results and impacts at all levels of the organisation. Instead of legitimation, evaluation culture highlights continuous learning, improvement and strategic intelligence in managerial operations.

Renewal includes the renewal of VTTs Key Performance Indicators (KPIs) to a direction where impact and excellence are better included and corresponding managerial and learning practices throughout the whole organisation. Following figure illustrates the new framework for evaluating and learning at VTT (Figure 1.).

Figure 1. Framework for evaluating and learning at VTT



In the new framework, impact for customers and the society have been set as central aims steering our operations. Although similar impact-oriented approaches have been successfully used in the fully-fledged evaluation of a national foresight programme (see Popper et al, 2010), their effective application to a large RTO like VTT are yet to be seen, Prerequisites of impact are the quality of VTT's research and innovation ability, as well as the financial balance in the long run (excellence). The framework brings out that the impact created by VTT cannot be demonstrated with one indicator; wide-ranging evaluation of the benefits created by our operations and continuous learning from the impact produced are the prerequisites. This requires developing the current key performance indicators (KPIs) so that they better take into account the impact and excellence of our operations. This also requires the establishment of new mutual learning practices throughout the organization aimed to promote the joint mapping and assessment of 'critical issues' (e.g. barriers, drivers, opportunities and threats) that require forward looking management and co-creation of sustainable action roadmaps.[14]

In the framework RTOs like VTT would be reorienting their next generation R&I evaluation activities towards the assessment and management of the following four types of impacts: (1) societal impact and sustainable growth resulting from the everyday operation of RTOs. To ensure that, RTOs would need to co-create, together with partners and customers, technologies, services and innovations, which support both creation of new markets and renewal of industry, as well as secure societal well-being and sustainable development, (2) The long-span societal impact is based on RTOs' ability to create good customer experience and impact in shorter term. To ensure this, RTOs would need to support customers' success and growth and create actively new customerships and partner networks. (3) Prerequisites for creating impact are the agility of our ways of working and high-level competence (excellence) in research and innovation. This would require RTOs to pay attention to visionary leadership, well-being of the personnel and "doing the right things". Finally, (4) RTOs operative excellence and financial profitability should secure the balance of RTOs's finance in the long run. This would involve RTOs to focus on a systematic development of the turnover and profitability, through an efficient order and tenders back log, and effective and appropriate usage of resources.

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14 A practical online course providing methodological guidance, examples and lessons from the systematic assessment and managment of 'critical issues' related to sustainble innovation in Europe and the world can be found at: http://www.casi2020.eu/tutorial /

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4.2.3 Monitoring and evaluation of S3 strategies - Regional insights and future challenges

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Keywords: Smart specialization, monitoring, evaluation

This paper aims to critically review the currently established monitoring processes of regional smart specialisation strategies (S3) and to discuss critical issues and potential approaches for ex-post evaluations of these strategies. Based on a state of affairs analysis of Austrian regional innovation strategies, existing monitoring mechanisms, as well as of best practice examples, different monitoring approaches in European regions are discussed. Based on an analysis of these strategies, the existing monitoring mechanisms and lessons learnt from evaluating previous regional innovation strategies, we describe the expected challenges for the evaluation of S3 strategies. Given the political and economical relevance of S3 and the fact that more than 200 S3 strategies have been developed, the paper will contribute to the discuourse about monitoring and evaluation of regional research and innovation systems.

Smart specialisation is a policy framework to foster knowledge-intensive (regional) development and a central element of the Europe cohesion policy. Even though S3 as a concept is relatively new itself, it builds on the experience of two decades of regional innovation strategies and aims to address their shortcomings. The essential distinguishing features between S3 and previous strategties are the involvement of a broad set of stakeholders in priority setting (entrepreneurial process of discovery) as well as the focus on very specific technologies. These elemets of the framework should help regions to reveal where they can do best in terms of innovative activities. However, the implementation of smart specialisation is challenging because it integrates different policy areas and responsibilities, in a horizontal sense between ministries, and vertically from the local and regional to national and European levels. Additionally, it requires different innovation actors to work closely together, including firms, knowledge centres, government and civil society itself (the end users of innovation and on occasion co-producers of knowledge), in a so called 'quadruple helix' (cf. Leydesdorff 2012, Foray 2014; Gianelle et al., 2016).

This complex governance system, as underlying policy framework for S3 strategies, constitutes a challenge for monitoring and evaluation. Monitoring, which usually encompasses all sorts of activities regarding the collection and processing of information about implementation of policy measures and expected results, has seen in a broader context for S3. According to Gianelle and Kleibrink (2014), monitoring mechanisms for S3 perform three fundamental functions:

- inform about what the strategy achieved and whether implementation is on track and making this information available to decision makers;
- clarify the logic of intervention of the strategy and make it comprehensible to the broader public;
- support the constructive involvement and participation of stakeholders through transparent communication and promote trust building.

Surveys show that, policy-makers believe providing information for stakeholders is one of the most crucial aspects of S3 monitoring and contributes to endured engagement and policy ownership. Therefore, monitoring of S3 constitutes an exercise that must go beyond a narrow focus of meeting audit requirements and has been described as strategic monitoring (Kleibrink et al., 2016).

In this this new requirments for strategic monitoring, the regional innovation strategies of Austrian states have been analysed. S3 strategies in Austria are shaped by a multilevel governance system consisting of the European level (Europe 2020, ERDF, Horizon 2020), the federal level (RTI strategy, federal RTI funding) and the state level (RTI strategies and regional funding agencies). For this study, interviews with representatives from regional implementing bodies have been conducted in fall 2016. This analysis has been put in context of good practice examples from different regions and then has been discussed with stakeholders at the Bundesländerdialog, a biannual steering meeting organised by the federal ministry. Particular emphasis has been put on the regional understanding on the role of monitoring as part of the S3 process.

RTI strategies in Austrian regions focus on collaborative R&D projects between universities and local firms. Thematic priorities are set in cooperation with the regional stakeholders and the support measures (e.g. endowment professorships at local universities to increase research in these domains) fit conomic needs. In terms of monitoring the perception of the stakeholders vary significantly. Many Austrian regions are now only at the beginning of the process of setting up a monitoring mechanism and lack know-how and capacities to implement a strategic monitoring system. While some regions show high ambition different approaches and aims exist. A common preference would be a joint monitoring organised on federal level as the states lack resources. However, the question of how to organise such a joint monitoring and in how far specialisation or even smart diversification should be monitored appropriately, remained open. In general the awareness that S3 monitoring goes beyond established practices and also should fulfill further requirments exists only in part. Based on the regional experiences and the international good practice examples we outlined key characteristics that a strategic monitoring system for S3 should cover. The monitoring system should contribute to answer the questions about the direction of the regions economic development, with a special focus on the thematic priorities outlined in the strategies and the participating actors. This includes the application of suitable sets of indicators. The communication aspect of the monitoring system is rather underdeveloped in the Austrian context, whereby the motivetional aspect of monitoring is not achieved.

The specifics of the S3 framework and the strategic monitoring as outlined above do have implicatins on the evaluation of these strategies. Building on the wealth of expieriences of preceeding regional innovation strategies in the framework of the EU cohesion policy, strategy development exercises (RIS, RITTS, RISI) and inter-regional best practice demonstration (RTT, RISI2), and pilot actions (RIS+, RISI+) we will draw conclusions for the evaluation of S3 strategies. (cf. Charles et al. 2000; European Commission, 2005; Grillo and Landabaso, 2011).

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4.3 Session 4.3

4.3.1 The governance of Responsible Research and Innovation (RRI) at the level of a large Research and Technology Organisation (RTO): Experiences from stakeholder dialogues on RRI-related goals

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Keywords: Responsible Research and Innovation, Visioning, Goal setting, Stakeholder processes, Organisation theory

Introduction

It can be assumed that organisational sense-making processes, structures and routines related to Responsible Research and Innovation (RRI) evolved long before the concept emerged. The JERRI project[15] bridges between such existing practices and structures and the ambition to further align the orientation and effects of research and innovation to societal needs and values (cf. Lindner/Kuhlmann 2016). At the current stage of the project, long-term organisational orientations as well as goals for pilot activities in thematic areas corresponding to the five RRI key dimensions currently promoted by the European Commission – Ethics, Gender, Open Access, Societal Engagement and Science Education are developed. This process unfolds in a series of stakeholder workshops within the Fraunhofer-Gesellschaft (in the following termed 'Fraunhofer') and TNO.

Obviously, the (research) organisation is the primary place where decisions on the institutionalisation of RRI-related practices are made. Aligning research and innovation to societal needs and values (cf. Lindner, Kuhlmann 2016), however, implies that "external" normative orientations, interests and legitimacy pressures are already addressed in the institutionalisation process itself. An integration of both perspectives seems to be analytically and practically underrepresented, which may also be due to the fact that stakeholder theory either mostly takes on an organisation-centred, "managerial" viewpoint or considers wider "stakeholder systems" without single organisations as their reference point (cf. Haegeman et al. 2012, pp. 6 ff.). "Lessons learned" how to combine both views in goal setting processes are however highly relevant for each endeavour to systematically promote RRI in terms of the alignment between societal expectations and research and innovation practices. Moreover, it can

15 The project Joining Efforts for Responsible Research and Innovation (JERRI) draws on the concept of Responsible Research and Innovation (RRI) to orchestrate a deeper transition process within the two largest European Research and Technology Organizations (RTOs), the German Fraunhofer-Gesellschaft and the Netherlands Organization for Applied Scientific Research (TNO), towards responsible research and innovation (R&I) practices. The project is funded under the European Commission's Horizon 2020 / Science with and for Society programme as a response to the call "Supporting structural change in research organizations to promote Responsible Research and Innovation (ISSI-5-2015)" (JERRI 2017). It runs from June 2016 until May 2019.

be assumed that, apart from the internal/external dichotomy of stakeholder involvement, there may be additional relevant characteristics of stakeholder involvement affecting RRI-related decisions and goals.

Aim of this paper

This paper aims to reflect the procedural experiences from the five stakeholder workshops of the Fraunhofer-Gesellschaft[16] at the level of the methods used to engage in five stakeholder dialogues on organisational, RRI-related goal setting. At the analytical level, it takes the perspective of stakeholder approaches and links the observations to concepts from the neo-institutionalist perspective. The experiences from the five stakeholder workshops allow for a comparative reflection. This reflection is empirically based on the workshop protocols that capture both the process and the results of the stakeholder discourses. The comparative reflection is guided by the following questions:

- How do different contingencies affect the outcome of vision and goal development?
- How do different contingencies affect the stakeholder dialogues themselves?
- What can be learned for future RRI-related vision and goal development settings at the level of the processes and methods used?

The outcomes of this paper are twofold: First, the results will comprise methodological insights for RRI-related vision and goal development settings in a large RTO. The analysis of how different contingencies can affect both the process and the outcome of the respective stakeholder dialogues will be turned into a set of "lessons learned" from a practitioner's view. Second, implications at the level of STI governance will be outlined.

Method

The comparative reflection of workshop results in view of different contingencies is primarily based on what could be observed in the protocols of the five visioning and goal development workshops at Fraunhofer that took place as part of the JERRI project in spring 2017. Each workshop focused on one of the five RRI key dimensions: 'Ethics', 'Gender', 'Open Access', 'Societal Engagement' and 'Science Education'. In addition, individual oberservations of the moderators in the forefront and at the workshops form the empirical basis of the comparisons made.

Although the concrete realisations of the five visioning and goal setting processes at Fraunhofer varied, they followed a common methodological approach for the preparation and the moderation of the workshops. The methodological approach underlying the five workshops consists of the following major components:

1. *The identification and selection of stakeholders*: A process of stakeholder identification based on the "critical systems thinking" approach of Ulrich (2000) is applied. A distinction is made between different stakeholder types to account for the participatory logic of stakeholder involvement as one of the key principles of RRI. Different selection criteria being applied to the involvement of stakeholders are described.
2. *Visioning*: A visioning method (cf., for example, Wiek/Iwaniec 2014; Neuvonen/Ache 2016) is applied in the workshop settings to account for the long-term nature of RRI-related institutionalisation processes and to build on individual and shared values. The visions represent an explicit form of the preferred future in each thematic area.The application of the visioning method in the workshop settings comprised several steps, including the development of individual and group

16 An inter-organisational comparison between the goal development processes of TNO and Fraunhofer could not be made yet but will be a route for further inquiry.

visions and a synthesis of these visions towards a final vision shared by all workshop participants.

3. *Goal development approach*: A method suited for the specific JERRI case is applied by building on the existing framework of governance principles provided by the Res-AGorA Co-construction Method (Bryndum et al. 2016) allowing for a systematic discoursive identification of RRI-related goals and actions in group work.

Results

The comparative reflection on the five RRI-related goal development processes unveiled the following contingencies to have affected the five participatory vision and goal development processes: (1) the participation of stakeholders external to the organisation, (2) the distribution of expertise among workshop participants and (3) how well the organisation already developed a thematic area in terms of sense-making processes, structures and routines. It could be observed that the diversity of statements as well as the related convergence/divergence of the visions developed in the five workshop settings were in part a result of these contingencies. At a conceptual level, these observations could be turned into a tentative typology of stakeholder involvement in RRI-related participatory visioning and goal development exercises and beyond. From a practicioner's view, future inquiry could turn such a typology into a framework for stakeholder involvement in similar settings.

The workshop discussions demonstrated that the values and goals articulated by the stakeholders external to the organisation did not diverge to a greater extent from the other stakeholders than the ones of the 'internal' stakeholders. This could speak against an over-estimation of organisational boundaries in stakeholder processes inherent to 'managerial' stakeholder approaches (e. g. Freeman 1984, Mitchell 1997)[17]. In some respects, this observation is in line with neo-institutionalist theories of the organisation, claiming that the institutional context leads to homogeneity among organisations in a field (cf. for example DiMaggio and Powell 1983, Kirchner et al. 2015). The decisive reference point for converging/diverging perceptions is thus not the single organisation but field-specific legitimacy pressures that many organisations in a field are subject to.

In contrast, expertise in the workshop topic seemed to be a decisive factor for the participation of stakeholders: Despite an orientation in the "critical systems thinking" approach (Ulrich 2000; Achterkamp, Vos 2007) where legitimate interests (and hence not expertise) was the criterion for the invitation of stakeholders, a remarkable 'bias' towards the actual participation of stakeholders with high field-expertise could be observed. Whereas field expertise can always be related to stronger interests and motivation to participate in related decision-making processes, the question how the presence of expertise affects the outcome of stakeholder processes seems to be nevertheless important. Among the five workshops, different shares of experts[18] in the entirety of workshop participants could be observed. A comparison between the visions developed by different groups and the common vision developed by all workshop participants led to the observation that lower shares of experts eased the process of finding a common vision, whereas higher shares of experts related to less shared views and goals. Neo-institiutionalist approaches highlight the professions as an institutional order (cf. DiMaggio and Powell 1983, Friedland and Alford 1991, Thornton and Ocasio 2008, Randles 2017, p. 22). Moreover, different degrees of professionalism are assumed to facilitate common views and goals within the organisation (Zucker 1977, p. 737). The observations show that sheding further light on the effects of expertise/laity could help to better understand such dynamics in stakeholder dialogues.

Partly related to the latter observation, the development of a common vision tended to be characterised by a higher convergence of goals and underlying values in fields where stakeholders had a basic previous understanding but that are not present in everyday processes, structures and routines. In RRI-related fields that were both framed / developed in the organisation in a relatively weak

17 Although they are mostly normative and not descriptive, they may frame the way we think of stakeholder processes.

18 The criterion for attributing 'field expertise' to stakeholders was a strong relation of their job description to the field.

or a relatively strong way, participants revealed less converging views. On the one hand, these observations correspond to the assumption that logics unfamiliar to the organisation cannot be easily reconciled with existing institutional logics (on multiple/contradicting logics within the organisation also cf. Randles 2017, pp. 8, 42 ff.). On the other hand, consciously 'breaking up' stronger institutional logics in a visioning exercise may equally lead to diverging views. This observation could be particularly relevant for *RRI-related* visioning and goal setting processes as (re-)framings of organisational, responsibility-related discourses (cf. Teufel et al. 2016, p. 64).

Discussion

Practical implications

A further analysis along the directions shown could help practitioners in stakeholder-based visioning and goal development processes to reflect on the design of stakeholder involvement. The findings are particularly relevant for RRI-related stakeholder processes. Differences in the values and goals of external as opposed to internal stakeholders seem to be less pronounced and hence the focus on the internal/external dichotonomy seems to be somewhat exaggerated. As external stakeholders cannot only be easily involved but also enrich RRI-related visioning and goal development processes, this can be a practical argument in favour of more 'inclusive' stakeholder approaches. In contrast, other dimensions such as the field expertise of the stakeholders involved seem to affect the process results. This would mean that the 'self-selection of experts' into visioning and goal setting processes should not be left to chance but rather be subject to a more deliberate stakeholder selection.

Beyond such workshop-based stakeholder dialogues on RRI-related goals, the assumptions made would have further implications for orienting STI towards societal needs: Rather than opposing 'organisational' approaches of RRI-related transformation on the one hand to sectoral or overarching governance approaches on the other, further tailorings and levels of governance towards more responsible research and innovation might deserve attention[19]: More stakeholder dialogues and governance mechanisms could be differentiated according to groups of similar (research) organisations, to different research(-related) professions (also cf. Randles 2017, p. 22), scientific communities or to cross-cutting discourses.

Methodological limitations

Results of this study should be interpreted in view of the relatively low number of cases observed. The empirical data – workshop protocols and individual observations – were not primarily collected with the objective of an in-depth comparative study. Moreover, results partly resort to individual observations of the moderators during the five workshops. Therefore, the comparative reflections cannot exceed the status of inductively gathered ideas and hence can only be the starting point for further inquiry.

Conclusion

This paper aimed at reflecting the procedural experiences from the five stakeholder workshops of the Fraunhofer-Gesellschaft at the level of the methods used to engage in five stakeholder dialogues on organisational, RRI-related goal setting. Based on the observations made, assumptions were raised as to how the participation of stakeholders external to the organisation, the distribution of expertise among workshop participants and the development of RRI-related topics in the organisation may affect this convergence/divergence. These observations are widely consistent with neo-institutionalist approaches. Further analyses in this direction could result in a framework for stakeholder involve-

19 For similar thoughts on the adequate levels of Foresight execises cf. Schoen et al. 2011.

ment in similar settings. Based on the results it can be argued that further, orienting governance approaches to cross-cutting 'fields' for transforming STI towards more responsible research and innovation may be effective.

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4.3.2 A long-term experience with evidence and judgement, narratives and discourse: the case of the Alexander von Humboldt Foundation

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Introduction

Since more than 60 years, the Alexander von Humboldt Foundation (AvH) in Germany promotes academic cooperation between excellent scientists and scholars from abroad and from Germany. Their main intervention is the sponsorship of international academics as part of foreign cultural and educational policy, strengthening cutting-edge research through internationalization, with an impetus for the research location Germany by promoting individuals. Both in fellowship programmes and inaward programmes, the sole selection criterion of candidates or nominees is academic excellence. The Humboldt Professorship, based on the long-term engagement of the hosting university also refers to the persuasiveness of the concept outlining the nominee's importance for and prospective involvement in the process of achieving the nominating institution's strategic goals. Various multidisciplinary Selection Committees are in charge of the selection.

A particularity of the Alexander von Humboldt Foundation is its engagement in alumni sponsorship and international networking: More than 27.000 researchers worldwide are part of this network and eligible for alumni sponsorship.

Since 2006, an independent Academic Council has steered the evaluation of the Humboldt Foundation's sponsorship programmes. The Council is responsible for monitoring and mentoring the evaluation, developing ideas based on the results of the evaluation and formulating concrete recommendations. Since 2008, the author has evaluated five major programmes[20] of the Alexander von Humboldt Foundation: The Research Award Programme (2009), the Humboldt Research Fellowship Programme (2011), the Feodor Lynen Research Fellowship Programme (2012), the Sofja Kovalevskaja Programme (2016) and the Humboldt-Professorship Programme (2017). In these evaluations, we cooperated with experts, notably in bibliometrics, but also related to specific contextual knowledge and experience. It seemed important to us to "always change a winning team", one of the key features of evaluation by external partners being related to their independence. The reconfiguration of our team added a new perspective from outside for each new evaluation exercise.

After nearly 10 years of evaluation activity for this institution, we take one step backward and ask ourselves: What was our value added to the performance? How might this be linked to the evaluation studies themselves: the approach, the evidence we referred to, the evaluation process, the interface with the client, the role of the Evaluation Committee?

Christina Schuh, the former head of the evaluation unit within the AvH, saw the challenges of impact evaluation firstly in the understanding of moderating factors of fellows and awardees[21]: worldwide,

20 More precicely, some of these evaluations covered a group of programmes, for instance two different award programms adressing researchers at different career stages with different funding amounts, but with a similar selection process, or fellowship programs that have mainly a commthe same design as the programs mentioned, but being based on bilateral agreements, and therefore additional funding and promotion abroad. The evaluations are pubished on the homepage of the AvH, https://www.humboldt-foundation.de/web/evaluation.html, so far apart from the evaluation of the Humboldt-Professorship program, expected soon.

21 K. Warta, C. Schuh, 2012.

given cultural differences, across all scientific disciplines, across cohorts, and gender. Secondly, she sees an issue related to the double expectations of research versus policy advice. Apparently, we have been selected in most calls for tenders to do the evaluation for exactly this mix in our approach: which seems neither to be too academic missing the broad overview, nor too “consultancy like”. Our aim was indeed to take a comprehensive approach, to understand “the issue”. And the issue was: impact. How is impact generated, why, and what could they do better? Third party evaluation should add a new type of evidence base to the client’s every days’ understanding of his activities. Evaluation is evidence plus judgement. Section 0 will provide details on the evidence base.

Since the launch of their evaluation activity, the team and the approach to evaluation within the AvH has professionalized. In October 2012, the head of the evaluation unit and myself presented a paper on “Client-evaluator Interaction: Learning from Each Other by Doing with Each Other” at the American Evaluation Association Conference in Minneapolis. Still, the most challenging “learning” happened three years later, when we did not come up with the same judgement of the evidence presented in the evaluation and therefor with recommendations that were more conflilctual. The interesting point is that this conflict lead to increased exchange and debate both between evaluators and the client and within the Evaluation Council, and resulted in the publication of the statement of the Evaluation Council next to the summary of the evaluation.[22]

Basically, our judgment of the first three programmes evaluated was mainly positive, with comments on potential improvement on a high level. There were some issues about transparency, about networking effects where networks tend to reproduce themselves, and gender effects related to well established networks traditionally including men, and about the recognition of patterns of cooperation in Humanities in the award programs. We will come back to the consideration of these recommendations by the AvH in section 0.

The evidence base

Bill Trochim proposed the appealing definition of evaluation being “the systematic acquisition and and assessment of information to provide useful feedback about some object”. Before presenting what kind of learning and change the evaluations have stimulated, introduced or supported, we shortly provide a summary of the evidence base referred to in these evaluations. The following table shows for each of the five evaluations the years covered, the funded population covered[23], qualitative and quantitative data used. Both on the qualitative and on the quantitative side, we introduced innovative approaches, on the one hand in designing group interviews and workshops, the latter used explicity both for exchanging information and as evidence base for the study, on the other in developing new approaches in using bibliometric data, in close cooperation with Juan Gorraiz and his colleagues from the biobliometrics team of the Vienna university.

22 See: Zusammenfassung der Ergebnisse der Evaluation des Sofja Kovalevskaja-Preisprogramms sowie die Stellungnahme des wissenschaftlichen Beirats zum Evaluationsbericht, https://www.humboldt-foundation.de/web/Evaluation-Kovalevskaja-Preis-2016.html

23 We also analysed non funded project submissions or nominations in more or less depth, including these numbers would go beyond the scope of this paper, we refer to the individual studies for more detail on methodologies and coverage.

Table 1: Overview on evidence base of five evaluations

Evaluation	Years covered	Cases	Survey	Case-Studies	Bibliometrics	Interviews	Other
Humboldt Award	1986-2006	1.232	Awardees, hosts in Germany, Lynen-Fellows hosted by Awardees	10 case studies	Physics and Chemistry. Copublications of Awardees with German colleagues,	AvH, Stakeholder, Experts	Network analyses based on bibliometrics
Humboldt-Fellowship	1970-2009	16.875	Fellows and hosts	10 case studies, based on archives, online research and interviews		Stakeholder interviews	162 comparisions of final reports of fellows and hosts
Feodor Lynen-Fellowship	1979-2010	3.099	Awardees, control group: rejected applicants of the last 10 years		In selected fields of physics and chemistry, control group analysis	Stakeholder, Focusgroups with awardees	Participating observation Analysis of final evaluations by hosts abroad Comparison with funding data of DFG and DAAD
Sofja Kowalewskaja Award	2001-2012	90	Awardees	On site visits at four sites (towns/regions)	Analysis of international cooperations of awardees compared to average in Germany in their field.	Focus groups with awardees	Comparison with other programs Workshop with host institutions' repsresentatives at AvH premises Online information to complement database on careers
Alexander von Humboldt Professorship	2008-2015	50	Online: Humboldt Professors, University Presidents & Department Leaders in host organisations	14 in depth case studies based on on site-visits, focusing on structural effects in the university / research organisation	Inidividual publication profiles for all case studies; in depth analysis of structural effects four three selected case studies	Stakeholders, additional interviews with Humboldt-Professors having finished their funding period	Additional secondary data analysis to complement AvH database

Source: Technopolis

On a methodological level, each evaluation presented specific challenges:

- The Humboldt-Award programme was the first evaluation we conducted. The po-gramme is unique in terms of flexibility concerning the use of the award money. It was tricky to identify against what this programme could be evaluated, without a comparable programme and without a clear intervention matrix.
- The Humboldt Fellowship programme was overwhelming in size: 16.875 fellows in the database, more than 1500 responses to the survey … At that time, the information system of the AvH was under reconstruction. Conceived as a programme management tool, it has not been used for evaluation so far, it was rich in information but extracting this information was not yet straight forward, and could take up to two months, with several quality control loops. Today, the new system allows for data extraction by the members of the evaluation unit themselves, facilitating the evaluation process considerably.
- The evaluation of the Feodor Lynen Fellowship programme presented a challenge as it provides grants to researchers from Germany joining research groups of members of the Humboldt-Network abroad to enhance the network. This seems straightforward, but looking more closely, the design is tricky as, in line with the AvH's mission, priority is given to enhancement of the network compared to the benefit of the individual post-doc. However, it is on the individual level, that we can "read" the impact, so we had to find an appropriate approach to deal with these various layers.
- The Sofja Kovalevskaja Award allows young researchers during a five years' period to build up a working group and working on a high-profile, innovative research project of their own choice at a research institution of their own choice in Germany. As mentioned above, at the end of the evaluation of this programme we came up with conclusions which considered the positioning of the programme – and the intervention of the AvH – in a broader context. In considering the complexity of research systems, we necessarily had to go somehow beyond our sound evidence base and refer to more general studies and knowhow about the research system and researchers' careers. The critierion of relevance asks whether an intervention has defined the right goals given observed problems in society. The discussion of the Evaluation Council shows that empirical evidence opens the room for interpretation and discussion, which is, to our view, one of the most useful outputs an evaluation can provide.
- Finally, the evauation of the Alexander von Humboldt Professorhip programme had to face the challenge of the high degree of uniqueness of each professorship, making any control group or maching pairs approach impossible. We opted for in depth case studies combined with sound bibliometrical analysis, and complemented with both questionnaires and telephone interviews to assure a broad coverage.

We came up with a new type of evidence on the different role of internationalization within the German research landscape and within scientific fields. We also showed the impact on interdisciplinarity. Our approach in bibliometrics was experimental in the sense that we received highly professional bibliometric analysis and questioned it from a more political perspective: We used bibliometrics not to judge quality in the first stance, but to understand differences in bibliometric fingerprints and the impact on various cooperation dimensions over time.

Terms of reference reflect the evaluation competence on the demand side

The evaluations we conducted showed that questions formulated too vaguely related to the achievement of goals, themselves formulated to broadly, couldn't be satisfyingly answered based on empirical observations. Surveys might be a possibility to crasp impacts on the perception of Germany, to give an example, co-publication analysis might hold as an indicator for internationalization but if the concepts of cultural perception and internationalization are not clearly defined, results remain vague. In the AvH, terms of references for evaluation studies became more precise over time. Most importantly, the evaluation unit started to define intervention logics, including different levels of objectives, related to input and to expected outcomes and impacts. The terms of reference (ToR) of the Sofja

Kowalewskaja evaluation were the first including an interventioin logic diagram, prepared by the evaluation unit in cooperation with the departments in charge of the implementation of the programme. As Martina May, head of the evaluation unit, states in a recent interview, this is because evauations are not produced for the shelves, but are an instrument of quality improvement of the foundation. (See section 0). Whereas our evaluation team had some suggestions for improvement of this first interventionogic, in the case of the evaluation of the Humboldt-Professorship, the intervention logic was very helpful for the evaluation and has been integrated in the report, to describe the several aspects of the programme. In that case, the can focus on searching empirical evidence on the questions: How much? How? And why so?

The preparation of the evaluation of the Humboldt-professorship programme was even more comprehensive, as the evaluation unit conducted an internal study including data analysis and case studies and an online survey beforehand. On this basis, they formulated recommendations for further research that have been incorporated in the ToR of the external evaluation study. As a matter of fact, some of the evaluation questions were very precise, resetricted to specific support measures, and the overall understanding of the programme within the AvH was already advanced. The situation of increasintly well informed clients can be broadly observed[24]: Programme owners have their own monitoring system, they have learned how to deal with their database beyond using it for programme management and annual reports. The expectation is then that external experts bring in both methodological value added, extensive external data and strategic advice.

Responsive practices of third party evaluations within the Alexander von Humboldt-Foundation.

"Evaluation, which is carried out in cooperation with external partners, does not only contribute to transparency and performance assurance but also helps to develop and optimise the Foundation's programmes."[25] This optimization process is formalized as follows: Five years after an evaluation, the evaluation unit assesses in how far recommendations have been implemented. "The Council is responsible for monitoring and mentoring the evaluation, developing ideas based on the results of the evaluation and formulating concrete recommendations."[26] On this basis, we can scetch the following process, which has been improved over time:

Table 2: Evaluations as a tool of longer term optimization

Phase	Acotors involved	Role
Preparation of ToR	Evaluation unit	Formulation, preparatory analysis
	Operational departments in charge of the programme	Input to ToR formulation, providing questions, defining the intervetnion logic
	Academic Council	Validation
Selection	Evaluation unit	Organisation of the tendering process
	Academic Council	Selection of the evaluator based on a written proposal and a hearing

24 Compare K. Warta and S. Phillipp (2016)

25 See the online presentation of Evaluation by the AvH: https://www.humboldt-foundation.de/web/evaluation-en.html

26 ibid.

Evaluation	Evaluation unit	Day to day contact with the evaluators, interface to data provision, interface to the Academic council
	Deputy Secretary General, Operational departments in charge of the programme	Members of the steering group, information source (interviews), meetings
	Academic Council	Monitoring and mentoring the evaluation Developing ideas based on the results of the evaluation and formulating concrete recommendations
Follow up	Operational departments in charge of the programme	A project group is responsible for the implementation of recommendations within the departments
	Evaluation unit	Assessment of the implementation five years later ('Interim report')
	Evaluation Council	Reception and discussion of the Interim Report on the implementation of recommendations

Source: Technopolis

AvH is organized in four departments: Strategy and external relations, Selection, Sponsorhip and Network, and Administration. Wheras the Selection department is organized in five units along scientific areas, the Sponsorship and Network department is organized along five world regions plus one unit in charge of conferences and programme assistance. There is no single head of individual funding programs, even though within each department, one person is in nominated as responsible. These persons are in general contributing all the long of the evaluation process.

Today, the evaluation unit is highly resepected within the overall organization. At the very beginnings, this was less clear, as an evaluator I encountered strong sceptisism towards external solicitation of awardees and fellows. Indeed, during the first years, we observed kind of an inflation of surveys, sometimes addressed to the same people by various companies, researchers or the AvH herself. ToR in later evaluations addressed this issue, and aksed to avoid doubling of questionnaires. Today, acceptance is high, both in the operational departments and in the governance of the AvH, as the they recognize the utility of evaluations and of the work of the evaluation. A crucial point is the involvement of operational units both upfront and after the evaluation, as shown in the table above. It is crucial, that after the evaluation, representatives of the operational departments are leading the working group in charge of implementation of recommendations, but not the evaluation unit. They come back five years later to assess the implementation. This assessment has been done so far for evaluation of the Humboldt Award Programmes. A second one, of the Humboldt Fellowship Programms, is ongoing.

The interim report related to the Award Programmes shows that 70% of recommendations have been implemented and show first effects. Other recommendations have not been implemented, so there are no effects to be seen and further steps need to be defined. In this case, the evaluation unit formulates questions. This assessment work is done in close consultation with the operational departments and is summarized in a 40-pages report submitted to the Evaluation Council.

As a matter of fact, various changes have been introduced, some clearly related to recommendations, others in line with them, but probably on the way independently of the external evaluation. We don't have access to the interim report, but based on an interview and observations we can refer to some of these reforms:

- The Evaluation of the Awards Programmes has addressed underrepresentation of Humanities and Social Sciences within the Humboldt-Awardees and recommended to increase awareness of these group. In 2011, the Anneliese Maier Award has been introduced, a collaboration award to promote the internationalisation of the humanities and social sciences in Germany. This new programme had an important effect, increasing the visibility of the AvH in this target group and inducing multiplier effects in other programs.
- Another recommendation addressed the integration of Awardees in the Network, which has led to the design of new events, notably the Bonn Humboldt Award Winners' Forum, where Award Winners and fellows are meeting.
- One of the recommendations of the Award Programm addressed a lack of transparency in the selection process, as the reasons for rejections have not been communicated to nominators. Since then, several measures increasing transparency have been established: In the selection process, reasons for rejections are formulated, nominators (and applicants in other programs) can get the explanation if they wish to. Both the information on the selection process and the members of the various boards are published.

One of the reasons of the success of evaluation activities is probably that the external imput is sollicitating internal relfection on goals, instruments and outputs, outcomes and impacts. These reflection rounds bring together people from different departments, facilitating the consideration of change. Another reason might be the change in leadership of the AvH in 2010. Finally, the orchestration between the evaluation unit representing this activity within the Foundation, the Academic Council respresenting the academic anchoring, the external evaluators representing independence and methodological knowhow, the Deputy Secretary General representing governance, and the operational departments representing implementation, has evoved together, ending up with a clear understanding of each others roles.

Conclusions

This paper addresses the aspect of new concepts and responsive practices of third-party evaluations. In concluding, we should ask in how far our evaluation experience with the Humboldt Foundation was new, in how far our approach was new, and in how far the Foundations' evaluation governance played a role in observed changes.

Our approach was new in the sense that given the complexity of AvH interventions, firstly we considered quantitative evidence at least as important as the historical context. There is a need to underpin evaluations with quantitative evidence, to clarify what can be measured, and how these results can be interpreted. Interpretation must consider the historical context. Secondly, our approach explicity recognized the variety of individuals that needed to be captured by our research tools. There is nothing new about triangulation, but there is something to be learned every day and every study from scratch: the combination of being bold and humble, of thinking strategically and technically. There is a tricky relation between data and understanding. Data provide indicators, and evaluators shall collect, calculate and contextualize them, so that they can come up with a judgement.

Within my team, we concluded that a core output of an evaluationis the meeting where key findings and conclusions are discussed once data collection is finished, and before the drafting of the final report. If these discussions are lively, if hierarchy participates, if the meeting is sufficiently long to go into details explaining the conclusions, the final report gets more interesting, worth the money and effort. If evaluation is a learning exercise, it necessarily must deal with language, with text, with a narrative, which goes beyond

data. The experience with the Humboldt-Foundation showed that a discourse – might it lead to consensus or not – is facilitated by a high degree of transparency on the sources we rely on.

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4.3.3 Scientists' guidance in the formulation of STI policy – a necessity or a hurdle to democratisation?

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Keywords: Well-ordered science, CIVISTI, Democratisation

Introduction

In recent years there has been a questioning of expertise, along with a demand by citizens for more participation in governance. STI has many specificities, such as its transformative potential for the lives of significant portions of the lay public, its increasing pervasiveness in everyday life, as well as the perception that it is only via STI that the major challenges of our times may be faced. The specificities of STI together with the questioning of expert knowledge and authority and the demand for more participatory forms of democracy, have given birth in recent years to a philosophical and Science and Technology Studies literature focussing on questions of the democratisation and of the opening up of STI policy.

Within this context, I will critically examine a key proposal in the philosophical literature on the democratisation of STI policy-making and compare it with some insights from actual practice as well as from two innovative EU-funded projects on this domain. More specifically, I will compare Philip Kitcher's (2011) ideal of well-ordered science with an opposing vision as promoted by the CIVISTI and CIMULACT EU-funded projects, before making a further comparison with actual EU practice. The comparison will focus on the question of the degree of democratisation and underlying assumptions. The two ideals and the practices that I will compare focus on a specific stage of the policy-process, that of target and priority setting. My key claim will be that the ideal of well-ordered science, as a form of participation in the governance of STI, ought to be resisted because of certain elitist conceptions of science and of the role of scientific knowledge that are incorporated into its methodology. I will argue that these elitist conceptions of science, their resultant elevation of the role of scientists in STI policy and the practical restraining of citizens, are not necessary and they may be replaced by a methodology that treats scientific knowledge as an input, among others, into a process that is led by citizens' visions of their futures, and that, furthermore, a high level of democratisation has been achieved by the CIVISTI and CIMULACT projects.

In this light, my suggestion for STI policy research will be to reflect on how to take advantage of existing schemes of democratic public engagement and seek ways of improving them and multiplying them in order to foster a culture of transparency and public participation in STI policymaking, rather than steer inwards towards more esoteric models and ideals that may be based on elitist presuppositions. In other words, I will argue that STI ought to assume a more political and praxis-oriented role.

Two conflicting Ideals

Philip Kitcher's ideal of well-ordered science is the most prominent and detailed treatment of the topic of science policy priority setting by a philosopher of science. In a nutshell, Kitcher's ideal is that priority ought to be given to lines of investigation 'reached through deliberation under mutual engagement' (2011, 114). Despite the level of detail, Kitcher is clear that the process is an idealisation that ideal practice should aim to approximate as much as possible. This is also reflected in the composition of the panel of the lay participants, who are envisaged as 'ideal deliberators' in the sense of deliberative democracy (Cohen 1989). To his credit, Kitcher insists that all viewpoints in society should be represented equally, and that no group ought to be absent due to power inequalities or lack of financial strength. Within the context of the conversation, the deliberators ought to be on

an equal footing. Of course, it is difficult to see how the ideal condition may be de-idealised and be set in practice, for example how it can be reconciled with the fact that in practice SMEs play a significant role in the development of the research outputs, a fact that motivates much of EU-funded policy practice. However, issue can be taken regarding the epistemological framework that Kitcher wants to impose, and which, according to my critique, is an elitist framework favouring scientists. I will now examine Kitcher's three-stage process of deliberation (2011, chap. 5) in order to articulate my criticism.

According to Kitcher at first the lay citizen deliberators become 'tutored', by being informed of the state of the art and the possibilities and options of scientific research. This tutoring process is deemed necessary by an epistemic condition embedded in the 'mutual engagement' requirement – Kitcher gives the example that altruistic people may arrive at bizarre conclusions if they ignore facts about the nature of pain ((Kitcher 2011, 51). At this point however, a first criticism may emerge. Kitcher's strong epistemic condition seems weakly supported by the argument that he gives, in other words one would be hard-pressed to find out what sort of knowledge would form this epistemological bedrock that Kitcher seeks: state-of-the-art scientific knowledge may be too contested to form a neutral basis for an impartial and unguided truly citizen-led process of deciding research goals, whilst on the other hand settled 'minimal' scientific knowledge may be claimed to form part of the general epistemic 'baggage' that the participants would bring to the conversation anyway. In this case, if any tutoring of the participants is to take place, then it should be in a more general tutoring by all stakeholders in research policy, for example industry stakeholders STI policy specialists and government officials.

The second stage of the process described by Kitcher is the adjustment of the deliberators' preferences to each other – this process happens via the deliberators' showing affect and understanding to each other's values and life-plans (Kitcher 2011, 115).

Finally, the deliberators reflect on the consequences of their preferred courses of action for research, and decide either via consensus or by majority voting on the research outcomes. Whenever there is disagreeement, and a clash between judgments of the consequences of potential courses of action for research, according to Kitcher a chain of deference shall be followed, with deference initially to 'the community of scientists', then to subfields and then to specific experts, with clashes between experts being settled by looking into their research records. However, a second criticism of the constraints of adopting a scientistic epistemological framework emerges at this point; despite the fact that scientific experts may know more technical details about their topics, they most likely are not equipped to answer complex question relating to the unpredictability of the effects of the adoption of technologies – hence the question of the responsibility for research ought to be undertaken collectively, and that is something that Kitcher totally ignores in his account. Kitcher does consider persistent clashes in opinion on research priorities, and proposes majority voting as a last resort – however it seems that he is oversimplifying overall by only considering the personal goals of the lay deliberators and the scientific knowledge of the experts as more or less the sole inputs into the dialogue. The oversimplification lies in choosing to frame the topic of setting priorities for scientific research as a relationship simply between an undifferentiated liberal lay public and an equally undifferentiated significant-truth-seeking expert scientific community, and on the other hand by imposing a strict scientific rationality framework within which the deliberation is supposed to take place (to be fair, Kitcher is mostly concerned with science, however it is questionable whether such a neat division between Science, Technology and Innovation may be meaningfully upheld at present).

The motivation of insisting on a 'guidance' by scientific expert seems to be the fear of the 'tyranny of the majority' or the exploitation of the ignorance of the lay participants by political or industrial elites. This fear may seem reasonable in an age of post-truth politics. However, there is no reason in principle why scientists too cannot fall prey to such exploitation or worse act as 'stealth advocates' promoting their political views in the veneer of science rather than act as 'honest brokers' policy alternatives (see (Pielke Jr. 2007) for

the terminology). The question of the capability of the lay public to decide important matters is itself at the heart of democracy, and it ought perhaps be best answered in the abstract in political terms whilst, furthermore there are good arguments affirming the epistemic capacities 'of the crowds' (Landemore 2013). Furthermore, it is my conviction that the stance that one takes regarding this question has a performative element. I will now briefly highlight two EU-funded projects which have implemented citizen-guided policy priority-setting exercises, in order to gather some practical support for my ideas.

The CIVISTI project ('Civisti.org' 2017) was an FP7 SSH-funded project that enabled a diverse (in terms of age, gender, educational level and employment) panel of 25 participants in each of the seven participant countries to deliberate about and formulate 'visions' for the future of their society. The participants self-selected to participate, but they were selected ultimately from a random sample of 100.000 people. A magazine (van Leemput 2009) was produced and disseminated to the deliberators to prepare them – this magazine contained input from artists, policy-makers and scientists on the topic of developing visions for the future. These visions were then presented to scientists and other stakeholders who undertook the task of translating these visions into concrete research agendas and policy options, in a three-day expert/stakeholder workshop. The latter were then handed back to the lay participants for validation and prioritization via a preference ranking that emerged through deliberation.

Two elements of this process stand out and set it in contrast to Kitcher's account: firstly, the epistemological content of the material that prepared the citizens for the deliberation was not solely scientific, rather it was inclusive of different epistemological frameworks; secondly, the citizens set the scientists' (and the other stakeholders') agenda and got the final say by judging the scientists' input and set the priorities themselves. In comparison, Kitcher's ideal effectively excludes epistemological frameworks other than the scientific one and has deference to experts as the conflict resolution mechanism.

An indication that funders from the EU seem to be becoming more sensitive to the demand for more citizen and stakeholder participation is the CIMULACT project ('Home – Cimulact' 2017), which is similar to the CIVISTI project but is more ambitious, aiming to draw input from 1000 citizens from 30 european countries in the formulation of desirable sustainable futures. The CIVISTI and CIMULACT projects, which are premissed on the notion of citizen guidance of science policy priority setting as opposed to strong 'tutoring' by scientists, have been carried out with significant success – however, of course, they remain strictly speaking one part of the consultation process for STI policy at EU level rather than the single comprehensive method for all stages of deciding research policy, from priority setting to funding and to the creation of the appropriate institutions and institutional frameworks for research governance.

EU Practice

In actual EU practice, things are significantly more complicated than what I have presented here, as other groups such as STI policy specialists, governance specialists representing the public interest as well as representatives of private interests play are all involved in the STI policy-making process under different capacities and in different degrees. Furthermore, the European Union institutions, such as the Commission (via tools such as the Open Method of Communication) are in constant negotiation on the question of how to balance in practice between expert and lay input on STI policy.

Conclusion

The fact that projects such as CIVISTI and CIMULACT are taken seriously be the EU shows that strict guidance from scientists is not necessary for priority-setting for STI policy. Such democratic approaches may even be necessary in the face of wicked problems that require mass significant lifestyle changes by the mass public. In the face of uncertainty, 'unknown unknowns' and global threats, epistemic diversity and encouragement of

active citizen participation and deliberation under conditions of substantial equality is an approach to policy-making worth encouraging rather than the reinforcement of hierarchies. This point ought also be taken into consideration by and inform STI practice, if it is to stay relevant to challenges both of a political and of a technical nature.

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4.4 Session 4.4

4.4.1 Policy learning in innovation policy: who is learning what, and how?

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Keywords: impact of innovation policy, dynamics of innovation systems, policy learning

Introduction

The past decades have seen significant progress in developing a conceptual understanding of the national system of innovation and how it works. At the same time, the systems have itself become more complex, with new policy instruments being introduced at an accelerating pace. Following these trends, we are witnessing an increased interest from both the academic and policy communities towards capturing the systemic effects that the different policies bring about. While first steps have been taken to propose frameworks for system evaluation (Arnold 2005, Edler et al 2008, Magro and Wilson 2011), we argue that the development of sophisticated instruments for system evaluation needs to be accompanied by research into how policy learning mechanisms work in complex innovation systems. More specifically, what are the policy makers learning through system evaluations and through which means do they do that? This research aims at addressing these issues by studying the cases of two EU member states, Denmark and Finland, providing an insight into the interplay between policy learning and policy making in these countries.

The originality and relevance of the proposal for the conference theme

By looking at policy learning in innovation policy, this project seeks to advance the existing knowledge in the field in order to provide a stronger ground for assessing the systemic effects of innovation policy. The project is original in two distinct ways: it provides an insight into the dynamics of learning in innovation policy and looks at the role of system evaluations in capturing the impact of innovation policies:

Firstly, is the first attempt to conceptualise policy learning in relation to system evaluations in innovation policy. While there have been previous attempts in placing policy learning in the context of innovation policy, none of them has specifically looked at learning on the system level. The previous examples of work on policy learning in innovation policy have concentrated either on institutional capacities affecting learning (Borras 2011), on transnational knowledge transfers (Malik and Cunningham 2006) or learning within and between innovation clusters (Nauwalers and Wintjes 2008). Policy learning has also been researched in the context of evaluations (Borras and Hojlund 2015), but no significant attempts have been made in the context of innovation policy evaluations.

Secondly, the project offers a novel approach to system evaluation by connecting it to the theoretical underpinnings of policy learning. While early attempts have been made in suggesting ways for evaluating the systemic effects of innovation policy (Arnold 2005, Edler et al 2008, Magro and Wilson 2011), these have not been guided by a specifc regard to policy learning in public policy. Therefore, improved insights into policy learning have the potential of creating a better understanding of the dynamics of innovation systems and thereby provide for the advancement of new methods and models for system evaluation.

Research aim and question

With this paper, I aim to explain how policy makers seek to develop a systemic understanding of innovation policy and what are the crucial factors shaping that process from a policy learning perspective. Based on this research objective, the general research question is established as follows: *who is learning what, and how in system evaluations of innovation policy?*

In answering the main question, I look at the following sub-questions:

- Who are the learners in the policy community, learning through system evaluations of innovation policy?
    - Who are the actors involved in the different phases of evaluations?
- What do governments learn when assessing their innovation systems?
    - How do governments define the objectives for learning about their innovation systems?
    - What are the goals set for system evaluations?
- How do governments learn about their innovation systems?
    - What are the methods/approaches used to achieve the defined objectives?
    - What are the factors contributing to the success of learning?
    - What are the organisational determinants of policy learning by system evaluations?

Theoretical and conceptual frameworks

The project is based on three conceptual frameworks: national system of innovation, system evaluation and policy learning.

Based on Nelson (1993), Freeman (1987) and Lundvall (1992), I define national system of innovation as the combination of public and private sector institutions, whose interactions provide for the innovative performance of companies related to a nation state. For the current research, this generic definition provides a useful framework of analysis, by allowing for a perspective on the role that the institutional set-up of a country's innovation policy plays vis-à-vis the productive sector.

In order to operationalise the sub-questions above, I define system evaluation as "an evaluation framework that assesses the innovation policies and institutional frameworks that are part and parcel of the innovation system in a way that provide an encompassing evaluative view of that system". In other words, system evaluations take a broad view of the object under assessment (the innovation system), in a way that takes into consideration individual policy programs, policy mixes and overall innovative performance. (Laatsit and Borrás, unpublished)

Based on the discussions by several authors (Sabatier 1993, Bennett and Howlett 1992, Sabatier and Jenkins-Smith 1999), I define policy learning as the alteration or change in the thinking or beliefs of actors in the policy setting, based on experience, information or knowledge and concerned with policy objectives.

Following the definition of policy learning outlined above, I will create a three-fold conceptual map of policy learning in order capture the overall strength/magnitude of policy learning in innovation policy in a specific country. The three dimensions (see also Table 1) of the map are derived from the definition outlined above, namely:

- Actors i.e. learners – involved in the preparation, execution and dissemination phases of innovation policy evaluation,
- Sense-making i.e. evaluation framework – understood as the process and setting for developing an understanding of the performance of the innovation system, e.g. through evaluations),
- Past-experience i.e. data – understood as availability and quality of data on the innovation performance of a country. In the case of innovation policy, this would mean data sources that serve as input to evaluations (i.e. evaluations).

Each of the dimensions will be given a scale in order to assign specific scores based on empirical findings. This will enable the creation of a conceptual framework for assessing the extent of policy learning in an innovation system.

Table 1. Three dimensions of policy learning

Concept	Dimensions	Definitions
Policy learning	Learners	Range of actors that learn in the process of and from the results of evaluations
	Evaluation framework	The breadth and sophistication of the evaluation framework for making sense of the performance of the innovation system
	Data	The availability and sophistication of the data on past experience, e.g. the innovation performance of a country

Empirical materials to be used

The paper relies on two sources of data: primary data from interviews with policy makers and secondary data from policy documents on innovation policy evaluations.

In order to collect the data on innovation system evaluations approximately 6-10 interviews will be carried out with policy makers and stakeholders in both countries selected for case studies (see below for case selection). Pilot interviews (six in total, three per country) have already been carried out with the heads of innovation policy and heads of policy analysis, the results of which have informed the current research design. The subsequent interviewees include senior officials and key stakeholders involved in policy planning and monitoring. The interviews will focus on one hand on exploring what information the policy makers deem necessary in order to understand the performance and effects of the innovation policy. On the other hand, I look at to what extent the existing evaluation practices provide for satisfying these information needs.

In order to validate the interview data, this study will also make use of secondary data sources. These include documents that provide information on the both the evaluation structures (evaluation frameworks, legal acts, regulations) as well as outputs – e.g. evaluation reports, evaluation protocols or policy documents providing insights into the national evaluation practices. To that end, data from the OECD Innovation Policy Platform and the SI-PER database will also be consulted and included in the analysis.

Furthermore, the paper is informed by data collected for a related project (Laatsit and Borras, unpublished) on system evaluation practices in EU member states. With more than 50 semi-structured interviews with policy-makers from the 28 EU member states, the dataset provides background information on the general evaluation practices as well as system evaluation of the selected countries.

Methodologies applied

I plan to use most similar systems design as the principal method to compare the two case studies of Denmark and Finland. Most similar systems would be suitable because both of the two countries are part of the 'Nordic' group of countries, sharing a somewhat similar thinking about innovation policy and have been exposed to EU and regional coordination efforts, peer-reviews, knowledge-sharing etc.. Furthermore, the countries are among the top innovation performers and have developed sophisticated innovation policy systems, coupled with advanced evaluation and monitoring systems. While being similar in the complexity and high performance of their innovation systems, our pilot interviews and background information reveals important differences in terms of policy evaluation and monitoring practices. Therefore, these cases provide interesting insights into how relatively similar foundations may produce different approaches to policy learning in terms of what is learned and how it is done.

Expected outcomes

The project has three principal outcomes:

Firstly, this study brings together literatures on policy learning and evaluation. This will enable to develop a clear and elaborated conceptual framework for advancing the models and methods for system evaluation.

Secondly, the project provides in-depth empirical evidence on a new phenomenon in policy evaluations – system evaluations – and demonstrates its implications for policy learning.

Thirdly, the research provides important implications for the design and re-design of innovation policies, by analysing how different types of system evaluation influence policy learning. It will thereby inform policy makers on developing better structures for assessing the performance of their innovation systems.

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4.4.2 Towards Responsible Research and Innovation Governance. The role of evaluation

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Governments across the globe strive for excellent science, a competitive industry and a better society. Furthermore, they allegedly seek to do so in a 'responsible' way, i.e. without compromising on sustainability goals or ethically acceptable and socially desirable conditions. However, what constitutes responsible is in fact contested, and the process by which responsibility is negotiated and institutionalized still needs to be governed appropriately.

As a result of an European project launched to develop a comprehensive governance framework for Responsible Research and Innovation (RRI) (www.res-agora.eu), a 'Responsibilty Navigator'© (RN) was conceived in 2016 as a set of ten RRI governance principles (Box 1) and illustrations designed to facilitate related debate, negotiation, learning and decision making in a constructive and productive way (Kuhlmann et al., 2015; Lindner et al., 2016).

The RN was built as an open, transparent, reflexive and adaptable tool to enable the inherent tensions in all governance of RRI to be actively addressed by procedural means aiming to facilitate constructive negotiations and deliberation between diverse actors (practitioners and strategic decision makers).

The RN was therefore born as a means to provide orientation without normatively steering Research and Innovation in a certain direction, and was conceived as a cognitive and normative guidance that is meant to be applied flexibly in different contexts, aiming at having direct impact on RRI practices (science, industry, policy), and strategic impact in terms of the political goals (Horizon 2020) and competitiveness (Lead Market through growing acceptance of new technologies).

In fact, inspired on Jessop's definition of ´governance' (Jessop, 2002), the RN relies on the reflexive, self-organised and collective nature of responsible research and innovation, where governance dynamics are shaped by specific instruments and arrangements, and where the design and operation of all instruments (even the formulation and operation of hard law) are in fact not a given, but actively constructed through processes of problem framing (appraisal), coordination and negotiation. In such context, what is judged 'responsible' and the ways to assess it is seen as part of these interactions, where the responsibility-related governance takes place in processes of sense- and decision-making in a collective way.

The target users for the proposed framework are then those who strive for a) leading research and innovation organizations and procedures towards more responsiveness and accountability; b) setting, defining policies, designing programmes and developing evaluation and assessment tools; and c) mediating between levels of the innovation system by bringing together different actors and different interests as well as defining the

practical implementation of governance instruments. Such actors typically work at research funding organizations, boards of universities or of companies, or at professional organizations, whereby these processes can be located within or between organisations.

Moreover, building on the collective nature of responsibility-oriented-governance and the challenges therein, the proposed framework is expected to also inspire institutional actors such as intergovernmental organisations, research performers, expert bodies and advocacy groups, particularly those operating at the analytical, the strategic or the procedural level, responsible for guidance, programming or performance of activities related to research and innovation.

But if such an effort is to make a difference, the resulting actor strategies have indeed to aim for effectively 'navigating' towards the intended cultural change transforming present day practices of research and innovation towards 'responsibilisation', in order to arrive at practices and directions that are widely accepted.

Given that there will always be multiple responsibility-related goals (from safety and sustainability to inclusiveness and responsiveness) as well as different instruments to promote it (from professional training and education, design principles, stakeholder and public dialogue to regulation by voluntary codes as well as hard law), the RN aims at facilitating strategic reflection and continuous formative evaluations to understand how instruments interact and play out at different levels and contexts and to what extent goals are ultimately achieved.

How such processes are to be assessed conceptually and in practice is an open question. What indicators would be needed to monitor and account for 'progress' or 'bottlenecks' in the intended direction (governance towards RRI)? These are some of the new set of questions we would like to address in this paper, where a set of assumptions and propositions are to be tested in a participatory way in the corresponding Eu-Spri conference track to assess their plausibility.

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4.5 Session 4.5

4.5.1 Less Government for Social Innovation: Governance of "Laissez Fair" the case study of “Quartieri Spagnoli”, Naples

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Introduction

Over the past three decades, the main innovations introduced in and for the society are characterized by a strong spatial component, especially in the more industrialized regions of the European Union. Public or private space, especially the urban one, has become the privileged scenario for public, private and civil society actors, aiming to demonstrate to the society their commitment to embrace great contemporary challenges. The schumpeterian creative input is manifested by in a transformation (where the creative work lies) of a space such as a buildings, lands, squares, abandoned buildings or “urban voids”[27]. To investigate the reasons why socially innovative ecosystems are often characterized by a spatial reference, one must focus, on one side, at the need of the State to: recover and value disassembled assets, preside over the territory and intervene to limit land misuse; on the other, to the civil society increased demand for participation.

Both social innovation and urban regeneration are concepts characterized by a dynamic component, since both relate to a mental process[28] of change recognition relative to to an initial time zero ($t_{\circ}$) and a time x (T_x).Moulaert et al. (2013) noted: “Socially innovative actions, strategies, practices and processes arise whenever problems of poverty, exclusion, segregation and deprivation or opportunities for improving living conditions cannot find satisfactory solutions in the “institutionalized field” of public or private action”[29]. These actions, strategies, practices and processes are linked to the widespread necessity to tangibly establish the occurrence of certain types of social change, at least that any sort of change. The most basic form of perception of “change” is the ability to recognize space transformation. Public policies, that activate socially innovative processes, often present the concept of space as a container for innovative initiatives and interventions. The literature on social innovation as suggested by Nicholls, Simon and Gabriel (2015)[30] can be represented by five main topics: research design challenge, change in social structure, change in pattern of work, diffusion of social change and urban studies (the latter being our subject of interest). In this regard, Moulaert et al. in 2007[31] described social innovation as "a polymorphic constellation of counter-hegemonic movements and initiatives" that initiate social change processes.

[27] Maria Pia Belski, con la collaborazione di Giovanni Fonti, Periferia come centro, Apollo e Dioniso, Rozzano, 2001

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Methodology

We will use the open data of the Agenzia del Demanio's database to provide a general view of the recovery practices of public goods activated by the Italian State, demonstrating evidence on the will of public actors to propose innovative uses of existing resources. However, we will focus on a case study that does not fall into those described by the Open Demanio database, in order to introduce a discussion on the many cases that respond to the same need to recover, value and respond innovatively to new needs, including new actors such as private actors and Third Sector. The case study relates to the Fondazione Foqus, which operates in the Spanish Quarter in the Municipality of Naples in 2014. The Foundation, which runs the Montecalvario Institute (originally owned by a religious order, then by the Italian State and finally acquired by private individuals and returned to the original religious order), performs social activities on a stable basis 3 years.

The method used for case analysis is descriptive and, by using a historical-evolutionary approach, we will investigate the transformation of the role of the local government over the last 30 years, in order to understand how today's innovative ecosystems are inclusive of public inputs and the preconditions for their existence.

Open Demanio is the Data Base owned by the Agency of the Demanio, a state agency responsible for the management, rationalization and enhancement of the state real estate assets. The need for open format database relates with the problem of non-use and therefore the deterioration of public buildings, that are consequenty mapped and then re-used and recovered in synergy with the Institutions and territorial institution. By maximizing the economic value of goods (e.g. through energy efficiency) the Agency not only intervenes on reducing public costs, but also contributes to the development of the economic, social and cultural capital of Italy[32]. The database updated in March 2017 maps 323 initiatives on the territory covering 110 Italian municipalities. Of these, 44.9% are expressions of inter-institutional collaboration with the transfer of ownership of public spaces (intended in a broad sense) by more public entities than the sub-ordinated ones through the "transfering" tool.

In the Campania Region, the database tracks 27 practices of transferring property from the State to Territorial Entities:

- No. 17 initiatives for the transfer, free of charge, of real estate to territorial authorities for the development of a program of cultural enhancement;
- No. 3 Operations aimed at the development and safeguard of the territory, by conceding the property for tourist-receptive and socio-cultural purposes;
- No. 7 Initiatives aimed at the valorization and re-naturalization of public property;

The mapped initiatives do not, however, cover all the sales practices (which also develop in the long run) of the share of public property to private individuals.This is very often a practice in which private investors inspired by philanthropic feelings aim to the conservation of “Common goods” or animated by the improper need to heal part of the social fabric where public actors fail, commit themselves to using discarded public spaces to launch new practices of social innovation and urban regeneration. In Campania, southern Italy, there are many more cases that, like those identified by Open Demanio, are characterized by the same logic as finding solutions to unfulfilled needs and using existing resources.

[32] http://dati.agenziademanio.it/#/portale/chisiamo

The case study

The case study is located in the Spanish Quarter, area of the city of Naples existing since 1536, used to host the troops of Spanish army, ready to quell popular riotsin the city. for the main purpose of our research is is exploring this case study since it appears to be emblematic under different point of view of current debate about "Governance without Government". One example is the apparentlack of state intervention and the "Laissez Fair" rule of the State towards private actors, especially the business world and the Banking Foundations, which in turn subcontract services to non-profit organizations, in particular, to social enterprises. The main question is how a socially innovative ecosystem would do without the State and its policies. The discussion will start by observing the projecton a intervention aimed to solving a collective problem, such as the case Montecalvario of Foqus Foundation that is a private initiative, although contextualized in a "constructed" environment by public policies, some weak, some more incisive, activated since the 1980s. If we wanted to identify the boundaries of the policy arena thatinsisted on Spanish Quarter to date, we would find ourselves into an intricate net of interventions at multiple levels, that involve sectors developed over several years. However, we can clearlyidentify three significant moments, all starting from from a set of public programs, plans and interventions (such as the opening of a subway station in Toledo Street, zoning market interventions, road and building security enforcement through urban plans etc.); followed by a phase characterized by a strong civic protagonism together with the rise of the private sector, which in a relationship of over-regulation with the private social, invests resources, not only of economic nature, in top social-value planss.

The first phase, called the activation of the essential conditions for the construction of innovative ecosystems, involves, within our case study, the Government as the main actor at all levels (European, national, regional and local). This is a historical episode that goes back to the 80's, when, after a earthquake, reconstruction policies, that lasted a decade, took placefor various buildings in the interested area, by means of city planning strategies.

At this stage, different actors showed more interest than the State, with initiative of the "Kingdom of the Possible" (due to the Banco di Napoli and the local entrepreneurial world leaders) and "Neonapoli"[33]. These experiences, mainly of study, aimed tothe relaunch of the neighbourhood, and at the end of the 1980s, contributed in sheding light towardsa renewed perspective. The advent of the 1990s led, as in the rest of the country, to the overthrow of the pre-established order, through the implications of judicial investigationson exponents of entrepreneurship and local political elite. If the urban transformation practices were micro-sized and often illegal from the 1990s onwards, a new approach, based on the reclamation practices of neighborhoods developing in the rest of Europe, that combined interventions of both urban and social type[34], was introduced.

The second phase, focused on the Government's assessmentof new types of legitimization of interventions, was based on a close alliance with the Third Sector Entities. Contrarywise to the rest of the country, that at that time saw policies as a project engine, the city of Naples experienced an inverse process, where the projects from the bottom urged the policies[35]. In the mid-1990s, in 1996, with a process of protagonism from the bottom (headed by the Spanish Quarterly Association), the City choose the Spanish Quarter as the dedicated area where the Urban program was going to be implemented. The two isntitutions that laid the foundations for the actual model of suburban government were on the

[33] Initiative of Minister Pomicino.

[34] Laino, Giovanni. "Il cantiere dei quartieri spagnoli di Napoli." *Territorio* 19 (2001): 25-31.c

[35] ibidem

one hand, the Pic Urban of Naples for the urban entity, and on the other hand, the European Social Fund, employed mainly for educational-educational interventions.

In the third phase, that includes present days, the combination of urban planning (regeneration) and social interventions has become a mainstream. This last phase, as Laino[36] states, was also characterized by a new service reform (L. 328/2000) which, combined with various innovations, introduced at a local level (e.g. the set of call fortraining of "street teachers", for Nurseries, for improvement of urban decor and public lighting and for support to local theatres) were the basis for the actual phase, characterized by a more moderated form of Government in the suburbs. It was noticed an important advancement governance stategy focused on direct, not just locally-based, investment in entrepreneurship (which is configured with non-profit forms closer to the market[37] such as the Foundations) in urban and social regeneration projects by delegatingto private sector to directly manage the services.

Results and conclusion

The case of the Spanish Quarters is emblematic because it clearly represents the current local Governance model, where the regenerated spaces promote innovation, tangible through material transformation. The innovative ecosystem is triggered by public policies that are rooted in the last thirty years, in which the main players providing public services are private entrepreneurs combining partnerships into associative forms, (they are part of the network: Ferrarelle Spa. Carpisa, Yamamay, etc.), in which the operating arm is the Third sector with its social enterprises and its co-operatives. The network of actors reconfigured. On a micro level, the Foundation is the guarantor of the provision of schooling, cultural and social services (currently, the entire educational district in the Spanish neighborhoods has been rebuilt from the nursery school to the University of the Third Age), of the selection of subjects of the private social to be involved, of the management of the spaces, almost with the same roles as the State. Meantime, the Third Sector supplies the services materially, maintaining the business risk and benefiting from the possibility of working in an area where it was unthinkable before to employ their own workforce. The Foqus Foundation directly collects the school fees from the families (thus finding their own resources for the market) and pays a fee for the use of the structure of the Montecalvario Institute. The agency's relationship to educational services comes out with the City of Naples, the holder of education policies and municipal child care, and within the scope of this report, the reserve of seats in the classrooms at reduced prices for those who are resident in the Spanish quarters[38]. The agency report is for other segments of activity, such as the "semiconviction" with the "main" Banco di Napoli Foundation for Child Care[39]. Starting from local governance studies, we can say that network configurations are significantly influencing innovative ecosystems. The social innovation of this case study seems to be of two types: innovation of process, considering the significant improvement in the production and delivery of services; but also organizational innovative since people manage and share resources differently from the past.

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38 Progetto Nuval "Azioni di sostegno alle attività del Sistema Nazionale di Valutazione e dei Nuclei di Valutazione" Progetto pilota di valutazione locale REVES. Studio di caso Quartieri Spagnoli. 22 Dicembre, 2016

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http://dati.agenziademanio.it/#/portale/chisiamo

5 Track 5: Inclusive Innovation and the Challenges for STI-Policy

Track 5 was organized by Barbara Ribeiro, Manchester Institute of Innovation Research, Alliance Manchester Business School, Philip Shapira, Manchester Institute of Innovation Research, Alliance Manchester Business School/School of Public Policy, Georgia Institute of Technology, Abdullah Gok, Manchester Institute of Innovation Research, Alliance Manchester Business School, Joanna Chataway, Science Policy Research Unit (SPRU), School of Business, Management and Economics, University of Sussex, and Robert Meckin, University of Manchester, and included three Sessions.

Inclusive innovation suggests that science, technology and innovation should not only be aligned to economic needs but should also reflect societal concerns and address the needs of the poorest and more vulnerable part of the population. Ideas related to inclusive innovation can be traced back to Robert Owen's small-scale mills in England in the early 1800's, and Gandhi's philosophy from the early 1900's, which influenced the work of the economist Fritz Schumacher on appropriate technologies in the 70's (Chataway et al. 2014). Although distant in time, these critical ideas remind us that technological development raises longstanding problems of social inequality related to the production and use of artefacts. A well-known global challenge, social inequality has been rising within European countries as well as in the US, and should no longer be considered exclusive to less economically developed countries from the global South. However, despite its relevance to research policy and evaluation, inclusive innovation is still a largely overlooked concept in the innovation studies literature (Foster and Heeks 2013).

Inclusive innovation could complement responsible research and innovation (RRI) frameworks as a parallel approach that brings on board a fundamental and missing discussion on social equity in the governance of emerging technologies. One of the few contemporary scholars exploring the notion of inclusive innovation applied to the case of emerging technologies is Doris Schroeder, who has argued that inclusive innovation may work as a bridging concept between system innovation approaches (as non-normative, descriptive) and RRI (as a normative concept) (Schroeder et al. 2016). Despite its inherent challenges, inclusive innovation could work as a tool for social development, where the notion of social justice is a central piece of the innovation process (Smith et al. 2013). Through engaging a broader range of people, concerns and values, collaborative learning and co-production processes are fundamental in achieving this (see Vooberg et al. 2015 for a review).

The question of whose and what values are accounted for in the development of science and technology and their social appraisal (Sarewitz 2016) requires a focus on equity and understandings of societal needs (Grimshaw et al. 2011). Through the lens of inclusive innovation, looking at emerging technologies in the fields of, for example, synthetic biology and nanotechnology, one would ask a) how societal needs, benefits and potential negative impacts of these technologies are defined and by whom and b) how benefits and trade-offs are likely to be socially distributed (regionally, nationally and/or internationally). These questions complement and expand the more typical economic approaches to the analysis of the societal benefits of technology and innovation.

In this session we are interested in unpacking the concept of inclusive innovation and using it as lens to analyse emerging technologies. By doing so, we would like to encourage broadening the scope of both inclusive innovation and RRI, moving beyond their internal debates, and favouring a global outlook. We seek reflection on how inclusive innovation could make a positive contribution to the development of emerging technologies and what challenges the operationalization of inclusive innovation might pose to science, technology and innovation policy. We would like to invite theoretical and empirical contributions that engage either directly or indirectly with the concept of inclusive innovation, both in the

European and/or international contexts. The following questions include some of the aspects we would like to explore during the session and to reflect on after the conference to inform a discussion piece (paper proposals do not necessarily need to be limited to them):

- What are the different understandings of the notion of "inclusiveness" being mobilised in innovation in emerging technologies, especially in the case of synthetic biology, nanotechnology, and next generation manufacturing?
- How has inclusive innovation been articulated in the context of emerging economies by multilateral organisations such as the UN, World Bank and OECD?
- What are the main concepts behind inclusive innovation in academic and policy circles?
- How can inclusive innovation be operationalized? Which tools can be useful and what are the criteria that can be used when assessing emerging technologies?
- What are the differences between inclusive innovation being articulated in the case of technological innovation and of other forms of innovation, such as social innovation and grassroots innovation?
- How co-production/co-creation is understood within the context of inclusive innovation?
- How can inclusive innovation be addressed in innovation governance and science, technology and innovation policy and what are the challenges to this?

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5.1 Session 5.1

5.1.1 Private and public values in emerging science and technology: an analysis of patents in synthetic biology

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Introduction

Research and innovation are increasingly expected to provide solutions to societal grand challenges (Stilgoe et al. 2013; Ribeiro et al. 2017). Yet, scepticism is raised about the benefits and social accountability of science and technology (Hessels and van Lente 2008; Tyfield 2012). Emerging technologies are reproached for not delivering on promises (Hopkins et al. 2007; Gittelman 2016; Wiek et al. 2016), while research and innovation increasingly use notions of societal needs, challenges, and public benefit as value propositions to justify public sponsorship (Youtie and Shapira, 2016). At the same time, universities, other public bodies, and the private sector actively seek property rights over potential applications through patenting. Patents represent an economic claim to garner returns from the novel outcomes of science and technology. They also embody claims related to social value by encouraging information sharing, further R&D investment, and the useful application of new knowledge (Machlup 1958).

Box 1: Defining public and private values in patents

Private value	Public value
The private value derives from capitalizing the stream of direct economic returns gained from the exclusivity (and associated use, sale or licensing) rights granted to inventions. Its evaluation is based on the analysis of several factors considered to influence the market value of patents (which, ultimately, determines the financial returns from the protected inventions). Ostensibly, the economic 'success' of a patent depends on a series of technical aspects such as the patents' lifetime, breadth, inventive activity, disclosure and the difficulty of inventing around it. There are also other aspects that influence the private value of an invention, such as market and industrial opportunities.	The public value of patents reflects their contribution to society as an extended 'measure' of the value of inventions. This 'measure' goes beyond their private value to inventors and assignees and does not take at face value the generation of benefits to society from incentivising innovation and markets alone. In patent applications, the public value of an invention is alluded to and represented by claims around the social utility of that invention. Articulations of public value in terms of statements about the potential social benefits of an invention can be found in different sections within the full-text of patent application documents and could be broader in scope than the technical claims linked to private value.

Source: Authors' analysis

The "value" of patenting has generated longstanding academic interest in innovation economics and policy with many scholars investigating its determinants based on econometric models (Bessen 2009; Suzuki 2011). The existing research has largely focused on evaluating factors that influence the market value of patents and the gains from exclusivity rights granted to inventions, which reflect the private value of a patent (Gronqvist 2009). Yet, the patent system is a socially shaped enterprise where private and public concerns intersect (Sunder Rajan 2012); less attention has been paid to other interpretations of patent value than narrow economic value to the inventor and owner (Calvert 2004).

This paper explores the meaning and significance of value propositions embedded in patent documents at the nexus of economic interests, societal needs, stakeholder interests, and strategic behaviour. In particular, we probe how societal needs are deployed as value propositions to rationalise innovations through a pilot study of synthetic biology patents. Synthetic biology is an emerging domain that is justified by expectations that it will contribute to a range of societal needs including environmental protection, reduced or higher value use of non-renewable natural resources, enhanced human welfare, and economic development (Shapira et al., 2017). Our analysis probes the private and public value propositions that are framed in these patents and their value translations in terms of the potential private and public benefits of research and innovation. Based on this framework, we shed light on questions of what values are being nurtured in inventions in synthetic biology, what publics are included and excluded as the potential beneficiaries of these inventions, and how private and public values intersect in this emerging area.

Mapping the private and public values of patents

The private value of patents, based on the capitalization of the stream of economic returns expected from an invention, is at times also seen as a proxy for social value. This is based on the idea that the "generation of economic benefits" is in itself a type of social value and that broader public benefits are automatically translated from an ever-growing marketplace. However, there are challenges to the assumption that private market economies unquestionably drive social welfare (Meckstroth 2000; Freeman 2010). Whereas many forms of value from patents can be social, some translate into more exclusive benefits than others. We thus seek to differentiate private patents benefits from public ones (Box 1), noting that any patent may have a mix of different types of benefits (with some having no obvious benefits except perhaps in terms of inventor self-worth). The private value of patents relates to its technical features, impact, and strategic competitive utility. Reitzig (2003) understands the technical 'importance' of patents in terms of their novelty and impact on inventive activity. Other aspects of the technical value that influence the private value of patents explored by Reitzig (2003) includes stakeholders' perception on

the difficulty to invent around, that is, the degree to which the design of a patent prevents others from inventing similar products; learning value through disclosure, that is, how advantageous might be competitors to learn about the specific aspects of your invention and research; portfolio position, in relation to how the patent might serve as basis to other patents and the difficulty of proving infringement of a patent.

The public dimension of patents has also long been scrutinized, arguably since governments around the world started to implement and regulate patent systems. In the early 18th century, Thomas Jefferson, the first patent examiner of the US patent system, voiced concerns over the power of monopolies and how they could be detrimental to society, producing "more embarrassment than advantage" (Jasanoff 2016: 183). In Germany and France, compulsory licensing laws were passed in the early decades of the 20th century to protect the "public interest". This was fuelled by concerns over the accessibility to basic goods enjoying private protection, such as technologies and pharmaceuticals needed in war times, which motivated public interest and public policy clauses in patent law (Parthasarathy 2017). Yet, in relation to the public value of inventions, the role of governments in patents governing has been mostly reactive. Although debates have been theorised on broad ethical grounds, they have been limited by a focus on preventing public harm and avoiding value conflicts. This has outweighed critical analyses of the role of innovation in promoting public benefits, their alignment to social needs and the distribution of such benefits in the case of patents. Such a broadened scope of analysis is the basis of our definition of the public value of patents, that is, the intended contribution of patents to society as an extended measure of the value of inventions that goes beyond their private value to inventors and that does not take at face value the generation of benefits to society from incentivising innovation and markets alone. In patent applications, the public value of an invention is alluded to and represented by claims around the social utility of that invention.

Research approach and initial coding

We pursue a qualitative full-text analysis of patent documents. This is a pilot study to inform a future machine-based analysis of a larger number of patents in the field of synthetic biology and biotechnology. For the present study, we draw on patents in synthethic biology as identified by Kwon et al. (2016). Our sample comprises 34 US synthetic biology patent documents published in 2013. For each of these patents documents, full text was downloaded from the Patent Lens database. NVivo 11 was used as support software for qualitative content analysis. We focused on articulations of the private and public value of the inventions, reflected in claims made in the documents. Such claims provide a narrative about the objectives and expectations related to developments in synthetic biology. We also examined problem framing behind inventions and a series of characteristics which help contextualize the invention such as public funding disclosure, geographical location of inventors and assignees, and type of invention.

A two-stage coding process is undertaken (see Hsieh and Shannon 2005). The first stage is based on a framework developed by the authors that differentiates between three tentative dimensions of value in patenting and patent documents: value orientations (VO), value propositions (VP) and value translations (VT). VO corresponds to the different motivations behind patenting as a social activity, that is, the rationales of inventors that guide patenting. These rationales can be shaped by the different values of individual actors or those embedded in private enterprises and public institutions. VPs are written articulations of the embedded values of inventions as reflected in the actual content of patent applications, including any related documents within a patent family. Both private and public values can therefore be identified in articulations of desirable states toward which 'progress' can be assessed or through the interpretation of such articulations. In patent documents, these articulations reflect desired/intended, but not necessarily realisable, goals. Finally, VT can be understood in terms of the potential impacts of private and public value propositions in terms of the generation of private and public benefits. This translation is certainly not automatic and depends on social and political factors. VO and VT are therefore more 'interpretive' categories, whereas VP tends to be more directly connected to the

actual claims made in the text of patent applications. The second and final stage of the coding process was more inductive aimed at refining these categories and differentiating between different types of private and public VPs in order to support the development of the initial typology. A snapshot of the key values identified in documents analysed is provided in Figure 1.

Figure 1: Pilot coding of public and private values in patents

Private values	Documents	Public values	Documents
Technical and scientific advancements	23	Energy alternatives (renewables)	16
Market and industrial opportunities	21	Human health and safety	12
Production of Intermediate and consumer goods	19	Environmental sustainability	10
Improved cost efficiency	17	Alternative materials and pathways (non-energy)	5
Increasing production	13	Animal (non-human) health improvements	1

Source: Based on NVivo analysis of USPTO synthethic biology patent documents published in 2013 (N=34). Note that the same document may be coded at multiple nodes.

Observations and Next Steps

The typology of private and public values put forward by the present study will be enhanced by employing rule based and machine learning approaches in a subsequent text mining study, using a larger patent set. We continue to work on refining the typology of private values and public values.

Reflection on the values embedded in innovative technologies is a key step in the evaluation of research and in the anticipation of potential positive and negative impacts of science and technology. Most importantly, shedding light on these values can be helpful in understanding what are the directions being taken by translational research in a given field and how we might shape (and ultimately align) innovation to the needs of broader publics. Especially when combined with deliberation activities, we believe that the framework and approach outlined in this paper can be developed as a supporting tool for RRI and inclusive innovation programmes, as well as for deliberation and decision-making in science and technology policy.

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5.1.2 Entry Points for Responsible Research and Innovation – A Case Study of Small and Medium-Sized Austrian Medical Device Enterprises

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Introduction

Research and innovation have become key drivers in Europe's quest for economic and social prosperity. With the ambition to support "'the best science for the world' and not just 'the best science in the world'" (as cited in Owen et al. 2012: 753), the European Commission has been investing billions of Euros in research and innovation activities that not only aim at advancing scientific knowledge and increasing Europe's competitiveness but also at triggering societal benefits. The current European Framework Programme for Research and Innovation ("Horizon 2020") promotes "Responsible Research and Innovation" (RRI) to find sustainable research and innovation solutions for societal challenges. According to the European Commission (2012), "Responsible Research and Innovation means that societal actors work together during the whole research and innovation process in order to better align both the process and its outcomes, with the values, needs and expectations of European society."

RRI has gained visibility as a distinct research area. This is mirrored, for instance, in the foundation of the Journal of Responsible Innovation and an upcoming special issue of Sustainability on "RRI in Industry". The scientific discourse on RRI takes place in a few specialized fields of research and policymaking, addressing scientific debates on ethics (Davis and Laas 2014, Schröder and Ladikas 2015), emerging technologies (Stilgoe et al. 2013, Stahl et al. 2014), research and innovation governance (Fisher and Rip 2013, Stahl 2013), and sustainability innovation (Schaltegger and Wagner 2011; Boons and Lüdeke-Freund 2013). Businesses, however, have neither been involved in these discussions nor in the active perpetration of the concept. Consequently, evidence on how research and innovation is realized "under the terms of RRI" is rare (cf. Kahn et al. 2016: 78), and knowledge on how to foster the implementation of RRI in businesses is limited.

The purpose of this study is to extend the body of knowledge on RRI implementation in a business context by identifying entry points for RRI in Small and Medium-Sized Enterprises (SMEs) in the Austrian Medical Devices sector. The sector has been associated with a large quantity of innovations with the potential for the advancement of human health, well-being, and increase in life expectancy (Jennett 1986, Pickstone 1992, OECD 2008). Findings should help scholars and policy-makers to further develop ways of integrating the principles of RRI in business practice.

Research aim of the paper

While the roots of RRI can be traced back to the early 1990s (cf. Owen et al. 2012), the concept has gained particular visibility in European policy-making and research communities in course of the past few years. The first working definition of RRI was proposed by von Schomberg (2011); followed by discussion on implications and practical value. While the discussion about terminologies and definitions is still ongoing, there is an emerging general agreement about the meaning and key elements of RRI (cf. European Commission 2013, Stahl 2013, Stilgoe et al. 2013). At the same time, there is still little evidence on how RRI should be put into practice (cf. Davis and Horst 2015, Blok and Lemmens

2015, Kahn et al. 2016). The debate is currently lacking insights into business reasons for implementation (including expected value-added for business) as well as into entry points for supporting implementation. The aim of this paper is to identify such entry points for RRI in business by means of analyzing the factors that influence innovative behavior in SMEs.

In our analysis we draw upon previous literature studying personal, organizational and external characteristics (incl. e.g. Galende and de la Fuente 2003, Romero and Martínez-Román 2012, Halme and Korpela 2014) influencing innovative behavior in businesses. Dosi (1988: 1121) already distinguishes between general characteristics of innovation processes, on the one hand, and factors that account for "differences in the modes of innovative search and in the rates of innovation between different sectors and firms and over time", on the other. We focus on characteristics of SMEs (including start-ups) and their specific capabilities and resources and dependencies, and institutionalization of research and innovation processes.

Methodological approach

We apply a qualitative case study methodology to explore potential entry points for RRI in a specific contextual setting. Our analytical framework is based on previous work on determinants of innovation in SMEs and entry points for RRI in industry. Regulations and standards in the Austrian Medical Devices industry are analyzed as contextual factors. Primary information is gathered in 15 semi-structured expert interviews with CEOs/founders. The focus on one specific sector, namely the Medical Devices industry, allows taking industry-specific external factors into account (e.g. regulations and funding schemes). The focus on Austrian SMEs (i.e. SMEs based in Austria) increases stability of the contextual setting.

A range of complementary strategies are applied in the search for potential interview partners in order to develop a most complete sample. This includes directed searches via classified directories and clusters, incubators and accelerators, conference speakers and participants, innovation award winners as well as undirected keyword searches with different search engines. Potential interview partners (companies or individuals) are prioritized according to their research activities and innovation output. Interviews are conducted face-to-face or and via telephone. They address general company characteristics (including history, structure and goals), research and innovation processes and practices (including models, regulations, drivers and external cooperation) and the different RRI elements. Information is analyzed by means of qualitative content analysis based on Mayring (2008).

Outlook on findings and conclusions

Initial findings highlight the following factors as determinants of RRI in our case study: While sophisticated innovation management models are rare, company cultures value innovation and intrinsic motivation to become responsible towards society via company activities (including research and innovation) is high. This is mirrored in high awareness about many of the elements that make up RRI, partial implementation in company conduct and willingness to reflect on potential consequences of their research and innovation. The interviewed companies rely heavily on their networks and on innovation support organizations: They take advantage of (mostly national) public funding programs, make use of training and coaching opportunities and cooperate closely with scientific third parties.

Based on these initial findings, conclusions regarding implications for research and innovation policy-making will likely address the following four entry points: Culture, networks and hubs, financing bodies and trainings, and industry-specific regulations. When intrinsic motivation is already high, support for RRI will likely generate more satisfactory results than increasing regulation. Based on initial findings, interviewed SMEs would benefit from

an overall scheme to promote innovation management (including RRI), knowledge exchange and development of strategic alliances along the value chain.

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5.1.3 Innovation meets sustainable development: A framework for engaged, responsible, and inclusive research

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Keywords: Sustainable development, transdisciplinarity, equity, inclusive Innovation, multi-stakeholder processes

Introduction

Inclusive innovation is on the upswing, not only in innovation studies (Fagerberg et al, 2013) but also in both the theory and the practice of poverty- and equity-focused international development cooperation. In STI Policy, inclusive innovation generally means to address not only economic needs but to achieve profitable growth benefiting also the poor. However, unorthodox scholars have observed a very limited interpretation of inclusion, upholding a biased relationship between active innovators and passive beneficiaries. They further have observed a narrow exploitive and often destructive use of innovation (Benneworth et al, 2015; Ott, 2017). Inclusive innovation then insufficient for countering the development and climate crisis of the Anthropocene, and must be reconsidered in the quest for future STI policy.

Inclusive innovation in international development cooperation has a more fundamental meaning as it calls for equity-based relationships between citizens and science, decision-makers and stakeholders in the generation of knowledge. This has recently been confirmed in the global 2030 Agenda for Sustainable Development, in which global leaders recommit all members of society to join forces in organizing a sustainability transformation (UN, 2015). This Agenda's 17 Sustainable Development Goals (SDGs) are instrumental in implementing and monitoring the transformation of all societal subsystems and achieving a sustainability transformation of the global system. Although innovation is mentioned quite prominently (in SDG 9), innovation concepts have only recently entered international development cooperation thinking and practice, for example in formal R&D programmes. Concepts of inclusion, by contrast, have a much longer tradition in international development cooperation, e.g. participation is an old and fundamental inclusive concept. However, as the ongoing debate illustrates, there is still a lack of more equity-based interaction with stakeholders in development interventions.

Since the turn of the millennium, proponents of sustainable development – especially those coming from the humanities and social sciences – have thus reconsidered such concepts of inclusion and innovation. In sustainability science, which relies substantially on transdisciplinary methodologies, they developed a wealth of conceptual and practical knowledge about equity-based science–society interaction and stakeholder inclusion in development interventions (Patterson et al, 2015). This has brought fundamental progress in the work of development actors seeking to reduce poverty and increase sustainability. Nevertheless, in development practice and debate, inclusion and innovation have reached buzzword status. Unfortunately, omnipresence, and arbitrary and vague usage are common characteristics of originally promising concepts in the field of science, technology and development – not to forget the Rio concept of sustainable development itself. To overcome the resulting inefficiency in development practice and unlock the concepts' transformative potential, clarification is necessary.

In search for common ground

In this conceptual paper, I argue that ongoing changes in theory and practice for sustainable development are highly promising for the future of science, technology development, and innovation (STI) policy, too. Especially, guided by the sustainability paradigm, an

emerging sustainability science has developed transdisciplinary concepts and research and innovation practices, which offer ways out of the current widespread confusion, arbitrariness and ineffectiveness in mission-oriented development cooperation and innovation policy. To support this argument, I explore the normative content of inclusive innovation under the paradigm of sustainable development and its consequences for and achievements in the organization of equity-based science–society interaction. Sustainability theory and transdisciplinary practice – especially in global environmental assessments and in long-term North–South research partnerships of the Centre for Development and Environment, University of Bern, Switzerland inform my analysis. As a result, I frame sustainable development as a radically emancipatory concept (Ott and Kiteme, 2016). The rationale behind it is the following: The complexity and uncertainty characterizing the development and climate crises as well as the necessary future-forming processes (Gergen, 2014) require that appropriate responses integrate not only facts, but also values (Schroeder et al, 2016). Consequently, knowledge and innovation for sustainable development are necessarily an outcome of deliberative democratic processes and joint learning among diverse actors with different knowledge and value systems and diverse understandings of development, or innovation (Dryzek and Stevenson, 2011; Ott, 2017).

This emancipatory construction of sustainable development fundamentally effects the conceptualisation of inclusive innovation. It can provide guidance for STI policy on how to expand its epistemological base and to align with the 2030 Agenda and its 17 SDGs and with other development communities in addressing global challenges of the Anthropocene. Based on this background, I propose a three-fold innovation framework for sustainable development. It covers and integrates three major co-existing innovation paradigms, which interfere with each other and create tensions between development actors. Nevertheless, they are all fundamental in a concerted development approach. Consequently, the organization of engaged, responsible, and inclusive research and innovation processes is central to equity-based science-society interaction for sustainable development.

Innovation at the science-society interface

The organization of transdisciplinary research is per se experimental, and the science–society interaction is affected by self-interests, conflicts, competition, misunderstandings, and inefficiency. My analysis shows that in practice, the organization of inclusive processes between actors with different institutional backgrounds, worldviews, and levels of economic and social power lacks adequate support and conceptual underpinning. Standard planning and budgetary frameworks do certainly not favour it. This is highly problematic in global environmental assessments or in a North–South research context, which are both characterized by multifaceted issues of inequity and disparity. Nonetheless, there are opportunities – and an urgent need – for improvement. I argue that detecting the different actors' understanding of development and innovation along with their specific reference systems is a key issue in knowledge production at the science-society interface. In addition, the integration of diverse actors and concepts into co-production of knowledge and innovation under the frame of sustainable development is mandatory. My analysis lets me distinguish three major conceptual approaches to inclusive innovation in international development cooperation:

(1) A first, most conventional innovation paradigm takes science as frame of reference. Inclusive innovation in such a context consists of scientific and technological achievements that eventually reach and benefit the poor (directly or indirectly). The intense development discourse on science–society interaction, at times, may mask the dominance of this innovation paradigm – and, with it, the monopoly of Northern science and technology as well as a profound trust in economic growth and business model innovation (Foster and Heeks, 2013). Although the role of science in creating today's development and climate crisis is widely acknowledged, the expectation (or hope?) that scientists and researchers are capable of providing and transferring the 'right' knowledge and solutions to decision-makers is widespread throughout both the scientific community and society at large. Most importantly, scientism and technocentrism are deeply ingrained in institutions and standard procedures, including evaluation systems. Scientists are perceived – and

are trained to perceive themselves – as value-free fact producers. It is undisputed that disciplinary and technological progress has a crucial role to play in poverty eradication; but this role is insufficient where normative decisions have to be taken on issues that affect us all (Sarewitz, 2015; Schroeder et al, 2016). Nonetheless, the increasing commodification of research, growing pressure to prove its impact, efficiency, and social relevance, and the urgency of global problems are again strengthening the dominance of this conventional innovation paradigm (Warren and Garthwaite, 2015).

(2) The second innovation paradigm centres around interaction between science and society. In the context of this paradigm, inclusive innovation means developing better solutions by combining facts (non-normative knowledge) and values (normative knowledge) in multi-stakeholder processes. Born in the spirit of the 1980s, this innovation paradigm holds that scientists and civil society must communicate to improve the efficiency and effectiveness of development measures, enable evidence-based decision-making, and ensure ethically sound application of knowledge. At first glance, such collaboration between science and society is broadly accepted. It is at the top of the development agenda, and most development actors and institutions – and generally also the innovation community – refer to it when addressing today's grand/global challenges (Kallerud et al, 2013; Benneworth et al, 2015). Promising ways of tackling obstacles and trade-offs at the interfaces between science, society, and policymaking are well-described (van den Hove, 2007; Wiesmann et al, 2011). In practice, however, this paradigm causes misunderstandings, resistance, and conflict, because actors from science, governmental and non-governmental institutions, business, and communities each follow their own rationales or subsystems of reference. Resulting multi-stakeholder processes generally remain open, sectoral and arbitrary, with criteria and measures of evidence and success depending on the different actors' negotiation power. This is illustrated by the climate discourse under the UNFCCC – ostensibly a major field of for science-society interaction –, where power imbalances and conflicts of interest limit integration of the public and thwart action and equity-based solutions (Dryzek and Stevenson, 2011). While efforts and achievements in public inclusion are increasing, science and technology remain dominant. Certainly, such open multi-stakeholder processes are likewise insufficient for addressing today's global challenges.

(3) A third innovation paradigm takes sustainable development as frame of reference. Although development actors often refer to this paradigm, it is rarely applied in its strong meaning. Key is the inseparability of development and equity in sustainable development. Ethical and equity concerns open the floor for contesting existing power structures and decision-making processes (Biermann et al, 2009; Wiesmann et al, 2011). Based on an emancipatory construction of sustainable development, sustainability scientists have built a radical understanding of inclusive innovation, which integrates, but goes beyond the two insufficient understandings of innovation outlined above. A basic characteristic is that all stakeholders are equal agents of change in the co-production of knowledge and innovation towards the shared goal of sustainable development. Scientists and researchers have a special role in organizing this process. In addition to the provision of scientific knowledge and databases, they produce analytical and communicative tools to inform, structure and facilitate participants' interaction and learning. Visualizing data in process-specific planning and decision-making tools and making them available in knowledge platforms is another major contribution. Certainly, the deliberative capacity of individuals and institutions needs specific attention and generally must be developed and secured for their equal and meaningful inclusion (Dryzek and Stevenson, 2011). In joint research navigation, actors organize reflexive and recursive processes, which are well-suited for integrating different development and innovation paradigms in a fruitful way (Ott and Kiteme, 2016; Ott, 2017). As knowledge producers and brokers, they identify common research needs and approaches; they assess, evaluate, and reuse evidence and innovations; and they organize sequences of disciplinary, interdisciplinary, and transdisciplinary steps, including steps that involve governments, civil society, and business. This procedure replaces unspecific interaction between science and society by integrating actors, knowledge, and value systems in joint learning, and an active and coherent developing

and shaping of the context. This fosters evidence-based contextualised knowledge and innovation, and corresponding institutions.

In sum, if taken as a superordinate system of reference that is valid for all actors involved, a strong sustainability paradigm unfolds its integrative and transformative power and open the way out of the confusion that characterizes current development efforts. It implies, and guides the organization of, equity-based and democratic processes of research, learning, and innovation in a specific context. What is fundamentally new in this paradigm is that disciplinary and technological innovation is subordinated to a shared goal outside its traditional rationale. However, in sequences of disciplinary, inter- and transdisciplinary research within a process, innovators from all backgrounds can recognize and secure their part in providing coherent solutions to global challenges. Overall, an innovation paradigm based on a strong conception of sustainable development enables sustainability-oriented actors from all scientific and practical fields to seek consilience (Farley, 2014) and to synchronize differing development agendas and research frameworks on behalf of societal co-production of knowledge and innovation. In this, long-term interaction and partnerships are helpful, if not mandatory. If we are to achieve the SDGs formulated in the Agenda 2030, there is no alternative to such equity-oriented, transdisciplinary, reflexive, and co-evolutionary research and innovation.

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5.1.4 Evaluating and simulating the role of civil society organisations in European research networks

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Keywords: Civil society organizations, EU framework programme, research impacts, agent-based modeling, network analysis

Introduction

Collaboration between different actors in research and innovation (R&I) activities has been a cornerstone of EU research policy, especially in the context of the EU research framework programmes (FP). In previous FPs, this collaboration aspect has mainly been centred on research-conducting organisations such as universities, private research organisations and companies. Recent approaches, such as advocated by the current EU framework programme – Horizon 2020 – or through the concept of "Responsible Research and Innovation" (RRI), call for also involving other societal actors, in particular civil society, in the R&I process.

Studies such as CONSIDER (www.consider-project.eu) have revealed a number of benefits related with involving civil society organisations (CSOs) in R&I. These include shaping R&I towards societal challenges (thereby making sure that research helps solving societal problems), translating research results back into society (thereby promoting science education and making scientific knowledge more accessible), or gaining legitimacy for scientific research (thereby addressing requirements of research funding agencies).

However, while the participation of universities, private research organisations and companies in European R&I activities has already been well researched through numerous evaluations and monitoring activities, the role of Civil Society Organisations (CSOs) is largely unexplored. This lack of evidence poses a challenge for policy makers and pro-

gramme managers dealing with the multifaceted challenges of engaging CSOs in European research, in particular when it comes to designing policy interventions in the complex European research and innovation system.

Research questions & methodology

Against this background, our study aimed at answering the following research questions: To what extent did CSOs participate in the 6th and 7th EU research framework programmes (FP6 and FP7)? In which roles, positions and thematic areas did they participate? How did they contribute to research and network performance? Through which policy interventions can their involvement be further strengthened?

The methods applied in the study comprised of case studies, social network analysis, analysis of publication output and media presence, and agent-based modelling. The main data source for the study was the European Commission's E-CORDA (External Common Research DAta warehouse) database, containing information on all FP6- and FP7-funded projects and their participating organisations (universities, research organisations, companies, public bodies, and other organisations).

CSOs constitute a heterogeneous group of organisations as regards size, strategic orientation, business model or funding streams, which makes it challenging to clearly identify and categorise them in the FP6 and FP7 research networks. We therefore developed a typology distinguishing between different types of CSOs based on two criteria: target group (i.e. "beneficiaries" of the organisation's activities) and funding sources. For the purpose of the proposed presentation at the Eu-SPRI conference 2017, we will mainly distinguish between citizen- and society-oriented CSOs on the one hand, and CSOs representing commercial interests (e.g. business associations) on the other.

Findings & conclusions

The role of Civil Society Organisations (CSOs) in the FPs

The findings of our study reveal that CSOs have so far only played a marginal role: although they accounted for 6% of all participating organisations in FP7, they received only about 1% of the funding provided by the European Commission. Business-oriented CSOs made up a large proportion of these shares; in contrast, the society-oriented CSOs only accounted for less than 3% of all organisations and received less than 0.5% of the EU funding.

CSO participation was not evenly spread across the different parts of FP7. They mainly participated in the specific programme "Capacities", in particular in the themes "Science in Society", "Regions of Knowledge", "Research for the benefit of SMEs" or "Activities of International Cooperation". Health- and ICT-related research also constituted important funding sources for CSOs, due to the large amounts of budget allocated to these themes. In contrast, CSOs were practically absent from the more excellence- and technology-oriented parts of FP7, such as the European Research Council (ERC), the Marie Skłodowska-Curie actions or nanotechnology research.

CSOs were largely characterised by nonrecurring participations, meaning that after participating in one FP-funded project they usually dropped out of the programme. Among all the different types of organisations participating in the FPs (universities, private research organisations, companies, etc.), CSOs showed the highest drop-out rate between FP6 and FP7, of 85%.

The position of CSOs in the FP networks

CSOs consequently also did not occupy central positions in the FP6 and FP7 research networks. They were mainly located in the periphery and semi-periphery of the network,

they did not build sub-clusters or bridge gaps, and they did not have an important brokerage function. Removing CSOs from the FPs would have had virtually no effect on network parameters and morphology. Similarly, CSOs did not contribute to research performance in terms of publication output. On the contrary, we found a significant negative correlation between CSO participation and publication output across EU-funded projects.

This pattern of a mainly marginal contribution of CSOs to FP-funded research projects can be explained by fundamentally different logics: while the FPs are shaped by researchers, focusing on scientific excellence, and the business sector, focusing on profits and competiveness, CSOs follow a different logic, focusing on societal impacts. They therefore find it difficult to link up with the highly competitive and excellence-driven logic of research and innovation. In addition, since CSOs usually act on a local or regional scale, they hardly gain added value from participating in EU-wide projects.

Conclusions for simulating CSO participation in the FPs

As a consequence, when simulating policy interventions aimed at strengthening the role of CSOs in the FPs, one has to take into account other aspects and roles than merely focusing on CSOs as project partners. For example, CSOs could also be involved in agenda setting or proposal evaluation. Another consequence is that benefits related with CSO involvement in the FPs cannot be adequately assessed by applying the typical success criteria such as "network performance" or "research performance". Instead, it would be necessary to assess the (potential) societal benefits of the FPs as a whole.

Characteristics of the developed agent-based model

The agent-based model developed in the course of our study consequently expands existing modelling approaches such as SKIN (Simulating Knowledge Dynamics in Innovation Networks): instead of agents' behaviour being based on "knowledge" (i.e. scientific disciplines) exchange alone, our model also includes an "impact" domain, referring to the Sustainable Development Goals (SDGs) adopted by the UN in 2015. This makes it possible to not only look at knowledge flows throughout the simulation, but also to assess the system's contribution towards societal impacts.

Simulation results

Four main scenarios were simulated in our model, representing different strategic orientations of future FPs. The results showed that a scenario focusing on societal challenges and process-oriented types of research, combined with funding more but smaller projects than in the past and putting more emphasis on the evaluation criterion "impact", leads to the most beneficial outcomes in terms of CSO participation, network effects, cohesion aspects and capacity building: this scenario significantly increases the capacities of all actors to contribute to solving societal problems without diluting scientific excellence and without disrupting the existing network or completely altering the nature of the programme, thus still being able to adequately address the logic of the main research and innovation players such as universities, research organisations and companies.

5.2 Session 5.2

5.2.1 Inclusive Innovation Policies: Lessons from International Case Studies

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Keywords: inclusive innovation, inclusive growth, innovation policies, international case studies

Inequalities are one of today's most pressing challenges OECD countries face. Over the past three decades, income disparities have risen to unprecedented levels, with the richest 10% in the OECD area earning almost ten times more than the poorest 10% (OECD, 2015). People who are economically disadvantaged often also fall behind in other non-income dimensions of well-being, including in terms of educational attainment and health status. These inequalities do not only significantly affect the well-being of the most vulnerable segments of the population, but also undermine countries' economic performance, as disadvantaged groups have fewer resources to invest in skills and education and therefore contribute less to innovation and growth.

While innovation policies are central to growth agendas in most countries, they have figured little in strategies to promote social inclusion. Other policy areas such as education, social and labour market policies, competition and tax policies have traditionally played a stronger role in fostering more inclusive societies. Yet in many countries these traditional policies have not resulted in more inclusive growth in past decades. Could innovation policies be a complementary tool for inclusive growth? If so, how can innovation policies be effective?

The paper analyses inclusive innovation policies. These policies aim to remove barriers to the participation of individuals, social groups, firms, sectors and regions that are underrepresented in innovation activities in order to ensure that all segments of society have the capacities and opportunities to successfully participate in and benefit from innovation. The analysis is based on 33 detailed case studies of inclusive innovation policies from 15 countries (Chile, the People's Republic of China [hereafter "China"], Colombia, Germany, Hungary, India, Ireland, Israel, Japan, Korea, Lithuania, Mexico, New Zealand, South Africa and the United States) and two cross-country programmes. The case studies are presented in detail in the *Inclusive Innovation Policy Toolkit* – a practical and interactive guide for policy makers to design and implement effective innovation policies for inclusive growth (OECD, 2017a).

The distribution of innovation capacities and opportunities: effects on inclusiveness

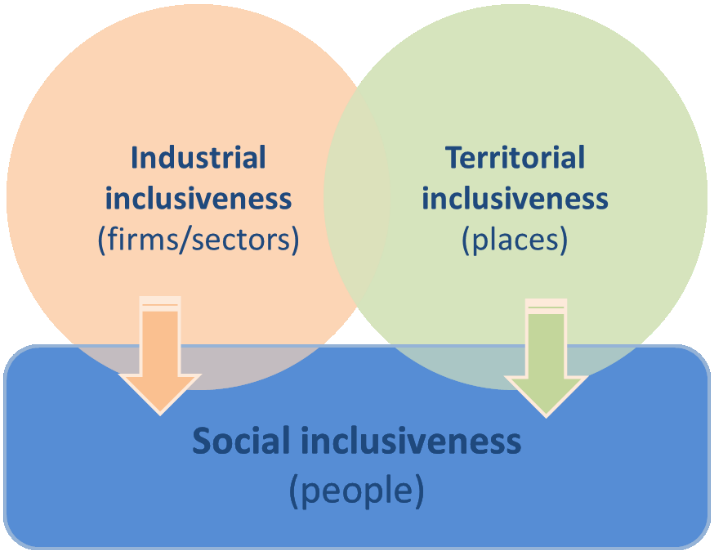
Participation in innovation activities is not evenly distributed across social groups. Women, ethnic minorities, immigrants and residents in deprived areas, among others, are systematically underrepresented in research, innovation and entrepreneurship activities in most countries. This is mainly due to:

- lower capacities or skills (e.g. entrepreneurial and managerial skills, digital literacy, technical skills, creative competence) for example due to insufficient levels of formal education, vocational education and/or on-the-job training; and

- fewer opportunities, for example due to discrimination in the labour markets, the persistence of stereotypes, or barriers to entrepreneurship faced by certain social groups.

The particular features of a country's production system also play a central role in shaping inclusive growth. The distribution of capacities and opportunities to participate in innovation activities across firms/sectors (referred to here as "industrial inclusiveness") and regions ("territorial inclusiveness") might be the most important of these features. The industrial and territorial dimensions are closely linked to social inclusiveness (Figure 1). When innovation capacities are not widely distributed across sectors and regions, the well-being of individuals working in less innovative sectors and/or living in less innovative regions is affected. Individuals working in less innovative sectors and/or living in less innovative regions that suffer from multiple factors of disadvantage (e.g. low skills, low income), as they are less able to move to more innovative activities.

Figure 1. Interactions among social, industrial and territorial inclusiveness



Source: OECD (2017b)

Innovation policies for tackling social, industrial and territorial inclusiveness challenges

Different inclusive innovation policy instruments can foster inclusive growth (Table 1). Policy instruments that address social inclusiveness include, for example, the provision of grants to researchers from disadvantaged groups, the use of role models and mentoring programmes to tackle stereotypes, and the deployment of programmes to popularise science and technology.

Innovation policies aimed at addressing industrial and territorial inclusiveness can also support inclusive growth by shaping the opportunities individuals in different firms, industries and regions have to participate in innovation. To address industrial inclusiveness challenges, innovation policies may focus on addressing the main barriers to entrepreneurship encountered by disadvantaged groups, such as obstacles to access finance (e.g. through the provision of micro-credit and equity financing), talent (e.g. through grants to SMEs to recruit researchers or experts to implement innovation projects) or other support services (e.g. through the provision of business counselling and assistance to access new markets).

Policies to address territorial inclusiveness challenges may proceed by facilitating the access of firms and entrepreneurs in lagging regions to existing knowledge and technology (e.g. through technology demonstrations), maximising the potential of existing regional assets (e.g. by promoting the use of intellectual property protection in traditional sectors), and

attracting innovative firms to peripheral areas (e.g. through technology parks or the provision of grants to firms locating their R&D activities in peripheral regions).

Table 1. Overview of innovation policy approaches to foster inclusiveness

Inclusive innovation policies to:		
Foster the integration of disadvantaged groups	**Address barriers to entrepreneurship encountered by disadvantaged groups**	**Enhance innovation in lagging regions**
Building capacities • Access to high-quality science education for disadvantaged groups • Schemes for communication and popularisation of S&T • Entrepreneurship education • Grants for researchers from disadvantaged groups • Funds to research institutions for implementing plans to improve the research environment for disadvantaged groups Addressing discrimination and stereotypes • Campaigns to raise awareness of the business potential of activities of disadvantaged groups • Mentoring programmes and provision of role models to incentivise disadvantaged groups Providing incentives to invest in (inclusive) innovation • Grants • Repayable grants	Facilitating access to finance • Microcredit (micro-loans) • Equity financing • Educating in finance Providing support for business development • Information to entrepreneurs • Coaching and mentoring • Business counselling/advice to entrepreneurs • Assistance to access new markets • Technology transfer assistance Promoting networks involving industry, academia and the financial sector • Innovation vouchers • Entrepreneurial networks Improving access to talent by small businesses • Grants to SMEs to recruit researchers/experts to implement innovation projects • Providing SMEs with access to specialised online job portals	Accessing global knowledge and technology • Demonstration of new technologies and training by S&T specialists • Financial support to projects that use STI solutions to address local challenges Maximising the potential of existing assets • Identification of sectors with potential in a region and training of potential regional entrepreneurs in those sectors • Intellectual property protection in traditional sectors • Support for regional governments to implement STI projects and develop research capabilities Attracting innovative firms to peripheral regions • Technology parks • Special economic zones • Grants for business R&D in peripheral regions

Rationales for implementing inclusive innovation policies

While rationales for implementing inclusive innovation policies vary, they all share a core goal which is to tackle the misallocation of resources in the economy due to inequality and exclusion (Table 2). Correcting that misallocation is critical, both for economic growth and for job creation. Social inclusiveness policies in particular address discrimination in labour markets by demonstrating the potential of certain social groups and changing the attitudes of employers and investors towards them. They also foster social mobility and inclusion by integrating disadvantaged groups in more productive activities of the economy. Industrial inclusiveness policies are implemented to address the problem of a dual economy (i.e. one divided into highly innovative/productive sectors and traditional/low

productivity sectors) by improving the competitiveness of less innovative firms and foster the emergence of new activities by increasing the enterpreneurship of underrepresented groups. These new activities may address previously underserved needs. Territorial inclusiveness policies foster the development of more productive and innovative activities in lagging regions, offering better opportunities for people in those areas. They also increase the chances of other initiatives (e.g. investment in R&D and transport infrastructure) to have their intended effects on innovation performance and growth.

Table 2. Summary of rationales for implementing inclusive innovation policies

Social, industrial and territorial inclusiveness		
Tackle the misallocation of resources in the economy due to inequality and exclusion, fostering job creation and economic growth		
Social inclusiveness	**Industrial inclusiveness**	**Territorial inclusiveness**
Reduce discrimination in the labour markets by demonstrating the potential of certain social groups and changing the attitudes of employers and investors towards them	Tackle the problem of a dual economy (i.e. one divided into highly innovative/productive sectors and traditional/low production sectors) by improving the competitiveness of less innovative firms.	Foster the development of more productive and innovation-intensive activities in lagging regions, offering better opportunities for people living in those areas.
Foster social mobility and inclusion by integrating disadvantaged groups in more productive activities of the economy.	Promote entrepreneurship from disadvantaged groups so as to foster the emergence of new economic activities (e.g. activities addressing previously underserved needs).	Increase the chances of other initiatives (e.g. investment in R&D and transport infrastructure) having their intended effects on innovation performance and growth.
Promote diversity in research and business teams to support inclusion and growth.		Strengthen regions' economic resilience and reduce their dependence on transfers from the central government.

Specific implementation challenges and policy responses

Inclusive innovation policies, by focusing on disadvantaged groups and laggard industries and regions, are often confronted with a number of specific implementation challenges that apply less to other innovation policies. These include the low involvement of the target group in policy programmes, for example due to low awareness of their existence or low trust in governmental intervention; and low capabilities among the target group to undertake activities promoted by the programme. In consequence, the success of inclusive innovation policies relies on stronger involvement of target groups, including by using new digital tools, and often require strong capacity-building efforts matched to funding support. Table 3 presents an overview of those challenges and provides recommendations as to how the challenges can best be addressed.

Table 3. Inclusive innovation policies: Implementation challenges and proposed policy responses

Implementation challenges	Proposed policy responses
Ensuring the involvement of the target group in policy programmes	• Design a tailored outreach strategy. • Engage the targeted group in programme design and/or implementation. • Communicate the programme's objectives, activities and benefits to the targeted group through a member of the same community/group. • Promote interaction among the target group, the STI community and government actors. • Provide information about the benefits of S&T, research and innovation. • Streamline and simplify administrative processes linked to the programme.
Establishing appropriate criteria to select the target group and support innovation activities	• Establish selection criteria that consider the motivation and potential of applicants in parallel to their skills, capabilities and previous performance. • Clearly define the scope of activities that could be supported and plan monitoring activities to ensure effective implementation. • Establish criteria to select firms with potential to become profitable businesses and create jobs. • Provide public support that is conditional on the participation of the private sector in financing the programmes. • Involve experts and the target group itself in the design of the programme structure (e.g. application procedure, eligibility rules, award criteria).
Building capabilities for the target group to undertake activities promoted by the programme	• Tailor programmes to the capabilities of the target group. • Invest in capacity-building activities. • Invest in universal, high-quality basic scientific education.
Building adequate expertise of public sector officials and experts deploying the programmes	• Provide assistance to regional authorities to enhance their capacities to design and execute projects. • Involve third parties in addition to regional authorities in the design of specific projects. • Set up a targeted recruitment process to select experts to deploy programmes. • Provide tailored training to experts and advisors prior to implementating the programme. • Recruit experts that already have experience with the target group or geographic area.

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Introduction

Transition to a more sustainable and fossil-free energy system is of global interest, and implies social challenges for the developed world including the European Union. In particular, the energy consumption related to transport constitutes a significant challenge. If not serious changes are made the transport sector can lead to more than a doubling of CO2 emissions by 2050 (Edenhofer et al., 2014). Transport in this context includes transport of both people and goods, and it includes transport on land, sea and air. Responsible research and innovation should take into account this large social challenge of securing a more sustainable and fossil-free energy system. Furthermore, responsible research and innovation should take into account both the required changes in all citizens' daily life due to this transition as well as the driving force of grassroot innovation movements.

This work-in-progress reports from a large ongoing research project, the COMETS project, which aims to develop a decision tool for identifying and optimizing public STI policies and investments within the energy and transport sector (www.cometsproject.dk). COMETS is designed to be a participatory project between academic researchers, policy makers, and relevant stakeholders. COMETS aims to contribute to a cost-effective fossil free energy and transport sector by 2050, by understanding the impact on the energy system from 1) the transport sector, 2) consumer preferences and behavior regarding transportation, and 3) planning of cities and transport infrastructure. As a part of this larger project one work package explores participatory approaches to scenario development combined with a joined energy system model (TIMES DK) and a newly developed behavior based national Danish transport model (LTM). The aim of the work package is 1) to advance theoretical and applied research into novel methods of stakeholder inclusion in scenario analyses and 2) to develop and apply qualitative methodologies (participatory and interactive methods) in order to add informed expert and stakeholder assessments to the developed scenarios. This includes both front-end (input to scenarios) and back-end input (vetting the preliminary results) from key stakeholders and users. Among the stakeholders and users are: energy and transport model researchers, interests groups (e.g. associations/NGOs within public transport, car owners, bicyclists), technology companies, energy companies, citizens, policymakers, and politicians.

Stakeholder inclusion in scenario planning

Public engagement in science and technology has been studied for several decades (Rowe and Frewer, 2005; Selin et al., 2016; Stilgoe et al., 2014). This research has documented, that involving stakeholders and citizen is crucial to secure impact on actual policy making (Volkery and Ribeiro, 2009), and that the political processes affect the citizens choices of more sustainable technologies (Kern, 2015).

The theme has also become high on the political agenda in Europe. The Rome Declaration has emphasized that '*early and continuous engagement of stakeholders is essential for sustainable, desirable and acceptable innovation*' (EU-Council, 2014). This has been conceptualised as 'Responsible Research and Innovation (RRI) defined in as the on-going process of aligning research and innovation to the values, needs and expectations of society. Stilgoe et al. (2013) have suggested a framework for responsible innovation that includes four dimensions: Anticipation, Reflexivity, Inclusion and Responsiveness.

The literature (e.g. the science sociology literature) lists numerous methods for stakeholder involvement in scenario planning and similar in long term planning. One study has identified approximately 100 methods for public engagement (Rowe and Frewer, 2005). The scenario literature has produced several reviews and categorizations which have dealt with principles of participatory processes (Amer et al., 2013; Bradfield et al., 2005; Cairns et al., 2016). However, most of literature on stakeholder inclusion seems to be of a conceptual kind, and there seems to lack empirical information on the content of the participatory processes and on how impact of the processes and contextual factors affect the processes.

The work behind this paper relates to this gab in literature. The overall research question of this paper is: how can we apply qualitative methodologies (participatory and interactive methods) in order to add informed expert and stakeholder assessments to scenarios in the energy and transport sector?. This includes both front-end (input to scenarios) and back-end input (vetting the preliminary results) from key stakeholders and users. From this overall research question, three detailed research areas are derived. First, the paper investigates the functions of stakeholder involvement in scenario planning. No comprehensive overview seems to exist in literature. However, a preliminary literature review indicates that stakeholder involvement mostly is related to judgmental and anticipative elements of scenario planning. Second, the paper investigates the relation between functions of stakeholder involvement in scenario planning and the types of stakeholders participating in the process. Literature often mentions stakeholders in general with limited details, or it focusses on particular stakeholder types; e.g. grass roots (Smith et al., 2014). Third, the paper investigates detailed processes or methods for stakeholder inclusion, and how best to design a process according to type of stakeholder and type of inclusion. Fourth, the paper investigates factors affecting implementation of stakeholder inclusion (Calof and Smith, 2010; Stilgoe et al., 2013). Finally, the paper considers how to study stakeholder involvement in scenario planning. Literature has surprisingly little information on this. Studies of stakeholder involvement and scenario processes is a practice-oriented field. Similar academic scenario literature is usually descriptive/normative and based largely on practitioner experiences (Miles, 2008) - and in few cases the studies are of a conceptual kind (Selin et al., 2016). Studies mostly use traditional qualitative research methods; e.g. case studies based on observations, interviews, and questionnaires. However, some exceptions can be found; a recent Finnish study has employed protocol analyses of similar processes (Dufva and Ahlqvist, 2015).

Later stages of this ongoing research will comprise the development of methodologies for integrating participatory methods with qualitative models and socio-economic analyses as well as full scale experiments with participatory and interactive processes. The latter are carried out in cooperation with the Danish Board of Technology Foundation and includes experiments with actual stakeholder inclusion through 'Interview-meetings', 'Deliberative (Mini-publics) workshops', 'Perspective workshops' and a digital 'voting conference'. However, this is beyond the scope of this paper.

Approach

The work presented here is based on a systematic literature review. The material for the study was retrieved through searches on Scopus and Science Direct databases, and covered the timeframe 1945-2016. The collection included only journal papers leaving out conference papers and abstracts. A total of 198 papers were found. The abstracts of those papers were studied according to the scope of our study and 43 papers were extracted as being the most relevant. Hereafter the papers were evaluated against the research question and the papers that included the most thorough description of the stakeholders were applied to the final list. This list was narrowed down to 25 by evaluating the papers against the research question.

Preliminary findings

The paper presents the findings in relation to functions of stakeholder involvement in scenario planning, types of stakeholders, and processes or methods for stakeholder inclusion.

The table below summarizes the preliminary findings on linkages between types of stakeholders and functions organized by the four dimensions of responsible innovation as suggested by Stilgoe et al (2013). As mentioned above literature has identified approximately 100 methods processes or methods for stakeholder inclusion (Rowe and Frewer, 2005). However, the literature review find that only few methods are utilized: Workshops, Interviews (open or structured), Questionnaires, Surveys & Delphi like methods, and Expert notes. Finally, the paper discusses approaches to study stakeholder involvement in energy scenarios.

Table 1. Typology of stakeholder inclusion and its functions in scenario planning (first draft).

Dimension	Type of stakeholder	Function in scenario planning
Anticipation	Citizens	Identifying possible future trends and challenges in the external environment (e.g. demographics, oil prices)
	Experts	Visioning – establishing coherent visions Forecasting – judgmental assessments of future eco-technical specifications (e.g. cost and fuel efficiency of electrical cars in 2030)
Reflexitivity	Researchers Experts	Wind tunneling – testing policy and strategies in different scenarios
Inclusion	Citizens Policy makers Politicians	Prioritizing (with respect to impact and uncertainty) among the identified trends, challenges and technological solutions. Selection for further analyses
Responsiveness	Policy makers Politicians	Backcasting – identification of policies to arrive at a socio-technical vision

Source: Dimensions based on Stilgoe et al. 2013).

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5.2.3 Epigenetic economics dynamics and the Internet ecosystem

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Extended abstract

We are witnessing a very rapid development of mobile telephone-related sectors, firms and technologies on the Internet. The changes being perceived at the present time are characterized by their high speed, giving rise to high velocity markets and high velocity environments (Eisenhardt and Martin, 2000). As an illustration of the abrupt changes occurring in these high velocity environments, the paper focuses on the dynamics of the Internet ecosystem (Fransman, 2014). Apart from well-known incumbents like Google, Apple, Facebook, Amazon, Samsung, Microsoft, IBM, Intel, Twitter, Yahoo and telecom operators like Verizon, AT&T, Deutsche Telekom, Vodafone, Telefonica or Orange, new entrants are increasingly occupying leading positions in the market. In particular, Chinese firms like Baidu (the Chinese Google), Alibaba (the Chinese Amazon), Tencent (the Chinese Facebook), Weibo (the Chinese Twitter), and telecom providers like China mobile, Huawei, Xiaomi and ZTE are challenging the global leaders. In the remaining of the paper these large business groups are described as the GAFAS (i.e. "glasses" in Spanish). We refer to them as the GAFAS, because they do often constitute the "glasses" through which we observe the "reality", while at the same time determine the direction and intensity of global social and innovation dynamics (Iyer et al., 2006).

Our goal here is to analyze the evolution and dynamics observed of some of the GAFAS, determining how these expand and diversify their activities, in what we refer to as epigenetic dynamics. Our aim is to understand how epigenetic dynamics of the business groups mentioned above address change in response to variations in their environments. With it, we intend to provide a comprehensive view of the trends and dynamics observed in the Internet ecosystem.

When observing the recent activities of the GAFAS it can be noticed that their development does not conform to gradual innovation processes (Gómez-Uranga et al., 2014). These large groups were originally distinctive for know-how that resulted in some 'initial business routines' as well as certain products that fit into their 'original activity'. However, these groups suddenly and rather abruptly take on new routines and enter fields that initially have nothing to do with their businesses. Some examples of these radical and abrupt economic dynamics are the increasing moves toward health and genetics, self-driving cars, augmented reality, provision of telecom services, higher education, or finance and banking to mention a few (Zabala-Iturriagagoitia et al., 2016).

The concept of epigenetics is applied to the analysis of the dynamics of the large Internet groups that dominate this fast paced panorama. Many authors have imported Darwinian principles of biology to their fields and methodologies in the social sciences (Aldrich et al., 2008; Boschma and Martin, 2007, 2010; Hodgson, 2010; Pelikan, 2010). The main pillar of Darwinian principles centres on inheritance, where mechanisms such as replicas and descent act, and through which information concerning adoption is retained, preserved, transferred or copied over time (Darwin, 1859, 1871). Of the three key principles of Darwinism, variation, inheritance and selection, it is the latter that shows why a group of self-organised units are able to survive by gradually adapting to their environment (Ansoff and Sullivan, 1993).

Gene expression is highly regulated, enabling it to develop multiple phenotypes that characterise the different cell types in an organism, which provides cells with the elasticity to adapt to a changing environment (Masuelli and Marfil, 2011). Changes in the environment may cause chemical alterations that affect certain proteins (histones) and which may alter gene expression, activating or deactivating coding genes. These are called ‘epigenetic’ processes (Carey, 2012). Waddington coined the term epigenetics (1953) to refer to the study of interactions between genes and environment that take place in organisms. Epigenetics focuses on understanding the influence of the environment on genome expression; in other words, changes in gene expression that can also be transmitted and inherited.

Epigenetics supports the thesis that the adaptation of organisms does not necessarily have to be gradual, but sometimes evolution and adaptation can occur very quickly and even extremely abruptly (Gómez-Uranga et al., 2014). Therefore, an epigenetic approach may prove to be very useful when explaining the evolution of the big Internet industry groups (i.e. the GAFAS). The study of the epigenetic dynamics of the GAFAS focuses on their patenting behaviour and the mergers and acquisitions (M&As) completed. Patents are one of the strongest environmental properties in of the Internet ecosystem (Cunningham, 2011). The GAFAS do not only apply for thousands of patents a year. They also acquire large portfolios from other firms (mainly start-ups) to protect those areas that represent their core capabilities and to get access to those areas where they do not have particular strengths. This convulsed patent purchasing is known as the ‘patent war’, which is particularly relevant in the context of the GAFAS (Cass, 2015). As an illustration of the relevance of M&As, the acquisitions completed by Facebook between 2005-2014 amount to more than USD 23 billion, some of them being particularly noteworthy, like the ones of Instagram (USD 1 billion), Whattsap (USD 19 billion) or Oculus (USD 2 billion). In the case of Google, the number of acquisitions between 2003-2014 were 153, representing a total investment of USD 137000000 billion. The financial surplus of the GAFAS is therefore essential to acquire knowledge which is not available internally and allow them to rapidly adapt to the environment and compete in it.

In particular, in the paper we provide evidence for the technological diversification strategies followed by the GAFAS, and discuss to which extent these can be regarded as “epigenetic” and respond to an economic rationality. In this regard, we propose a research agenda that might be pursued in the next years so as to deepen into the knowledge on the epigenetic dynamics that can be derived from this patent analysis. Given the large amounts of patents, by studying the forward and backward citations it is possible to identify the networks of inventors and their geographical location, the technological areas the GAFAS are going into, if this diversification responds to a related or an unrelated variety rationale, which are the most relevant patents, and if these are the setting the standards. By identifying the patents that act as standard essential patents, it is also possible to understand the reasons for the GAFAS to engage in patent lawsuits. In turn, the analysis of the M&As provides insights about the amount of investment required and how these can be financed, the age, size and geographical location of the firms acquired and the sectors they belong to, and if the strategy to diversify through the acquisition of new firms responds to a related or an unrelated variety.

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5.3 Session 5.3

5.3.1 Responsible Research and Innovation – the researchers' view

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Keywords: Responsible Research and Innovation, Science Society Relations, Science Policy, European Research Policy, Science Research

Conceptional Background

The idea of RRI, as currently promoted by the European Commission, aims to bring science and society closer together, stimulating productive mutual exchanges for the sake of both sides. Presented as open and transformative by the European Commission, it is contested and presented as rather vague by some scholars. In order to bring more light into the evolution and the impacts of RRI (Responsible Research and Innovation), DG Research and Innovation commissioned a study led by the Technopolis Group (MoRRI – Monitoring the evolution and benefits of RRI) to investigate in detail the current status of the underlying concepts of RRI including its recent dimensions Public Engagement, Science Education / Science Literacy, Gender Equality, Open Access and Ethics.

Based on survey data we are able to investigate the following hypotheses: (1) Institutional Frameworks support the implementation of RRI activities within research organizations, (2) the normative orientation of research, e.g. curiosity vs. challenge-driven, influences the scope and extent of RRI activities; (3) the perception of RRI is shaped by the openness of researchers towards actors beyond the research community. (4) the national framework conditions influence the intensity of RRI activities, (5) the less-established researchers like female and junior scientists are more open-minded towards RRI than established ones, (6) the scientific discipline shapes the acceptance of RRI.

Please note: These are provisional results which do not necessarily reflect the view of the Commission and the Commission cannot be held responsible for any use which may be made of the information presented.

Database

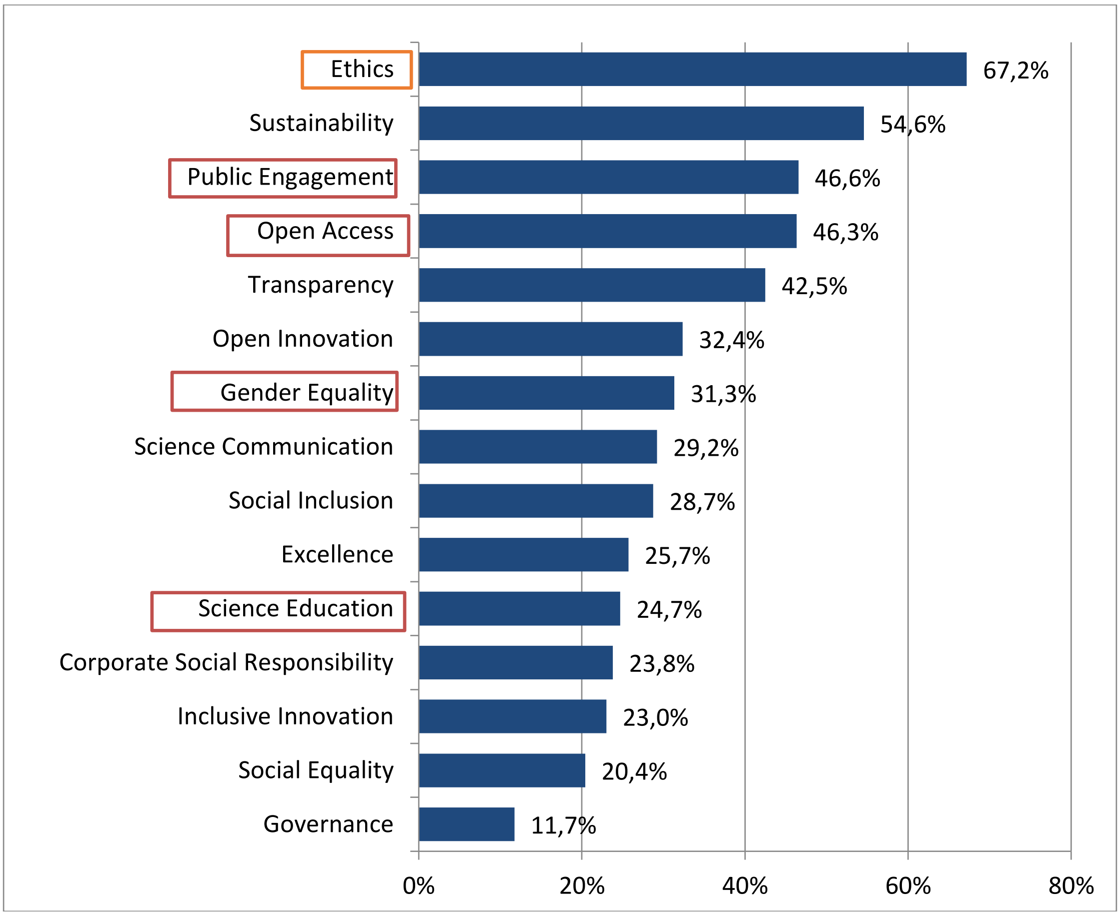
The online survey for the EU-funded resaechers was based on a databank delivered by the Commission Services. This dataset contained contact details of numerous researchers funded by the H2020 framework programme, the European Research Council or Marie-Curie. After data cleaning (deletion of multiple entry names), 22.947 persons were contacted by E-mail, but 673 could not be reached. Of the remaining 22.274 persons 3117 responded actively to the survey request, resulting in a response rate of 14%. All in all 2755 participants completed the survey (completion rate: 12.4%). The second survey was directed toward a control group and launched on March 14th, 2017 in order to analyze a control group of researchers that, unlike the first group, has not received any EU research funding within the last five years. The control group was compiled by using Scopus Author IDs. Selected main characteristics to generate the control group were country of origin, gender and scientific discipline. Accordingly, 25,968 identified researchers were contacted by E-Mail. However, 8,245 persons could not be reached due to absence, retirement or invalid/outdated mail address, resulting in a net sample of 17,723 persons. All in all 1,264 researchers responded to the survey request, constituting a gross response rate of 7.1%. Of these, 945 participants responded to at least half of the questions in the survey, resulting in a net responding rate of 5.3%. In total, 723 participants completed the survey (completion rate: 4.1%). At the beginning of the control group survey a filter question was positioned in order to evaluate if participants have actually not received financial research support from the EU within the past 5 years. 417 respondents indicated that they actually have either received funding from the EU Framework Programme (FP7 or H2020), ERC Grants, EUREKA, COST or other EU research programmes. As a consequence, this group was excluded from further analysis, leading to an adjusted de facto control group of 528 participants that factually did not receive any EU funding.

Results

Familiarity with RRI

At the beginning of our questionnaire we asked the respondents to what extent they already had heard about the concept of RRI. Not surprisingly, this is the case for only a minority of about one quarter of the respondents. More interestingly, however, is the fact, that those who indicated to have heard about RRI do not associate the same dimensions that underlie the Commission's concept: Looking at the most frequently mentioned categories, only Ethics, Public Engagement and Open Access are among the top five categories. Gender Equality and particularly Science Education are rarely associated with the acronym "RRI". Instead, sustainability and transparency seem to be important properties of RRI, according to the perception of the survey respondents.

Figure 1: Most frequently associated RRI terms (EU funded researchers)

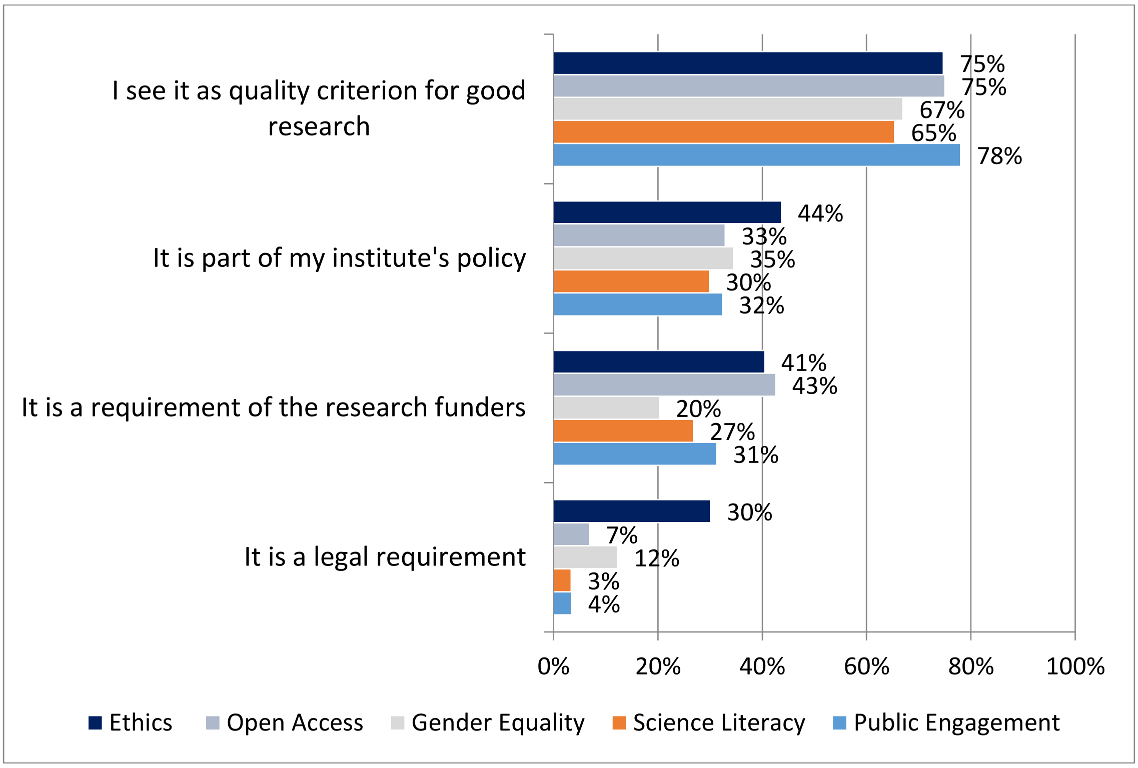


Source: Own survey data, compiled by Fraunhofer ISI

Main motives, promoting and hindering factors to practice RRI

When we look at the main motives to conduct different kinds of RRI activities, we can observe several differences. Generally, we see that the perception that the respective activity is a quality criterion for good research dominates throughout all five RRI dimensions. For Ethics, Open Access and Public Engagement, at least three quarters of the respondents note that this is their main motivation, whereas at least two thirds agree for the Gender Equality and Science Literacy dimension. External factors such as the institute's policy, requirements of the research funders but also legal requirements are especially important for Ethics.

Figure 2: Main motives to conduct RRI activities (EU funded researchers)



Source: Own survey data, compiled by Fraunhofer ISI

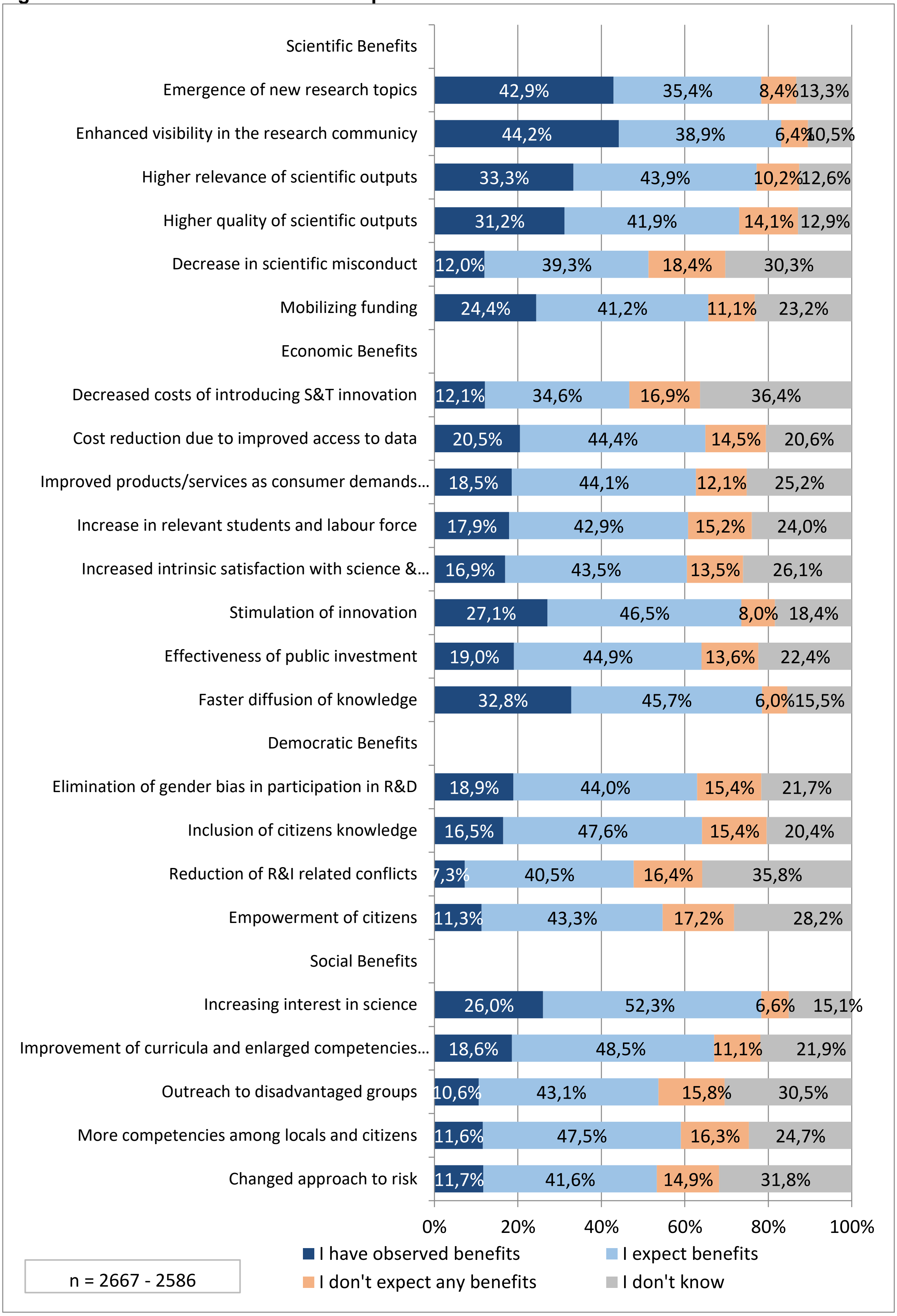
Overall we can ascertain that the respondents perceive more supportive factors than hindering factors. Whereas more than half of the respondents mention supportive factors, only slightly more than one third mention barriers. The most important supportive factors are, from the point of view of the respondents, the personal motivation but also the institutional strategy which can play a crucial role. An additional instrument to promote RRI is the prospect to get better access to research funding. Finally, if a positive contribution to scientific excellence could or can be shown, this would also be an important promotional factor to spread RRI. In this regard it is worth to be mentioned that one third of medical researchers affirms that they have already observed a gain of scientific excellence through RRI.

Looking at concrete barriers it becomes obvious that an overload of tasks is the most important hindrance, followed by a lack of experience and skills and increased direct costs. But the respondents do not worry about a loss of scientific excellence. Overall, women seem to be more inclined to perceive barriers than men, particularly regarding a lack of institutional incentives and experience / skills but also a lack of motivation to deal with RRI. Also researchers from the Natural or Structural Sciences do more typically more often perceive barriers than other respondents.

Perceived benefits

In order to receive a realistic picture about RRI benefits, we asked the respondents (1) whether they already observed any benefits when conducting a respective activity in the area of Gender Equality, Science Education, Open Access, Public Engagement or Ethics as the five main pillars of RRI, for example whether they use open data repositories, (2) whether they expect respective benefits in the future or (3) whether they do not expect any benefits. The benefit categories used were scientific benefits, economic benefits, societal benefits and democratic benefits.

Figure 3: Overview of observed and expected benefits



Source: Own survey data, compiled by Fraunhofer ISI

Figure 3 shows that the respondents most frequently report scientific benefits, followed by economic benefits. Social as well as democratic benefits are less frequently mentioned, but even if already observed benefits are less widespread within these two categories, the respondents frequently expect benefits. This holds particularly true for an increasing interest in science, an improvement of curricula and enlarged competencies among students as well as an inclusion of citizens' knowledge.

The role of EU funding

Within the control group, much less respondents are familiar with the concept of RRI compared to the EU funded group: Whereas from the latter group about 26% indicate that they already have heard about RRI, this is only true for 13% of the control group respondents. In addition, they also associate different key notions with RRI: Besides Ethics, which is on the top positions, more than half of the control group mentions sustainability and transparency as important parts of RRI. In contrast, Gender Equality is only associated by a minority of 23% whereas about one third of the EU funded group perceived gender equality as being part of RRI.

According to the smaller familiarity with RRI, the control group is also more reluctant to indicate concrete benefits than the EU funded researchers: Even if in most cases more than 50% of the control group indicated an observed or expected benefit, the share of control group respondents who do not expect any benefits is substantially higher than among the EU funded researchers. This holds true for all four benefit categories, i.e. scientific, economic, democratic and social benefits, whereas the differences are highest for the scientific and economic benefits. To give an example: While among the control group respondents only 34% affirm the emergence of new research topics, this is the case for 43% of the EU funded researchers. Furthermore, 25% respectively 23% of the control group indicate a higher relevance and quality of the scientific outputs compared to 33% and 31% of the EU funded survey participants.

Conclusion

With the data gathered in the course of the MoRRI project we could show that institutional strategies positively influence the level of RRI practice and awareness for RRI benefits. The most important benefits are observed or expected for science itself, followed by the economy. Social and democratic benefits are hardly associated with RRI. The most important barrier for researchers in Europe to practice RRI is an overload of tasks.

EU funding makes a clear difference: within the control group, much less researchers are familiar with RRI or practice it. The control group respondents are also less inclined to expect any benefits. The control group results thus show that regarding the "universe" of researchers in Europe there is still a long way to go before RRI is broader known and accepted.

A challenge-orientation of research is posivitely associated with the familiarity with RRI, the daily practice and also the expectation of RRI benefits. But in contrast to our assumptions, it is not the less established group within science like younger and female researchers who are more open-minded towards RRI but male and elderly researchers.

Finally we could show that the five existing pillars of RRI are not self-evident: even if the respondents are familiar with the acronym, they associate not necessarily the same dimensions which form the basis of the Commissions' concept. Instead, sustainability but also transparency plays a crucial role.

5.3.2 Openness and barriers for societal engagement. Does usable research face higher obstacles within the academy?

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Keywords: Societal engagement, Barriers, Openness, Academic norms, Research policy

Introduction

The recognition of academic research as a potential source of economic growth and social welfare has attracted the attention of both policy-makers and academics over the past decades. On one side, policy makers are interested in identifying and promoting the research that makes an impact on society. On the other side, academics are concerned with demonstrating the societal impact of their research as part of their societal license to practice and the public support for their activities. There may potentially be a tension between these issues, such as the effects that this has for research governance and decision-making where there is heavy-handed top-down attempts to more directly align individual research agendas with research policy priorities (Gläser, 2012; Hessels and Van Lente, 2008; Leisyte et al., 2008).

In this paper, we are concerned to understanding how policy-makers can help to guide researchers towards producing knowledge that benefits society but without imposing top-down research agendas. From our governance perspective, top-down steering can heavily skew the natural governance processes by which scientific communities collectively decide which research topics are the most valuable and worthy of immediate attention.

To address this question, we make a distinction between two factors that affect the societal impact of academic knowledge, namely (a) the type of knowledge that is created (knowledge production) and (b) the researchers' engagement with societal partners to move this knowledge outside academia (knowledge transfer).

Literature about knowledge production has emphasized the importance of a mutual process by which research agendas are set together with users as a means of taking into account socioeconomic problems and needs, working with rather than against scientific governance (Gibbons et al., 1994; Ziman, 1996). A recent approach to knowledge production has identified "openness" as the characteristic of conducting research drawing upon external knowledge (Olmos-Peñuela et al., 2015). In incorporating that external knowledge into the everyday business of science, open research allows external interests, knowledge and considerations the opportunity to become salient to the business of science and shape the eventual knowledge resulting from those research projects.

The openness model focuses on the different research micro-practices of individual researchers – reflection, inspiration, planning, execution and dissemination – where openness can be observed. The mechanism by which this improves relevance is that open research micro-practices lead to the production of knowledge more cognate to users' needs (Amin and Cohendet, 2004; Gibbons et al., 1994; Isaksen and Karlsen, 2010; Nowotny et al., 2001). Even where it is rigorously produced, because the knowledge is cognate to users, that means that it ultimately offers a higher potential to be relevant, and hence generate an impact beyond the academic sphere. But this potential represents one side of the impact generation model, and the effects of research are also dependent on the transfer of knowledge into society. Taking the metaphor deployed by Sarewitz and Pielke (2007, see also Rip, 1997) of usable research offering a reservoir of potential knowledge, the outlets from that lake are also important for determining how research is used in society. We therefore take the Olmos-Peñuela et al., (2015) model, which is concerned with flow into this reservoir, and develop a model for understanding this rate of outflow.

Literature about knowledge transfer has focused on analysing diverse aspects related to university-industry collaborations (within science-society interactions) such as the different channels used to establish collaborations with external partners (D'Este and Patel, 2007; Landry et al., 2010), individual characteristics affecting these interactions (Boardman and Ponomariov, 2009; Giuliani et al., 2010), organizational and institutional characteristics (Bekkers and Bodas-Freitas, 2008; Polt et al., 2001; Ponomariov and Boardman, 2008) affecting collaborations, and motivations for engaging in collaborations (Baldini et al., 2007; D'Este and Perkmann, 2011; Lam, 2011; Ramos-Vielba et al., 2016; Iorio et al., 2017), among others (see Perkmann et al. (2013) for a review). One key topic relates to the barriers or obstacles for researchers in establishing collaboration with societal partners (i.e. the ease of flow of that knowledge out of this reservoir).

Different types of obstacles have been identified in the literature (Hughes & Kitson, 2012; Mitton et al., 2007). The first type of obstacles are related to those that emerge when researchers' practices deviate from the Mertonian norms of science (Partha and David, 1994) that Tartari et al. (2012) identified as orientation barriers. These obstacles are related with *secrecy* (confidentiality issues, constraints for publishing research results), with *skewing* (the loose of freedom in choosing research topics and the ultimately changes in the research agenda as a results of this collaborations) and with the risk of *losing scientific credibility* (Gulbrandsen and Smeby, 2005; Lee, 1996; Ramos-Vielba et al., 2016; Tartari and Breschi, 2012). The second type of barriers are related to the potential users because of their lack of awareness of researchers' capabilities, their different interest and objectives and their lack of enough absorptive capacity to integrate scientific results (Bozeman, 2000). A third type of obstacle is related with transactional barriers (Bruneel et al., 2010; Tartari et al., 2012), including those related to contract negocition and intellectual property and confidentiality restrictions. Finally, the last type of obstacles refers to the lack of institutional support, information and structures (such as transfer offices) to establish collaborations (Jacobson et al., 2004; Siegel et al., 2004).

Our contribution to the field of Sarewitz & Pielke (2007) is bringing together the literature on knowledge production and the literature on knowledge transfer related to the barriers to societal engagement. We specifically explore whether academics that conduct research following and 'open' approach (those who create knowledge cognate with users) face problems in deviating from these Mertonian norms. We operationalise this as exploring whether they experience obstacles to engaging with external partners compared to academics that do not follow an 'open' approach and that thus do not deviate from Mertonian norms. Thus, the key theoretical frameworks that will be used are the "openness" approach (Olmos-Peñuela et al., 2015, 2016) and the literature on societal engagement obstacles (Ramos-Vielba et al., 2016; Tartari and Breschi, 2012; Tartari et al., 2012).

The aim of the study is to address the following research questions:

1. Do researchers that seek to make their knowledge more accessible to society (i.e. cognate to users) experience problems as scientists from their deviation from Mertonian norms?
2. What kinds of barriers for societal engagement emerge when researchers seek to make their research more 'open' and hence more useful to societal partners?
3. What kinds of policy frameworks and approaches could help steer the academic system to reduce the barriers and obstacles experienced by scientists deviating from Mertonian norms?

Methodology

To answer our research questions, we conduct an empirical study drawing upon entries in a unique database derived from the IMPACTO project, a project funded by the Spanish Council for Scientific Research (CSIC) aiming at analysing the relationships that CSIC researchers establish with non-academic partners. Specifically, the database analysed results of a questionnaire answered by CSIC research staff with the right to act as principal researchers and enter into contracts and agreements with external partners. The questionnaire includes a range of question including information about researchers' profile, their research characteristics or their motivations and obstacles to establish collaborations with non-academic partners, among others (see Olmos-Peñuela et al. (2014) for more details on the database).

We analyse a sample of 1,583 researchers (accounting for 37% of total population). Using IMPACTO, we focus on two groups of variables, those related to openness and those related to obstacles for collaboration. Regarding openness, we draw upon previous work (Olmos-Peñuela et al., 2015, 2016) to build a dichotomous variable that distinguish between open researchers and no-open researchers. Regarding barriers to establishing collaborations, we consider 11 obstacles that correspond either to orientation or transactional barriers. We conduct an exploratory factor analysis and we identify 4 types of barriers related to: a) the researcher (e.g lack of interest, scientific recognition or time); b) the non-academic user (e.g. lack of fit between different communities, interest and absorptive capacity); c) the transaction (e.g. risk for confidentiality and intellectual property rights, negotiation issues); and d) the institutional settings (e.g. lack of information, financial resources or institutional support). We conducted t-test analysis to explore whether open and no-open researchers experience different barriers for societal collaboration.

Results

Results indicate that institutional settings are identified as the most important barrier for collaboration for both open researchers and no-open researchers and no significant differences are found between these two subgroups of researchers. Conversely, we found significant differences between open and no-open researchers in their perception of the barriers related to the researcher, the non-academic user and transaction aspects. Specifically, no-open researchers experience more barriers related to participants in the collaboration (researchers and societal partners) than open researchers; while open researchers experience more obstacles related to the transaction process than no-open researchers. Thus answering our two first research questions, compared to no-open researchers, researchers that seek to make their research more accessible to society (open researchers) experience more transactional barriers, but lower barriers for collaboration to related to themselves or their potential collaborators.

Discussion and Conclusions

From a policy perspective a number of implications can be derived from this study. First, in the context of our study (CSIC), all researchers (either open or no-open) perceive institutional setting as the main barrier for establishing collaboration with societal users. This result shed light on the opportunities for scientific organisations to develop active policies

contributing to reduce the perceived obstacles (e.g. favouring meetings with potential societal partners to facilitate mutual knowledge, providing effective support to collaborate with societal partner, providing specific funds for knowledge transfer and exchange as well as for developing joint projects). In short, our finding suggests that researchers demand an active involvement of their organisation for promoting knowledge transfer and exchange processes.

Second, no-open researchers perceive more barriers related to themselves (lack of intrinsic motivation, recognition and time to address societal collaboration) and to their potential societal partners (cultural differences, lack of interest and lack of absorptive capacity) than open researchers. However we find the opposite results when we focus on the transaction characteristics, i.e. more barriers are experienced by researchers exhibiting an open profile, having somehow included societal partners in any stage of their research process. Those, the collective of researcher that experience more barriers related to the transaction itself are those how have previous experience in collaborating with societal users. The political implication from this finding is that different types of researchers (open vs. no-open) need differentiated support policies to promote their involvement in societal collaborations. Thus, if the scientific organisation is interested in increasing the number of researchers-societal agent collaborations, it should focus its effort on improving the recognition of societal collaboration in the recruitment and promotion process, on alleviating the workload (specially administrative duties that consumes a remarkable time of scientific tasks) and on favouring the encounter of potential societal partners interested and able to effectively collaborate with these researchers.

In short, the research collective can be seen as a set of subgroups of scientists with different degrees of openness towards knowledge transfer and exchange activities that demand different support policies to overcome their respective barriers. It is possible that some of these subgroups do not want to interact with users because they consider themselves basic researchers, but the issue is that this ‘self-exclusion’ is not due to the fact that their organization has not made the needed effort to move them towards a more open approach. Thus, regarding policy approaches that could help steer the academic system to reduce the barriers and obstacles experienced by scientists deviating from Mertonian norms (open researchers), since actions should be mainly directed towards more institutional support and the reduction of the transaction impediments of the collaboration itself.

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6 Track 6: R&D Networks and Geography: Novel Empirical and Analytical Approaches in a Policy Context

Track 6 was organized by Martina Dünser, AIT Austrian Institute for Technology, Center for Innovation Systems & Policy, and Thomas Scherngell, AIT Austrian Institute for Technology, Center for Innovation Systems & Policy, and included four Sessions.

The focus of the proposed research track will be on the geography of networks and R&D collaborations in a STI policy context. Special emphasis is placed on the spatial dimension of policy induced interactions between organisations performing joint R&D, for instance in the form of collaborative research projects. Such interactions have attracted a burst of attention in the last decade, both in the scientific study of the networks, as well as increasingly in the policy sector. Specifically the study of the spatial dimension of R&D networks has meanwhile become an essential and fascinating domain for advanced research on the spatial and temporal evolution of innovation systems at different spatial scales (see, e.g., Scherngell 2013). Also from a policy perspective, the analysis of the spatial dimension of R&D networks is of high relevance, for instance EU level, considering the policy goal that networks of actors performing joint R&D should span the territory of the EU, and, by this, affect the circulation of knowledge and researchers in a Europe-wide system of innovation (see Hoekman and Frenken 2013).

However, specifically in a policy context, empirical works that have been conducted up to now often remain unsatisfactory. This is mainly related to the analytical and methodological approaches used, as well as a lack of systematic and clean data on R&D networks. One crucial aspect in this context is the difficulty to isolate policy effects (i.e. additionalities) on the development of such networks over geographical space and time, and to grasp impacts of policy induced R&D networks on – generally speaking – the socio-economic development of organization, regions or countries in a more systematic way. On top of the research agenda in this context is, for instance, the investigation of structural and dynamic impacts of policy induced R&D networks on knowledge creation and inventive behaviors of innovating actors, and the innovative capability of regions, countries or the EU as a whole.

Recently, scholars have started to combine network analytical approaches with spatial econometrics in analyzing the geography of policy induced R&D networks, in comparison to co-publication and co-patent networks (see Varga et al. 2014, Wanzenböck et al. 2014). The integration of spatial analysis methods in combination of network analysis seems particularly promising in this respect, as is the complementary usage of simulation techniques to e.g. frame different policy scenarios. Concerning the empirical side, it is worth noting that novel data infrastructures have been established recently, e.g. under the umbrella of the RISIS infrastructure (risis.eu), collecting and systematizing data for science, innovation and policy studies. These new data infrastructures show great potential for capturing and modelling impacts of policy induced R&D networks in a more systematic way, but they have only hardly been exploited up to now.

Against this background, this track will shift attention to novel methodological approaches and empirical strategies for the analysis of policy induced R&D networks, particularly emphasizing the relevance of their geographical dimension when capturing policy impacts. By novel empirical and analytical approaches, we refer to both, models and new data infrastructures that are able to capture R&D networks. By this, the track is intended to bring together a selection of contributions providing novel empirical insights into the geographical dynamics of policy induced networks and R&D collaborations, in particular across Europe by focusing on e.g. networks funded under the European Framework Programmes (FP).

The contributions to the track will employ new, systematic data sources, e.g. by drawing on information given in new datasets provided by RISIS. Further, innovative methodologies will be proposed to capture policy impacts, ranging from cutting-edge spatial analysis and spatial econometric techniques, network modelling techniques as well as simulation, such as agent-based modelling (ABM) approaches. In that sense, it welcomes contributions on analytic advances and methodology, on structure and spatial characteristics of policy induced R&D networks, and on impacts of R&D networks on knowledge creation and innovation activities. The latter may be specifically contextualized in contributions focusing on policy impacts in the context of Key Enabling Technologies (KET) or Societal Grand Challenges (SGC) as major cornerstones of the current EU STI policy.

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6.1 Session 6.1

6.1.1 Profiling the territorial embedding of marine biotechnology research centres: developing global and local STI indicators[40]

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Keywords: STI Indicators, Marine Biotechnology, Territorial Embedding, Peripheral Regions

Short abstract

Our study tackles the challenge of developing STI indicators for assessing marine biotechnology (Blue Bio) research institutes that are geographically located in peripheral regions, far from major metropolitan areas. The promise of Blue Bio couples (a) the promise of new sources of knowledge and innovation with (b) the promise to stimulate jobs and growth in regions which struggle to prosper due to a number of factors, such as economic migration from peripheries to large cities and the decline of traditional coastal economic activity. In this paper, we outline the context of marine biotechnology assessment, the systematic approach that is being applied, and a glimpse at the results of its application to a specific case. This activity mobilises platforms and databases from the RISIS network (www.risis.eu).

Long abstract

Marine biotechnology, otherwise known as "blue bio", promises advances in biotechnology driven innovation in medicine, cosmetics, nutraceuticals, food production, advanced aquaculture, bioremediation and bioenergy. Similar to other Key Enabling Technologies, marine biotechnology has been earmarked as a key technology driver for growth, particularly for those countries which leverage large coastlines for economic development (Ritchie et al.

40 This work was supported by the EC Horizon 2020 project European Marine Biological Research Infrastructure Cluster (EMBRIC)

2013). Therefore, understanding and evaluating the effects of marine biotechnology is becoming important for policy (COM2012).[41]

Many of the research centres involved in this area are based on the coastal peripheries of their countries – meaning close proximity to the sea, but greater distance from large metropolitan areas that are the usual locations of knowledge intensive research and innovation activities. The importance of marine biotechnology to the regions where the research centres are located is not clear. The promise of this emerging field for these peripheral regions is being taken up in the Smart Specialisation Strategy of the regions in which marine biotechnology research centres are located, with an expectation that of many the activities of the research not only provide new knowledge for a variety of industries, but will stimulate jobs and growth in the region. Thus, there is a need for profiling and characterising these marine biotechnology research centres, their link to their territory and with criteria that make sense. For this purpose, our research is driven by two key questions:

1. How does an excellent research centre located in the periphery assess its impact?
2. How does it assess its additionality to global science and to local socio-economic activity (its territorial embedding)?

To answer these questions, assessment tools must be developed and applied to (a) capture the existing impact profiles of the different marine biotechnology research centres in terms of scientific excellence and socio-economic impacts and to (b) create comparative criteria for developing best practices and to evaluate, compare and monitor change.

As a pilot study, we choose Roscoff Marine Station (SBR - Station Biologique de Roscoff) to build and test assessment tools. Roscoff is a research centre *physically* located in a periphery region (Brittany) whilst *institutionally* located in a metropolitan hub (Paris).[42] We will describe our pilot study which is currently being used in the characterisation of a number of other marine biotechnology research centres across Europe as part of a European Horizon2020 project EMBRIC.[43]

The broad framework for characterising a research centre

We have constructed a multi-criteria assessment tool to assess the regional embedding of the research centre and the global connections (in the global world of knowledge, but also in national and international networks and links). We mobilise the "research compass" Mustar and Laredo (2000) to position our own descriptors, markers and indicators and assess the research centre in a dual movement of local and global assessment.

41 This claim of policy relevance is reinforced by the fact that the authors of this paper, were invited to present preliminary version of this paper for EU-SPRI at the European Parliament in Autumn 2016 : http://searica.eu/media/com_eventbooking/161013%20Agenda.pdf

42 SBR is both a CNRS research centre (French national research organisation for fundamental research) and part of the UPMC (Université Pierre and Marie Curie), with its main campus in Paris.

43 www.embric.eu

Figure 1: An adapted research compass card (Laredo and Mustar 2000)

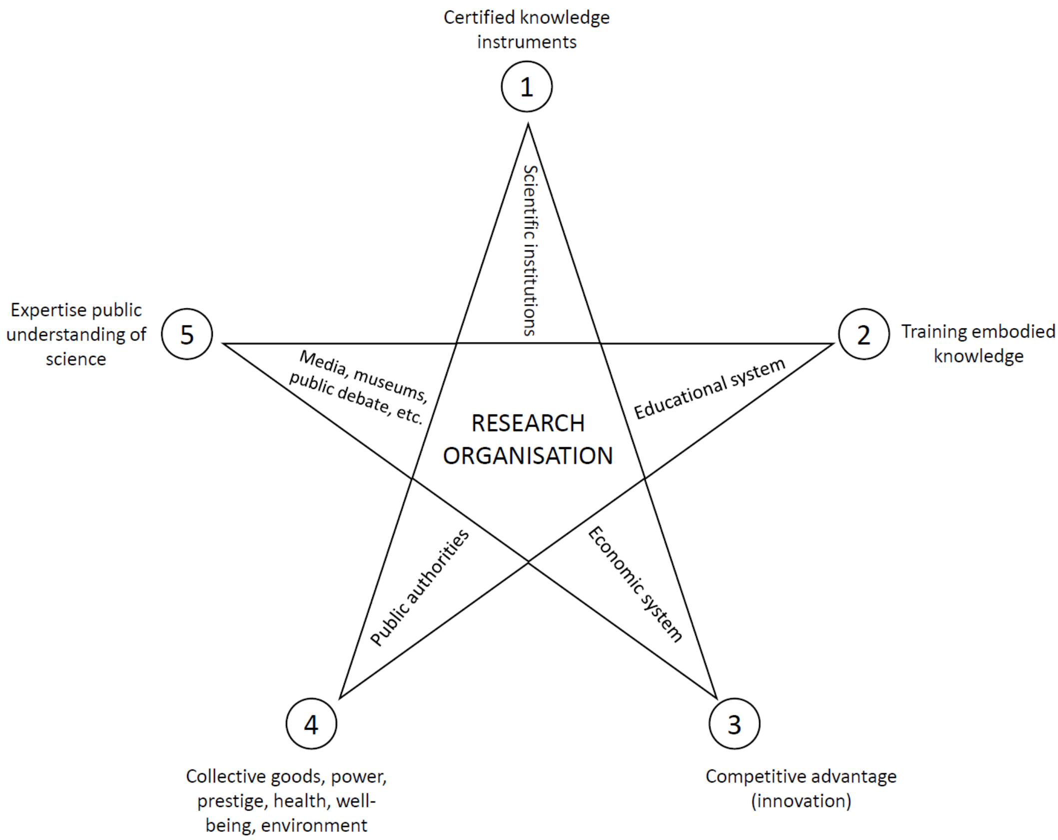


Table 2: Brief description of each spike of the research compass

Point of Compass	Short Description
1a) Publications	Peer-Reviewed scientific publications identified as broadly linked to Marine Biotechnology and/or Marine Biological Resource Management
1b) Competitive Funded projects	Public funded projects, most often from public funding organisations (European Commission, national research councils) but can also include regional funds and foundations.
2. Training	Professional and academic training activities broadly linked to Marine Biotechnology and/or Marine Biological Resource Management
3a) Contracts with private sector	Economic relations between the research centre and the private sector. This includes contract research, consultancy, service provision, provision of a PhD student, commercial use of infrastructure, etc.).
3b) Patents	Patents as broadly linked to Marine Biotechnology and/or Marine Biological Resource Management

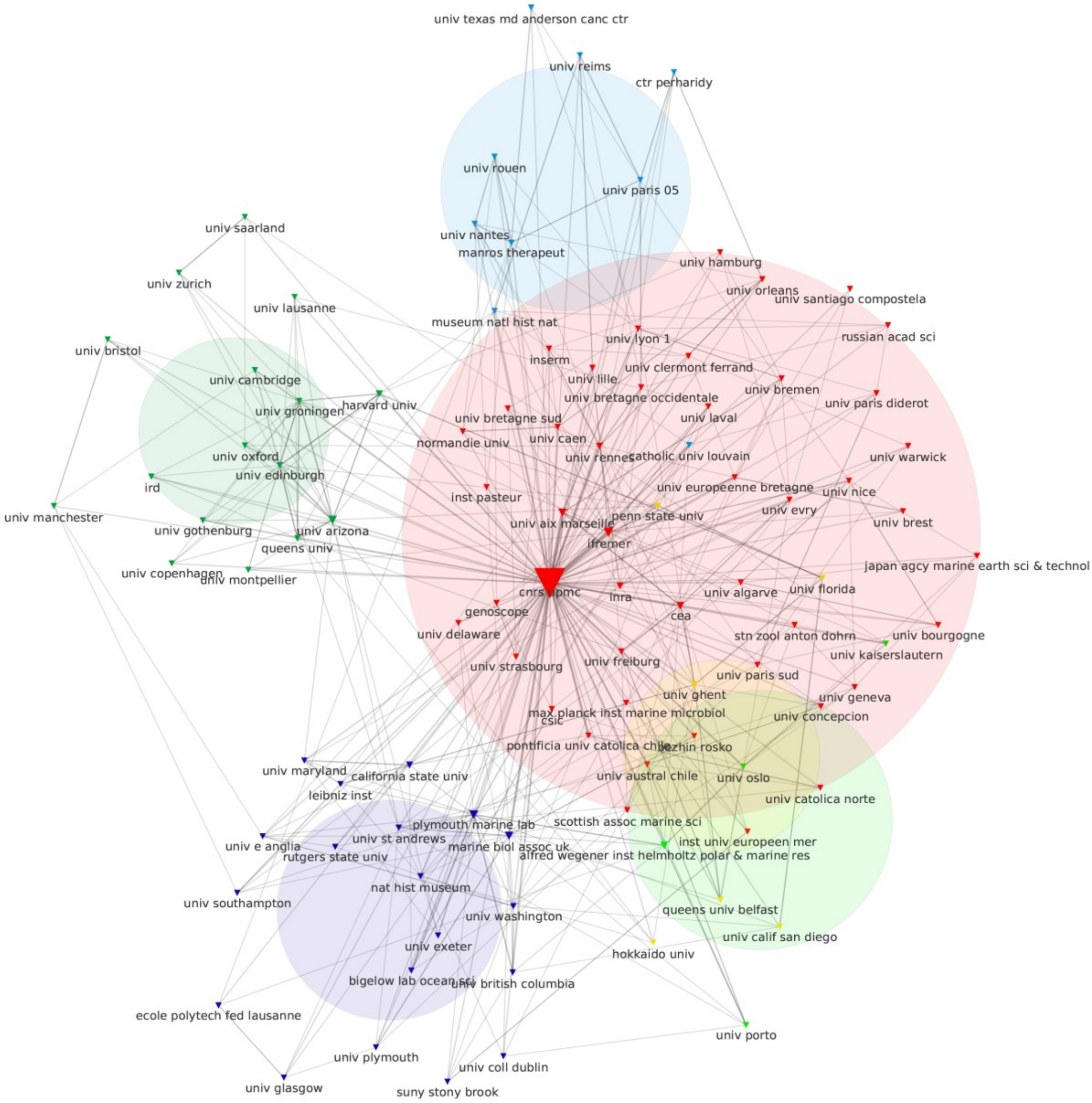
4. Connections with policy for market creation	Participation in standards organisation, in regional committees, etc.
5. Connections with civil society	Links between the research centre (and individual researchers) with civil society.

The Table above provides a description of the data for each spike of the compass. The paper presentation will provide details of each of the five points of the compass. However, to provide an indication of the analyses that will be presented on the SB Roscoff case

The case of SBR

To explore the scientific profile of the research centre, spike (1) of the compass, we gathered the publication list of the different units in SBR for the period 2010-2014 inclusive. From this list, we extracted from the Web of Science (WoS) the meta-data for all those peer-reviewed articles that could be found in the WoS. From this data, we could visualise the cognitive landscape of the corpus, as well as the institutional connections through co-author linkages (see Figure 2 below). From this data we can see that the largest cluster of institutions (see central circle, figure 2) contains both regional and international institutions.

Figure 2: Map of co-author institutions from the 2010 – 2014 SBR corpus of articles extracted from the Web of Science (powered by CorText).



To explore the economic/innovation activity, point (3) in the compass, we have gathered and analysed data on all the contracts between SBR (CNRS-UPMC) and other actors (public agencies, firms, charities and foundations). At the time of writing we have over a hundred contracts in the database where the majority (approximately 80% of private sector contracts are from the region of Brittany (see table 2 below).

Table 2: Looking at the datasets 1a, 1b, 3a and 3b (Table 1) through the lens of regional, European and non-European

Geographical origin	Publications (for the top 100 nodes)	Scientific part-nerships in projects	Patents	Contracts with firms
SBR	1%	0,24 %	4,17 %	1,75 %
Brittany	13%	9,44 %	33,33 %	80,7 %
Europe, outside Brittany	65 %	84,75 %	37,5 %	17,54 %
Non Europe	21 %	5,57 %	25 %	0 %

What can already by said is that scientific publications and partnerships in projects indicate global research collaborations. For co-patenting, we see an even spread across regional, European and non-European. Regarding contracts with firms we see 80% of contracts stem from the region.

Discussion

Our research seeks to distinguish between “loci of impact” of Public Research Centres. The Marine Biology case helps us do this, because many of the research centres are located on the coast in peripheral regions and often far away from metropolitan areas. We see that for “Scientific Excellence”, the location of the research centres in peripheral regions plays less of roll, except that certain types of marine facilities are possible when located on the coast. However, our data so far indicates that, when looking at economic ties in the periphery, regional ties play a strong role.

This echoes a broader trend observed in urban studies and regions. Since the early 2000s, the literature has pointed to a trend towards agglomeration of R&D (production of knowledge) in large metropolitan areas where an increasing concentration of activities in these cities could be observed at the expense of others (Varga 2000, Duranton and Puga 2004, Fujita and Thisse 2013). In this stream of literature, agglomeration is an important factor for R&D productivity in “Edison-type” application driven research whereas agglomeration is less important for “Pasteur-type” science driven research (Varga et al. 2014). In the latter type, *inter*-regional networks are emphasised more than *intra*-regional agglomeration. Recently a trend has been observed where the largest cities are undergoing a relative decline in a country’s collective scientific activity (Grossetti et al. 2013) with research moving away from the large cities to elsewhere.

Our early findings lead us to believe that collaborations in science in SBR follows the “Pasteur-type”, where there is little difference between regional linkages, national and international linkages. However, for the economic activities, the case shows “Edison-type” characteristics where regional linkages dominate. Our data so far also suggests that, the emergence of such regional districts does not happen on their own, they require institutional entrepreneurship (Garud et al. 2002, Robinson et al, 2007) through the forging of ties in the region through economic activity, regional policy and the training of a workforce.

Although at early stages, our data speaks to the “strong notion” of peripheries and the importance of exploring this theme in terms of indicator development as well as for regional research and innovation policy more generally, for example in tailoring and assessing smart specialisation strategies (Foray et al. 2009).

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6.1.2 Production of knowledge in European large firms in Chemicals and Pharma/biotech sectors: where is the knowledge produced

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Keywords: internationalization, large firms, patents, publications, Knowledge production

Introduction

The development of new products is a key issue for MNEs. In the R&D intensive sectors, it heavily relies on the production of new knowledge and on the ability to further exploit it to create innovation. To this aim, different skills and resources are mobilised by the firm in its knowledge networks, either in its internal network (own corporate R&D facilities in the firm's home country or abroad) or in external networks when the firm's R&D facilities collaborate with local R&D facilities outside its boundaries to benefit from the skills in science and technology in development in their host environment.

This paper seeks to contribute to the existing literature dealing with the management of the production of knowledge in MNEs. It deals with the corporate knowledge production by including both the exploration and the exploitation of knowledge. It relies both on the scientific publications produced by the firms, as a marker of the exploration of knowledge and the patents applied for by the firms, as a marker of the exploitation of knowledge.

Building on empirical data, we compare where the firms locate their activities related to the production of knowledge (scientific publications) and where are located those related to the exploitation of knowledge (patents). We contribute to the literature on the internationalisation of R&D in large firms by comparing the level and location of the R&D production both for the exploration and the production of knowledge. We do not aim at following the dynamics of R&D internationalisation and will not contribute in this paper to the debate on the increasing or decreasing trends of R&D internationalisation. Our objective is to compare the level (share of internationalisation) and the type of internationalisation (continental internationalisation vs. intercontinental internationalisation) in scientific publications and patents. We also aimed at knowing if the countries where the knowledge is explored are also the countries where the knowledge is exploited.

Our work studies the links that the firms establish internally or externally for the production of their knowledge. We compare the overall level of collaboration in scientific publications and in patents. We detail the level of coproduced knowledge and investigate the type of partners involved as well as their geographic proximity (at national level).

I Data production and characterization

This research exploits a database that identifies the priority patent applications and the scientific publications produced by a set of 115 large European industrial firms from the industrial sectors of Chemicals (36 firms) and Pharmaceuticals-Biotechnology (Pharm-biotech in the following) (79 firms) located in five European countries: France, Germany, the United Kingdom, the Netherlands and Switzerland.

The list of the firms was established using the 2009 edition of the IPTS “Industrial R&D Investment Scoreboard” that provides the names of the largest R&D corporate investors worldwide.

The final database contains:

- 87 965 scientific publications produced between 2001 and 2010: 18 733 publications of the firms from the Chemicals sector and 69 232 publications of the firms from the sector Pharma-biotech,
- 35 925 transnational priority patents filed between 2001 and 2008: 22 750 applied by firms from the Chemicals sector, 13 175 by firms from the Pharma-biotech sector.

The numbers of patents and publications distributed according to firms’ country, provides evidence of leading countries in Europe for both the corporate exploration and exploitation of knowledge : German firms lead the production of knowledge (both exploration and exploitation) in the sector of Chemicals ; in the sector of Pharma–biotech, the Swiss and the British firms lead the exploration of knowledge. There is a higher level of geographic diversification for the corporate exploitation of knowledge that takes place first in Switzerland but also to significant level in firms from Germany, the United Kingdom and France.

II Modes of knowledge production

We measure the share of the knowledge production carried out in the firm’s home country and the share of knowledge produced abroad, in Europe or overseas, relying the addresses of the signing institutions (publications) and of the inventors (patents).

We investigate the level of collaboration to assess to which extent the firms rely on their internal competences or interact with external R&D facilities. We calculate the shares of co-applications in patents and the shares of co-publications in publications and then by classifying the coproduced documents according to the type of the co-institutions involved in the co-publications and co-applications.

At last, we characterise the geographic proximities in collaborations in order to assess to which extent large firms collaborate with local external institutions either in their home country or in foreign countries where they have set their R&D subsidiaries, by measuring the share of national collaborations i.e. partners located in the same country (firm’s home country or abroad) and international collaboration involving authors from different countries (similarly inventors from different countries).

Our results give empirical evidences to picture the modes of knowledge production in the European large firms in the industrial sectors of Chemicals and Pharma-biotech

In a nutshell, the two sectors share similar practices in their modes of knowledge production, i.e. :

1. they explore knowledge on a collaborative mode involving external entities to similar extents, relying heavily on collaborations with universities; but they exploit knowledge internally. More than ¾ of the corporate scientific publications include an institution that is external to the firms (universities, PROs, governmental institutions, hospitals, firms, funding institutions, non profit organisations). This high level of external collaboration is encountered in Chemicals and Pharma-biotech. When exploiting their knowledge, the large firms rely most often only on their internal resources. In more than 95% of their applications, they apply for patents alone or co-apply by including several entities (e.g. subsidiaries) belonging to the same Global Ultimate Owner
2. they are more internationalised in the exploration of knowledge than for its exploitation; but for both types of activity, the R&D performed outside the firm's home country contributes significantly to the production of knowledge. To the exception of the patents in Chemicals, the contribution of skills located outside the home country exceeds the contribution of national skills. When they rely on the scientific and technological skills located abroad, the large firms use competences most often quite evenly distributed in Europe and overseas.
3. the R&D activities carried out in the United States matter as much as the R&D activities performed in foreign European countries, both for knowledge exploration and exploitation. In the Pharma-biotech, US based R&D institutions are engaged in almost ¼ of the scientific publications and more than 1/3 of the patent applications; in Chemicals, their share is lower but they contribute to 22% of the publications.
4. in their activities of knowledge exploration, firms gather skills worldwide and develop all types of collaborations : national internal and external collaborations either in the firm home country or in other countries where the firms has installed R&D facilities. They also develop international collaboration either from their R&D centres located in the home country or set abroad.
5. in their internal activities of knowledge production, the exploration of knowledge is either performed in the home country but also in foreign countries. In its exploitation is most likely carried out in the home country.

The main noticeable difference between the two sectors relates to their level of internationalisation in the knowledge production. Internationalisation is more pronounced in the sector of Pharma–biotech than in the sector of Chemicals. In Chemicals, the role of internal and external knowledge networks in the firm's home country dominates the production of knowledge while delocalisation of R&D activities is more pronounced in Parma–biotech.

Conclusion

This research reveals the variety in the modes of knowledge production within large firms. This diversity demonstrates how large firms benefit both from their worldwide spread internal skills and from external local networks. To complement the existing local networks, they also develop international partnership either to benefit from complementary skills and knowledge or to remain close to their markets.

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6.1.3 The role of European Programmes in the European distribution of knowledge, the case of nanoscience and technology

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Keywords: knowledge production, geographical agglomeration and networks, nanotechnologies, european research funding

There are multiple on-going debates about knowledge distribution or concentration worldwide. Recent work done by Grossetti et al. 2015 show a ‘deconcentration’ of knowledge production, visible not only at country level (linked to the periodic rise of new countries in the overall scientific production landscape, a long lasting phenomenon) but also at metropolitan / city level. At European level, this raises one central question: does this result that applies to the whole of scientific production also applies to frontier science?

We have addressed this question for nanosciences. The attempts to characterise the dynamics of nano S&T are not new (Noyons et al., 2003). After a review of the different attempts we have developed a fully lexical approach (Kahane and Mogoutov, 2007) which remained however static (considering only the whole period covered). We have updated it since in order to account for the explorations made proposing a ‘dynamic‘ approach (Kahane et al., 2014).

The exploration of the first dataset (1998-2006) enabled a characterisation of dynamics highlighting very strong agglomeration effects since 200 ‘clusters’ (very near in their bottom-up definition to the US definition of metropolitan areas and to the OECD recent developments on “functional urban areas”, OECD 2012) concentrate over 80% of world knowledge production (Delemarle et al., 2009). They provide a very different image than when keeping only track of national developments, thus corroborating the ‘deconcentration’ approach. These clusters gather over 80% of publications. As 70% of these publications come from more than one organisation, we hypothesised that a majority, for a science at the frontier, might be internal to clusters, and this was the case but to a far lower extent than expected, having 40% of total publications being inter-cluster.

Characterising collaboration practices (Larédo and Villard 2015) drove to two major results. First the share of intercontinental collaborations remained marginal (around 8% of total collaborations). This drove us to focus on the 80 European clusters and their collaborations as a dynamics per se. It showed that inter-country links are more important than intra-country ones, once account is taken of one central phenomenon: the very 'national' structure of linkages within the UK. This may also explain as well why, probably for the first time in science history, neither Oxford nor Cambridge play central roles in the European dynamics of science production. They are replaced by 'newcomers' at world level, such as Louvain, Julich or Grenoble. This very European nature of collaborations and networks in turn drove us to consider the role that European funding might play in this concentrated but geographically distributed knowledge production pattern. While there are numerous works on the spatio-temporal dynamics of European funding, in particular the European framework programme (FP) (see e.g, Scherngell and Barber 2011, Scherngell and Lata 2013), there are few empirical works that relate European funding to the spatial distribution of knowledge (see e.g. Hoekman et al. 2013, Di Cagno et al. 2016, Wanzenböck and Piribauer 2016).

Against this background, the objective of this work and presentation is to investigate the role of FP funding for knowledge creation in nanoscience and technology.

In our conceptual approach, we shift attention to two distinct dimensions of knowledge creation: One linked to exploration and the spreading of excellence, and the other associated with the development of exploitation capabilities. We consider publications as markers of exploration and patents as markers of exploitation. We know from previous work that the two spatial distribution of publications vs. patents differs remarkably across the European territory (Laredo et al., 2010) with, at country level, the UK playing a strong role in publications, while Germany plays a major role in patents.

This drives us to test three hypotheses:

- H1 European FP funding tends to reinforce the spatial concentration around central nodes of excellence in the Europe
- H2 European FP funding correspond to a maturing of the knowledge base and thus we can identify a stronger effect of the FPs on exploitation,
- H3 European FP funding is particularly conducive for the constitution of a number of sub-spaces that poorly connect with central nodes both in exploration and in exploitation

It is based on four methodological cornerstones:

- A full update of the nano database until 2012 for publications and patents. For publications, one important aspect is to build indicators of quality, complementary to indicators of size. We use for this citations and well-established measures of excellence (share of top 0,1 and top 1% cited articles in total production of a FUA). This enables to construct both absolute ('market share') and relative ('performance') measures. We remain at the level of absolute measures for patents focusing only on transnational priority patents (see de Rassenfosse et al. 2013 and Laurens et al., 2015)
- An exploitation of the EUPRO database on EU funded projects. EUPRO comprises systematic information on R&D projects and name-standardized participating organizations funded by the EU FP. It covers information on projects and, particularly relevant for this study, on the address of the participating organisations. In order to trace relevant funded projects in nanoscience and technology, we have used a semantic analysis to identify 'nano'- based projects using a simple query on 2 fields (subject index, project title and project objectives).
- A systematic approach of European metropolitan areas, based on OECD FUA approach (OECD 2012) and corresponding to 672 FUAs. Methodological developments were made to allocate addresses to FUAs (Villard 2016)

- We employ descriptive analyses, spatial visualisations and network analytic techniques to address the three hypotheses described above. For hypothesis H2, we employ a regression framework for limited dependent variables given the count nature of our dependent variables, relating the number of Nano publications and patents in Functional Urban Areas (FUAs) to the participation intensity in EU FPs, controlling for other factors influencing exploration and exploitation.

Preliminary results show that there is a clear difference in the relative role and centrality of metropolitan areas when considering publications and European funding. Per se these results are promising and show that we need further comparative approaches of the articulation between European funding and explorative / exploitative activities in nano S&T at European level.

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6.2 Session 6.2

6.2.1 Technological diversification of regions and public R&D funding: Evidence from the EU Framework Programmes

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Keywords: Relatedness, Diversification, EU Framework Programmes

Introduction

Today it is widely agreed that knowledge producing and innovating actors need to constantly re-adapt their innovation strategies in order to react to the increasing pace of technological change and innovative activity (see, e.g., Patel and Pavitt 1997). This forces innovating actors to build up capabilities in cognitive and relational dimensions, in particular through networks and collaborative knowledge production (see, e.g., Scherngell 2013). For regions, it is considered as important to diversify into new technologies and, by this, come into a position to develop new economic activities (Boschma & Frenken, 2011). This however is not equally feasible for all regions, as it depends on their idiosyncratic technological make-up. In recent literature the argument that regions tend to diversify into activities that are closely related to their incumbent ones therefore became prevalent (Hidalgo et al., 2007; Rigby, 2015; Boschma et al., 2015). Relatedness in this context refers to the extent to which different technologies and industries draw on the same knowledge and capabilities.

Thus, from a policy perspective the question arises which factors influence the capability for technological diversification and in particular whether and how public research and development (R&D) subsidies can be a positive impetus. Only a few studies identify factors beyond existing productive and technological capabilities (Boschma, 2017), such as Cortinovis et al. (2016) or Boschma and Capone (2015), who confirm the role of institutions and the form of capitalism in the diversification process. However, effects of public R&D subsidies are not systematically addressed in empirical works up to now. The rationale for subsidizing R&D activities and prioritizing certain fields is to actively shape the intensity and direction of inventive activity and, as a result, the technological diversification process.

Against this backdrop, the objective of this paper is to shed some light on the effects of collaborative R&D subsides on the diversification of European regions. It will more specifically ask to what extent subsidization of a certain technology will lead to the development of a comparative advantage in the respective technology. Secondly it will investigate to what extent subsidization can allow regions to diversify into less related technologies.

Background and hypotheses

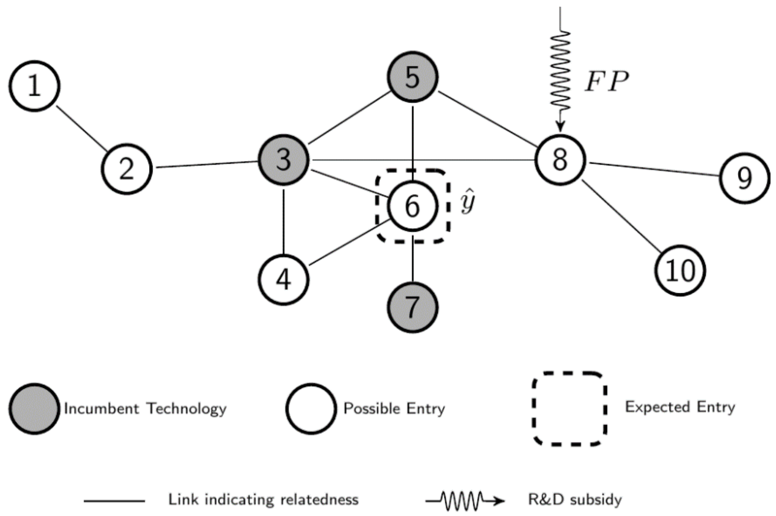
Traditionally, innovation policy aims at fixing market and system failures, mainly by subsidizing R&D activities in order to make up for the appropriability problem or by facilitating knowledge transfers, by promoting R&D collaborations (Aghion et al., 2009). The first question that arises in this context is whether such subsidies can trigger regional innovative activities. Theoretically there are good arguments to believe so, because they give access to extra regional knowledge resources, which can also lead to intra-regional knowledge spillover (Wanzenböck et al., 2014). The first hypothesis will therefore be as follows:

H1: *The participation intensity of a region in FP projects positively influences its technological diversification.*

Further, not all kinds of diversification are qualitatively the same. As the analogy of the knowledge space reveals, some technologies are easier to reach, as the region already has related knowledge and know-how available, while for others it lacks many. Latter is commonly referred to as unrelated diversification. This kind of diversification is rather an exception than the rule. For policy makers on the other hand, this will be the more interesting case, as it comes less natural, but commonly argued to play an important role in the long-term success of regions (Boschma, 2017). As Frenken (2017) lays out, generic R&D subsidization strategies will lead to more related diversification, whereas clearly directed and non-neutral subsidization has the potential to lead to unrelated diversification. This idea is depicted by figure 1, in which technology 6 is closest related to the region's portfolio, but technology 8 gets subsidized. The question will therefore be to what extent research efforts are directed towards field 8 and how this will change the entry probabilities of the respective technologies. Therefore it will be hypothesized:

H2: *The participation intensity of a region in FP projects aiming at a certain technology, decreases the deferring influence of relatedness on a region's capability for technological diversification*

Figure 2: Illustration of Research Questions



Notes: The figure depicts a technology space of a region in which each node represents a technology and the edges indicate whether two technologies are related to each other. In this example the region has a revealed technological advantage (RTA) in technologies 3, 5 and 7. The standard model would predict the entry of technology 6 as it is the most related to the regional portfolio (relatedness density (RD) = 75). Technology 8 however is less related (RD = 50) but the regions R&D activities in this field are supported by public funding.

Data and Methods

The empirical analysis is based on two different data sources. Firstly, the patent data set from OECD REGPAT was used to map the technological diversification of European regions. Secondly, the data on FP participations was extracted from the EUPRO data base. The EUPRO data base contains information about funded projects and their participants on the NUTS2 level and covers all FPs, i.e. 1984-2013. Yet, the information on the latest available programme, FP7, is not completely in the data base yet, and reliable information is available until 2012 (Heller-Schuh et al., 2015). The study area covers collaborative research projects from FP5 to FP7. Since not all subprogram areas from the FPs are relevant for technological diversification, only projects from the cooperation programme from FP7 (excluding “Socio-economic Sciences and Humanities) were selected. Relevant subprogrammes from FP5 and FP6 were selected based on the concordance table provided by Rietschel (2010).

The big challenge for the empirical analysis in this study is to combine two data sets that draw on fundamentally different classification logics; in essence, FP projects have to be assigned to technology domains appearing in patents. In order to match the data sets, a text classification approach was taken, which makes use of the textual descriptions of the FP projects. Thus, each FP project was linked to up to five technology fields, as proposed by Schmoch (2008).

Empirical Approach

In order to estimate the respective effects of subsidization on the technological diversification of European regions, we employ a fixed effects panel regression approach. In so doing 282 NUTS2 regions (EU27, Switzerland, Norway and Iceland) for two four year periods (2003-2006; 2007-2010) are used, in which the independent variables were lagged by one period (1999-2002; 2003-2006). In this approach however, relatedness and entry were computed on the level of 613 IPC classes, while funding related variables where computed on the level of technology fields (Schmoch, 2008).

Given our empirical setting, we employ – as in previous related works (see e.g. Boschma et al., 2015) – a fixed effects linear probability panel regression approach. This allows testing for omitted variables on the regional and technology level that would otherwise be neglected. The model specification in scalar notation is as follows:

$$ENTRY_{i,r,t} = \beta_1 FP_{i,r,t-1} + \beta_2 RD_{i,r,t-1} + \beta_3 FP_{i,r,t-1} * RD_{i,r,t-1} + \theta_i + \varphi_r + \omega_t + \varepsilon_{i,r,t}$$

In this model, the dependent variable $ENTRY$ is a binary variable taking the value 1 if a region r gains a specialization, as measured by the revealed technological advantage (RTA), in a certain technology i, at time t, it was not specialised in at period $t-1$ and the value 0 otherwise. FP is a proxy for subsidization intensity:

$$FP_{i,r,t} = \sum_{p \in i} \frac{x_{p,r} * w_{p,i}}{k_{p,t}}$$

It is measured by the number of participations x of a region r in a project p weighted by the field weight w and divided by the number of periods it covers k. The variable RD denotes the relatedness density (see e.g. Boschma et al., 2015) around a certain technology. The values of this variable range between 0 and 100, where a value of 0 indicates, that no related technologies are existing in a region and a value of 100 indicates, that all related technologies around technology i, are incumbent in region r. Next to FP and RD, an interaction effect FP*RD between the participations and relatedness is included to test the second hypothesis. This will inform about the conditional importance of relatedness at different levels of subsidization and vice versa. In a final step, observations that already have an RTA in period $t-1$ were deleted from the panel.

Table 3: Regression Coefficients Linear Probability Model

ENTRY	Model 1	Model 2	Model 3
Constant	0.1118 *** (0.0006020)	0.1150 *** (0.0006373)	
Log(FP)	0.0118 *** (0.0007677)	0.0159 *** (0.0007625)	0.0167 *** (0.0017133)
RD	0.0031 *** (0.0000458)	0.0030 *** (0.0000466)	0.0003 *** (0.0000804)
Log(FP)×RD		– 0.0010 *** (0.0000529)	– 0.0004 *** (0.0000565)

Notes: The independent variables in models 1 to 2 are mean centered. In model 3 time, region and technology fixed effects are added. Heteroscedasticity-robust standard errors are reported in parentheses. All variables are statistically significant at the *** $p < 0.01$ level.

Results and Conclusion

Overall, the results confirm our two hypotheses. An overview of the regression coefficients is presented in Table 1. Our findings suggest that a region's participation intensity in FP projects indeed increases its likelihood to diversify. However, the marginal effect of this very small. Model 1 suggests that at an average level of relatedness density, a 10% increase in participations results in an increase of the mean entry probability of 1%. Analogously, a 10% increase of relatedness density would increase the mean entry probability by 27%. This is within the range of previous findings (see e.g. Boschma et al, 2015). In line with our second hypothesis, we find that a high participation intensity can to some extent compensate for a lack of relatedness. These effects remain robust, after adding time, region and technology fixed effects.

These results, however, should be interpreted with caution as the study is not free of limitations. First and foremost, the established convergence introduces a set of problems. Due to the imperfection of the text classification, the subsidization of some technology fields may be underestimated, while on the other hand noise can be introduced, when wrong technology fields are predicted. Secondly, only a basic model was estimated, which is trying to capture a complex relationship. A key problem here can be seen in an allocation bias of the funds. This means that funds are a priori allocated in regions that already have an advanced R&D sector, and that are therefore already more capable of diversifying into less related technologies. Finally, by looking at a collaborative funding scheme, more effects can be thought to arise from the collaborations. It would therefore be adequate to also take into account spatial effects, as for instance done by Hazir et al. (2016).

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6.2.2 RTI policy for co-creation activities and its effects on Key Enabling Technologies: Regional evidence from the 7th EU Framework Programme

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Keywords: RTI policies for co-creation, key enabling technologies (KET), regional knowledge production, R&D network embeddedness, spatially filtered negative binomial model interaction effect

Novel and fast-growing technologies have gained anew interest at the European policy level. The emphasis on Key Enabling Technologies (KET) brings technologies into focus that are crucial for the development of the EU towards a sustainable, knowledge-based economy (see, e.g. EC 2012, EC 2015). KETs can be understood as generic technologies, which are characterized by relatively rapid pervasiveness and growth. They constitute technological inputs for the development of innovation, and by this require high R&D intensity and a high input of skilled labour in their creation. As it is assumed, directing knowledge generation towards KETs does not only contribute to the general industrial development but also to meeting the challenges our society is facing today.

Given the strong focus on industrial restructuring and change, stimulating the knowledge generation in KET fields has become one of the major priorities of the EU industrial policy; a priority which shows clear interrelations with current RTI policies or regional policy measures that have been promoted recently at the European level (e.g. in the context of smart specialisation; e.g. McCann and Ortega-Argilés 2015). The general motion when it comes to the role of policy in KETs is to support specialisation based on the region-specific conditions and domestic opportunities to create competitive advantages. However, from the few studies conducted on KET so far (Evangelista et al. 2015, Montresor and Quatraro 2015), we know that KET related capabilities are highly unevenly distributed across Europe, and that these cross-regional disparities are even higher than for average patenting intensities.

In this paper we aim at shifting the focus of the debate to the questions of whether and how current RTI policies for co-creation activities, as reinforced by the EU Framework Programmes (FP), can contribute to a region's propensity to generate knowledge in different KET fields. R&D networks across regional borders have been identified as important stimuli for the innovativeness of regions (see e.g Wanzenböck and Piribauer 2016). Also the policy funds provided by the EU FPs built on the idea that co-creation stimulates knowledge diffusion across regional borders and with that overall innovative activity. Two scientific arguments are relevant in this regard: First, collaborative research provides opportunities to access specific pieces of knowledge in a fast and purposeful way, and second, innovation in regions can be accelerated due to region-external R&D linkages and the new knowledge flowing into the region (Bathelt et al. 2004, Fitjar and Huber 2015).

As we focus on different KET fields, we are particularly interested in whether such a positive influence of collaborative R&D can also hold for specific technologies, given the different rationales and strategies of collaboration, the different modes and spatial scales of knowledge production, or the diversity of technological conditions and knowledge competences needed in the fields. In our empirical analysis we therefore focus on identifying similarities and differences in how EU funded R&D collaborations influence knowledge generation across fields.

To observe co-creation activities in the different fields, we make use of the KET definition as provided by the European Commission (see EC 2015). We first create a list of keywords based on desk research and the screening of background literature. To identify only those collaborative projects which are relevant for a specific field, we scan the descriptions of all projects funded by FP7 with respect to associated key words and vocabulary. Given the network-like character of our data, we use SNA centrality measures for each organisation and aggregate these values (based on their regional assignments) to measure a region's embeddedness in technology-specific pan-European R&D networks. Our regional sample consists of a set of 258 European NUTS2 regions.

The empirical model we are employing in this study is based on the assumption that EU funds for collaborative R&D are only conditionally effective to the generation of new knowledge (Wanzenböck and Piribauer 2016). This assumption is motivated by the following reasons: R&D collaboration, be it policy funded or not, requires own resources and skills which are, on the one hand, necessary to find partners and to provide them with knowledge that is relevant for them to engage in a joint project. These skills may then again be necessary to benefit from the collaboration in form of absorbing external knowledge and combining the individual pieces into new technologies. In other words, regions need 'absorptive capacity' (Cohen and Levinthal 1990) to benefit from co-creation. On the other hand, regions that are already equipped with high own skills are likely to draw lesser value (learning effects) out of their connections (e.g. Goyal 2007). Hence, we assume that the internal skills and human resources of a region might significantly moderate the effects arising from EU-funded R&D collaborations and the way of how external knowledge can be transformed into the generation of new knowledge.

We not only account for this potential non-linearity in our spatially filtered negative binomial model, but also show how the interaction effects between external R&D linkages and internal R&D resources can be interpreted precisely in our modelling approach. Based on specific marginal effect interpretation for count data models we are able to fully disentangle and quantify the impact of EU-funded R&D collaboration, and also compare it across KET fields. Our first empirical results show indeed a significant positive relationship between a region's involvement in FP7 projects and the generation of new technologies in regions, however, with effects being dependent on the domestic skills. Concerning the observed leading technologies, we find significant differences between the KET fields, with the highest relevance of region-external R&D collaboration for industrial biotechnology and microelectronics but comparatively low collaboration effects for photonics or advanced materials.

Based on these first results, the paper provides interesting empirical insights in how R&D collaborations funded by the FP7 relates to domestic skills and knowledge generation activities in KETs. The similarities and differences we found for these leading technologies call for further investigation, for instance with respect to field-specific knowledge creation modes and institutional configurations, or the dominant collaboration behaviour and its spatial scale. Especially the latter might be of particular importance for a more comprehensive perspective on EU policies, where the interrelations between the major RTI policies for co-creation (FPs), industrial (KETs) and regional policy strategies (smart specialisation) are thought in an inclusive way.

6.2.3 Participation of EU 13 Countries in FP 7 and Horizon Programs Measured by Segregation Indexes

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Research Subject

The debate on research collaboration activities within European Research Area funded by EU Framework Programs (FPs) has more recently concentrated on participation of EU-13 countries within FPs, which has remained very low and even decreased despite of the increasing research capabilities in those countries and increasing co-publication rates with EU old members (Makkonen, Mitze 2015). In 2016, a public hearing was held in European Parliament on closing the success gap in FPs concluded that the "*EU-13 participation in H2020 is still very low and without intervention this trend is likely to continue*." However, besides studies reporting lower participation and success rate indicators (number of granted projects, funding etc.), there have been relatively few reports investigating more closely the geographical distribution or pattern of participations from EU-13 countries across applications and projects. This study aims to assess, how segregated (opposing to integrated or homogenously distributed), are the EU-13 participants across projects and applications in two recent FPs and how this segregation has changed in time.

Participation in EU-funded research programmes has been relevant for both EU and non-EU researchers, universities and national research systems for increasing their international visibility, exchanging knowledge and experience, but also for training and career advancement etc. (e.g. Hakala et al. 2002, Prohoryles 2002, Enger & Castellacci 2016). It has been discussed that the FP participation has created more durable links between the collaboration partners (Prohoryles 2002, Barber et al. 2006). However, as the network patterns have still remained quite fixed, especially in larger member states, it has been concluded that Europeanization has been more common amongst smaller European countries (Okubo and Zitt 2004; Tijssen 2008). Considering spatial studies, researchers have found geographical, cultural, institutional and technological barriers hindering this kind of research cooperation (Schrengell, Lata 2011). FP funding seems to substitute the resources from other sources in old member states, but tends to compensate for their less developed infrastructure in Central and Eastern European members thus being found a viable option for increasing regional innovativeness in these regions in combination with other policies (Varga & Sebestyén 2016).

Methodology

We employ here the indexes of segregation, which are commonly used quantitative measures describing the social separation. "People get separated along many lines and in many ways. There is segregation by sex, age, language, religion, color, taste, comparative advantage and the accidents of historical location. Some segregation results from the practices of organizations; some are deliberately organized; and some results from the interplay of individual choices that discriminate. Some of it results from specialized communication systems, like different languages." (Schelling 1971:143).

The total number of participations is T, and M is representing the participations from the EU 13 country group (0 < M < T). The overall fraction of EU-13 country participations is P=M/T. In case there are n projects, the $p_i = m_i/t_i$ is the fraction of EU-13 participants in the particular project i. We calculate first, the index of dissimilarity (D) (originating from Duncan & Duncan 1955, but in this version adopted from Baroni, Ruggieri 2017):

$$D = \frac{1}{2 \cdot P \cdot (1-P)} \sum_{i=1}^{n} \frac{t_i}{T} \cdot |p_i - P|, \tag{1}$$

where *2P(1-P)* is a normalization factor to place the index in the range between 0 and 1. Dissimilarity index would be in its minimum, when the distribution of participants from EU-13 countries is uniform over the projects. (Similar measures of Theil and Gini indexes could be calculated here, too (Duncan & Duncan 1955)).

Secondly, we calculate *the isolation index,* which is defined as the likelihood of a participant from EU-13 countries is exposed to another member of the same country group in a project. For the particular project *i*, this is estimated as the product of the likelihood that a member of the EU-13 countries is in the project (m_i/M) by the likelihood that she is exposed to another EU-13 participant in the unit (m_i/t_i, or p_i) assuming that the two events are independent:

$$I = \frac{1}{M} \cdot \sum_{i=1}^{n} m_i \cdot p_i \tag{2}$$

The isolation index runs over the range from *P* to *1*, whereby higher values denote higher segregation. Again, the minimum value is reached where $p_i = P$; maximum value is reached where there is only *k* such that $m_k = t_k = M$ that means when there is the only unit containing all EU-15 members and no EU-13 member.

A complementary measure is the *interaction (or exposure) index,* which is the likelihood that a member of the minority group is exposed to a member of the majority group in a unit, which is the following:

$$Int = \frac{1}{M} \cdot \sum_{i=1}^{n} m_i \cdot (1 - p_i) \tag{3}$$

It is clear from (2) and (3) that *I* + *Int = 1*.

As the totals of *T* and *M* cannot be so easily detected from the data, but also participants can join several projects, we use here $T = \sum_{i=1}^{n} t_i$ and $M = \sum_{i=1}^{n} m_i$, then the size of total population of participations is by definition the sum of the sizes of the unit (project) populations, and similarly for the minority group (Baroni, Ruggieri 2017).

Data

The data comprises of the European Commission's ECORDA dataset for FP7 and for Horizon 2020 projects comprising the total number of participations (T) in FP7 granted projects (T_{FP7} = 136341) and Horizon 2020 granted projects (T_{H2020}=49017). The participations (M) of EU-13 country researchers/research groups are, respectively M_{FP7}=10884 and M_{H2020}=4144, and the overall fraction of participations (P) from EU-13 is P_{FP7}=0.0798 and P_{H2020}=0.0845.

Results

The first empirical results show that the segregation of EU-13 participations has increased from 0.61 to 0.64 if judged by the value of dissimilarity index. Similar results are reflected by the indexes of isolation and interaction (Table 1). There are no common rules on how to judge or interpret more broadly these indexes, for example Marcińczak et al. (2015) suggest to adapt commonly used thresholds in ethnic segregation (D < 30 indicating low and D > 60 high segregation) to a lower level in case of socio-economic segregation thus D < 20 indicating low and D > 40 high segregation. Hence D values show high and growing segregation levels in EU FPs along old-new membership divide.

Table 1. Segregation index values for the EU-13 participations in Framework Programs, BONUS and Interreg

	Index of dissimilarity (D)	Index of isolation (I)	Index of interaction (Int)
FP7	0.61	0.32	0.68
H2020	0.64	0.37	0.63
FP7 (Baltic Sea region)	0.61	0.29	0.71
H2020 (Baltic Sea region)	0.64	0.37	0.63
BONUS	0.37	0.32	0.68
Interreg	0.27	0.38	0.62
Interreg (Baltic Sea region)	0.33	0.34	0.66

Source: Authors' calculations

Compared to the smaller and regionally/thematically focused programs (as BONUS, Interreg), it can be shown that although the dissimilarity index is lower there (stemming from the smaller number of participants), still the probability of having other EU13 partners in the project remains about one third.

The segregation indicators are calculated also based on the thematic fields or priorities (as far as these have been comparable between FP7 and H2020) in Table 2. It can be seen that the projects under "Spreading excellence and widening participation" have clearly reduced segregation indicators in H2020. The other topics show increased (or similar level) segregation in the conditions of smaller number of projects (thus confirming the results of the segregation increase on the more general level shown in Table 1).

The limitations of the indicators are related to the fact that the underlying segregation processes are not revealed, e.g. how much from these general trends are attributable to the lower investment in R&D (personnel, infrastructures), less efficient R&D systems and policies, closed networks, but also brain drain problems due to salary gaps (Calsworthy & McKee 2013).

Table 2. Segregation index values for the EU-13 participations in Framework Programs and Horizon 2020 by Thematic Priorities

EU13	FP7				H2020			
	D	I	Int	# projects	D	I	Int	# pro-jects
Research infra-structures	0.43	0.21	0.79	341	0.47	0.17	0.83	153
Spreading ex-cellence and widening partic-ipation	0.57	0.46	0.54	475	0.52	0.53	0.47	118
Leadership in enabling and industrial tech-nologies (LEIT)	0.61	0.18	0.82	3914	0.67	0.28	0.72	2104
Health, demo-graphic change and wellbeing	0.68	0.19	0.81	1006	0.67	0.24	0.76	547
Secure, clean and efficient energy	0.61	0.21	0.79	374	0.60	0.32	0.68	624
Smart, green and integrated transport	0.60	0.21	0.79	635	0.61	0.27	0.73	597
Climate action, environment, resource effi-ciency and raw materials	0.54	0.20	0.80	494	0.51	0.23	0.77	328
Secure socie-ties - Protecting freedom and security of Eu-rope and its cit-izens	0.51	0.21	0.79	319	0.57	0.27	0.73	169

Europe in a changing world - inclusive, in-novative and reflective Soci-eties	0.37	0.22	0.78	253	0.47	0.26	0.74	191
Science with and for Society - Cross-theme	0.39	0.24	0.76	183	0.39	0.25	0.75	53

Source: Authors' calculations

The policy measures that could be considered to reduce the segregation of EU13 belong to the following categories:

- Increasing the participation (especially coordination) capabilities of EU13 countries;
- Increasing the mutual cooperation of EU13 members within Horizon projects;
- Increasing the intake (mutual, but especially on behalf of EU15 coordinators) of broader geographical coverage of partners to the projects;
- Some limitations set on the numbers of project partners might also improve the segregation situation of EU13.

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6.3 Session 6.3

6.3.1 International University Research Ventures: An Emergent Node in Global Knowledge Networks?

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Keywords: globalization of R&D, global knowledge networks, university internationalization, research university, joint research venture

Research universities around the world are increasingly seeking to establish long-term institutional research presence overseas through the creation of research centres, facilities and partnerships outside of home countries. Examples include research centres opened by Massachusetts Institute of Technology (MIT), the University of Cambridge, and the Technical University of Munich at CREATE campus in Singapore; R&D facilities at Georgia Tech's campus in Lorraine, France; and Fudan-Yale Biomedical Research Center in China. We argue that such international university research ventures (IURV) are a distinct type of intermediary node in global knowledge networks that emerged relatively recently at the intersection of two trends: (1) expanding international research collaborations, and (2) globalization of higher education. IURVs differ in form and function, while their scope often includes not only research but also an expanding mix of knowledge exchange and developmental objectives, suggesting growing IURV impact not only on global knowledge production but also on human capital, innovation, economic competitiveness, security, and international development.

Previous literature related to the topic has focused either on the internationalization of higher education (Altbach and Knight 2007, Kinser and Lane 2015), or on international research collaborations in general (Katz and Martin 1997, Wagner and Leydesdorff 2005). There are only a few case studies of IURVs (Friedman 2005 pp.301-303; Bonnema et al. 2006; Pfotenhauer et al. 2013; Hird and Pfotenhauer 2016). Even fewer studies tried to look at the effect of IURVs in the national context (Jonkers 2009; Jonkers and Cruz-Castro 2010; Guimon 2016), and no study attempted to understand and explain global proliferation of IURVs or their impact on global knowledge flows. To fill this gap in knowledge, we have undertaken an exploratory study of the scale and scope of global IURV activity. Following the research collaboration typology proposed by Katz and Martin (1997), we focused only on initiatives in the internationalization of university research at the inter-institutional or departmental level rather than on a micro-level of individual or team research collaboration, or a macro-level of inter-governmental research cooperation. An entity was considered an IURV if explicit evidence of R&D activities and affiliation with the „parent“ university was found for it, and it had distinct institutional characteristics, including name; governance structure; and institutional (rather than individual) commitment of resources to it. We also excluded from consideration university activities focused only on international education; formal Memoranda of Understanding between institutions not supported by actual research activities; and large networks of multiple actors, such as university alliances. We focused on IURVs that undertake research in science and engineering, social sciences, health and medicine, and agriculture.

We collected relevant quantitative and qualitative data by web scraping the websites of research universities, their partners, and IURVs, and supported it with additional evidence from related policy documents and news sources. Several in-depth case studies were also conducted which included travel to IURV locations and interviews with local researchers and administrators. The initial effort targeted the sample of 108 top U.S. research universities as defined by the "Carnegie Doctoral/Research Universities – Very High Research Activity" classification, 2010 edition. The database is being expanded to include the sample of 40 top non-U.S. research universities based on Times Higher Education World University Rankings 2016, plus an additional 40 top non-US and non-European universities from the same rankings stratified by region to ensure broader regional coverage. The non-US research university sample totals 80 universities.

First results convincingly confirm that IURVs are, indeed, a global phenomenon. Our current analysis finds 392 unique IURVs created by 54 U.S. and 45 non-U.S. universities in 84 countries. While the majority of IURVs are located in emerging economies, with China (125 IURVs), India (24) and Singapore (22) as distinct leaders, the full geographical distribution is more dispersed. We found IURVs established in some of the most and the least developed or research-active countries in the world. Top European research universities show stronger engagement in IURVs, with 87% of the European sample reporting at least one, compared to roughly 50% of their North American and Asian peers. In contrast, countries in Africa and Latin America tend to be on the receiving end of joint research ventures, hosting 48 and 27 IURVs correspondingly, but "exporting" little to none. The top IURV-creating institutions are the University of Oxford with 30, MIT (24), and the Chinese University of Hong Kong (21).

IURVs are a relatively recent phenomenon. While the earliest IURV in the sample has been in operation since 1954, a significant growth in IURV entry started only around the turn of the 21st century and continues to this day, with the peak of 39 new entries reached in 2012. Most recorded IURVs are still currently active; only 22 of them were found to terminate operations or become independent. Furthermore, it is a distinctly networked phenomenon. For example, only 4 out of 183 IURVs created by universities in the U.S. sample did not mention having any partners in the host countries. Partnerships may include local universities and public research institutions (PRI); national, regional, or local governments; local industry or multinational companies (MNC); community-based non-governmental organizations (NGO); charity foundations; and international development structures such as the United Nations Development Programme or the World Bank.

IURVs are distinct from other types of international research and development (R&D) ventures created by MNCs (Von Zedtwitz and Gassmann 2002; Allen and Link 2015) or by mission-driven PRIs (Zacharewicz et al. 2017). In contrast to them, IURVs tend to exhibit opportunistic and exploratory rather than strategic behavior in their activities, following an evolutionary rather than planned pathway of development and gradually expanding the scope and scale of their activities. Strategic planning and behaviour are rarely seen in decisions to establish a particular IURV. For example, we found that in the full sample of 108 U.S. research universities, only 47 had any kind of international strategic plan, and there was no correlation between the availability of international strategy in the university and IURV engagement.

IURVs are rarely focused strictly on research and nothing else. They often add some combination of education, commercialization and economic development activities to research, with significant number of them (e.g. 31% for the U.S. subsample) adopting all four missions. Moreover, IURVs are not static: typically, the earlier IURV was established, the broader the scope of its activities is at the present day. We can conclude that by following this trend, IURVs tend to mirror the growing role of universities as a whole (Youtie and Shapira 2008). IURVs also tend to become more autonomous with time.

Drawing on our findings, we propose a four-stage model of IURV life cycle. At the first stage, a weak, often informal collaborative link is established between two institutional partners. It is mainly driven by one or some combination of the following factors. First, personal connections of individual faculty members matter. Second, “parent“ universities are attracted by opportunities for excellent research in host countries provided by the strength of their domestic research system or their unique environment. Third, domestic science, innovation and economic development policies in host countries can create demand and provide funding for engagement with top foreign research universities. Finally, some university collaborations emerge in the international development context and initially target basic developmental needs in low-income countries.

At the second stage the strength and complexity of the collaborative link grows to the point where its formalization is sought by partners, either in need for coordination, or as a response to institutional pressure from both home and host countries to organize, control and appropriate the flow of knowledge between partners. IURV then becomes formally established and develops a variety of institutional characteristics typical of research organization, such as the name, agreement on roles and responsibilities of partners, resource commitment, research agenda, governing bodies, and administrative as well as research personnel (Youtie et al. 2006). It has a hybrid function of being both an intermediary in knowledge exchange between partners, and knowledge-producing entity in itself.

At the third stage, an IURV goes through further formalization and increase in complexity of institutional characteristics, and expands the scope of activities by adding partners, expanding research agenda, and adopting new missions, such as education, commercialization, or economic development. From being merely a hybrid intermediary in knowledge creation and exchange between partners, it becomes an autonomous actor in its own right. Not all IURVs reach this stage, with some maintained at earlier stages of institutionalization. Finally, at the fourth stage, autonomy can lead to independence, although only a few IURVs in our sample went all the way to this stage. It should also be noted that as a result of conflicting interests and tensions between partners, or exhaustion of resources committed to the venture, at any stage of development IURVs can be either absorbed by one of the partners or completely dissolved.

Our findings suggest not only differences but also certain similarities between the processes of worldwide expansion of IURVs, development of complex international science, technology and innovation partnerships (Pfotenhauer et al, 2016), proliferation of international branch campuses (Kinser and Lane 2015), and internationalization of public research institutions (Jonkers and Cruz-Castro 2010, Zacharewicz et al. 2017). It is possible that these examples are different facets of the same phenomenon of increasing complexity of international knowledge networks (Wagner and Leydesdorff 2005). Evaluating the impact of IURVs on global knowledge flows and probing the generalizability of our findings with other types of international R&D ventures are the next steps in this line of research.

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6.3.2 Regional innovation policy and the geography of systemic failures

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Keywords: Regional innovation system, Innovation policy, Systemic failure, Innovation networking

Summary

In this paper, we develop a geography of systemic failures at the regional level, providing a clear link between types of regions and type of failures. Previous literature has emphasized the possibility of linking certain general characteristics of regions with specific failures of the innovation system. However, the variety of the cases, contexts and concepts used in these studies does not allow regional comparisons. We construct this geography of systemic failures based on information from almost two hundred regions of EU members, to suggest a clear regional component of policy design, and to discuss selected cases of regional innovation policy in the light of the geography of systemic failures. Preliminary results show that the complexity of regional policy design might be significantly reduced knowing that similar regions face similar problems. For example, we show that the creation of non-regional (e.g. national and foreign) networks might be, in some important cases, the symptom of not necessarily a "strength", but a "failure" of regional innovation systems. This possibility suggests a complex/non-linear approach to the relation between networking and incentives to innovate, providing a clearer picture of the geography of open innovation and its specific role in the strengths and weaknesses of agents within each region. Connectivity between agents is crucial to innovative activity. Innovation policy instruments are currently directed to promote this connectivity through different participation schemes. However, as our results show, one size does not fit all, in the sense that patterns in network formation could evolve in ways that consolidate regional systemic failures in knowledge flow. The design of innovation policies should consider the complex (non-linear) relationship between the formation of innovation networks and the incentives to undertake innovative activities. Finally, the paper also discusses how the possibility of generating reliable and comparable empirical information on these types of regional patterns might reduce significantly the efforts in policy design.

Antecedents

A recent study of the innovation policy mix in EU countries finds that most countries are deploying similar combinations of instruments irrespective of their innovation position or the specific challenges they face (Veugelers, 2015). However, specialized literature on regional innovation systems points to the fact that policy action must target specific problems that may vary across regions, since the agents within each region might have specific strengths and weaknesses, and face different obstacles to innovate (Asheim et al., 2003; Cooke and Memedovic, 2003; Dohse, 2000; Edquist, C., 2005; Borras and Edquist, 2013). In the field of evaluation, there is also some consensus around the strategy of identifying these problems as "malfunctions" or "failures" of a system, where available knowledge is created and applied within networks whose limits fall beyond the boundaries of one isolated organization (Smith, 1999; Edquist et al., 1998; Klein Woolthuis et al., 2005; Bergek et al., 2008; Jenson et al., 2016). This research line allowed to emphasize not only the need for supporting the creation of knowledge within organizations (such as

firms), but also to pay attention to the incentives and obstacles faced by organization in "opening" to the use of external knowledge.

The emergence of certain specific systemic failures might follow regional patterns (Feldman, 1994; Feldman and Audretsch, 1999; Fritsch, 2000; Fischer et al., 2001; Tödtling and Trippl, 2005; Camagni and Capello, 2013; Ooms et al., 2015). Obviously, this must be true (at list to some extent) given the fact that the creation of networks is subject to "location constraints" in knowledge spillovers (Jaffe et al., 1993; Audretsch and Lehmann, 2005; Acs et al., 2013). But, more interestingly, there is also evidence that there might be certain types of failures typically showing in certain types of regions. For instance, in a very lucid literature review Tödtling and Trippl (2005) suggest that failures such as "organizational thinness", "lock-in" and "fragmentation" might be attached, respectively, to peripheral regions, old industrial areas, and some metropolitan regions. These line of research showed a simple picture of a geography of systemic failure, linking types of regions to specific types of failures. However, the variety of the cases, contexts and concepts used in these studies does not allow a clear regional comparison. The possibility of generating reliable and comparable empirical information on these regional patterns might reduce significantly the efforts in policy design, by increasing the possibility of coordination at different governance levels.

In this paper, we identify these regional patterns though empirical analysis to suggest a clear regional component of policy design, and to discuss specifically selected cases of regional innovation policy in the light of the geography of systemic failures.

Methods

We use a database with almost two hundred regions of EU members, constructed with different official sources like OECD, Eurostat and World Bank. In the empirical analysis, the typology of regions and failures is supported by specialized literature on regional innovation systems and systemic failures, respectively. Research methods include descriptive statistics, econometric modeling and case studies. For example, in this stage of our ongoing research we use descriptive statistics of co-patents to show the complementarity/substitutability between regional and non-regional networks, and we also propose an econometric model to estimate the effect of these types of networks on innovative activities, and to study the possibility of nonlinearities in this relation. This results allows to identify typical and atypical cases for in-depth analysis and policy discussion.

Preliminary results

Our results show that even though each region must be taken as a singular case, the dimensionality of regional policy design might be significantly reduced knowing that similar regions face similar problems. Some specific patterns found at this stage of this ongoing research are: (a) the effect of regional networks on incentives to innovate is typically higher than other non-regional (e.g. national and foreign) networking, and (b) the different types of non-regional networks are typically complementary to each other, and substitutes of regional networks. Together, both results are consistent with the possibility of observing the creation of non-local networks as a symptom of "organizational thinness" within the region. This possibility suggests a non-linear approach to the relation between open innovation and incentives to innovate, providing a clearer picture of the geography of open innovation and its specific role in the strengths and weaknesses of agents within each region.

Connectivity between agents is crucial to innovative activity. Innovation policy instruments are currently directed to promote this connectivity through different participation schemes. However, as our results show, one size does not fit all, in the sense that patterns in network formation could evolve in ways that consolidate regional systemic failures in

knowledge flow. The design of innovation policies should consider the complex (non-linear) relationship between the formation of innovation networks and the incentives to undertake innovative activities.

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6.3.3 Interdisciplinarity in academic research? Evidences from competitive project funding

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Keywords: interdisciplinarity, multidisciplinarity, academic research, project funding, disciplinary boundaries

Aim of the paper

Several papers in the literature highlight the shift toward crossing the disciplinary boundaries that characterizes the new ways of knowledge production, with interdisciplinary work gaining importance. Since the nineties Gibbons and colleagues highlighted that modern science is adopting new organizational forms largely using trans-disciplinary perspectives instead of disciplinary or multidisciplinary ones (Gibbons et al., 1994). In late 2000s Bonaccorsi pointed out the notion of search regimes as a way for investigating the new dynamics in emerging research fields where interdisciplinary approaches are very important (Bonaccorsi, 2008). Despite the advantages of interdisciplinary research, the literature also illustrated several constraints in public competitions for academic funding. In fact, evaluation practices largely show disfavour toward non-conventional research (Lamont et al., 2006; Langfeld, 2006; Laudel 2006; Klein, 2008; Wooley et al., 2014, Bromham et al., 2016). Moreover, the assumption that interdisciplinary research is more direct toward solving practical problem is not generally recognized (Katz and Martin, 1997).

Using a sample of principal investigators (PIs) that succeeded in academic not-oriented project funding competitions from 2000 to 2011 in Italy, the paper investigates the characteristics of academics with interdisciplinary research orientation with respect to those more disciplinary oriented. The research questions are: how scholars dealing with interdisciplinary research appreciate the quality of their projects, and the stability of the collaborations of the research teams? How they assess the importance of interdisciplinary when they act as peers of projects submitted for funding, comparing with those dealing with disciplinary research?

Because motivations and reputation of academic researchers are not based on interdisciplinary research, we expect that researchers do not consider interdisciplinary as a feature of specific quality/advantage/disadvantage; however the collaborations in research projects between scholars with an interdisciplinary-oriented profile might show a lower stability over time than those between researchers more disciplinary-oriented because the issues addressed through interdisciplinary research change very frequently, and the projects needs different combinations of competencies.

Interdisciplinarity is the tendency toward the integration of different disciplinary perspectives in order to solve a complex problem, which needs different types of knowledge and expertise (Ribeiro, 2015). In this paper we consider multidisciplinary research the activity that integrate different sub-fields within the same disciplinary area to address the proposed research questions; we consider interdisciplinary research when the activity integrates different disciplinary areas in order to address research questions that are generally aimed to solve a complex scientific problem.

Conceptual framework and methodological approach

The paper uses evidences coming form the scholars funded -in the period from 2000 to 2011, under the Italian Programme of Research of Relevant Interest-PRIN, a responsive mode funding scheme for academic research, basic and applied, in all disciplinary fields, with a selection based on peer review. PRIN is similar to other existing schemes in European countries, which are devoted to support collaborative academic research using competition in order to select the best proposals.

The conceptual framework is based on the socio-cognitive triangle developed by van Raan (2000) in order to study the characteristics of interdisciplinarity. We use the van Raan's working hypothesis of problem-driven motivation of scholars and reputation-driven regulation, which form the socio-cognitive triangle driving interdisciplinary research, to consider the following hypotheses:

1. Scholars dealing with interdisciplinary approaches do not consider their projects more innovative than scholars with a multidisciplinary or a disciplinary approach. The capability to generate innovative results is not related to the orientation toward interdisciplinary research.
2. The interdisciplinary orientation of a project proposal represents neither a positive nor a negative criterion in the peer assessment, since it is not perceived as a signal of quality of the projects per se.
3. Researchers dealing with interdisciplinary issues have less stable collaborations than their colleagues more oriented toward multidisciplinary/disciplinary research. Dealing with changing societal problems needs different expertise and competences, so they tend to be more flexible than the others.

The paper focuses on scholars belonging to four disciplinary areas (Physics, Chemistry, Economics and Sociology), which allows pointing out whether differences between fields emerge as to the characteristics of interdisciplinary research.

The evidences used are data collected though:

- Secondary data on the PRIN allocation for disciplinary, multidisciplinary and interdisciplinary projects from 2000 to 2011 in the four areas;
- A on-line survey on researchers acting as principal investigators (PIs) in the competitive project funding scheme PRIN, the most important funding instrument aimed at supporting academic research in Italy, either curiosity driven or applied, in all fields of sciences. The survey covers and collected answers from 983 researchers, 23% of the total population of researchers funded by PRIN from 2000 to 2011 in the same areas (4,322). Data are analysed through descriptive statistics.

Results

The analysis shows that the attributes of interdisciplinary research being 'more creative' than disciplinary/multidisciplinary, more oriented toward applied research, more unstable in the collaborations are not supported by evidences demonstrating that academics recognize the mentioned characteristics. Interdisciplinary research therefore does not have a special consideration in the peer assessment, positive or negative, as far as academic research based on competitive responsive mode funding is concerned. This observation has been verified both for researchers with an interdisciplinary research orientation and researchers with a disciplinary/multidisciplinary orientation. Finally, the four broad scientific areas investigated do not present important differences in the proposed analysis.

In sum, there is not an inbred tendency of academic scholars to consider interdisciplinary research as generating more quality in the results; instead, it is the changing socio-cognitive reference driving the emerging of interdisciplinary and its appreciation by scholars.

However, the analysis of secondary data shows that the higher the funding available for the PRIN programme per year, the higher the proportion of interdisciplinary oriented project funded. This might be a signal that when funding is scarce, projects with an interdisciplinary orientation are less likely to be funded. Thus, an open issue to be explored is also whether the magnitude of funding mobilized might discourage the decision of researchers to submit an interdisciplinary-oriented project because of the low possibility of succeeding affecting interdisciplinary oriented projects in peer review.

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6.4 Session 6.4

6.4.1 Economic crisis and company R&D in Spain: do regional and policy factors matter?

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Keywords: R&D investment, economic crisis, resilience, regional innovation policy

The financial and economic crisis which began in 2008 has had a far-reaching impact on countries around the world. Several recent empirical studies have shown that the crisis has also affected the innovation behaviour of firms (Filippetti & Archibugi 2011; Paunov 2012; Archibugi et al. 2013a,b; Peters et al. 2014; Holl & Rama 2016) and its components, e.g. in-house R&D.

This paper proposes to examine changes in firms' internal R&D expenditure since the onset of the economic crisis and their relationship to regionally specific factors, including regional R&D policies. Few studies have analysed the role of regional location in innovation persistence; some recent exceptions are, Eickelpasch (2014), Tavassoli and Karlsson (2016) or Holl and Rama (2016). There is still little known about the degree to which regional factors and regional government innovation policies have shaped companies' innovation behaviour in response to the economic crisis. There has been very little empirical research into the possible effects of innovation policies on multilevel innovation systems in company R&D and innovation dynamics. To the best of our knowledge no research has included regional R&D policies in an analysis of comparative perspective. For comparison among regions, we propose to distinguish between factors associated to the size of the regional economy, the type of regional innovation system (RIS) in place and the importance of regional R&D policy. Particularly in multilevel systems such as Spain, this can contribute to a better understanding of company innovation strategies and their determinants during the crisis.

There is broad agreement among economists and policymakers that economic growth is today largely driven by the capacity of firms to innovate. As shown by a study of Germany, firms with greater innovation expenditure during the crisis are able to put new products or better quality products onto the market earlier than their competitors when the crisis is over (Hud & Rammer 2015). Therefore, the behaviour of corporate R&D expenditure during the crisis may, indirectly, anticipate the recovery of regional and national economies; consequently, the present study is of great interest.

During economic downturns companies may be faced by financial constraints, such as the shortage of bank credit or the reduction of public R&D funding as a result of fiscal consolidation policies; given such circumstances, account must be taken of the different roles of the various governments' funding sources and levels, especially regional ones, and previous analyses of multi-level systems must be extended to crisis times.

We propose the following research questions:

RQ1: Do regional characteristics influence the innovation resilience of firms?

RQ2: Do changes in regional public R&D budgets during the crisis affect regional firms' resilience in terms of innovation activities?

RQ3: How do regional characteristics mediate the impact of regional R&D policy on innovation resilience?

Spain provides an interesting setting for analysing the role of regions and their differential support for local firms. Not only has Spain been one of the countries worst hit by the economic crisis, it also has a highly decentralised, quasi-federal political structure. Spanish regions have very diverse economic structures and also different degrees of fiscal and political autonomy and various priorities regarding R&D and innovation; they vary greatly in terms of their innovation performance and in their science and technology policies (Sanz-Menendez & Cruz-Castro 2005). Moreover, regional responses to the economic crisis have also varied. This paper aims to contribute to the literature on innovation resilience by taking into account characteristics of the regional economy, the regional innovation system (RIS), and the role of different levels of government support for R&D investment.

We will use data from the Spanish Technological Innovation Panel (Panel de Innovación Tecnológica, PITEC), a survey performed by the Spanish Statistical Office (Instituto de Estadística Nacional, INE) under the auspices of the Community Innovation Survey (CIS). PITEC includes information on the technological innovation activities of all the principal sectors in the Spanish economy, including services and manufacturing.

We are focusing on the changes that have taken place since 2008. For this purpose we focus on how factors related to company location are related in turn to decisions regarding innovation expenditure following the onset of the economic crisis. Specifically, we analyse the probability that firms abandoned expenditure on internal R&D during the crisis period.

Accounting for regional factors and R&D policies:

In order to address our first research question we start by testing regional dummies for the 17 Spanish regions. Regions in Spain have, as has been stated, diverse economies and varying degrees of fiscal and political autonomy. The inclusion of regional dummies will take account of such regional differences. Secondly, we try to open the "black box" and test for specific regional characteristics. We include regional GDP in 2008 to proxy the economic size of regions. Next, we characterise the RIS. Autio (1998) distinguished two building blocks of the RIS: i) the knowledge application and exploitation sub-system, and ii) the knowledge generation and diffusion sub-system. The knowledge exploitation system is characterised by a dominance of companies' R&D and their respective innovative networks. By contrast, the knowledge generation system is characterised by regional R&D concentrated in public research institutions such as the government and higher education sector. RIS differ insofar as they are based more on a knowledge exploitation subsystem or a knowledge generation subsystem. In other words, certain RIS may be mainly "entrepreneurial", while others may be principally "institutional" (Cooke, 2009). We use the

location quotient to measure the dominance of the specific RIS subsystem. The variable LQ_BERD is defined as the share of regional business expenditure in R&D (BERD) in regional gross expenditure in R&D (GERD) divided by the national share of BERD in total national GERD; in this way the comparative RIS type among regions is measured.

To the best of our knowledge this is the first time that regional government budgets assigned to R&D are included as an explanatory factor. To address our second research question, and to account for the importance of R&D in regional budgets and the role of regional public support for private R&D investment, we use the change in regional R&D budgets: (Δ regional R&D budget: 2008-2012). In order to answer our third research question we include the interaction between LQ_BERD and the change in regional R&D budgets; this will show whether the RIS subtypes influence policy outcomes and under what conditions the changes in regional R&D budgets could reinforce company resilience.

Accounting for firm-specific characteristics:

We include a wide range of firm-specific characteristics as control variables. Here we draw on the firmly established literature which has analysed various firm-specific characteristics and their relationship to innovation persistence in general (see Cefis & Orsenigo 2001; Peters 2009; Martínez-Ros & Labeaga 2009; Antonelli et. al. 2012, amongst others).

Our preliminary findings show significant regional heterogeneity in innovation persistence, related to regional economic size and the type of RIS. Public R&D funding, especially regional funding, also matters. Those firms receiving public financial support prior to the onset of the economic downturn display a lower probability of abandoning innovation activities. However, our results also indicate that changes in the intensity of regional R&D policies during the crisis have only meant lower rates of the abandonment of innovation by companies in regions where a strong knowledge exploitation system is in place.

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6.4.2 What determines industrial funding for university research? Exploring economic and proximity factors

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Keywords: university-firm interaction, contract research, geographical distance, regional co-location, university characteristics

In a nutshell, the paper focuses on the amount of contract research from firms to universities and the role of distance, accounting for differences in firm and university characteristics. Our main proposition is that a firm sources relevant university research wherever it is offered and not necessarily from nearby universities. Hence, we nuance the attraction of universities with respect to firm location as being of second order importance. Based on a panel of three consecutive waves of R&D surveys the linkages of R&D active firms with universities are examined for the small open economy of Belgium.

There is now a large empirical body of research on university-industry linkages based on large surveys, patent (citation) analyses, bibliometric research and case study material (Fontana et al., 2006). Also the topic of R&D collaboration has had much attention. However, the practice of contract research to universities remains understudied as a particular source of knowledge. Hence our paper meets the call from D'Este and Patel (2007) and focuses on the industrial funding by firms to universities and the role of distance, accounting for firm and university characteristics. These are examined for the small open Belgian economy.

The paper contributes to research in four ways. First, it advances an understanding of contractual university knowledge sourcing at different spatial scales by including the international linkages. Second, the paper contributes to the ongoing debate on the impact of the physical distance between firm and university using the amount of contract research as a starting point. Third, we contribute to the debate on the effects of regional co-location of firms and universities. Fourth, by accounting for idiosyncratic university characteristics, this study treats universities as a heterogeneous group of actors accounting for differences in research capacity; research quality; and scientific disciplines.

Various actors and channels exist for transferring knowledge and technology between firms and universities (OECD, 2002; D'Este and Patel, 2007, Perkmann et al., 2013). These channels can be organised using different dimensions. For instance, formal versus informal (Schartinger et al., 2002; Trippl et al., 2009; Grimpe and Hussinger, 2013) or those involving tacit versus codified knowledge (Cowan et al., 2000). Most studies on channels between firms and universities involve R&D collaboration (Fontana et al., 2006; Abramo et al., 2011; Laursen et al., 2011); research joint ventures (Bercovitz and Feldman, 2007); and mobility of human capital (Schartinger et al., 2002; Dietz and Bozeman, 2005; Breschi and Lissoni, 2009). This contribution focusses on a particular relationship between firms and universities that has received relatively less attention: contract research. Schartiger et al. (2002) found contract research to be the most important channel

of university-firm knowledge interaction (22%), well before collaborative research (15%) and other channels of knowledge interaction.

Contract research handles formal agreements connected with commissioned or sponsored research and academic consultancy. Commissioned research covers university research performed by academic personnel on behalf of firms to be readily relevant to them (Bekkers and Bodas Freitas, 2008). Consultancy is, according to D'Este and Patel (2007), university research that is also commissioned by firms but does not require any original research.

Contract research to universities by firms should be seen against the background of the growing body of literature on university-industry interactions (Muscio et al., 2014) or industry-science linkages (OECD, 2002). Interactive research activities carried out by universities give rise to voluntary or involuntary knowledge spillovers (Döring and Schnellenbach, 2006). Recent academic literature classified these interactions in two broad categories: untraded knowledge spillovers and market-mediated channels (Mowery and Ziedonis, 2015; Maietta, 2015).

The analysis draws on two separate, but related, databases to form a unique database created through a micro-linking exercise based on the OECD R&D survey for firms and a similar one for universities. Both R&D surveys follow the guidelines of the OECD Frascati Manual to ensure that definitions are the same across regions, countries and performers (OECD, 2015). The surveys are directed to the entire population of R&D active firms and non-profit organizations.

Information on the value of firm contract research and the spatial dimensions of the relationship with the university are so obtained; while at the same time gaining information on university characteristics (research capacity, quality and scientific specialization).

However, not all surveys could be used because of different questions; leaving three consecutive waves covering the period 2004 and 2009. We have complete information on 410 contract relationships by 182 firms: 363 contracts with domestic universities by 175 firms and 47 contract relationships by 29 firms with foreign universities.

Using the amount of industrial funding as a dependent variable implies that we can revert to the use of standard multivariate techniques such as ordinary least squares to explain the amount of contract research by highlighting the impact of three spatial dimensions: international linkages between firms and universities; the physical distance between these two and regional co-location. As usual a number of control variables are included such as size, age, foreign control, sector, R&D intensity and the obtainment of regional funding.

Our paper offers four contributions to the literature on university-industry interaction. First, it could be expected that foreign universities are solicited by way for complex knowledge; when there are no local or regional alternatives for that knowledge; or if the university research results are cheaper. Even though the average amount of contract with foreign universities surpasses that when domestic universities are concerned, there is no difference when controlling for other influences. Second, the ongoing debate on the impact of the physical distance between firm and university using the amount of contract research corroborates findings of other scholars, however, there is no strict linear relationship. The analyses shows a nonlinear U-shaped relation to the value of contract research: universities located nearby can be seen to be part of a technology cluster of the firm; when the desired knowledge is located at distant located universities these are also eligible partners for contract research. Third, being co-located in the same region also displays a positive association, yet not negating the finding on physical distance: the cluster-pipelines

operate at regional level as well. The research quality of universities is positively associated with the amount of contract research, implying that the academic reputation of the university attracts firms' interest. University research capacity showed no significant association, suggesting that the size of available university research is less important. More interesting is our finding that the often uttered assumption of exact sciences attracting high value contracts proved false: the social sciences and humanities are associated with higher contract amounts.

The contribution of the paper rests on the identification of relevant determinants in contract research to universities. Industry funding for university research is an important channel of knowledge transfer, and the identification of its key determinants helps to direct policy makers of regions and university administrations to recognize the factors that can be used to promote further knowledge transfer.

6.4.3 Comparative analysis of knowledge production in analogous large European firms: how much do individual strategies matter?

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Keywords: industrial R&D, strategy, patents, publications, positioning indicators

Abstract

This research analyses, with a comparative approach, the production of knowledge in two pairs of analogous large European companies: two German companies from the Chemicals sector (Bayer and BASF) and two Swiss companies from the pharmaceuticals sector (Novartis and Roche).

The results show that, within each of these two pairs, the firms, which display several similar main characteristics (same home country, same industrial sectors, annual sales and R&D investment of the same order of magnitude), differ significantly in the way they produce knowledge. Modalities of knowledge exploitation (assessed through the patents applied for by these companies) are alike, but new knowledge (assessed through the scientific publications authored by researchers from these companies) is being explored rather differently within the two pairs of analogous companies.

Data

This research exploits a database that identifies the priority patent applications and the scientific publications produced by 4 large European industrial firms from the industrial sector of Chemicals (Bayer and BASF) and from the industrial sector of Pharmaceuticals (Novartis and Roche).

Table 1: Main characteristics for the pairs of corporations benchmarked in this research

Relying on the Orbis database edited by Bureau van Dijk Electronic Publishing, we have identified the subsidiaries included in the consolidated perimeter of the 4 industrial groups (considering subsidiaries with a share of ownership above 50.01%). Corporations' boundaries are based on a single outlining of subsidiaries established in 2008.

After several stages of firms' name cleaning, harmonising and completion of missing information, the names of the firms and their subsidiaries have been looked for as potential

applicant names in the Patstat patent database and as signing institution of scientific publications in the Web of Science database.

As a next step of data preparation, the patents and publications identified as produced by the 4 firms have been then cleaned and enriched. For the patent data: first all natural persons mentioned as applicants have been removed in order to keep only legal entities as applicants; then remaining applicants' names have been normalised. For the publications, the names of the signing institutions have been normalised. Then the entities appearing in patents (as applicants) or in publications (as signing institutions) have been classified according to their institutional affiliation, being categorized either as firms or as institutions from the public research sector (universities, PROs, …).

First results

Within each pair of comparison, firms display similar characteristics regarding the exploitation of knowledge assessed trough patent applications.

In the first place, inventive activities are predominantly carried out within the perimeter of each firm – co-application is an exception. Corporate exploitation of knowledge is not a collaborative acitivity.

Second, each pair of firms tap in the same geographical zones for their inventions. For the two German Chemicals firms: 80% of Bayer's and BASF's inventors are located in Germany, with the US as the second ranked inventor's country. For the two Swiss Pharmaceuticals firms: roughly half of the inventors appearing in Novartis and Roche patents are located in the US, Germany and Switzerland representing the bulk of the remaining contributing countries.

The situation is pretty different regarding the production of scientific publications: analogous corporations use largely different strategies for exploring knowledge.

In the Chemicals sector, the three main differences between the to benchmarked corporations relate to: the extent of collaborations with other corporations (i.e. co-signing institutions not belonging to the public research sector; the weight of public research institutions located in the US.

The table below shows show intensively BASF collaborates with other industrial actors for producing scientific publications: corporate co-authors account for roughly 1/3 of BASF's top 20 collaborations and 1/4 of top 50 collaborations, to be compared with respectively 5% and 8% for Bayer.

Bayer's top collaborations involve more heavily US public research institutions, which account for 20% of the corporation's top 20 collaborations and 18% of top its 50 collaborations, to be compared with respectively 0% and 8% for Bayer.

Table 2: BASF and BAYER respective strategies regarding exploration of knowledge in collaboration with other firms and with US public research institutions

The next table presents the top 10 partners in scientific publications for both corporations.

Table 3: Top 10 partners in scientific publications for Bayer and BASF

The two networks graphs (based on an author keyword co-occurrences) below, which present - as heat maps built on the same base map - the thematic specialisations of the scientific production of firms which, reflect as well distinctive strategies regarding knowledge exploration.

In the Pharmaceuticals sector, the bulk difference between the to benchmarked corporations relates to the extent of collaborations with public research institutions located in the US. Knowledge produced in the US is important for both corporations, but as appears in the table below Roche relies significantly more on research collaborations involving American partners from the public research sector than Novartis.

Table 4: Novartis and Roche respective strategies regarding exploration of knowledge in the US

The next table presents the top 10 partners in scientific publications for both corporations.

Table 5: Top 10 partners in scientific publications for Novartis Roche

The two networks graphs (based on an author keyword co-occurrences) below, which present - as heat maps built on the same base map - the thematic specialisations of the scientific production of firms which, reflect as well distinctive strategies regarding knowledge exploration.

Policy relevance

Industrial policy, be it at European or at national level, is mostly designed and assessed at sectorial level, using sectorial indicators as key monitoring tools.

Both comparisons carried out in this research, which benchmark analogous actors (same sector, same home country), have revealed striking differences regarding the way corporations explore knowledge, highlighting thus how indicators computed at sectorial level could be misleading as they picture average situations that don't reflect the actual reality shaped by a few powerhouses that eventually develop diverging strategies. It seems therefore important that, first, industry policy is designed with a granularity as fine as possible, being fine-tuned according to individual actors' characteristics, or involving regional public bodies likely to have an informed knowledge of these individual characteristics.

Secondly, these examples plead for caution when one intents to analyse globally industrial sectors that are populated by heavy weight actors, who could potentially develop diverging strategies. The comparative analysis presented in this research demonstrates the interest of designing positioning indicators able to reflect, not sectorial features as usual OECD type indicators do, but able to reflect individual behaviours. The use of databases and indicators allowing an analysis of individual strategies for characterising actors from the research public sector is rising within STS studies, e.g. using several RISIS resources as the Leiden Ranking and the ETER database. A similar actor-based approach has already been developed for characterising corporate inventive activities in the CIB database (as well a RISIS resource). As a complement, a new database characterising scientific publications produced by the largest industrial actors seems to be crucial for grasping the whole of corporate knowledge creation.

7 Track 7: What Models of Innovation Governance for Emerging Economies?

Track 7 was organized by Gonzalo Ordonez-Matamoros, University of Twente and Universidad Externado de Colombia in Bogotá, and Stefan Kuhlmann, University of Twente, and included two Sessions.

Innovation, technological and social, is key for boosting the economies and the institutional capacities of emerging countries. Although stable public innovation policies are necessary, a better understanding of the specific governance challenges in those countries is required. Their institutional setting, while differing substantially country by country, is by and large characterised by instability, lack of trust, and even violence. Indeed, emerging countries are exposed to conditions differing quite substantially from the dominant OECD model of innovation policy for development and welfare.

Hence, focusing on innovation governance and public policies in emerging countries, this session aims at gathering a group of scholars willing to discuss related governance failures and to jointly explore options for alternative, more efficient approaches (Stefan Kuhlmann & H.G. Ordonez-Matamoros, 2017).

- For so doing, the convenors invite papers that bring a new perspective on innovation policy, focusing on governance issues resulting from the 'dance' (Kuhlmann, Shapira, & Smits, 2010), i.e. the interplay between innovation policy, theory and practice in emerging countries to
- better understand failures and opportunities,
- acknowledge that there are different perspectives on the role of innovation policies for development, where a more systematic discussion on the possible causes explaining the lack of progress on the use of innovation for development as a key governance challenge in poor countries is judged necessary,
- new options and emerging opportunities for change are identified at the conceptual and policy levels reflecting the emergence of the option for a 'turn' from the traditional growth-and-competitiveness-based innovation policy towards a more social-distributive-inclusive-based innovation policy, and
- feasibility and practical relevance of this turn is assessed. For so doing, careful policy analysis and evaluation are indeed needed.

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7.1 Session 7.1

7.1.1 Innovation and inclusive growth in the small-scale fishing sector of the Fonseca Gulf, Central America

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Keywords: Innovation, innovation policies, sustainable development

This paper presents the analysis of a project that evaluated the innovation enhancement capabilities in the small-scale fishing sector in the Gulf of Fonseca, observing the three countries concerned: El Salvador, Honduras and Nicaragua. We started with a participatory approach, in which, at different stages, information was obtained from the relevant actors through interviews and workshops.1 The study was based on a combination of different approaches: sustainable development, innovation systems, inclusive growth and global commodity chains. The fishing sector has existed for many years in the Gulf of Fonseca. Nonetheless, the fishermen and other participants in the value chain have remained virtually stagnant in a situation of survival, despite many efforts and institutional changes to support them. The aim of this study is to analyse the sector, using the global value chain concept, to understand the forces that favour or limit innovation processes to improve the performance of firms in the sector. We also include an analysis of the possible ideas of the actors in the chain to determine the factors that could improve business performance and, therefore, the quality of life of the people involved. We detected a number of features of the governance of the value chain that limit the potential for innovation and that somehow generate vicious circles that do not allow significant improvements in business performance and in the quality of life of many actors, especially the fishermen. It is clear in the sector that innovation is of a social, economic and technological character. We can conclude that in the fishing sector the learning processes are hindered because of poor coordination among the actors.

Considering the innovation policy dance, we can argue that the actors are dancing to different tunes. There are some institutional innovations promoting new rules in order to avoid the concentration of income in some of the actors. However, the results did not change the situation in a radical way. There has been slow interactive learning among actors in different spheres, the innovation practice, the innovation-related public intervention strategies, and innovation research and theory (see the concept in Kuhlmann and Ord..ez-Matamoros, 2017). There are some interactions, but the results in terms of innovation in practice have been poor. With this background, the study raises a number of policy implications.

One of the main problems of fishery in the Gulf of Fonseca is that more extraction may jeopardize the sustainability of the resource. The fishermen agree to it because they suffer from the increasing difficulties of catching fish. It is essential to develop targeted, sustainable fishing techniques. It is also necessary to strengthen the institutional capacity to adopt and enforce rules that lead to sustainability, such as closed seasons and the use of appropriate networks that allow the reproduction of the species. For this to work, fishermen from the three countries should have better environmental education and participate in collaborative networks in conjunction with relevant institutions to enforce rules that lead to protecting the sustainability of the resource. It is important that promoted innovation also be evaluated against criteria of the sustainability of the resource. Some innovations can encourage the extraction of new species or smaller samples of the species commonly extracted. In these cases, greater efficiency or greater volume are clearly detrimental to the sustainability of the resource.

There are many initiatives in the countries involved to promote new business or to try to organize them differently, so that the fishermen are left with a greater proportion of added value. However, while the financing of the daily activity remains in the hands of intermediaries, it is very difficult to achieve that goal. It is essential to channel efforts to achieve financial mechanisms to help break the existing unfavourable dependency on a number of intermediaries. To achieve this, it is necessary to promote a scheme to generate new capabilities of the people involved, which in turn reinforces a culture change towards ownership of business practices and adopting more commitments to sustainability. We must break the fear fishermen have towards financial commitments. The logic of daily micro-credits used by intermediaries, who provide inputs and then buy the product, may be emulated in the context of a more favourable institutional framework for fishermen.

It is convenient to generate a culture of performance evaluation, looking at all the critical factors that determine it along the value chain. There are technological, organizational and marketing factors that can be improved by incorporating the business insight. In order to incorporate the necessary knowledge there need to be training and other mechanisms in place. Also, there can be identification of joint ventures and design programmes of suppliers of inputs and services in a network of collaboration between producers and businesses. In the case of fishery products, improvements can include, for example, the logistics to ensure supplies and services for the maintenance of vessels and also improvements to the ways of marketing to other businesses that add value to the products, such as restaurants and fishmongers.

There are several governmental and non-governmental entities participating in various programmes in the Gulf of Fonseca, in the three countries involved. However, they lack a strategy to coordinate these efforts. It is essential that producers are groups that are empowered to achieve decoding processes and support resources that can be obtained from the various sources of cooperation. In that sense, it is also very important that these institutions promote a strategic process to address together the problems of the area. For a start, it would help if CENPROMYPE finished mapping institutional actors and organized workshops to develop a strategic vision of the area or territory. One of the examples that can be mentioned about the importance of this coordination refers to efforts by stakeholders to raise awareness about the need for farming fish and shellfish, where the technical involvement has been of high importance. However, issues related to marketing and financing (for growth) are not well resolved, and this has implications in the productive and organizational processes.

One mechanism to better understand the potential of some productive activities within the chain is from cluster analysis. It is important to promote new economic activities to avoid more problems in the fishing sector. A holistic approach of development could be useful to identify new kinds of business, for example restaurants, hotels and other activities that could be connected to the fishing sector. In other words, improving the living conditions of the population linked to fishing activity does not see this production in an isolated way, but rather integrated into the development of the territory as a whole. It is therefore clear that the concentration of efforts in fishery may be counterproductive from the standpoint of sustainability, and hence the necessity to advance other parallel activities among the population of the area. This requires the analysis of new business opportunities, the creation of mechanisms for building capacities in the population so new business can be promoted, and strengthening collaborative networks between different actors to adequately address the critical aspects of performance in each new business.

In general, fishermen and small farmers in the area do not have training to develop a strategic vision of their businesses. Therefore, focus on the day-to-Day prevents them from seeing beyond. A process of management training with emphasis on the strategic vision of business must be developed. One of the most important achievements of producers in the Gulf of Fonseca is to be clustered and see themselves as part of these groups (cooperatives and associations of producers) rather than as individual producers, as they were

previously. It is therefore necessary to understand that, in this case, the whole (the group production) is greater than the sum of its parts.

7.1.2 When developing countries meet transnational universities: searching for complementarity, not substitution

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Keywords: Transnational universities, International branch campuses, Higher education systems

During the last two decades a growing number of universities, mainly from developed countries, have established branch campuses overseas (Knight, 2014; Wilkins, 2016). From the perspective of developing countries, attracting foreign universities may contribute to addressing financial and capacity shortages in higher education and to enhancing the quality of teaching and research. Compared to the international mobility of national students, the establishment of branch campuses might allow a larger share of students to obtain an internationally recognized degree at a lower cost, while reducing the risk of brain drain. The attraction of foreign universities might also be a more cost-efficient and faster solution, at least in the short term, than the organic growth of national universities that lack expertise and qualified academic staff. But relying on the attraction of foreign universities also entails challenges and risks, particularly if they replace rather than complement endogenous efforts to build the national higher education system.

Against this background, the general objective of this paper is to examine the policy options for developing countries to minimize the risks and maximize the opportunities associated with the attraction of foreign universities. The paper explores different scenarios and policy options through a literature review and a systematic analysis of four cross-national case studies, comprising recent experiences in China, Kazakhstan, Malaysia and Chile. The development of these case studies relied on secondary data as well as field research and personal interviews with key stakeholders, including high level policy-makers in charge of running these programs and senior directors of the international branch campuses or research centers.

Countries aiming to attract foreign universities may have different objectives (e.g. undergraduate or graduate studies; teaching or research, etc.) and may rely on many different policy instruments and operational approaches (Dobos, 2011; Knight, 2014; Mok, 2011; Olds, 2007; Pfotenhauer et al., 2016). In particular, considering recent international experiences, we draw attention to the following four policy options:

a. Establishing joint-ventures between foreign and local universities. The expectation is that the local university will learn from the experience of a world class university, while both institutions share risks and rewards. Under this model, local universities can increase their reputation by linking with a global brand, while enhancing their teaching and research capacities.

b. Creating a new public university in partnership with one or several foreign universities. This is similar to the first option, although in this case the government retains full ownership of the new university, implying stronger national control but also higher risks.

c. Building an international higher education hub through the attraction of several foreign universities. The objective here is not only to provide better higher education opportunities to national students, but also to attract foreign students and thus exploit the opportunities of higher education as an export sector.

d. Attracting foreign universities to build research centers of excellence aligned with local industry needs. Beyond education, policy-makers can also provide incentives for attracting the R&D activities of foreign universities, with the aim of contributing to enhancing the innovative capacity of domestic firms and universities.

We illustrate each of these approaches through a specific case study. Each approach has its own advantages and disadvantages, and it is evident that there is no such thing as a best practice policy to deal with the attraction of foreign universities. Thus, rather than prescribing a specific solution that can be adopted across the board, this paper elaborates a set of overall criteria to address the tensions and imbalances implicit in the reliance on foreign universities to enhance the higher education systems of developing countries.

First and foremost, our results suggest that developing countries should avoid an excessive reliance on foreign universities, leading to a substitution or crowding-out of national universities. Rather, governments of developing countries should try to align incoming foreign universities with identified problems in their national higher education systems, searching for a strong complementarity with endogenous efforts by local universities. This might involve, for example, targeting specific disciplines where national universities lack capacities, as was the case with Educity in Malaysia. In the case of Chile the concern of the government was not to address shortages in education, but rather to improve the national innovation system by attracting foreign universities and public research institutes with a proven capacity of performing applied research in collaboration with industry. The malfunctioning of university-industry links was considered to be a major weakness of the national innovation system, which foreign universities and research institutes could help to address. In Kazakhstan, given the lack of world class universities in the country and the rigid education system inherited from the Soviet era, the government decided to create a new university in partnership with foreign institutions that could instigate a demonstration and learning effect on local universities. For China, the rationale was to keep up with the high growth of demand for tertiary education as well as to foster internationalization at a time when the country was opening up to the world.

Second, we suggest that governments of developing countries should aim at pushing the local embeddedness of international branch campuses and nurturing their linkages with local actors, such that externalities can unfold. China represents an extreme case in this regard, since foreign universities are only authorized to operate in the country through joint ventures with local institutions. This approach to enforcing local linkages by law, however, may not be feasible for other smaller emerging countries that lack the bargaining power of China's huge market. In all the cases analyzed, efforts are being made to encourage foreign universities to engage in applied research in collaboration with local firms and universities, with varying degrees of success. In the case of Chile's International Centers of Excellence program, the capacity of incoming universities to establish collaboration agreements with local universities and to work with local firms were among the main criteria in the selection and evaluation process. Thus only those centers that demonstrate strong local linkages received public funding, and the program was structured around a multi-tiered grant process subject to interim evaluations to ensure compliance with initial commitments. In general, the case studies analyzed suggest that by nurturing linkages between foreign universities and local actors (including universities and firms), policy-makers can contribute to avoiding substitution and encouraging complementarity.

Third, in view of the challenges associated with the dual embeddedness of international branch campuses, we argue that it is important to balance the benefits for the host country with those of the parent unit at the home country (Dobos, 2011; Shams and Huisman, 2016). For international branch campuses to be sustainable in the middle to long term, it is imperative that they demonstrate not only local impact, but also benefits for the foreign university. Therefore, Pareto-optimal foreign/local relations need to be recognized and promoted more explicitly by policy makers. The rights, responsibilities and modus operandi of both the host government and the international branch campus should be clearly articulated from the outset in contracts or memoranda of understanding that commit the different parties and reduce the risk of misunderstandings and conflict in the implementation stage (Hénard et al., 2012; Olds, 2007). These contractual relationships should address principal-agent problems that may follow from the dual embeddedness of international branch campuses. For example, host countries should ensure that foreign universities are subject to accreditation and quality control systems to avoid potential moral hazard problems resulting from the friction between academic and commercial priorities (Dobos, 2011).

7.1.3 Entrepreneurship, knowledge spilled-over and the evolution of the innovation system: The case of pharmaceutical innovation system in China

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Keywords: innovation systems, pharmaceutical industry, China, entrepreneurship

Research Aims

This article explores the dynamic interactions between individual entrepreneurial activities and the evolution of the innovation system. The entrepreneurship examined in this article refers to the ventures which not only intensively use and spill over knowledge but introduce innovations into the innovation system (Melarba, 2010; Andretsch and Keilbach, 2007). The article has two purposes. On the one hand, we hope to analyze the opportunities provided by the innovation system to individual entrepreneurs. On the other hand, we also tend to understand how the response of entrepreneurships to the system opportunities shapes the evolution trajectories of the innovation system. We will especially pay attention to the response of individual entrepreneurships to system opportunities and their function on the system evolution. Moreover, since different approaches of innovation systems draw the boundaries of systems by different criteria, we will focus on the analysis of sectoral innovation system (SIS) which defines an innovation system by 'a set of related products' developed on a global scale (Malerba, 2002).

A sectoral system following Radosevic and Yoruk (2013) will generate three sources of opportunities for individual entrepreneurships, i.e. technology, market and institutional opportunities. Since nations are fixed to the geographical borders, a sector which is developed on a global scale thus intersects with the innovation system of different countries. Different kinds of entrepreneurial opportunities provided by the sector therefore could be in fact embedded in different nations within the sector. While the knowledge-rich countries could provide technology opportunities to individual entrepreneurs, the knowledge-poor countries could provide market and institutional opportunities for the further growth of individual entrepreneurships. Once the individual entrepreneurs respond to the opportunities provided by the sectoral system globally, they are able to serve the role as international 'knowledge conduits' which not only transfer knowledge from initial knowledge-rich to knowledge-poor countries, but formulate new technology trajectories in the initial knowledge-poor countries.

We choose the Chinese pharmaceutical innovation system for empirical case study, because the country provides an interesting example for the analysis of the interactions between individual entrepreneurships and system evolution. In fact, the evolution of pharmaceutical innovation system in the European Union (EU) and the United States (US) has been well documented (McKelvey et al, 2004). Pharmaceutical sector originally emerged in Europe in the 1840s, and the initial knowledge base of pharmaceuticals was chemical engineering. Only in the 1970s, modern biotechnology which is defined as the biotechnology developed in the post-genetic engineering era in the 1970s (Laage-Hellman et al., 2004) emerged in the US and became a new knowledge base of the pharmaceutical sector. However, in the case of China, pharmaceutical innovation system only developed since the late 1940s. The original knowledge base of the sector was also chemical engineering which was originally transferred from the Soviet Union to the large state-own

pharmaceutical enterprises. Modern biotechnology as the new knowledge base of the sector was only introduced into the system in the late 1980s through a group of Chinese scientists returned from the United States. These Chinese scientists had previously conducted specific biopharmaceutical projects or innovated particular technologies in the MNCs or universities in the United States. Once, the returnee Chinese scientists set up many new biopharmaceutical SMEs in China in the middle 1990s, they usually received venture capitals from the government or state-owned pharmaceutical enterprises which had strong interests in innovating new biopharmaceuticals. With public fiscal supports, the returnee Chinese scientists quickly built up their capabilities to develop biopharmaceuticals and sold their products in the domestic market. For example, Sunway Biotech was founded in 1995 by a returnee Chinese scientist who had helped to develop one of the core genetic technologies of anti-tumour medicine in the United States. The company not only received funding from a state-owned pharmaceutical enterprise and a state-owned venture capital firm but also obtained substantial R&D funding from the government. In 2006, the company successfully developed 'recombinant human adenovirus type 5 injection (Oncorine)', which was the world's first oncologic medicine made from viruses. In short, it was the US pharmaceutical sector which provided the initial technology opportunities, and the system of China provided market and institutional opportunities for the returnee Chinese scientists. The response of returnee Chinese scientists to the overall system opportunities, the establishment of the new biopharmaceutical SMEs, indeed not only transfer the knowledge of modern biotechnology from US to China but shaped the new trajectories of biopharmaceutical innovation within the Chinese pharmaceutical innovation system.

To deepen the understanding towards the interactions between individual entrepreneurships and the evolution of the innovation system, we establish the conceptual framework based on the existing literature. After the analysis of the evolution of the Chinese pharmaceutical innovation system, we will reflect on the existing literature on the basis of our empirical findings. Eventually we expect our finding of the system opportunities and the response of individual entrepreneurships will contribute to the present RTDI policies which concern the sectoral development.

Methodologies and empirical materials

Several data sources were used to collect all types of data to conduct a comprehensive analysis of the evolution of Chinese pharmaceutical innovation system.

First, archival data were collected from the China Food and Drug Administration (CFDA) and Chinese National Knowledge Infrastructure (CNKI). CFDA provided key governmental policy and regulatory documents related to pharmaceuticals and biopharmaceuticals in China since the 1950s in both digital and paper formats. CNKI was searched using the search term 'pharmaceutical' and 'biopharmaceutical' for titles of academic publications to provide scientific and technological development information about the trajectories of biopharmaceutical innovation in China.

Second, field interviews were conducted with industrial practitioners and academic researchers. A series of interviews was conducted with high level managers of three new leading Chinese biopharmaceutical SMEs which have successfully innovated 'new' biopharmaceuticals rather than 'me-too' medicines. A series of interviews will also be conducted with leading pharmaceutical university researchers who specialize in modern biotechnology and biopharmaceuticals to understand the international knowledge transfer processes. The interview questions will consider international technology transfer, industrial development, policy support and technical obstacles.

Expected outcomes

The technology trajectories of biopharmaceutical innovations within the Chinese pharmaceutical sector were synthetically established through the dynamic interactions between

individual entrepreneurships and system opportunities. Through the investigation of China's experiences, we find entrepreneurships are not just individual activities but system functions which go beyond the analysis of the existing literature. While Malerba (2002) describes that government RTDI policies should 'match' the development of sectoral innovation system, we find the concept of 'match' should be clearly re-defined. Individual entrepreneurships indeed formulate important functions in knowledge spill-over and the creation of new technology trajectories of the system As it is the sectoral system which at first provides the different kinds of opportunities for the development of individual entrepreneurships, RTDI policies should strategically set up the institutional opportunities which appropriately generate further technology and market opportunities for individual entrepreneurs. Even the technology opportunities are originally provided by another foreign country, the domestic government could still establish institutional opportunities which foster the development of technology and market opportunities. Therefore, RTDI policies could not only encourage international knowledge spill-over through individual entrepreneurships but support the newly emerging technology trajectories within the existing sector.

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7.2 Session 7.2

7.2.1 STI policy in ASEAN: Enhancing heterogeneous cooperation

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Introduction and aim

The Association of Southeast Asian Nations (ASEAN) unites countries with a strong innovation performance, like Singapore and Malaysia, and countries where respective efforts were nearly impossible until quite recently, like Lao PDR and Myanmar. The national differences in terms of economic capabilities, political systems and resource endowments are tremendous. Since its establishment ASEAN aims to promote active collaboration of its members on matters of common interest – including science and technology development. With limited resources and a general preference for short-term results, STI policy shapers in ASEAN are challenged to build a convincing rationale for their agenda. Targeting the academic and entrepreneurial 'elite' during past decades (Kuhlmann & Ordonez-Matamoros 2017) has resulted in well-established pockets of excellent research (Degelsegger et al. 2014). It has, however, not generated an innovation performance that satisfies the needs and aspirations of ASEAN Member States (AMS). There is the general impression that isolated efforts should be replaced by more and intensified cooperation of public and private, domestic and foreign actors. Joining hands across prevailing organisational divides is expected to multiply opportunities for innovation successes.

This paper is based on insight gained in the framework of German development cooperation in 2014 and 2015 with a working group nominated by the ASEAN Committee on Science & Technology (COST). Efforts aimed at the identification of options for a strengthened national and regional promotion of heterogeneous cooperation in R&D and innovation. The following question is addressed on the basis of the ASEAN case:

• How do the framework conditions, and notably STI institutions, of innovation systems in AMS facilitate or hinder heterogeneous collaboration?

The aim of the paper is to contribute to methodological developments because the analysis of diverse innovation systems in emerging and developing countries is bound to require some adaptations of existing approaches. At the same time, the review of empirical evidence on the opportunities and challenges related to heterogeneous cooperation under ASEAN framework conditions leads to practical implications for policy making. Improved alignment of policy interventions with actual barriers to the cooperation and innovation activities of specific actors in specific sectors can improve outcomes. The recognition of patterns in actual challenges could fertilise further research and societal / political discourse.

Theory

Cooperation of a wide array of actors has been identified to be a key to strengthened innovation performance of industries, regions and nations (Cohen 1995; Lundvall 1992, 1997; Freeman 1988, 1995). According to Powell and Grodal (2006), diversity in the portfolio of collaborators leads to a widened stock of available knowledge. With more experience and a divers set of competencies new opportunities open up. Cooperation of private companies with public research institutes is widely perceived to be especially conducive to innovation. National innovation systems (NIS) of emerging and developing countries,

however, are characterized by weak cooperation and interactive learning (Chaminade et al. 2009). From a systemic perspective, it is found necessary to embark in an analysis with full NIS coverage. Explicit consideration of embeddedness of the relevant phenomena is assumed to disclose the institutional contingencies and context particularities.

NIS analysis at the micro level was based on the so-called policy domain model developed by Guy et al. on behalf of the European Commission (2009:9), later refined by Kadura, Langbein & Wilde (2011). It groups STI actors in four subsystems - representing the IS functions of knowledge producers and knowledge users with differentiation according to operational logic (utility or profit maximisation versus societal benefit orientation). The importance of international actors and arenas of exchange (Metcalve 2008; Meuer, Rupietta & Backes-Gellner 2015) was considered by data collection on the presence and relevant activities of foreign/multinational companies, international Donors and NGOs.

Actors and interactions at the micro level of the IS are embedded in an immediate evironment (meso level) and wider framework conditions (macro level). While factors and/or functions to be considered in NIS models as well as delineations are still under intense scientific debate (e.g. Carlson et al 2002; Arc, Autio & Szerb 2015; Lindner et al. 2016; Warnke et al. 2016), an accord with sufficient operational capability had to be reached in the ASEAN case. Thus, available evidence on governance modi, bundles of institutions and structures were included on the one hand. Actors' perceptions of the impact of these framework conditions on their cooperation willingness, abilitiy and opportunities were recorded on other hand.

Cooperation opportunities of IS micro-level actors are typically supported by the presence of 'brokers' in knowledge and technology transfer (KTT) as well as KTT and quality assurance infrastructures. Besides, the presence of international actors, qualified public research units and company agglomerations is commonly assumed to effect 'knowledge spill-overs' and thus enhance cooperation opportunities (Porter 2000; Mowery & Shane 2002, Audretsch & Feldman 2004). Malerba's (2002) finding of major differences of the pattern of innovation activities across sectors alongside similar pattern across countries was relevant in the ASEAN case. Therefore, the analysis is focused on 3 industries, namely food processing, renewable energies and pharmaceuticals. The selection of these industries is justified by the importance attached to nutrition, energy and health, and the resulting implication that these sectors do exist (on diverse technological levels) in all AMS.

Methodology

Evidence collection on IS framework conditions, actors and cooperation incidences (macro, meso and micro levels) in 8 ASEAN Member States (AMS) comprised reference to standard macro-economic indicators as well as literature review and in-country information collected by COST working group members on the basis of structured questionnaires. Strategies for STI promotion are just being introduced in Myanmar, Cambodia and Lao PDR. Most other AMS long since elaborated national plans. General STI policies were analysed alongside the promotional regimes of a) R&D and innovation finance, b) public R&D and innovation incentives, c) non-financial R&D and innovation support d) IPR protection and e) the quality assurance regime (meso level). Cost working group members also implemented group interviews and non-representative surveys to record primary actors' perceptions.

An effort in pattern recognition based on actors' cooperation and innovation capabilities and opportunities led to a typology of dominant challenges by country and industry. Actors' perception of obstacles were used as crosscheck. On this basis, generic promotional approaches could be specified. As the relevance of specific promotional regimes at the meso level differs by industry, the selection of promotional foci was also proposed to be adjusted accordingly. Macro-level evidence was used for the evaluation and selection of

specific cooperation instruments. However, in the framework of the ASEAN-German efforts, it has not been possible to determine priorities for change of those macro level framework conditions which lie outside the realm of STI policy. Most importantly, the cultural suprastructure, widely assumed to have a substantial bearing on actors' cooperation behaviour, was not considered at all.

Results and conclusions

The paper will demonstrate how a meaningful NIS analysis in developing and emerging countries is feasible. Results will show the missing or weak links between micro-level subsystems in most AMS alongside dysfunctional or inappropriate institutions at the meso level. The paper will also show how a restricted range of effective STI policy instruments is due to the status of certain macro-level framework conditions.

Strengthened cooperation of heterogeneous actors requires targeted investments in the subsystems under public governance in some cases. More importantly and widespread: meso–level institutions require careful reform. The research output can be used by ASEAN policy-shapers as a baseline to build hypotheses on feed-back loops of interventions and monitor their impact. In addition, results achieved will contribute to the implementation of the ASEAN Plan of Action on Science, Technology and Innovation (APASTI) 2016-2025.

The cross-country policy learning processes started in ASEAN supports the understanding of the specificities and particularities (Chaminade et al. 2009) of NIS- and industry-specific development challenges. Though no comparative analysis of innovation governance modes was aimed at, the theory-led and evidence-based effort unveiled many strengths and weaknesses. Public control of STI investments with eventually long gestation periods is a widespread concern in ASEAN. Socio-economic challenges and widespread corruption exert a strong pressure for the justification of policies. In consequence, prospects for 'experimentation space' (Rodrik 2008) are rather dim. Following the example of Chinese strategies, it might however be possible to introduce some scope for regional adaptation of general STI policies or industry-specific 'pilot schemes'. Experimentation, however, should be supported by international Donors and NGOs in most AMS. Whether a 'dance' (Kuhlmann, Shapira & Smits 2010) of STI theory, policy and practice can develop in emerging economies, might be dependent on increasing levels of trust that can be nurtured through heterogeneous cooperation. The contribution will highlight strategies towards that end.

Further research should be directed at two issues that were found critical:

a) Tracing observable indicators for a monitoring of the willingness, capability and opportunities of relevant actor groups to cooperate and innovate might greately enhance the prospects for effective and rapid STI policy learning.

b) Limited resources given and with the same objective in mind, a validation of substituting survey-based assessment tools definitely deserve further research.

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7.2.2 Searching for appropriate innovation governance models for emerging economies

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Keywords: Innovation Governance, Emerging Economies, Innovation Theory, Innovation Policy, Innovation Practice

Rationales and Relevance

Focusing on innovation governance and public policies in emerging countries, this paper aims at provoking discussions related with theoretical, governance and social capital failures and options for implementing alternative, more efficient approaches to effectively allow science, technology and innovation activities make sound contributions to development in such countries.

In particular, the authors reflect on basic/fundamental questions such as - Why in many cases knowledge, science, technology and innovation activities are not satisfactorily contributing to the expected progress at the desired pace in emerging countries?, - What can be attributed to theoretical failures, governance failures and social capital failures? And - How can emerging developments, opportunities and options taking place both in terms of innovation theory, policy and practice in emerging countries be understood?

In so doing, the authors bring a new perspective on innovation policy debates, focusing on governance issues resulting from the 'dance' (Kuhlmann, Shapira, & Smits, 2010), i.e. the interplay between innovation policy, theory and practice in emerging countries.

Hence, following an interpretative approach, substantiated by discussions in several workshops with policy scholars, in this paper the authors assess the rationales and relevance of current/dominant innovation theories and policies and assess their consequences, while exploring options based on new developments found in the arena.

More specifically, to understand failures, the authors analysed:

a) The underlining assumptions supporting innovation policies implemented in emerging economies

b) Key features of innovation policymaking processes

c) Typical innovation governance challenges in the framework of poverty and globalization

d) Contextual determinants of innovation policy change, failure or effectiveness by examining the role of cultural, historical or political drivers, barriers, policies and governance issues

e) The role indigenous knowledge play in development policies implemented

f) The role of international aid, cooperation, funding organizations, NGOs, multinational corporations, universities, networks and/or media

g) The role of local management, leadership and entrepreneurial capabilities

h) The role of organizations, institutions, norms and values

i) The role of corruption

j) The role of ideology

To understand current options and opportunities, the authors analysed:

a) The conceptualization of ‘innovation’, involving grassroots innovation, social innovation, social technologies, innovation for inclusion and innovation for the ‘bottom-of-the-pyramid’, the role of new.

b) The role of ‘new’ actors

c) New ways of governance

After applying the innovation policy dance metaphor, this process helped the authors to identify ‘bumpy dancing’ and stories of systemic failures expressed in terms of

a) Theoretical failures when theory is the leading dancing partner,

b) Governance failures when policy is the leading dancing partner, and

c) Social capital failures when practice is the leading dancing partner.

The process also helped the authors to identify creative dancing and stories of success of making knowledge and innovation an engine for development resulting from the emergence of:

a) New and/or more relevant theories and concepts,

b) New and more relevant policies and programmes, and

c) New and more relevant innovation practices.

This paper extents from discussions proposed at the introductory chapter ‘Governance of innovation in emerging countries: understanding failures and exploring options’ of the recently published book “Research Handbook on Innovation Governance for Emerging Economies: Towards Better Models”, edited by Stefan Kuhlmann and Gonzalo Ordonez (Stefan Kuhlmann & H.G. Ordonez-Matamoros, 2017).

In so doing, the authors identified a set of key governance challenges developing countries would have to face to embrace a new paradigm of innovation policy if they are serious in their intent of making STI an engine for development in a more effective way.

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7.2.3 STI Policy and Regional Innovation Systems in Emerging Economies: A System Dynamics Approach

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Objective

The literature on innovation systems is characterised by a strong prevalence of conceptual studies and qualitative methods (D'Allura et al., 2012). In this regard, it is needed a more comprehensive approach in the analysis of regional innovation systems (RIS). Therefore, this proposal aims to analyse science, technology of innovation (STI) policy at regional level in the case of emerging economies from the perspective of the system dynamics (SD) methods. It evaluates alternative STI policy scenarios of the performance of RIS in emerging economies. The case of Mexico is analysed in this paper. However, this perspective allows identifying key relationships between actors that set up a RIS. In this sense, it would be interesting to inquire on the relationship between the development of firms' innovative capabilities and the performance of RIS under alternative STI policy scenarios (Mocciaro, 2012).

In order to develop this analysis, two important assumptions are made. First, innovation is a systemic phenomenon (Bergek et al., 2008; Smith, 2000; Woolthuis et al., 2005). Second, innovation is pervasive and central to explain competitiveness among firms (Smith, 2000). Accordingly, innovation can be seen as a non-linear process of learning (Mytelka and Smith, 2002) that involves complex interactions between firms and the environment characterising a particular innovation system and explains the dynamics of RIS as a complex phenomenon (Smith, 2000).

On the other hand, it is argued in this research that SD methods allow finding out the nature of the system failures characterising many RIS in emerging economies. In addition, this approach allows revealing the operation and development of RIS as a whole (Wieczoreck et al., 2012), opening up the possibility of a new policy rationale that replaces the neoclassical market failure concept (Edquist, 1997; Wieczoreck et al., 2012). From this perspective, it would be interesting to inquire on the role played by STI policy when system failures appear, given that system failures may negatively influence the speed and direction of technological change and innovation processes (Wieczorek and Hekkert, 2012). Importantly, system failures have been identified in the literature as (Chaminade and Vang, 2006; Chaminade et al., 2012; Woolthuis et al., 2005): (i) infrastructural, (ii) transition, (iii) lock-in/path dependency, (iv) hard institutional, (v) soft institutional, (vi) strong networks, (vii) weak networks, and (viii) underdeveloped capabilities.

In the case of emerging economies, the main concern about RIS is how they emerge and evolve to support regional economic growth through sustaining indigenous firms in the transition to a more innovative and competitive economy (Chaminade and Vang, 2006; Chaminade et al., 2012). In this regard, special attention must be paid to a systemic approach when analysing RIS in the case of emerging economies given that an interactive learning and innovation process takes place at regional level (Chaminade and Vang, 2006). This approach also allows identifying new rationales for government intervention by implementing a more accurate and comprehensive STI policy in each case (Woolthuis et al., 2005). It is worth saying that there are four innovation-policy-relevant approaches developed in the analysis of innovation systems based on the systemic and evolutionary view of innovation (Wieczorek, 2009): (i) the structural analysis of innovation systems (Nelson, 1993; Freeman, 1988), (ii) the functional analysis of innovation systems (Johnson, 2001; Hekkert, 2007; Bergek et al., 2008), (iii) the systemic problems approach (Smith, 2000; Jacobson and Johnson, 2000; Woolthuis et al., 2005), and (iv) the systemic instruments approach (Smits and Kuhlmann, 2004; Wieczorek at al., 2009). These approaches should be seen as complementary rather than exclusive.

Finally, the analysis of RIS from a systemic perspective allows analysing innovation systems as complex adaptive systems (McCarthy, 2003; Viale and Pozzali, 2010), and thus exploring the theoretical and empirical basis of RIS in terms of the relationships established between different actors in the process of technology transfer and innovation developments (McCarthy, 2003; Schwaninger and Grösser, 2008; Viale and Pozzali, 2010). Indeed, there are two reasons to favour a systemic perspective in the analysis of RIS (Viale and Pozzali, 2010): (i) each particular RIS has its own characteristics, and (ii) it is necessary to give a dynamic description of the configuration of a system of innovation in order to forecast the possible evolution in the next future.

Research Questions

Two questions conduct this research. ¿How alternative STI policies may affect firms' innovative capabilities, and thus the performance of innovation systems at regional level? And ¿What is role played by alternative STI policies when system failures appear within RIS in emerging economies?

Research Methods

It is important to have a suitable tool to model innovation systems given that previous analyses have been conducted according to a subjective and qualitative approach (D'Allura et al., 2012; Doloreux and Parto, 2004, 2005). In this research, it is argued that SD methods is a more comprehensive approach to address the study of RIS. In this regard, SD methods allow modelling and simulating the behaviour of RIS revealing the actual nature of the relationships established between the stakeholders participating in the process of technology transfer and innovation. Moreover, SD methods may contribute to theory development when the theoretical focus involves multiple and interacting processes, time delays and other non-linear effects as it provides an analytically precise means of specifying propositions linking constructs, assumptions, and a coherent theoretical logic underlying the theory (Davis et al., 2007). In addition, this approach has stressed the importance of the structure of a system when determining the behaviour and relationships in which the system operates (Davis et al., 2007; Morecroft, 2007; Sterman, 2000; Schwaninger and Grösser, 2008; Wolstenholme, 1999). In this way, SD methods have proved to be an adequate conceptual and methodological framework to model innovation systems as it contributes to develop a more formalised and precise theory that clarifies the underlying causal relationships between variables in a system (Niosi, 2010). Actually, SD methods are useful dealing with time, scarce data, summarising and simplifying the main assumptions and hypothesis in a model, uncovering data to clarify the importance of different variables, and exploring new possibilities at the time of developing new theories (Niosi, 2010).

There are four elements characterising SD models (Forrester, 1975): (i) feedback loops, (ii) flows and stocks structure, (iii) time delays, and (iv) non-linearities. These characteristics reveal the fact that innovation systems can be seen as complex multi-loop systems interconnected within a structure that reinforces multiple feedback processes with a high degree of uncertainty. In addition, these features characterise RIS as constantly evolving systems in a disequilibrium, non-linear, historically dependent, self-regulating, adaptive, and counterintuitive trajectory, making them to be resistant to policy (Sterman, 2000). Accordingly, SD models may contribute to theory development when the theoretical focus involves multiple and interacting processes, time delays and other non-linear effects as they provide an analytically precise means of specifying propositions linking constructs, assumptions, and a coherent theoretical logic underlying the theory (Davis et al., 2007). In fact, RIS are composed by multiple dimensions (variables), each of which is associated with its own rate and direction of change causally connected to produce patterns of change (McCarthy et al., 2010).

Finally, SD modelling comprises five steps (Sterman, 2000): (i) problem definition and articulation, including selection, problem definition, key variables and time horizon, (ii) formulation of a dynamic hypothesis, (iii) formulation of a simulation model, including specification, estimation and tests, (iv) testing process, containing comparison to reference models, robustness under extreme conditions and sensitivity analysis, and (v) policy design and evaluation, including scenario specification, policy design, and interaction of policies

Results

From the results achieved in this research, a general model is discussed in this paper aiming to demonstrate how SD methods can be applied to simulate and evaluate alternative STI policy scenarios. Two cases of RIS in Mexico are analysed in this study revealing how some kind of systems failures may arrive at regional level (Rodríguez et al., 2014; Rodríguez and Navarro-Chávez, 2015). The comparison between these two cases contributes to get insight on the nature of successful practices when implementing alternative STI policies at regional level in the case of emerging economies.

8 Track 8: Social Innovation as a Challenge for a Comprehensive Innovation Policy

Track 8 was organized by Jürgen Howaldt, TU Dortmund University, Sozialforschungsstelle, Effie Amanatidou, Manchester Institute of Innovation Research, University of Manchester, Paul Benneworth, University of Twente, and Dimitri Domanski, TU Dortmund University, Sozialforschungsstelle, and included three Sessions.

Research into innovation has a long history, arguably dating back to the pioneering work of Schumpeter in the early 20th century (2006). Much of the early theoretical work emphasised the socio-cultural dimensions of innovation (Kallen, 1932; Tarde, 1903; Ogburn, 1966). However, this socio-cultural dimension was displaced by more economic and technological perspectives, in part because of the increasing importance of innovation to economy and society, and greater policy interest to stimulate innovation for economic growth. Indeed, a belief in the central role of science and technologies for socio-economic development is still the basis for contemporary innovation policies as well as much of the scientific discourse on various kinds of "Innovation Systems".

In recent years, in parallel with this, there has been a growing realisation that both innovation research and policy is falling short of its potential to address the multiple globally-derived challenges that affect contemporary and future societies. Attempts to address these challenges through innovation demand a better understanding of 'the new nature of innovation', including the changing role of technologies (FORA, 2010). These challenges are not only grand in scope and scale, but also complex, made up of wicked problems and "largely impervious to top-down rational planning approaches" (Cagnin, Amanatidou & Keenan, 2012, p. 141). There may exist a potential relationship between increasingly economic-functional perspectives on innovation, and the growing disassociation between innovation and the so-called 'grand challenges'.

Against this background of emerging paradoxes and confusion in prevailing innovation perspectives, it is clear that technology-oriented innovation paradigm relevant for the industrial society is becoming increasingly less functional. International innovation research is providing a variety of indicators where we are witnessing a fundamental shift in the nature of innovation (Fagerberg et al., 2005). What we might consider to be this new paradigm is characterized by at least three key stylised processes, namely:

(1) The opening-up of the innovation process to society,

(2) its orientation by the major societal challenges, and

(3) a stronger recognition of non-technological innovations geared to changing social practices.

What is common to all these three categories is the expansion of the purview of innovation to cover more explicitly social domains, and indeed social innovation is becoming increasingly evident in policy, scientific and public debates (see e.g. The Economist Intelligence Unit, 2016). A social innovation can be defined as a new combination of social practices, which is prompted by certain actors in order to better respond to needs and problems and diffused throughout society (Howaldt & Schwarz, 2010).

But social innovation studies and practices have emerged largely outside the field of innovation studies, and it is acknowledged that we are still lacking conceptions of social innovation in both research and practice. The challenge for science and policy is developing a theoretically sound concept of social innovation beyond the empirical and policy domains

in which it is popularised, across a range of different policy areas, research fields and regional perspectives.

There is now a considerable body of evidence exploring this diversity of policy areas and regional perspectives, led not least by the European Commission who have invested heavily in research in this area (including SI-DRIVE, TRANSIT, CrESSI or SIMPACT).

Comprehensive approaches to innovation policy, supporting both technologies and new social practices, remain in their infancy. We contend a new model for innovation policy is needed that supports both technological and social innovations and creates framework conditions for developing systemic solutions. Many potential social innovations are hindered by traditional approaches in public policies alongside various barriers (financial, legal, institutional etc.) that could be addressed through public policy. But what makes it difficult for the necessary policy innovation to develop rules and regulations supportive of social innovation is precisely the fact that “social innovation” has emerged as an activity disconnected from the mainstream.

This conceptual differentiation between social and technological innovation requires above all a deeper understanding of the principles and modes of action of social innovations and their relations to and embedding in technological innovations. The systemic perspective on innovation, an important achievement of Innovation Studies, provides new coherent visions of social innovation beyond its current sector-specific and actor-centred approaches. Technology Assessment perspectives would likewise help in bringing a differentiated perspective towards the ambivalence of social innovations, where analyses are often dogged by an implicit normative belief in the moral goodness of these social changes.

This research session aims to further this dialogue within Innovation Studies and seeks for contributions to this debate, potentially addressing one or more of the following questions:

- How can the area of social innovation benefit from the experience of Innovation Studies?
- How are social and technological innovations intertwined and what does it mean for innovation policy, also regarding designing new policy instruments?
- To what extent do social and business innovations interact? In which ways do these various innovation processes affect each other?
- How can we shape or govern social innovation to move towards social transformation?
- What is the role of universities and research institutions in developing social innovations and which new forms of policy advice can be introduced?
- How can the innovation potential of societies be used and which concepts and methods can be developed and applied to support social innovation, especially considering the changing relationship between citizens, researchers, policy decision-makers and other stakeholders?
- What kinds of policy interventions are needed to foster social innovation ecosystems, also considering new innovation systems concepts, and which governance models are becoming increasingly important?
- Social innovation as an autonomous policy area or as a part of a comprehensive innovation policy: What are the (dis)advantages of both approaches?

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8.1 Session 8.1

8.1.1 Balancing Social and Economic Objectives in Social Innovation – From Micro to Meso Level Impact

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Traditional companies and companies initiated by individuals (e.g. user-driven companies) have a clear focus on economic objectives, but there are recently also a growing number of companies which strive for innovation management strategies including social objectives. And vice versa, initiatives with a strong focus on social objectives (social innovation initiatives, e.g. social enterprise, charities, associations and cooperatives) integrating multiple innovation management elements because of their responsibility to become economically sustainable on the one hand and to cause social impact growing from micro level (economic and social impact) to meso level (creating institutional change) on the other hand. To be specific, actors in the field of social innovation (e.g. social innovators, policymakers, intermediaries) still lack a profound understanding of balancing social and economic objectives to get from individual social and economic impact at micro level to institutional change at the meso level.

The current study positioned single social innovation initiatives/actors by allocating them to two societal levels (micro, meso) and with respect to actors´ economic and social objectives. Further on, it is assumed that a balance between efficiency and effectiveness is essential for developing institutional change at meso-level. Therefore, this study describes a balance model analysing the interplay of the four dimensions (efficiency, effectiveness, social and economic objectives) with the aim to improve social innovation actors´/initiatives´ innovation management and to support their understanding in how to balance opposite objectives and trade-offs.

Current Understanding

Europe is confronted with many complex and interrelated socio-economic challenges that have clearly been exacerbated by the economic crisis. Welfare services struggle to cope with these challenges and growing segments of the population experience increasing difficulty in accessing support, what paves the way for social innovation. Accordingly, social innovations are assumed to emerge in a social field which is structured by existing institutions, while at the same time social innovations are calling these institutions into question. It is argued that actors' social embeddedness (Granovetter, 1985) and institutional contexts shape their behaviour and interactions. Whereby, striving for legitimacy and creditability by being embedded in society, social innovation is viewed as an ongoing process of institutionalisation (Colyvas & Powell, 2006), which goes hand in hand with conformity to established rules and norms. This stands in harmony to social innovators' social and economic objectives to reach social and economic impact and change institutional frames. From a strategic perspective, social innovation is seen to be subject to management theo-

ries and the entrepreneurial school which is recommended to take a broader social perspective grounded in intuition but also care for societal and environmental challenges (Mintzberg & Lampel, 1999, Porter & Kramer, 2011).

Moreover, organisational efficiency, an organisation's ability to implement its plans using the smallest possible expenditure of resources and effectiveness, which points to adequacy of purpose and degree of accomplishment and producing the intended result (Terstriep, 2016) are important elements for social innovations´ social and economic impact. In this frame, quality of innovation management is perhaps the most influential factor on organisational efficiency since it is management that chooses how to implement strategic plans. The current debate on efficiency is primarily concerned with social innovation in public sector and more efficient and effective delivery of services while little information is given as to what efficiency means in the context of social innovation initiatives. Having regard to these investigations, the current study concentrates on the transfer from micro to meso level supporting social innovation actors/initiatives (micro level) to a sustainable and effective balance between social and economic objectives as well as to a better understanding how to handle trade-off between efficiency and effectiveness in order to reform or change the institutional frame (meso level).

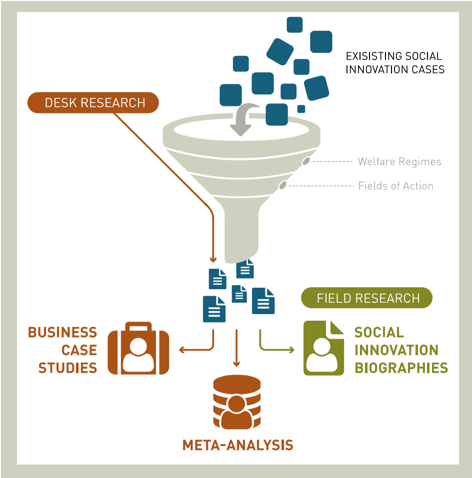
Research Design

Several key issues need to be addressed to tackle social innovation challenges within the European economic sphere and its policy environment. Gaining a better understanding of the components, objectives and principles of social innovation, as well as the underlying processes and contexts of social innovations is at the core of the EU-funded FP7 project SIMPACT[44].The research question is on how to support the hybrid social innovation activities/initiatives at micro level to a sustainable and effective balance between social and economic objectives to reform or change the institutional frame at meso level. To identify what works, how and why for socially and economically successful innovations, it is necessary to gain detailed insights into the processes of social innovation throughout its lifecycle. The empirical work focuses on by systematically collecting data, analysing them in a comprehensive way and elaborating an approach towards a better understanding of how social innovation initiative should balance their social and economic objectives and handle the trade-off between efficiency and effectiveness to move from social and economic impact at micro level to institutional change at meso level.

Linking theoretical research with the collection, analysis and modelling of empirical evidence and continuous stakeholder dialogue has allowed us to develop the appropriate model for analysing the balance between social and economic objectives as well as the trade-off between efficiency and effectiveness of social innovation actors/initiatives. The research discussion was built on a multidisciplinary middle-range theory that explores the economic dimensions of social innovation including a common understanding of social innovations' components, objectives and principles. Following an iterative process of theorising and evidence collecting, a narrow categorisation of social innovations provided the joint framework for our empirical research. In an attempt to identify how and why socially and economically successful innovations work, SIMPACT's empirical work provided detailed insights regarding the innovation process throughout different stages of the social innovation lifecycle. For this purpose, data was systematically collected and analysed by means of 'Meta-Analysis', 'Social Innovation Biographies' and 'Business Case Studies' (Terstriep et al., 2015).

44 'SIMPACT – Boosting the Impact of Social Innovation across Europe through Economic Underpinning' has received funding form the European Union's Seventh Framework Programme for research, technological development and demonstration under Grant Agreement No. 613411.

Figure 1: Research Design



Source: Terstriep et al. (2015)

BCSs are descriptions of cases of social innovationl that occurred across Europe during the recent years, with a specific focus on their economic foundation. Their construction was based on the case study methodology, as a research frame particularly appropriate for examining a "*(…) contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident"* (Yin, 2014), or else to give answers to *'how'* and '*why'* research questions within an environment rich with contextual variables.

SIBs envisage deepening our understanding of innovation processes, developmental trajectories and stakeholder interactions at the ***micro-level*** of the single social innovation (Terstriep et al., 2015). Innovation biographies are basically an in-depth *biographic-interpretative methodology* for analysing narratives of participants' experiences in relation to the larger cultural matrix of society or economy (Wengraf, 2001). Through the combination of interviewing techniques, network analysis and triangulation is possible to reconstruct innovation processes from the first idea to its implementation (Butzin, 2013; Butzin & Widmaier, 2015).

Findings

The comparative analysis of the data indicates that the interplay of social and economic objectives as well as of efficiency and effectiveness drive social innovations' economic and social impact at the micro level and institutional change at the meso level. The findings show that social innovation initiatives mostly struggle in balancing those components, because they are naturally defined as extremes which are difficult to combine. As a favourable result of the comparative analysis a balance model is elaborated, which includes associated social innovation actors from micro level (social enterprises, mutuals, associations and cooperatives) as well as further types of organisation working in the field of social innovation. The model is structured along the dimensions of social and economic objectives on the one hand, and efficiency and effectiveness on the other hand. Taking efficiency and effectiveness as two opposing poles does not pose them as two extremes on a continuum, but bases on the assumption that there is a trade-off between efficiency and effectiveness in social innovation processes.

Figure 2: Balancing Economic & Social Objectives, Effectiveness & Efficiency

Source: Terstriep (2016)

SIMPACTs empirical findings show that the preference to reach both efficiency and effectiveness result in, for example, bricolage attitudes which could endanger the survival of the organisation itself. In this vein, bricolage is a consequence of a dominant focus on results (effectiveness) and the need to acquire more and more resource instead of improving the process of balancing efficiency and effectiveness. Moreover, the interplay of economic objectives and social objectives are traditionally characterised by a trade-off. A priority for economic objectives and a strong focus on social aspects could be found in the area of economic-driven companies, namely social enterprises. The companies which follow a 'efficient-social' and 'effective-social' strategy emphasise a strong focus on social objectives, for which cooperatives and associations are good examples. While cooperatives focus on output ('social-efficiency'), associations tend to emphasise outcomes ('social-effectiveness').

Conclusion

The underlying balance model is a first step towards a deeper understanding of innovation management in social innovation initiatives and the challenge to expand their impact from mirco to meso level. It contributes to the overall discussion about how social innovation actors/initiatives perform in reaching social and economic impact at the micro level and in how far social innovation actors/initiatives struggle to pursue institutional change at the meso level. Analysing the paths of the four dimensions (efficiency, effectiveness, social and economic objectives) we argue that in general, traditional companies focus on economic objectives and little on efficiency or on a socially sustainable process, because cost cuttings and time saving dominates the business strategies of companies. These companies are mostly not interested in initiating social innovations. Nevertheless, it could be of high interest to raise their awareness for the economic potential resulting from engaging in social issues and in cooperating with social actors. It is further recommended to manage social innovation initiatives, for instance, with a focus on social objectives towards a central balanced position including the aim of effectiveness and efficiency in order to reach long-term sustainability. This is particularly the case for self-organised groups of disadvantaged people, activities which engage the beneficiaries (i.e. embedded

participation) as well as public embedded activities and activities with strong charismatic leadership.

In this vein, Social innovations cannot only be observed in their evolutionary pathways or be supported at the policy level. The use of the underlying balance model can consequently improve our understanding of social innovation in practice and support social innovators in reaching effectiveness and replicability of their social solution as well as reshaping and integrating several objectives. Furthermore, intermediaries, policymakers and other stakeholder in the field of social innovation get a better understanding of social innovation challenges to reach social and economic impact at the mirco level as well as institutional change at the meso level.

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8.1.2 Tapping the Full Innovation Potential of Society – On Social Innovation and a Comprehensive Innovation Policy

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While there is an increasing consensus among both researchers and practitioners regarding the need for more government activity in social innovation, it still remains largely unclear how these activities should look like in order to support social innovations successfully (The Economist Intelligence Unit 2016).

The results of the first global mapping of social innovation initiatives reveal the importance of social innovation addressing social, economic, political and environmental challenges of the 21st century on a global scale (in the framework of the research project SI-DRIVE, a global mapping of social innovations – understood as new social practices – was conducted, thus creating a database of 1005 cases, which covers about 80 countries from all world continents and addresses seven policy fields: education, employment, environment, mobility & transport, health & social care, poverty & sustainable development). Social innovation has become a ubiquitous concept with high dynamics (Howaldt et al. 2016). At the same time, there is an increased awareness of the size of the challenges modern societies are facing and the complexity of innovation processes. Like technological innovations, social innovations are based on many presuppositions and require appropriate infrastructures and resources. Moreover, social innovations are requiring specific conditions because they aim at activating, fostering, and utilizing the innovation potential of the whole society. Therefore, new ways of developing and diffusing social innovations are necessary (e.g. design thinking, innovation labs etc.) as well as additional far-reaching resources, in order to unlock the potential of social innovation in society and to enable participation of the relevant actors and civil society.

This is not only a matter of appropriate funding but also of new participation and collaboration structures, co-creation and user involvement, empowerment and human resources development. Attention has to be paid to the invention and its development as well as its diffusion and imitation. From this innovation process and development perspective resources, capabilities and constraints, drivers and barriers are not only relevant for the invention and implementation but also for scaling and diffusion of innovations (Moulaert et al. 2013).

The mapping demonstrates that social innovation processes and the underlying resources, capabilities and constraints are related to the actors of the different sectors of the social innovation ecosystem. This includes a new role of public policy and government for creating suitable framework and support structures, the integration of resources of the economy and civil society as well as supporting measures by science and universities (e.g. education for social innovation performance, know-how transfer). The main questions evolving from SI-DRIVE's theoretical review are: How can we enhance the 'innovation capacity of society' and 'how can we empower citizens'? Which resources and capabilities are necessary for the development of social innovations? How can these resources and capabilities be used for diffusion, adaptation and imitation of innovations?

The mapping reveals that a wide range of different financial and personnel resources (including volunteers, employees, external advisors etc.) already exist. They build the ground for many successful social innovation initiatives. Yet, there are big differences in the budget the initiatives can deal with and a variety of funding sources. The growing importance of social innovations is especially indicated by emergence of infrastructures and institutions that promote social innovations and provide a variety of funding and support structures.

At the same time, the mapping reveals an underdeveloped status of conceptualisation and institutionalisation. There is no shared understanding of social innovation (including a clear differentiation from other concepts such as social entrepreneurship or technological innovation) and no uptake/integration in a comprehensive (social) innovation policy. Policy field related documents of public authorities such as the European Commission, the United Nations, the OECD, the World Bank, etc. often even do not refer to social innovations (exceptions are Horizon 2020 documents as well as publications of some DGs). Only in a few countries, such as e.g. Colombia, Germany, Italy, Sweden, the United Kingdom and the USA, social innovation has been taken up by policy. But in most of the countries there are no policy institutions with direct responsibility for social innovation. Hence, initiatives and their sustainability are highly dependent on individual persons, groups and networks.

The good news is that there is an increasing awareness and promotion of social innovation: In many countries, the promotion of social innovation itself by the EU has served as a driver and opportunity for various actors to embrace new ways of working, access new funding streams, and promote change at a national level. Even though a lot has been done during the last years, there are still some important steps to take in order to move social innovation from the margin to the mainstream of the political agenda.

The absence of a comprehensive innovation policy, which includes social innovations and not only technological innovations, corresponds with the low maturity status of the social innovation ecosystems. While social innovation initiatives and practices have drawn a lot of attention within the last years in the different world regions, being imitated by manifold actors and networks of actors and diffused widely through different societal subareas, the ecosystem of social innovation "is in very different stages of development across Europe, however. In all countries, though, the ecosystem is under development and there are a number of important factors enabling the development of social innovation, including important support and impetus from the EU" (Boelman & Heales 2015, p. 7). One of the major challenges will be the development of these ecosystems.

This also raises the question of the role of universities in social innovation processes. The marginal engagement of research and education facilities is in strong contrast to their essential role as knowledge providers in classical innovation processes and as one actor of the triple helix model. That means that currently we find an uncompleted ecosystem of social innovation (quadruple helix) with one important pillar missing. It will be a major challenge for the development of social innovation to ensure a much higher involvement of research and education facilities. This also includes the question of new modes of knowledge production and scientific co-creation of knowledge aiming at an integration of practitioners and social innovators in the innovation processes.

In this context, the mapping reveals the capacities of social innovations to modify or even re-direct social change and to empower people – i.e. to address a wide variety of stakeholder groups, as well as the broader public, in order to improve social cohesion and to allow for smart, sustainable and inclusive growth. The mapping shed light on the great many, often nameless but still important, social innovations responding to specific and every-day social demands or incremental innovations.

The distinction between three different output levels (social demands, societal challenges, systemic change) is taken up by the SI-DRIVE project, but also has to be modified to some extent. There is a strong relationship between social demands, unmet social needs, societal challenges and transformative social change in different policy fields and approaches. However, the very idea of systemic change implies that multiple institutions, norms and practices will be involved, and that multiple kinds of complementary innovations would have to be introduced in order to cope with the high complexity of problems which require structural changes in society. Only then we will be able to fulfil the excessive expectations of ground-breaking systemic social innovations (or radical innovations in the common language of innovation theory and research) and transformative change.

Another key finding refers to the drivers of social innovations. While the development of technological innovation is a self-driving dynamic process often driven by the new possibilities of technologies, social innovation processes are more problem-driven. Therefore, the need to respond to a specific societal challenge or a local social demand is by far the main motivation and trigger for initiating and running a social innovation. More than 60% of the initiatives started from this perspective. These objectives are more relevant than having an inspiring new idea (28%), a policy incentive like a policy programme or strategy (18%) or a social movement focusing on specific issues (15%). The possibility of taking advantage of new technologies for tackling social problems is a first motivation or trigger only in 23% of the cases (Howaldt et al. 2016).

In conclusion, a clearer understanding of social innovation as a new social practice has to become a relevant part of policy-makers' minds in order to support collaborative solutions in a medium and long term perspective, and unlock the bottom-up potential of social innovations.

Against this background, the paper – submitted for the conference's Track 8 Social Innovation as a Challenge for a Comprehensive Innovation Policy – will outline the challenges for a comprehensive innovation policy, which focuses on new participation and collaboration structures, co-creation and user involvement, empowerment and human resources development as basic conditions for social innovation.

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8.1.3 Three Approaches to integrate Technological Innovation and Social Innovation: Responsible Research and Innovation, Science with and for Society, and Sustainable Development Goals

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Current policy considerations about turning research, technology and innovation policy towards societal challenges include at the same time approaches to integrate technological Innovation and social innovation. Prominent approaches in the field are Responsible Research and Innovation (RRI), Science with and for Society (SWAFS), and (indirectly) the Sustainable Development Goals (SDGs).

Based on a review of these approaches, we examine how the integration of technological innovation and social innovation is conceptualized in these approaches. We present the concept of RRI, the conceptual rationale behind the program Science with and for Society, and the UN agenda for Sustainable Development Goals (SDGs) as potential approaches to bridge the (perceived) gap between technological and social innovation.

8.1.4 Social, Economic and Political Innovation: Differences, Similarities and Consequences for an Integrated Innovation Policy

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Introduction

Currently we are witnessing that the concept of innovation moves beyond the mere economic sphere and spreading into a variety of societal and political fields, resulting in blurred boundaries while running danger to become even fuzzier. Yet it is recognized that an integrated innovation policy has to balance the dilemma between a broad and hybrid strategic approach on the one hand, and clearly defined strategic targets on the other hand. In the light of an increasing fuzziness of the innovation concept and associated policy dilemmas, beginning with clarifying the concept of innovation in its distinct manifestations, the paper will discuss several new approaches of innovation policy especially at the regional level from a social science perspective.

Theoretically the paper refers to the »concept of social fields« (Bourdieu), and adapts results from Elias' »social processes theory», Kingdon's »policy stream approach«, Bloch's »study on asynchrony in time« ("Ungleichzeitigkeit"), Putman's »social capital approach«, and others to reflect on three current research streams: (1) research on social innovation, especially in the context of the two EU-funded FP7 projects SIMPACT and the SI Drive ; (2) research on cluster and regional innovation systems with reference to the triple helix approach; (3) research on new modes of regional governance with a focus on transformation of old industrial regions..

Innovation in Different Discourses

The first section will discuss the roots of »innovation« in different societal discourses. The notion "innovation" roots in philosophy, polical theory, and theology. In this original context innovation means something new, different and is related to change. In the 20th century innovation became a key concept in economy and increasingly centred on technological innovation. In response to the recent diffusion of innovation in almost any societal fields several approaches are in search of an integrated innovation concept. One approach aims at opening the economic understanding of inno-vation by adding new actors form civil society (quadruple helix) or integating social and economic aims in companies (corparate social responsibility). A further approach aims at studying the inter-play between different types of innovation with focus on large scale changes (transition, socio-technical systems), patially talking about systemic innovation. In contrast, we argue that a specific understanding of innovation is needed that moves beyond notions such as

»change«, »better« or »new« and acknowledgeds distinct mechanisms of specific social fields.

Innovation in three Societal Fields Compared

In consequence, section two starts by a deconstruction the innovation concepts and an elaboration of specifics for the social, economic and political field. To advance understanding the distinct characteristics of innovation in the three fields we use universal categories not limited to a specific social field: Components (actors, resources, and institutions), objectives (social, political, and economic objectives), and principles (efficiency, governance). The key argument is that innovation refers to modes of change that strengthen the capability of actors in different social fields in a way that the social field functions more efficient. Concerning social innovation it is assumed that there exists a positive relationship between strengthening individual capability to participate in societal life and social cohesion (capability approach, empowerment). In the political field it is about the relation between individual political rights and engagement on the one hand, and the overall capacity of governance on the other hand. In the economic field it is about the well known assumption that individual competitetiveness results in societal wealth.

The following aspects are further elaborated:

- Subject to the social field innovation varies.
- Characteristics of the social field shape innovation logics and dynamics.
- Innovation as an integrated approach necessitates combining various theoretical streams (institutional, evolutionary, action based, rational choice).
- Notwithstanding the above, at a certain stage of development innovation in different social fields are interlinked and mutually interdependent.

Figure 1: Innovation in three Social Fields compared

		Social Innovation	Economic Innovation	Political Innovation
Components	**Actors**	Companies, Movements, Clubs, Projects, Foundations Self-Organisation, Movements etc. Disadvantaged People (Beneficiaries), Public Sector	Companies, Households, Public Sector, Research	Politicians, Administration, Civil Society, Pressure Groups
	Resources	Economic Capital (different sources), Social Capital, Premises, Participation, political resources (vote, protest)	Capital, Labour, Land, Knowledge	Vote, Power, Legitimation
	Institutions	Market, Welfare Regime, Urban Modes of Governance	Market	Elections, Bureaucracy, Self-Organisation
Objectives	**Social**	Dominating	In classical business irrelevant, partially addressed by CSR, sponsoring or foundations	Welfare, Coherence

		Social Innovation	Economic Innovation	Political Innovation
	Political	Partially in a direct way, partially addressed in cooperation with further actors (NGO's, Foundations, etc.)	Business associations (lobbying)	Staying in power
	Economic	Often neglected or subordinated	Dominating	Competitiveness Growth Taxes
Principles	Efficiency	Balance of economic, social and political objectives with clear priority for social objectives	Balancing different modes of economic objectives (long-term – short term, shareholder – stakeholder driven etc.)	Good governance
	Governance	Internal: participative External: Complex mode of regulations, bargaining, cooperation and competition, conflict, or protest	Internal: hierarchical, different degrees of participation External: Competition, partially combined with pre—competitive co-operation	Internal: Balancing fragmentation and co-ordination External: hierarchy and participation

Interdependencies between Innovation in different Social Fields

The third section of the paper discusses overlaps and reciprocal interdependencies between the three fields. It demonstrates how social aspects influence economic and political innovation, how economic aspects influence social and political innovation, and how political aspects influence social and economic innovation. Whereas the influence of economic aspects on all societal fields has been broadly studied the influence of social innovation in the economic and political field has been of minor interest. For instance, in the economic field the new balance between co-operation in networks or clusters has been an important social innovation in overcoming the given lonesome rider attitude. In the political field new modes of governance and participation resulted in a new non-hierarchical mode of policy making. At the macro-level the interplay between different modes of innovation results in rebalancing the division of labor between state, economy, and civil society, we call this societal innovation.

Figure 2: Interdependencies of Innovations in different Social Fields – Examples

	Economic aspects influence…	Social aspects influence….	Political aspects influence…
Economic innovation	Research and technology, business model, organizational models	Overcoming the lonesome rider capitalism (Cluster, networks, CSR)	Internalization of external effects, shaping of markets
Social innovation	Strengthening economic underpinning (entrepreneurship, evaluation, measuring, monitoring)	Empowerment Self-organization Responsibility Protest	Institutional frame Legal frame Prohibitions Tipping points
Political innovation	New public management Competitive calls	Resistance Social fragmentation	Decentralization Regionalization

	Benchmarks Best Practice	New modes of participation Value change	»Good governance« Coordination

Consequences for Innovation Policy

The fourth section discusses the implications of our findings for an integrated innovation policy. So far, we present three conclusions: Firstly, as innovation in the single social fields varies and social fields follow their own logic, timeline and so on, the potential for integrated approaches are limited. An integrated innovation policy that covers all conditions and aspects seems to become overcomplex. This is especially important because experience shows that the capacitiy of public policy to coordinate their ministries or policy fields are rather limited.

Secondly, therefore rather than developing a holistic concept of future innovation policy, we formulate points of reference as dilemmas that need to be balanced. Dilemmas policy and decision-makers face on their way towards an integrated innovation policy are for instance:

1. The need of broad participation as consensual bases for integrated innovation strategies vs. the conflictual and in certain terms disruptive character of innovation that often bases on outsiders and conspiracy.
2. The need of hybrid goals of an integrated innovation policy that combines social, economic, and political innovation vs. the different logics that drive innovation in specific social fields.
3. The far reaching and long-standing processes of integrated innovation policy vs. the need of clear and realistic goals when you want to motivate and integrate engaged actors.

Thirdly, innovations related to distinct social fields are mutually dependent. Accordingly, situations or places of successfull integrated approach have to be studied. In this respect it emerges that integrated projects at the regional level are most promising, but require a conducive environment. This is exemplified by three case studies: Innovation City in the Ruhr Area, It's OWL in East-Westphalia-Lippe, and Innovation Campus in Aachen.

The outlined dilemmas are systematically examined and concepts of innovation policy with an integrative potential are discussed, whereas concepts with a strong focus on the local, urban or regional level take centre stage. Concepts of topical interest are open innovation, quadruple helix, innovation ecosystems, transition, smart cities, urban laboratories, design centers of innovation, or smart specialisation

Conclusions & Open Questions

The final section will summarise the discussion and provide an outlook on societal innovation and future research needs especially as regards the impact of an integrated innovation policy in the con-text of sustainable, inclusive and smart growth strategies.

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8.2 Session 8.2

8.2.1 ICT-Enabled Social Innovation: Lessons from a pan-European study

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Introduction

Social innovation is gaining renewed attention in policy and academic debates since its revival in the European policy agenda with the Innovation Union Flagship Initiative in 2010 and the Social Innovation Initiative, in the US with the Office of Social Innovation and Civic Participation and the Local Economic and Employment Development of the OECD in the forum on Social Innovation.

ICTs have been identified as the enabler of this renewed effort. The rationale for this perspective lies in the digital transformation of the globalised 'Knowledge Economy' which is mostly service-based. Whilst the potential positive impact of the 'digital revolution' is often overemphasised, some consolidated relevant socio-technical trends support the provision of social services in an innovative, integrated, and personalised manner.

The reliance on ICTs may support a twofold objective: 1) the modernisation of social protection systems and 2) act as a catalyzer for facilitating the operationalization of the innovation-driven rationale to social investments, through experimentation.

Based on a large qualitative dataset of ICT-Enabled Social Innovation initiatives, our study explores the characteristics of these initiatives.

Insights from the literature and theoretical framework

A definition widely used within the European institutions considers social innovation as new ideas, products, services and models developed and implemented to meet social needs and create new social relationships or collaborations (Murray, et al. 2010). It is somehow implicit that in the economic and social agenda, social innovation is called upon to provide a social net for unemployment, poverty and social exclusion and improve the resilience of the welfare system in a longer term perspective. For this agenda, the idea of social innovation concerns mainly social services and the organisational setting for the

ideation development and delivery of personal social services of general interest. The bridge between social innovation and services innovation is built on a multi-agent framework. The creation and deployment of innovative social services happens in a context of co-creation where citizens, organisation, social entrepreneurs and NGOs take a prominent role in the innovation process and the actions are sustained by the stakeholder agency (Windrum et al, 2016).

Undoubtedly, in the last decades there has been an increasing focus on services research especially in conjunction with the development of ICTs. The trend is rather complex but the growth of the service economy is investing all sectors of social and economic activities and, in particular, personal services. This growth, however, is characterised by an increase in intra-organisational structures as well as inter-organisation networks of value creation. The four dimensions of the service logic 1) service concept, 2) client interface, 3) service delivery system and 4) technology (den Hertog, 2000 and Miles, 2008) is particularly invested in the conceptualisation of service innovation since any change (or innovation) in one sphere may trigger changes in the other connected dimensions and, depending on the degree of personalisation/formalisation of the service, it may engender the formation of new innovation ecosystems. These ecosystems, as argued by Lusch and Vargo (2014), originate from the integration of resources and the exchange mechanisms that are institutionalised for the creation of value benefitting the parties involved. ICTs may be considered as mere contributors to service efficiency (as in the traditional theory of service innovation) or they may have a transformative role (Lusch and Vargo, 2014).

Co-creation is an important aspect of social innovation as (Vooberg et al, 2015 p.1334). From the perspective of the provision of public services, co-creation between citizens and institutions may have different forms and ICTs may assume a central role in the creation and functioning of the ecosystem. ICTs combined with knowledge and skills constitute the main set of resources within which innovation emerges and at the same time the ICT architecture/infrastructure is the means through which new or improved services are delivered.

Against these considerations, the definition of ICT-Enabled social Innovation adopted in the present study - 'A new configuration or combination of social practices providing new or better answers to social protection system challenges and needs of individuals throughout their lives, which emerges from the innovative use of Information and Communication Technologies (ICTs) to establish new relationships or strengthen collaborations among stakeholders and foster open processes of co-creation and/or re-allocation of public value' (Misuraca et al, 2015, p.8) - may be grounded both in the foundation work on social innovation and on the aspects brought forward by service innovation research.

Some descriptives of the sample

The knowledge base of our study includes 613 inventoried ICT-enabled social innovation initiatives distributed mostly across Europe. 300 initiatives that met a further eligibility criterion - evidence-based results in terms of outputs and/or outcomes - have been studied in much more detail.

The distribution of the sample according to the services provided is as such: 20% of initiatives operate in Social Inclusion and Participation, 16% in Education and Training and 13% in the Civic Engagement,18% in Active and Healthy Ageing and long term care constitute and 15% in Employability and Employment.

The distribution of the inventoried social innovations by country/welfare area consists of circa 500 initiatives operating within national boundaries. Their scale of implementation is mostly at the national level (over 50%) whilst just over 35% operate at the regional and local level. The remainder of the sample consists of initiatives operating in more than one

country. Moreover, the initiatives are rather young, 50% of them are younger than 5 years and about 90% younger than 15.

Findings

The main message is that ICT-enabled social innovation initiatives are very diverse. There is great variety in terms of sectors of engagement, in the modes they approach their respective remits and in the use they make of the technologies.

1) Initiatives, even those operating on a smaller scale, may have multiple objectives (i.e. the provision of services in more than one area).

Though active in more than one field, they are increasing their remit especially by extending their reach in terms of target groups, geography or even expanding in different sectors.

2) There is variety also in their organisational models.

Some initiatives are born-small and are easily replicable in other contexts: the multiplicative effect is to be found in replication rather than growth of the initiative. Other initiatives are centred on technologies and business models that are easily scalable (even globally). In these cases, rather than replicability, the growth model can be described as 'organic growth'.

These are important indicators of the dynamism of the sector. However, the sectoral dynamics may still be dependent on the relatively young age of the initiatives that are exploring new areas of intervention or testing operative possibilities rather than an indication of long term / sustained growth of the sectors.

3) The different degree of innovativeness is also remarkable.

The innovation potential of these initiatives is –for the majority of initiatives - disruptive, meaning that ICTs are becoming increasingly embedded in the conception and innovation process of the services to the point that, without technological integration, the services would not be possible. In a small but significant number of ICT-enabled social innovation initiatives exhibiting radical/transformative innovation potential, the direct involvement of beneficiaries and intermediaries in the delivery of services is particularly strong, indicating that co-creation and co-production of the services with the actual user is highly important to fine-tuning technological appropriateness.

4) In terms of ownership and governance, we found that there are many possible combinations of ownership/partnership arrangements.

However, the co-creation and co-production–types of arrangement are predominantly at the inter-sectoral level. Combining this finding with the observations that almost all ICT-enabled social innovation initiatives are need-driven and outcome oriented, with a prevailing arrangement towards open processes of co-creation/collaborative innovation networks, we can infer that the innovation model followed is mainly based on the principles of open/democratised innovation.

The most important aspect is the driving force behind this trend, the third sector, and the adoption of a user-centric perspective where the service provided involves the beneficiaries in the creation and development of the services.

Conclusions

Our findings may be important to policymakers and practitioners. The documented research design, theoretical framework and findings contributes to the growing scientific interest and debate about ICT-enabled social innovations in the field of social services innovation and social policy redesign within the scope of the recent discussions concerning the European Pillar of Social Rights and the future of welfare systems. The nature of the study offers novel insights into the characteristics of digital social innovations, their diversity points towards different innovation models and organisational structures. These insights may reveal useful in designing and innovative personal social services.

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8.2.2 Innovation policy interventions for social impact

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Introduction

In recent years, several scholars in innovation studies have commented that the rationales underpinning innovation policies are changing. It is argued that innovation policy is beginning to take account of the wider role of innovation in society, and in particular its potential to address 'grand challenges' such as climate change (e.g. Fagerberg, 2016; Cagnin et al, 2012). In parallel, social innovation has grown as a field of practice and study, and governments in several countries - as well as transnational bodies, particularly the EU - have begun to experiment with policy initiatives to support it (Reynolds and Gabriel, 2016). At present, however, there tends to be little connection between mainstream innovation policy and policy for social innovation.

This paper starts from a contention that the theory and practice of social innovation are relevant to discussions of innovation policy and its broader societal role. Our central question is: if an ambition is emerging to reframe innovation policy towards broader social goals, what might this mean in practice? First, we review the ways in which 'social' or 'societal' objectives are currently discussed in relation to innovation policy. Second, we consider the concept of social innovation, exploring its various dimensions and what these could mean in the context of innovation policy. Third, we explore two programmes implemented by national innovation agencies (Tekes in Finland and Vinnova in Sweden) that explicitly combine 'economic' and 'social' objectives. Finally, we draw out emerging conclusions and implications for innovation policy, innovation studies and the field of social innovation.

This paper is based on a critical review of relevant scholarly work on the evolution of innovation policy, and empirical study of two innovation policy initiatives, including document review and semi-structured interviews with programme stakeholders.[45]

The evolving role of innovation policy

Schot and Steinmueller (2016) outline two dominant phases of innovation policy, and a third emergent approach, which each reflect contemporary thinking on the processes of socio-technical change. The first framing is referred to as 'innovation for growth'. Here, innovation is understood as a global public good. While innovation policymakers could enforce regulation where innovations had ex-post negative impacts, the wider human health, welfare and environmental implications were looked on rather fatalistically as being part of the cost of development.

[45] At the time of writing, semi-structured interviews were underway but not yet completed.

A second approach, 'national systems of innovation' (Freeman, 1988; Lundvall, 1992), focused on innovation policy as way for nation states to pursue economic growth in the context of increasing global competition and against the perceived risk of being left behind. This approach focused innovation policy primarily on unlocking economic value, but failed to acknowledge what has termed the "new world of problems" (see Svedin et al. 2009) in terms of their globalised, interconnected and wider societal context.

Schot and Steinmueller (2016) argue that a third framing, 'innovation policy for transformative change', is emerging. This explicitly acknowledges that innovation can have negative societal and environmental impacts, and can result in 'destructive creation' - benefiting the few at the expense of the many, producing lower quality jobs and creating new or other problems (Soete, 2013). In a similar vein, Mazzucato (2015; 2016) points to how governments can adopt more directional roles than simply fixing markets or systems, by channeling innovation towards creating new markets, many of which explicitly set out to achieve particular societal goals.

In line with changes in how innovation has been theorised and understood, there has been increasing interest in using innovation policy instruments not only to generate commercial value, but also to help meet social needs and promote sustainability and inclusivity (see for example Giovannini et al., 2015). Initiatives like the European Union's Horizon 2020 programme, Sweden's 2015 Lund Declaration, and the United Nations' Sustainable Development Goals all point to an effort on the part of governments and other stakeholders to channel innovation in a way that takes into account its social, environmental and distributive effects. A key proposed way to achieve this is by directing public investment in innovation towards 'grand' or 'global' challenges. Foray et al. (2012) note that this can be seen as a new framing of 'mission-oriented' innovation programmes of the past (like the Apollo space programme).

In a European context, meanwhile, there have been calls for greater public engagement in science and technology with the emergence of responsible innovation in EU policy discourse since the 2000s. For Owen et al. (2012), these developments indicate a desire for a more "institutionalised and consistently-applied approach that is inclusive and values-based (or at least values-sensitive)". This effort to democratise science and innovation policy has seen the public and stakeholders involved in formulating grand challenges through processes such as the 'Danish model' for technology assessment based on public participation and deliberation (Mejlgaard et al. 2012).

More recently, Zehavi and Breznitz (2017) have commented on the potential of innovation policies to increase inequality between regions and social groups and described how 'distribution-sensitive innovation policies' can be designed to counter this tendency.

Applying a social innovation lens to innovation policy

Social innovation research is still an emerging field of study, and the term has been described as a quasi-concept: it has some theoretical basis, but as yet no single, agreed definition (Jenson, 2015). However, despite its conceptual ambiguity, definitions of social innovation include several dimensions that may provide a useful framework through which to explore how innovation policy might support innovation to achieve broader societal goals. Some of these are listed in Table 1.

Table 1. Dimensions of social innovation[46]

Dimension	Characteristics
Drivers	Tackling social problems/challenges Addressing unmet social needs Providing solutions not provided by the market
Value created	Social wellbeing (alongside or instead of economic gain) Public value (alongside or instead of private gain)
Form	May involve, though is not dependent on, creation of new technology Recognises that innovations come in many forms, beyond products
Participants	Not limited to business/private sector, but often located in civil society or public sector Often characterised by cross-sector collaboration/'blurred boundaries' between sectors
Innovation process	Involves a wide range people in the innovation process Builds capacity of participants (e.g. to solve problems, to collaborate), and therefore valuable in itself as well as a means to an end

Source: authors' analysis

These dimensions suggest considerations for the design of programmes to support innovation for societal goals. For example, they suggest that tackling social challenges does not always involve development of new technology, but often recombinations of existing technologies and/or non-technological innovations.

Further, they emphasise not just outcomes, but also the processes through which innovation happens. The Young Foundation (2012), for example, states that social innovation is "social in ends and means" and "builds society's capacity to act". Practically speaking, this might suggest that more consideration needs to be given to the types of innovator supported (e.g. socio-economic background, gender) and, as Cagnin et al. (2012) have pointed out, innovation policymakers themselves may need to form new relationships with

[46] Not all definitions feature all of these dimensions, and they are emphasised to different extents by different theorists. Further, some characteristics may be in tension with one another.

a wider range of organisations across sectors. It also suggests that processes of innovation can be valuable in themselves, for example as a means of enabling those involved to better solve problems in future. This has relevance in relation to the idea of 'transformative' innovation policy, which suggests a relationship between innovation and social change: an insight from social innovation theory is that change comes about as a result of involvement in innovation processes (Howaldt et al., 2015).

Social innovation principles can also be applied to the policymaking process itself. Reynolds and Gabriel, 2016). Indeed, considerable emphasis is paid in social innovation literature to the ways in which public agencies conceive of their roles and design, deliver and evaluate policies in more participative, iterative, experimental and human-centred ways (e.g. Bason, 2010). This resonates with the ideas and practices described in literature on RRI.

Innovation policy interventions for social impact

To explore practical implications of combining social and economic goals in innovation policy, we analyse two existing programmes led by national innovation agencies. Given the challenges in defining social innovation set about above, this initial analysis focuses on policy interventions that explicitly describe themselves as aiming to create social impact alongside economic impact.

BEAM – Business with Impact is a joint programme between Tekes, Finland's innovation agency, and the Finnish Ministry of Foreign Affairs (MFA). The programme runs from 2014-2019 and its estimated total programme value is €50 million, of which half will come from Tekes and MFA, with the remainder co-financed by applicants.[47] BEAM has twin objectives: improving well-being in poorer countries and creating international business opportunities for Finnish companies. It does not focus on specific sectors or challenges, although lists themes that it expects projects are likely to address, including healthcare, education, environment, energy and ICT. It accepts applications for enterprise and research projects from a range of actors including Finnish companies, NGOs, research organisations, universities and others.[48] By May 2017, some 72 projects had so far been supported, with funding ranging from €22.6k to €543k.[49]

Since 2011, Swedish innovation agency Vinnova has run Challenge-Driven Innovation (CDI), which aims to use identified societal challenges as a basis for driving innovation whilst opening up opportunities for growth, prosperity and sustainable development. The programme focuses on four strategic challenge areas: 1) Future healthcare 2) Competitive industries 3) Sustainable attractive cities and 4) Information society. The CDI investment model involves a stage-gate approach - where the government funds relatively earlier stage, higher risk initiatives, decreased funding as the supported projects approach commercialisation. The programme model has been found to work - 90% of the projects that receive only the first stage of support continue the work in some form, which is taken to suggest that the programme "has a mobilising effect with respect to tackling societal challenges" (Vinnova, 2017).

In this empirical phase of the research, which is still ongoing, we explore the rationale and drivers for these programmes; their distinctive features; the ways that they define social

[47] Available online: https://www.tekes.fi/globalassets/ohjelmat-ja-palvelut_uusin/beam/tekes_ohjelmaesite_beam_2016_a4_web-002.pdf (accessed 11/05/2017)

[48] Available online: https://www.tekes.fi/en/programmes-and-services/tekes-programmes/beam--business-with-impact/ (accessed 11/05/2017)

[49] Tekes has published project information as an open dataset, available at https://extranet.tekes.fi/ibi_apps/WFServlet?IBIF_ex=o_projekti_rap1&YTARKASTELU=Q&YEDTASO=OHJELMA&YOHJELMA=BEAM&YMUOTO=HTML&YKIELI=E (accessed 11/05/2017). This shows funding amounts for 32 'research' projects, although funding information is not given for the 40 'enterprise' projects.

impact, and balance this with economic goals; and their delivery in practice - in particular, whether they place any new demands on innovation policymakers.

Interim findings and conclusions

Our interim findings indicate that although innovation policy is being discussed more frequently in terms of its contribution to societal objectives beyond economic growth, social innovation, as yet, is rarely discussed in relation to mainstream innovation policy. Nevertheless, there is some overlap between the concept of social innovation and concepts discussed in innovation policy, such as responsible research and innovation (RRI) and challenge-driven innovation. It is possible, therefore, that mainstream innovation policy initiatives are already supporting some social innovations - even while not using this terminology.

At the same time, a closer examination of the dimensions of social innovation suggests some additional ways in which social innovation could be integrated into innovation policy. For example, social innovation's emphasis on innovation processes that build participants' capacity and involve different sectors of society could be instructive if applied to other areas innovation policy.[50] Furthermore, the application of these principles could also be applied to the policymaking process itself to deepen the social impact of innovation policy areas already seen to create social value (e.g. clean tech). Incorporating social innovation principles when defining policy priorities, co-designing funding programmes, or even selecting innovations to support could help further democratise innovation policymaking processes.

By examining two current policy initiatives that support innovation for both social and economic ends, we aim to understand what it means to reconcile these at-times competing objectives in practice. Our initial analysis suggests that rather than embodying the 'transformative' innovation policy paradigm described in work by SPRU (2016), the programmes combine elements of different innovation policy frames and operate according to a more 'incrementalist' theory of socio-technical change in which social goals are at-times subsumed to economic goals. Our aim is to offer practical recommendations on how innovation policy might be best used to pursue social objectives. Further inquiry will look to identify how the programmes navigate and make sense of the trade-offs that likely arise when working between these competing value systems.

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8.3 Session 8.3

8.3.1 Hungarian Social Co-operatives: A policy tool to promote social innovation?

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Keywords: Social innovation policy tools; Social co-operatives; Public works programme; Unemployment and marginalisation; Hungary

The proposed paper analyses the emergence and operation of social co-operatives in Hungary with a special emphasis on the so-called 'new type' social co-operatives, which is an idiosyncratic Hungarian legal form.

To thoroughly understand the specificities of the 'new' type social co-operatives we compare the 'old' and 'new' type social co-operatives. We address two main issues: (i) we explore why the government changed the legislation in 2012 to allow the creation of 'new type' social co-operatives, and (ii) we analyse the operation of both 'old' and 'new' type social co-operatives. Our paper relies on document analysis and interviews with policy-makers at the central government level, decision-makers at the local level, as well as practitioners and experts. Some of the main findings are highlighted below.

Before World War II co-operatives had developed organically in Hungary. That evolution was drastically stopped by the introduction of central planning and collectivisation of assets, including land. Most of these co-operatives have been dissolved during the transition to market economy since the early 1990s. Yet, as a historical legacy, the notion of co-operatives still has a negative connotation for many people: reminiscent of the forced agricultural and industrial co-operatives set up between the second half of the 1940s and the 1960s. The lack of a thorough understanding of the actual operation and impacts of genuine co-operatives is a root cause of several problems faced by co-operatives and social co-operatives nowadays.

The new general law on co-operatives, passed in 2006, introduced social co-operatives as a novel legal form in Hungary. As the law stipulates, the aim of social co-operatives is to create jobs for their disadvantaged members and contribute to the improvement of their social status by various means. Given the historical legacy stressed above, i.e. the heavy political burden on co-operatives, that was a major social innovation to adapt the internationally well-known legal form in Hungary.

Social co-operatives are considered by the government as an important social innovation policy tool promoting the employment of marginalised people. Using EU sources, the Hungarian governments have provided generous grants to accelerate the creation of social co-operatives. By the end of 2014, over 2,000 social co-operatives had been established, the majority of them, however, become inactive when their grants had been exhausted.

In 2012 local municipalities were allowed to become social co-operative members, too. These are the so-called 'new type' co-operatives. Social co-operatives must have at least 7 members; in the case of the new type co-operatives at least two of them should be formerly employed by a project financed by a public works scheme. Local municipalities are allowed to lease free of charge their assets (land, buildings, machinery) stemming from the public works programmes to their 'new type' social co-operatives. The government has strong desires that these co-operatives would serve as effective exit route from the

unprecedentedly expansive public works programmes, from which the exit rate is disappointingly low. (Without public works the unemployment rate in Hungary would have been 10.5% instead of 6.8% in 2015.)

In spite of the large number of social co-operatives and the amendment of the legislation, the main role of social co-operatives has not been clarified in policy documents. Three, rather different possible roles have been perceived by policy-makers and practitioners. The first one is the so-called transitory employment, aimed at preparing social co-operative members to enter or re-enter the primary labour market. There is a strong need for tailored services assisting unemployed people re-entering the primary labour market. That can be provided without co-operatives. Moreover, insisting on social co-operatives and preferring this form is likely to be ineffective. Incentives provided to existing – that is, already proven – enterprises to create new jobs in deprived regions or setting up non-profit companies by local governments are likely to be more effective tools.

From this angle, schemes launched by OFA, the state-owned Hungarian Employment Public Benefit Non-profit LLC in 2007, aimed at supporting job creation by social co-operatives, can be questioned. These schemes requested that eligible social co-operatives need to have at least 3-4 marginalised people as members. That was certainly in line with the underlying objective of OFA, namely to increase employment. Yet, it is unlikely that an enterprise set up exclusively or mainly by marginalised people would be a viable one.

A second potential role is incubation, that is, setting up enterprises that would be viable in the market. To play this role effectively, an enterprise development network is also needed that can support social co-operatives by offering the relevant services. Further, preferable tax conditions should be introduced for start-up companies (which is not the same as promoting the employment of co-operatives' members). OFA has indeed set up a network to assist social co-operatives, co-financed by EU funds. Yet, it should have been done much earlier and it still needs to be developed considerably.

The third potential role is community development and societal integration, possibly the most important one from the angle of social innovation for marginalised people. This is severely hampered by tying new type social co-operatives to public works schemes, aimed at creating workfare type employment, run by the local government, and overseen by the Ministry of Home Affairs. Moreover, the local government (regardless of its ownership share) enjoys the dominant position in these new type social co-operatives. That is clearly against the fundamental principles of co-operation.

Given the Hungarian context it is a puzzle why the legislation excludes the Italian A type social co-operatives. (These organisations are engaged in delivering education, health, and social services.) The law on central budget stipulates the types of organisations that are eligible for obtaining public support when providing social and child welfare services. This is a rather long list, including civil society and religious organisations, as well as enterprises – but co-operatives are not on this list. Policy-makers and practitioners interviewed for this project, as well as all participants attending the policy roundtable held on 27 April 2016 in Budapest shared the view that making social co-operatives eligible for receiving public support when providing these social services would be an important step forward; that would contribute significantly to the development of social co-operatives. They also shared the assumption that this regulatory 'flop' had not been due to a conscious policy decision; it had been caused by a simple – and somewhat usual – co-ordination failure. As a government expert noted, awareness raising activities would be needed: the notion of social co-operatives is not yet an active element in the mind-set of many policy-makers.

Another major issue concerns profits vs. societal benefits generated by social co-operatives. Projects initiated by social co-operatives, supported by government schemes, are

expected to generate profits in a few years, or at least to become self-sustaining enterprises. This approach seems to be too narrow: social benefits should also be measured because the combined effects of social benefits and profits would decide if a given social co-operative – or more broadly, a social enterprise – is a viable one. All the benefits should be considered, including those that occur at the national or local level.

Our tentative policy conclusions are as follows: The policy agenda concerning social co-operatives has changed considerably in a relatively short period of time. The so-called new type social co-operatives, introduced in 2012, have no potential for empowerment and reduction of marginalisation. The existing power structures are reproduced and strengthened by these new type social co-operatives.

The very strong top-down interventions into the natural evolution of social co-operatives have distorted the fundamental principles of co-operation. The high amount of state subsidies with rather lax conditions have created ample and easy-to-exploit opportunities for rent-seeking. Allowing the membership of local municipalities has practically overwritten the one member – one vote principle. In the 'new type' social co-operatives the members heavily depend on the local municipalities, which can enforce their will using other means (beyond the legal form and rules of the co-operative).

Considering the broader context, there is a strong need for an overarching legislation and regulation on social economy, just as in many Western European countries. The current legislation only covers social co-operatives and civil society organisations. Having a proper, overarching regulation in place, various tasks – currently performed by social co-operatives in an inefficient, inadequate way – could be performed by other types of organisations more economically. Thus co-operatives could follow the fundamental principles of co-operation without distortions.

The case of social co-operatives also demonstrates a general policy dilemma: is it more beneficial from the angle of societal and economic impacts to focus on creating appropriate, conducive framework conditions for social innovations and let them evolve in an organic way – with the ensuing diversity and the plethora of bottom-up initiatives –, or provide generous funding to foster a particular direction of development, selected in a top-down fashion? (As mentioned above, the latter might also run the risk of rent-seeking.)

Finally, we need to add that the Law on Co-operatives was amended again in 2016, by the time we had completed our analysis. This amendment stipulates that all social co-operatives must be transformed into new type social co-operatives by the end of 2017. This is clearly against the fundamental principles of co-operation: members cannot possibly be equal. We need to continue our work to analyse the strategies and actions of existing social co-operatives to comply with this requirement and reconsider some of our policy proposals in light of this change in legislation.

8.3.2 Emerging Social Innovation and Living Lab in Seoul: Is It Possible to Establish Sustainable Cooperation between STI and Social Sectors?

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Keywords: Social Innovation in Seoul, Living Lab in Seoul, Seoul Innovation Park, Relationship between STI and Social Sector

First, we will look out the Seoul Innovation Park and Living lab, and then whether the social sector and the STI sector can establish sustainable cooperation.

1. Emerging Social Innovation and Living Lab Seoul

1.1 Social Innovation Park (SIP)

In 2015, the Seoul City Government established Seoul Innovation Park (SIP). Its sole purpose is to lead Korean social innovation. The Seoul Innovation Center is an organization that manages about 150 organizations inside the campus, of which mostly are social enterprises, cooperative associations, and start-ups. The Center's main role is to manage and support these organizations to be more active in social innovation.

1.2 Social Innovation Park(SIP): Social Sector-Driven

Unlike the flow of innovation derived from science and technology, social innovation in Seoul emerges from the social domain. Mayor Park Won-soon, who was once a famous human rights lawyer and social designer, is the founder of SIP. Until now, a number of members of SIP are playing an active role in social sectors and maintaining those activities. The problem is they are not much familiar with applying science and technology method in creating social innovation.

1.3 Living Lab in SIP: Networking with STI sectors

In the other hand, with the creation of Living lab in SIP last year, networks between the social sector and the STI sector started to emerge.

The Living Lab in SIP was established in 2016. Since then, it has implemented social innovation projects. Last year, we managed 6 projects and for this year, we're managing 11 of them. The total fund costs about 500,000 dollars. We support not only organizations inside park, but also any project team outside who would like to implement social innovation and living lab projects. Most of the projects use science and technology, such as application development, AR, VR, and drones. For example, in the case of drones, a project team, named angel swing, has used it to map out the slum areas to help the fire station get accurate information of the area. And they are doing it with the feedback of the residents. In this way, most of the teams use proper technology for their own projects.

2. Now the question is: Is It Possible to Establish Sustainable Cooperation between STI and the Social Sectors?

Let me explain the case of Seoul city in terms of historical institutionalism theoretically, putting more emphasis on the actor's roles.

2.1 Critical Juncture of social innovation in Seoul: The election of Park Won-soon as mayor of Seoul

First, there was a Critical Juncture of emerging social innovation in Seoul through the appointment of Park Won Soon as mayor of Seoul. This became an important catalyst to the development of social innovation. Mayor Park formally established Seoul Innovation Bureau as a mayoral organization and declared Seoul to be a city of social innovation. Social innovation policies were then implemented and in this context, we could say that SIP started to form during this period.

2.2 Path-dependency

But even with this organizational change, there are path-dependency aspects. Both the Social Innovation Bureau and SIP are driven by socially-oriented actors. Most of those actors played active roles in democratization revolution era way back in 1980s-90s. in terms of relationship with STI sectors, that means they are not much familiar with or even care about science and technology. Generally, they are likely to equate social innovation to solving social problems in the country, such as the marginalized people, the disabled, inequality problems, or political matters including government corruption. They are so much used to political actions, like demonstrations, political campaigns, or engaging in political party politics. They are likely to think that social problems could not be solved by just small projects or making prototypes, and assume that social innovation can be achieved by facilitating the social economy itself, like growing social enterprises or cooperative association.

In the other hand, recently, with the rapid emergence of the term “Fourth industrial revolution” in Korea, this sector began to accept the use of science and technology as the main factor to change the society. But they don’t link this new stream to social innovation. They are likely to deal with “Fourth industrial revolution” in terms of economic matters. They believe that this may facilitate economic growth or good for business sectors. But their key concerns is that new technologies like IOT or O2O services will make labor market problems even worse(especially) and inequality will be increased. In short, solving social problems and using science and technology are still not linked with one another.

2.3 Possibility to real change

But there are also other actors emerging in social innovation fields which actively use science and technology to solve social problems. Living Lab Projects in SIP is one of them. Each Living Lab Projects are generally small scale but not limited to certain issue. Its main purpose is to make practical solution in real life. On the broader side, it also deals with inequality and marginalized sectors, but focuses more on making practical solutions(prototypes) of any problems with users or citizens. Thus, it tries to use proper technology for each problem such as use of drones to map out the slum areas, or the creation of VR to help the community to remember their place of residents before the reconstruction of the place.

The same goes for the area of STI. Most of the actors are still research-oriented and concentrated in research capabilities or economic growth. On the other hand, some actors are growing who are more practical uses(or socially)-oriented, utilizing R&D programs to solve social problems. One of these actors in STI sector is STEPI (a Science and Technology Policy Institute of Korea).

These two actors, who are practical use-oriented in the social sector and socially-oriented in the STI sector, could make more sustainable cooperation between the social sector and the STI sector. Actually, Seoul Innovation Center started living lab projects because of STEPI’s suggestion to create a body that could implement living lab projects in Seoul. So since last year, the relationship between Living lab in SIP and STEPI and the central

government's bureau in charge of R&D evolved. This year, they organized Korean Living lab Network, named KNoLL (followed by ENoLL).

3. Remarks: Social Innovation in South Korea beyond Seoul City

Recently in Korea, the newly appointed President Moon substituted the name of 'chief secretary of civil society' into 'chief secretary of social innovation' and then appointed the former deputy mayor of Seoul City in Blue House. It means that social innovation is playing important role not only in Seoul government but in the Korean central government. Yet, it is little linked with STI sector. Until now, the main role of chief secretary of social innovation in Blue House is to support civil society as used to. There is little emphasis on the cooperation with STI sectors yet.

It is important time to make a close relationship between social sector and STI sector. We aren't yet sure whether social innovation and STI can maintain sustainable cooperation. But we can say that the cooperation of these two actors can make a difference, and the sustainable cooperation depends much on the cooperation of these two actors.

In this regard, I think this could be achieved if the STI sector understands that social problems can't be solved by mere science technology. It means that In the case of Living Lab Project, for example, many project teams generally apply science technology to solve social solution. However, they still find difficulty in finding what the right technology is for their own projects. To simply say, the STI sector needs to be aware of and have an in-depth understanding of social problems first, and then help people to find or develop the right technology for certain problem, rather than merely creating new technologies. We believe that with the help STI sector, we can make real solution of social problems.

8.3.3 Can Comprehensive Innovation Policy Reconcile Society and Economy?

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Keywords: social innovation, social change, social transformation, social grid, innovation policy, governance, fictitious goods

Recent studies on social innovation have investigated the origin and impact of such phenomena. Questions such as what drives social innovations, how can they be influenced, what is a typical life cycle of social innovations have been guiding the research of several grand EU projects under FP7 and Horizon 2020. Yet another central aspect is the question how are social innovation and social change linked, and how do both relate to social transformation.

This paper will be particularly committed to the latter aspect: the link between social innovation, social change and social transformation - from a Polanyian understanding of transformation. Our assumption is that there is a variety of change agents behind social innovations that give them the impetus to drive change. These change agents can be the government (the state, but also a city government); it can also be a particular social group or interest group. Depending on the degree of influence of the change agent, the link, development and outcome of the social innovation will differ.

In this paper we focus on a long time case studies and how the social innovations evolved toward social change and social transformation. The three long-term cases, comprising some 100 years of development, are social housing, fresh water supply and financial literacy. In Polanyian understand these three are fictitious goods that cannot be left to the self-regulating forces of the free market. Instead, there needs to be a governmental intervention to regulate the access to these goods for the welfare of society. What we can learn from all three cases is that change agents never act alone if they are successful. They are imbedded in a social grid (Beckert 2010) that consists of institutions, networks and cognitive frames. Though one type of change agent might be dominant at a certain point in time, we need to consider that they are only able to act as part of a supportive social structure.

We want to show diverging paths of social innovations, how they lead to social change and eventually to social transformation. This includes not only the analysis of empirical evidence but also the study of more theoretical discussion of social innovation with connection to social change and social transformation. Though there has been a lot of writing on social change, there is little coverage on the nexus of social change/transformation and social innovation. This relationship however is important if we want to understand how we can support social innovation to expand and have a long lasting effect on society. Such understand is important for a comprehensive innovation policy that goes beyond the conventional task of subsidizing industry and targeting economic growth. Instead, in order to tackle future societal challenges, comprehensive innovation policy needs to support social innovation in order to shape social cohesion, resilience and stability. With the recent increase in interest in the field of social innovation, such comprehensive understanding is of actual relevance for today’s society.

9 Track 9: Nexus Governance: Rethinking the Governance of Large Technical Infrastructures

Track 9 was organized by Marc Barbier, UMR LISIS & INRA, Université Paris Est Marne-la Vallée, and Peter Biegelbauer, AIT Austrian Institute of Technology, Center for Innovation Systems & Policy, and included two Sessions.

Growing demands for the global provision of food, energy and water through large socio-technical infrastructures are generating strategic challenges for communities, businesses and governments alike. We refer to the management and resolution of these challenges as ‘Nexus governance’. In this session, we will explore the way science, technology and political processes, both formal and informal, are crucially intertwined, and so influence sustainable development outcomes.

We will share a number of cases from different parts of the world that examine how nexus interactions emerge and are governed in different settings. Examples range from technologies allowing the global exchange of information and communication in real-time, mobility of persons and goods as well as production and distribution of electricity and other energy forms. In most OECD countries the construction of these infrastructures however tends to become engulfed into conflicts time and again. This holds true for technologies such diverse as renewable energy plants (e.g. windmills, solar, biogas), conventional power plants (e.g. nuclear, coal), power lines, railroads, railway stations and airports.

Citizens often complain about sight, sound and smell nuisance caused by (the construction of) new infrastructures. In addition, risks are regularly an issue, as for example in the case of cellular phone technologies, high-voltage power lines and nuclear power plants. Finally, home owners are concerned about the diminished value of their properties after a new infrastructure has been built. In the debate around large technical infrastructures, it is often insinuated that “Not-In-My-Backyard” stances (NIMBY) are the prime explanation for resistance against new infrastructures. More recent research however shows that this in fact is not true and that NIMBYism frequently is used by supporters of new infrastructures to discredit protesters (Devine-Wright 2011, Wolsink 2012).

This presents fundamental challenges for how to facilitate transitions to sustainability, as envisaged by the Sustainable Development Goals. In turn, this requires rethinking the relationships between science, technology and innovation in resource management, as well as the institutional arrangements and practices required. This goes beyond standard state-centred regulatory responses to a wider set of socio-technical and political arrangements known from decades of enquiries that have more specifically question the provision of bio-resources through research, innovation and value chain management.

- Mono-disciplinary, single-sector and state-led approaches are clearly insufficient, but what should be in their place?
- How STI policies should or could address the nexus governance challenges in a state of transition?
- What are the major factors at work with these conflicts? Are conflicts determined mainly by Not-In-My-Backyard thinking or other considerations?
- Can we learn from research regarding the acceptance of technologies or on the governance of technological risks?
- What are the critical issues in the governance of large technical infrastructures?

- Are there processes and instruments which are more promising than the ones currently employed?
- How can decisions on new infrastructures become more democratic, more acceptable and more sustainable?

Illustrated by the case studies or theoretical reflections to be presented in the session, we argue that transformative changes in framing, organisational arrangements, structural and institutional dynamics, and social-technical innovations for sustainability transitions are required. The focus will extend to collective, transversal system innovations and social movement encounters, rather than only on hierarchical forms of governance and knowledge production, including ways of challenging standard scientific-technical frameworks and historically-rooted incumbent regimes, and the roles of knowledge intermediaries and brokers in facilitating transition.

The session favours contributions that reflect on the coupling of STI policies and Resources policies in order to pay attention to incumbent limitations of harnessing sustainable transitions through sectorial knowledge and innovation systems. Case studies that examine nexus governance of water, food and energy, and their interactions are welcome, from any region of Europe or elsewhere. The session encourages contributions that pay particular attention to the challenge of transitions to sustainability and the processes of collective action, citizen mobilisation, state-business interaction and public policy making that influence governance. Paper proposals addressed at problems of governing large technical infrastructures are welcome and may focus on problem finding/agenda setting, decision finding/planning, decision making, implementation, evaluation or termination of policies.

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9.1 Session 9.1

9.1.1 Participation in Local Decision-Finding Processes on the Energy Transition

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Relevance/research questions

Recent changes focusing on the decarbonisation of modern societies cause the transformation of a number of infrastructure systems, most importantly regarding alternative energy production. Extensive discussions have been led on the question of scientific progress necessary, technologies available, regulatory decisions advisable and a variety of other issues. What often has been ignored is the question of how actually the decisions regarding the transformation should come about.

We want to argue that, for the addressed transition processes to be successful, it is highly important to apply appropriate ways of decision-finding and decision-making. This is the case not only in respect of strategic decisions, but also in respect of project implementation on the local level as well (Renn et al. 2014). Following our line of argument, we want to point out that the content is not the only important matter: the question of the process is at least of equal importance.

But how are the concrete processes regarding the transformation shaped on the local level? Who are the key stakeholders involved and how do they interact with each other? And how are citizens meant to participate in these processes? Are there governance processes and instruments which are more promising than the ones currently employed? How can decisions on new infrastructures become more democratic, more acceptable and more sustainable?

Therefore, we seek to confront the results of the study of six cases of wind power projects with assumptions and requests derived from democratic theories.

Decisions in democratic theory

Most people agree that decisions on political issues should be made in democratic ways. However, they might not agree on what democratic means. When they relate themselves to representative democracy, decisions made by town councils or administrations might be fine, as legitimacy is ensured on the basis of recurring elections of the political representatives. However, facing the ongoing discussion about the democratic malaise democratic innovations are hoped to cure the problems of contemporary representative democracies (Smith 2009; Alcántara et al. 2016). In respect to decision finding processes on the local level there are mainly two distinct approaches – citizen participation through referendums or deliberation. Both of these approaches rely on different concepts of legitimacy.

Participatory democracy sees the source of legitimacy in the opportunity for every citizen to express his or her opinions and views, and that all of these positions are being considered in the decision made (Pateman 2003). In this sense a legitimate decision is an aggregate of the different opinions of all citizens and consequently decision making by referendum would meet this requirement in an ideal way.

Theories of deliberative democracy put more emphasis on the decision-finding process itself. By deliberating about an issue mutual learning is made possible and, based on the new informed opinions, a consensus can be reached. This means that the decision made can be more than an aggregate of individual opinions and better decisions might be achieved (Held 2006).

Of course, finding a consensus may take time and generate costs. Therefore, some authors take into account the possibility of decision finding by referendums – at least in terms of political practice and as long as deliberation precedes these referendums (LeDuc 2015).

Empirical materials/ methods

We have selected six cases of contested wind power projects in Lower Austria, seeking high variance regarding the framework conditions of the projects and municipalities, the development of the decision-finding processes and their results. The only criterion to be fulfilled was, that a referendum had to be planned for at least once throughout the decision-finding process – which we interpret as an indicator for some sort of participation. To examine these cases media- and document-researches have been carried out in a first step and in second step expert interviews with mayors, operating companies and members of the citizens' initiatives have been made.

Policy issues: Six case studies on decision-finding processes on wind power plants in Lower Austria

When assessed after criteria derived from deliberative and participatory democratic theory, the decision-finding processes had not much to offer. Citizens had mainly been given the opportunity to participate in information events. They got informed about the already planned projects, but their interests and perspectives barely got taken into account. Only when serious resistance against the plans had been voiced, especially by a citizens' initiative, public deliberation of some sorts set in.

The crucial actors in the decision finding processes, as the ones who shape the participatory processes in the first place, had been the mayors. They aligned themselves with the operating companies and faced the need to integrate citizens into the decision-finding processes due to the knowledge of conflicts in other communities or disagreements in the town councils. The opposition parties themselves had a high tendency to ask for referendums, either as an opportunity to have a confrontation before upcoming elections or to gain popularity amongst project opponents.

Citizens' initiatives usually were founded because the participatory processes were regarded as biased. These initiatives were eager to provide citizens with information and oppose the claims by mayors and operating companies.

While citizens' initiatives characterized the participatory processes through a lack of esteem for citizens' views and interests, mayors and operating companies regarded critics often as NIMBY proponents (Not-In-My-Backyard), driven by envy or resentment. However, citizens were not offered more options than to be for or against the already planned projects, and opposing views on the effects on life quality, tourism or health were often portrayed as irrational and harmful for the dialogue.

This kind of non-participation (Arnstein 1969) led citizens' initiatives to collect signatures to enforce referendums as a way to stop a project, or mayors to schedule a referendum as a way to avoid further political damage. The upcoming election campaigns brought about further emotionalisation of the discussion, enmity amongst citizens and politicians, but mostly no positive participatory experience.

Finally, many referendums were close calls and a positive result in regard of the realization of a project did not necessarily mean that it would be implemented. In contrast, many referendums were followed by litigation pursued by citizens' initiatives and could not be realized.

But there have also been examples, which showed that the integration of citizens' perspectives and interests or a more cooperative planning process can lead to a high amount of agreement on a project. In one case this has been possible by fundamental re-planning of the concerned project in respect to criticism by citizens. As there had already been valid contracts, the opportunity to re-plan the project depended on the cooperation between the mayor and the operating company.

In another case the broad acceptance had been the consequence of the more cooperative approach in the town council at a very early stage, which allowed for collectively planning and was accompanied by a dialogue with citizens.

Outcomes in scientific and policy terms

The transition to renewable energy comes with the need for many projects in regard of power plants, power lines as well as other decisions that have a direct effect on citizens, like the installation of smart meters (Renn et al. 2014). These elements of the decarbonization of society cannot solely be dealt with as technical problems. As we have shown, they have to be accepted by citizens, shaped according to their interests and views and depend on positive experiences with the implementation of these technologies.

To establish that kind of positive experience operating companies and political representatives have to rethink their ways of planning and implementing these projects. Presenting already planned projects and setting up referendums in cases of resistance has not shown to be efficient or socially or politically sustainable. Even though referendums have gained popularity on the local level in the last decade, we found a variety of negative effects on the decision finding processes in regard of the quality of dialogue and the willingness to cooperate – both between politics, companies and citizens as well as within the town councils. Finally these referendums often were not able to redeem what they promised – to end conflicts and lead to generally accepted decisions.

Rather, citizens have to be a part of these processes at the earliest stage possible – best already before projects are getting sited. There is a need to shape common ground on the benefits and implications of a project for the local community and to explore the necessary framework conditions for a project to be economically and socially acceptable.

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9.1.2 Making integrative imaginaries across water, landuse and energy visible: advancing nexus governance theorizations for inclusive and desirable transformational policies and innovations

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Keywords: epistemic politics, innovation policies, sustainability transitions, politics of scales, boundary-work

Introduction

This paper discusses Nexus Governance as a "matter of concern" (Latour, 2004) rather than a "matter of emergency" (Allouche et al., 2015) to inform policies with relevance for the sustainable transition of Large Technical Infrastructures. Stemming from the field of natural resources management, nexus governance concepts have been introduced within an 'integrative imaginary' which emphasises the need for cross-sectorial integration among large scale technological systems e.g. water, energy, food etc. to respond to increasing urban world population and the resources pressure associated to what has been defined the 'antropocene' era (e.g. WEF, 2011; UN World Water Assessment Programme, 2014). At the same time, existing nexus framings have been critiqued by the social sciences because failing in problematizing the politics characterizing the implementation of such 'integrative imaginary'. More specifically, 'Nexus Thinking' has been critiqued for being driven by positivistic managerial ideals on 'efficiency' and 'supply security' assigning a very prominent role to epistemic communities, such as engineers and economists, and to large corporations to guide mankind towards sustainable futures (Cairns and Kryzwoszynnska, 2016; Allouche et al., 2015). Alloche et al. (2015), in their introductory paper to a special issue discussing the politics behind 'Nexus Thinking', have identified the following shortcomings: 1) questionable novelty: 2) difficulties of integration, failing to engage with different market logics; 3) neglected politics of the "global scarcity" framing; 4) the limits of optimisation promises. Williams, Bouzarovski and Swyngedouw (2014), acknowledge that "there has to date, been a striking absence of theoretically informed spatial and political analysis of the nexus" and argue "for an understanding of the nexus framework that goes beyond the technology-focussed interpretations that currently pervade the discourse, to one that is both technical and social, material and political".

The hypothesis of this paper is that to develop a spatial and political analysis of the Nexus and to resolve its shortcoming, it is necessary to understand the politics of scale and the boundary-work behind the 'integrative imaginary' informing Nexus Governance framings and their enactment. Jensen et al. (2016), for example, explored "why the boundaries, functions and challenges of large scale systems typically are framed differently at the urban level of governance rather than at more aggregated levels of governance [e.g. national level]". By examining the conflicting framings of water governance and their enactment at the urban and national levels, they showed how their juxtaposition produced transformational dynamics which are currently destabilizing the Danish water policy regime. This suggest that nexus framing enacted at the urban level have more transformative potential than those enforced at the national level because "they can associate systems with new objectives and thereby challenge the traditional boundaries and interrelations between systems and their contexts" (ibid). Within the same research, Fratini and Jensen (in print) suggest that, in order to support 'durable' transformational journeys, policies aimed at the 'sustainability transition' of large technical infrastructures should engage more closely with place-making dynamics rather than trying to contain them in discrete and sectoral framings – which is currently the case in e.g. Danish green policies.

To respond to complex grand challenges as those envisaged by e.g. the Sustainable Development Goals, 'nexus thinking' should be able to inform a set of policies and support the development of governance arrangements which are able to empower distributed and path-creating agencies capable of developing a variety of sometimes competing and sometimes aligning place-making - or value creating - innovation framings.

Aim and research design

Accordingly, this paper aims at fostering a reflexive understanding of 'nexus thinking' and its governance by presenting a historical mapping of cross-sectorial integration processes with relevance for water, energy and landuse governance in Denmark, on the base of qualitative interviews and text analyses of primary and secondary literature. This research was designed in order to identify and analyse the epistemic infrastructures - i.e. structures of knowledge flows and modes of doing - with potential for path creation across multiple socio-technical regimes. By employing "socio-technical imaginaries" as analytical framework – i.e. analysing "collectively held, institutionally stabilized and publically performed visions of desirable futures, animated by shared understanding of forms of social life and social order attainable through, and supportive of, advances in science and technology" - this paper present a critical discussion of those epistemic practices and structures which, by generating and performing powerful integrative imaginaries have contributed in rendering others critically invisible.

Preliminary findings

From the preliminary findings of the historical analysis, three integrative imaginaries which have characterized nexus governance practiced in Denmark in the last fifty years were identified: a resources-landuse imaginary (1973-2007), an energy-climate imaginary (1999-today) and an urban-climate imaginary (2007-today).

The resources-landuse imaginary emerged hand in hand with the institutionalization of ecological concerns in Danish politics, starting with the esblishment of the Ministry of the Environment in 1973. In the '80s and '90s, Denmark has undergone significant transformations based on a variety of innovative and coordinated public policy approaches aimed at sustainable industrial development, environmental protection and supply security in terms of both natural resources and public health. Motivations have been diverse but what has been remarkable is the level and quality of coordination between vertical and horizontal approaches, similarly to what has been observed for public policy approaches in other Scandinavian countries (Peters, 2006). The changes have aligned grassroots, epistemic communities, urban, regional and national civil servants as well as political parties. Of course, this has not happened without the emergence of controversies and conflicts but observing it with an outside view, the '80s and '90s have seen the successful construction of a number of transformational pathways towards the integration of concerns for supply security, landuse planning and environmental protection. Key for such transformation, has been with no doubts an effective coordination among the environmental ministry, the counties and the municipalities. Danish counties were responsible for mapping and monitoring pollution sources and their impacts across the whole country. In doing so, they became the central epistemic source of data and policy recommendations for pollution control at the national level and for landuse planning at the local scale. Furthermore, environmental policies were often purposively aligned to proactive grassroot movements involved in the development of new technologies as well as in place-based ecological transformations often under the patronage of progressive municipal administrations.

The resources-landuse imaginary started to weakened at the end of the '90s, with the introduction of a variety of institutional reforms aimed at the economic efficiency of public services. One of the key measures has been that of corporatizing the operation and management of important infrastructures such as energy (1999) and water (2009) in order to create a clear-cut between the management of infrastructures, believed to be a mere technocratic task, and the politics characterizing public administrations (Det økonomiske

råd 2004:276). Public services have, consequently, been placed under the strict scrutiny of a national competition authority developing benchmarking systems for economic efficiency of operational activities by establishing internal competitions within sectors' boundaries. These transformations, have produced a shift in priorities towards an increasingly vertical and strictly sectoral governance approaches. In 2007, the counties were dismantled and with that the capacities for mapping and monitoring the relation between landuse planning and environmental pollution. These transformations went hand in hand with increasing capacities allocated for the monitoring and taxations of CO2 emissions and energy use for both households and industries, particularly supported by a growing concern for climate change, reinforced by the preparation of and expectations on the COP15, hosted in Copenhagen in 2008. For example, benchmarking systems included energy efficiency and consumption as part of the economic efficiency calculation, thus pushing for investments on economically accountable technological innovations for energy production and efficiency, rather than on less economically accountable place-based and/or nature-based transformations. At the same time, counties' responsibilities for landuse and environmental planning were transferred to municipal administrations without, however, providing the capacities to keep the necessary professional skills 'in house' to fulfil such tasks. As a consequence, the most and the best engineers and planners in the work market were employed in the newly corporatized and financially independent utility companies, which merged in larger territorial entities and, therefore, were able to guarantee higher income and to promise steeper professional and carrier developments than those ensured by municipal organizations. These transformations produced the emergence of two co-existing and partly competing integrative imaginaries: an energy-climate imaginary and an urban-climate imaginary. The energy-climate imaginary emerged as a consequence of a neoliberal national logic committed to a narrowly framed green growth, reinforced by strict economic efficiency regulations. The urban-climate imaginary was supported by the patronage of a number of progressive and resourceful municipal administrations, in collaboration with pro-active local grassroots and green businesses. It emerged partly as a response to the increasingly pervasive neoliberal logic, it was reinforced by the increasingly frequent occurrence of urban flooding and characterized by the alignment of concerns for livability and public health.

Preliminary Conclusions

Different imaginaries stemming from a diversity of scalar and cultural perspectives provide different opportunities for prioritizing specific nexus components rather than others - e.g. in Denmark, the increasing visibility of the climate-energy imaginary, supported by governance practices committed to a narrowly defined green growth and to strict economic efficiency measures, has rendered concerns for biodiversity and for the quality of 'place-making' nature gradually invisible.

To conclude, by exploring the relationship - or 'boundedness'- among material engagement, processes of co-production and normative dimensions of integrative imaginaries across water, energy, and landuse in Denmark, this paper fosters reflexivity on how nexus governance theorizations could be advanced in support of inclusive and desirable transformational policy making conductive to place-making - or value creating - innovations across sectors and scales.

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9.1.3 Sustainable Nexus Governance (SNG): Rethinking the governance of siting a nuclear waste management facility

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Keywords: sustainable innovation, foresightful governance, transition management, public engagement, nuclear waste facility

Backround: Siting problems

Siting hazardous facilities (or any facilities with potential negative or collateral effects) has become increasingly difficult in modern society, and a nuclear waste management facility can be considered the archetype of unwanted facility. Final disposal of spent nuclear fuel (SNF) became an actual issue at the time of awakening to technological hazards and rise of environmental movements. After 60's, as the result of public controversies and risk management failures, welcoming attitude towards nuclear facilities had eroded away and nuclear industry, regulators and licensing processes were brought under tight public and political scrutiny and final disposal was put under the microscope (Sundqvist 2002, NEA, 1999). While, by the turn of the 1980s, it was already clear that there was huge selection of LULUs (locally unwanted land uses) eliciting resistance, there was also consensus regarding which were the most unwanted land usages, namely, nuclear installations and hazardous waste sites (Popper 1981, 12) – And, of course, nuclear waste management facility combines both of these, being nuclear installation and hazardous waste site at the same time.

Since 1991, when radioactive waste was established as the Achilles heel of nuclear industry in Blowers, Lowry & Solomon’s influential "The International Politics of Nuclear Waste"(1991), SNF management has proven growing problem. Despite all efforts, so far no country has been able to produce permanent solution for final disposal of SNF, and meanwhile wastes continue to accumulate. The nuclear waste problem has been predominantly framed in terms of an unmanageable risk, forcing the radioactive waste management community to defend itself, forming a ‘culture of confrontation’ encountered in most siting processes. However, waste management organisations and decision making bodies have been making changes in their operating culture in response to these difficulties since the mid-1990s, and the importance of social aspects is largely recognized today (Bergmans et al. 2008.) The radioactive waste management community has clearly become very conscious of importance of how things are perceived, what kind of value they are given and what kind of connotations they rise. For example Nuclear Energy Agency has moved its attention towards relationship building and symbolic dimension of siting (see e.g. NEA 2010.)

The way forward: The Finnish perspective

Nuclear waste management in Finland has long been praised as one of the most advanced (alongside Sweden), in both technical and social senses. The way to govern social and political tensions has been a mixture of transparency, voluntarism, incentives, science communication, public engagementn and mutual learning. That said, when the site selection process began in Finland in1980s it was in line with the Decide-Announce-Defend approach and public participation was non-existing. Local resistance, however, soon prompted industry to reconsider its approach.

In late 1980s the company responsible for site investigations started negotiating with local politicians and improving local communication. Later communication became also more reciprocal. Partly propted by the Nuclear Energy Act of 1987, which gave veto power to the proposed host municipality, the company wanted to learn stakeholders' views and perceptions concerning the final disposal and its impacts. In addition to this, public participation also became a notable part of the required Environmental Impact Assessment (EIA) procedure in the late 1990s, and parallel to the EIA procedure there were also talks with local authorities regarding the compensation package. (Litmanen et al. 2017.)

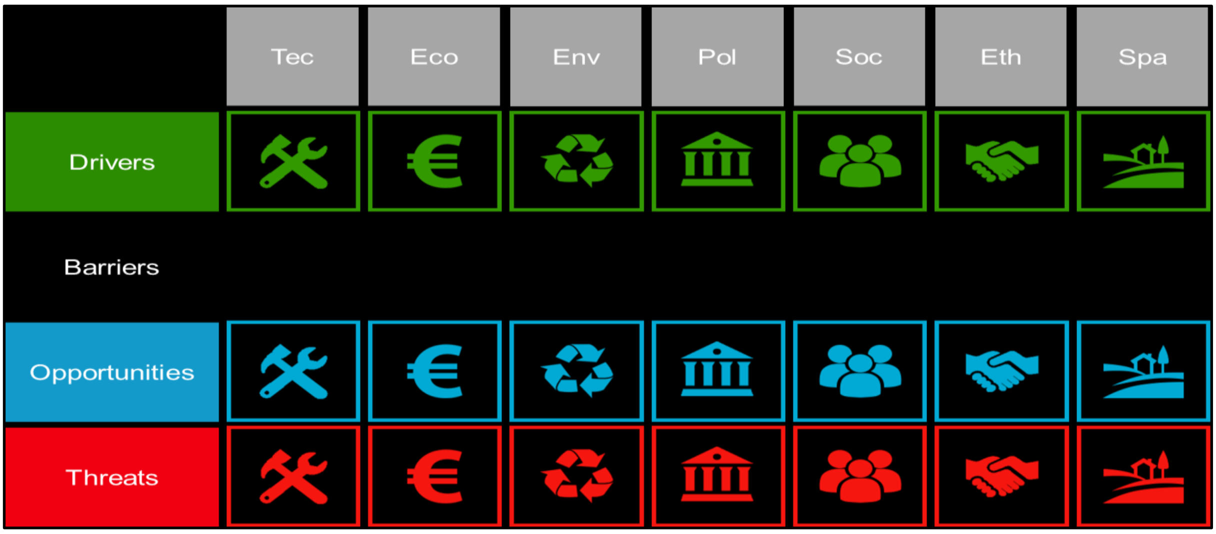
As the result of arduous process Eurajoki in Finland became the first municipality in the world to accept a SNF repository into its area when the site for the repository was chosen in turn of the millenia. Application for a Decision-in-Principle (DiP) for the construction of a final disposal facility for spent nuclear fuel was submitted to the Council of State in May 1999. The municipality of Eurajoki issued a positive statement to application in January 2000, thus choosing not to use its veto, and the Finnish Parliament ratified the DiP in May 2001. The construction license application was submitted in 2012, and the licence was granted in 2015. (Kari et al 2010.) According to a resident survey conducted in Eurajoki local acceptance is closely tied to already established 'local' operator, and instead of purely economic considerations (economic development and employment) it is more closely related to more a holistic notion of community well-being including residents' own image of the area, satisfaction with the area as a place to live and expectations for the future in the area (Kojo et al. 2012).

Drawing on insights from the Finnish case and extensive experience from strategic and technology foresight we propose new roles for civil society in the governance of STI policy related to nuclear waste disposal facilities, particularly in the identification, assessment and management of critical issues (barriers, drivers, opportunities and threats) related to governance innovations (Popper et al, 2016), such as new policies and business models for the receipt, storage and processing of SNF, as well as, other high-, intermediate- and low-level radioactive waste.

New role for civil society

We propose the following framework, where process starts by 1) Examining reasons behind the rejection of the proposed NWM facility and exploring different stakeholders' visions of a successful siting process. 2) Thorough mapping of the current situation enables to identify both common areas of consensus and key building blocks for shared understanding and identify incompatible areas, concerns and highly conflicting ideas. Based on acquired results 3) four scenarios are build; confrontational and consensual scenarios for realization of facility, and confrontational and consensual scenarios for lack of it. Next 4) stakeholders are engaged on exercise based on a stakeholder-specific visions analysis and opportunities mapping in the context of the four scenarios. By employing TEEPSES-analysis of barriers, drivers, opportunities and threats concerning technological, economic, environmental, political, social, ethical and spatial areas are studied and critical issues determined. 5) This enables the identification of shared and conflicting critical issues in need of strategic, tactical and operational actions, i.e. developing actions roadmap, assessing potential courses of action and ranking strategic value of future scenarios.

Figure 1: TEEPSES-analysis



Source: Popper et al. (2017)

- Common ‘drivers’ include: A country’s state of the art technological know-how; Economic growth; Robust habitats; Connection to energy production; poor economicl / employment situation; Growing concers about the rights of future genrations; and Suitable geology; etc.

- Common ‘barries’ include: Bad experiences regarding related industry’s operations; Negative impact on other sources of livelihood; Poor land use; Environmental protection movements; Organised community resistance; Vulnerable habitat; etc.

- Common ‘opportunities’ include: New expertise and know-how; Local infrastructure upgrade; Commitment to protect local habitat; Emergence of public-private partnerships; New jobs; Improved local infrastructures and services; etc.

- Common ‘threats’ include: Possibility of accidents; Negative impact to local image and other livelihoods; Possible contamination of the local habitat; Negative publicity; Perceived threats to health, wellbeing and way of life; and stress to local community or surrounding environment; etc.

The systemactic mapping of such issues resulting from interaction-based citizen engagement processes (e.g. *South Australia’s Citizen’s Jury on Nuclear Waste* initiative)[51] are like to broaden the scope of priority areas to be considered in the governance of siting a nuclear waste management facility.

Discussion

We feel that involving different stakeholders in building the shared understanding regarding the basis of the siting is most fruitful way to approach the siting of nuclear waste management facility. In that inhabitants are essential part of the puzzle as in order to be built somewhere facility has to be also accepted somewhere. As discussed in Keenan and Popper (2007), “Foresight could be used to enhance the standing and positive image of a particular facility, showing it to be future-oriented and open, and hence an attractive place

51 See http://assets.yoursay.sa.gov.au/production/2016/11/06/07/20/56/26b5d85c-5e33-48a9-8eea-4c860386024f/final%20jury%20report.pdf

for further investment. Furthermore, to identify strategic areas of research in line with pressing needs of society or science and technology development and innovation, in which to redirect the operation of the facility and thereby ensure the sustainability and leading position of the facility in the long run.” Often acceptance is linked to such straightforward aspects as economic incentives or employment considerations. However, insights from the Finnish case show how reality is much more complex, for example, the way that facility is perceived to affect community’s general wellbeing play important role in acceptance. This shows how we cannot afford to make assumptions regarding the willingness to accept, or lack of it, without examining situation properly and involving the civil society and local community in the process.

Overall, we are argue for the need to apply a quadruple-helix i.e. multi-actor and multi-level (strategic, tactical and operational) oriented ‘framework’ such as CASI-F (Popper et al, 2017) to both the assessment and management of 'critical issues' that are likely to shape the future of a wide range of innovations (product, service, governance, social, etc.), in the nuclear waste management. Such framework for sustainable nexus governance (SNG) assessment and management will help to bring foresight, organisational dynamics and systemic change approaches together in a process aimed to promote mutual learning about socio-technical system innovations for sustainability transitions at niche, regime and landscape levels (see Geels, 2004; Kohl et al, 2014; Auvinen et al, 2015; Popper and Velasco, 2017).

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9.1.4 From ‘climate science’ to ‘climate research’: interdisciplinarity, taxonomies and ‘grand challenges’

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Keywords: climate change, interdisciplinarity, classification systems, taxonomies, EUFPs

Background and aims

Climate change has been depicted as introducing “dislocations […] in widely held prior conceptions of community, polity, space and time” (Jasanoff 2010, p. 249). The evolution of climate-related research beyond the traditional ‘core’ of climate science (earth science, oceanography, and biogeochemistry) and towards the study of the interactions between climate, natural ecosystems and human societies is a process mirroring, and enabling, these dislocations. Climate research is today a field of study more and more interdisciplinary and transdisciplinary, displaying a social mechanism that in the story of science has no precedents in terms of size, scope, complexity, and efficiency (Weart 2013; Cornell 2010; Edwards 2010) and in which the integration of natural and social sciences is gradually becoming a reality. This mirrors a shift from focused and specialist research towards more collaborative approaches that emphasize cross-disciplinary teamwork. In this respect, a general movement towards inter and trans-disciplinarity has been observed as part of the shift to a new way of thinking about science which has been famously captured by the expression Mode-2 (Nowotny et al., 2001; Gibbons at al., 1994). Interdisciplinarity, which became itself an object of inquiry (Barry and Born 2013), drives the design of research funding by governments and funding agencies, and has increasingly become a criterion taken into account in the public funding process, the European Framework Programmes being an example. The approach of the ‘Grand Challenges’, one of the key organising principles of the current H2020 framework, is exemplar in this respect. By definition, a ‘grand challenge’ refers to complex issues, or ‘wicked problems’ that cannot be addressed by sectoral policies or a single scientific or technological discipline: what make them grand is precisely that they tend to involve different stakeholders, disciplines, dimensions of analysis and a kind of systemic, or ‘out of the box’, thinking.

Still, this approach is regarded as tentative and exploratory (Kuhlmann and Rip 2014), and therefore the question of how to support, stimulate and assess interdisciplinary research programmes and initiatives becomes poignant, increasing the demand for criteria and tools for its evaluation. Part of this task crucially relies on knowledge categorizations and taxonomies used to classify scientific activities and outcomes.

Theoretical framework and research questions

Taxonomies and categorization, used for classifying research outputs, projects and programmes into disciplinary fields (e.g. NABS; CERIF; FOS; ARRS, ERC), are employed in

research infrastructures such as digital repositories and databases. In Science and Technology Studies (STS) there is an established tradition of looking at classification systems as set of boxes into which things can be put to do some kind of work – bureaucratic or knowledge production (Bowker and Star, 2000; Lury and Wakeford, 2012). Categories and classifications are approached as devices that are involved in both making up and legitimizing particular versions of the social world (Ruppert, 2014); the implication of this approach is not merely reflexive, but it is also a call to think to how we can investigate and creatively challenge generally used categorizations. These issues, so far, have implications especially with respect to emerging or evolving research fields more and more interdisciplinary, whose characteristics cannot be defined according to commonly used categories, definitions and disciplinary labels (Frodeman, 2010).

These fields represent a challenge for research policies since it has been observed that there is a significant mismatch between the discourse of interdisciplinarity, the conception of knowledge and current governmental research funding and evaluation practices (Woelert and Millar, 2013). Funding agencies are increasingly concerned about evaluating interdisciplinarity as it is difficult to be captured in research practices: either because commonly used categories and taxonomies generally rely on a single standard based on disciplines (Klein, 2008) or because existing frameworks are mostly devoted at measuring degrees or kinds of interdisciplinary and at capturing the differences among interdisciplinary, multidisciplinary and transdisciplinary research. Huuttoniemi et al. (2010), for example, extensively revise these approaches and frameworks and propose a new framework that distinguish among three dimensions of interdisciplinarity. Firstly they consider the scope, which can be narrow or wide according to the scientific fields involved which might cross or not highly diversified and distant scientific areas. Then they consider the type of interactions among fields which, in the case on interdisciplinary research, can be empirically based, methodologically grounded or theoretically framed and are likely to produce different types of new knowledge, approaches or theories. Finally, they consider the goals that interdisciplinary research pursue, that can be epistemological (bridging cognitive and disciplinary borders), instrumental (also defined as pragmatic interdisciplinary), or a mixed orientation combining both types of goals. In a contribution oriented to bridge studies on interdisciplinarity with the practice of evaluation, Pohl at al. (2011) observe that evaluation of inter-transdisciplinary research is complex because of the variability of criteria and indicators existing, which in turn mirrors the ongoing and open debate on the nature of inter and transdisciplinary research.

The paper engages with this debate, proposes an empirically grounded classification aimed at supporting research funding and evaluation practices in relation to climate research - a field characterized by growing interdisciplinary dynamics - and experiments the potential of this classification by applying it to a wide set of research documents.

The research questions driving this work are:

1) How the design of climate research has changed looking at the research funded under EUFPs and other international programmes?

2) Which key ‘epistemic objects’ (Cetina, 2008) can be identified analysing funded climate research?

3) Which metadata should be integrated within research infrastructures and/or digital repositories and databases to support the assessment of interdisciplinarity of research projects?

4) Would evidence support the use and need for a new taxonomy to evaluate publicly funded research?

Methodology

Wagner et al. 2011 reviewed a wide set of empirical studies about interdisciplinarity, underlining that there are many approaches to understanding and measuring interdisciplinary research and that the assessment of interdisciplinary research inputs, processes, outputs, and outcomes is still a work in process. In this paper, we move from the appreciation of the interdisciplinarity character of the empirical material collected to the appreciation of how interdisciplinarity is enacted into the broad field of climate change research and translated into actual research priorities and strategie. Our specific aims, in this respect, are a) identifying a system of keywords able to capture the interdisciplinary nature of climate-related research and to b) present a more accurate description of the research funded in this broad field.

To this purpose, we assembled a multilayer system of categorization to capture to what extent our empirical material articulates into actual research programmes or projects issues of transdisciplinarity – both referred to research that “transcend the narrow scope of disciplinary worldviews through an overarching synthesis” and as “a new mode of knowledge production that draws on expertise from a wider range of organizations, and collaborative partnerships for sustainability that integrate research from different disciplines with the knowledge of stakeholders in society” (Wagner et al., 2011: 16) and interdisciplinarity (multidisciplinarity) -referred to integrated (parallel streams of) research across academic disciplines and/or fields of knowledge. The framework adopted builds and adapts existing classifications developed into studies and initiatives focused on the field of climate research.

The empirical material used is of two kinds: a) 290 R&D projects funded under EU FP7 focusing climate-related research: the list results from combining a dataset provided by CORDIS’ helpdesk with the catalogue of projects included in the publication "European Research on Climate Change Funded by the Seventh Framework Programme" (EC, 2013) and b) the collection of Joint Research Programmes included in the JoREP 2.0 database, developed by the Research Institute on Sustainable Economic Growth of the National Research Council of Italy during the project RISIS “Research Infrastructure for Research and Innovation policy studies”, funded by the European Commission.

A thematic analysis (Braun and Clarke, 2006), supported by the use of software for qualitative analysis, is conducted with respect to both sets of materials, focusing the abstracts of the funded FP7 projects (a) and the calls for proposals of the Joint Research Programmes (b). The thematic analysis uses the categories and dimensions of trans/multi/interdisciplinary mentioned above taking into account key words of the projects, abstracts and summaries of the research proposals on the one side and research programmes texts and calls for proposals on the other side. Looking at the former, it would be possible to see how interdisciplinary is put into practice in research funded activities while the latter, would show how, and to what extent, interdisciplinary emerge in the calls for research contributions as a key issue to address scientific problems or as an evaluation criteria.

This bottom-up approach and the match or the mismatch resulting from the analysis of groups of documents would allow acquiring an overview of the interdisciplinary characterization of research planned and funded under the FP7 and would also allow identifying themes and patterns of meaning on the basis of the information included in the calls of the relevant Joint Programmes which highlight the need for wider conceptual categorizations to be developed.

The innovativeness of the study relies on the exploration of changes that occurred in research funded by large European Programmes in the field of climate research. These are depicted, for instance documenting a) the raise of new categories for classifications and the widening of keywords used, b) how climate research increasingly cuts across different research fields (i.e. agriculture, security, biodiversity) including more and more the social

sciences and the humanities, and c) emerging priorities in terms of research topics and geographical areas.

Expected results

How can we analyse interdisciplinarity on the basis of the cognitive content of research proposals? What set of categories and definitions could be developed to capture changes in climate research? In what they should differ from already used ones?

These questions drive the study with the aim of increasing our understanding of epistemic and cognitive challenges posed by interdisciplinary research, the role of boundaries crossing in scientific knowledge production, but also for developing the practices of research funders and policy-makers when assessing research proposals.

Scientific studies are increasingly highlighting that reviewing and evaluating interdisciplinary research is challenging and needs a shift from traditional academic review process, rules and metrics mostly based on disciplinary affiliations and research domains. The work, based on the analysis of a set of FP7 research projects and of Joint Research Programmes, presents a bottom-up characterization of climate research and aims at identifying recommendations for strengthening interdisciplinary-sensitive assessments in science and technology policy. The expected result is identifying criteria/descriptors providing an alternative to scientific disciplines in representing and summarizing themes and topics of analysis in the field. The purpose of this exercise is to elaborate empirical evidences to argument the need to complement traditional, disciplinary-based, taxonomies with a set of categories designed specifically for climate research.

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9.2 Session 9.2

9.2.1 Energy Transformations in the European Union: Energy Timescapes and Discursive Power in Governance Processes

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Keywords: Energy Culture, European Union, Discursive Power, Time, Horizon 2020

The political institutions of the European Union (EU), such as the European Council, the EuropeanCommission and the European Parliament postulate the need to transform Europe's incumbent energy systems. Much is said about the ends, about carbon neutral societies and economies, more efficient energy use at affordable prices, an EU-wide energy infrastructure and the exchange of fossil fuels with renewable resources. The debate becomes less clear regarding the means and ways to get to the proposed ends, especially when the sociotechnical nature of energy systems is taken seriously. One of the key challenges is, to create collectively shared images and understandings of Europe's future energy systems and cultures. The energy narratives of the just mentioned institutions share despite their differences one main argument; no matter which challenges - chances and risks alike - will arise out of such a multifaceted and complex change process, they can only be solved together on a European level. Besides this foundational argument energy discourses overlap with discourses of sustainability, security, justice and competitiveness in multiple ways.

This contribution argues, that the EU integration goes beyond creating sociotechnical imaginaries (Jasanoff/Kim 2015) about energy futures, it includes collective perceptions about inclusiveness and exclusion through transgouvernemental governance enacted by the European Union as an imagined community (Anderson 2006). The construction of a European energy narrative is supported by constant community building efforts such as; the ´Energy Union´ and its policies, the ´Strategic Energy Technology-Plan´(SET-Plan), the mapping of and statistics on Europe's energy production, distribution and use as well as the accompanying financial, material and digital infrastructures.

European energy narratives then exist either in accordance with national energy systems and cultures or compete with them. To realize the political endeavours in the realm of European energy transformations; distributive science, technology development and innovation (STI) policies are much promoted. The most important funding instrument is currently the 8th research framework programme ´Horizon 2020´ and its proposed societal challenge ´secure, clean and efficient energy´. Against this background this paper asks how do power relations between relevant actors in processes of translation between political energy goals and concrete research practices emerge, repeat and stabilize? It focuses on processes surrounding the development and implementation of the European research framework programmes, mainly at the transition from FP7 to Horizon 2020. For example, a closer look is given at the development of a work programme of the societal challenge ´secure, clean and efficient energy´. Where a scientific advisory board, different General Directorates of the European Commission as well as representatives of all Member States co-create the framework for energy research within Horizon 2020. Another example are the controversies surrounding the role of the social sciences and humanities arising during the development process of Horizon 2020, where power relations were redefined several times, between scientific disciplines, research organisations, Member States and EU institutions. Based on that the characteristics of discursive power in this field are displayed and then it is illustrated how actors with less discursive power are affected in their practices within the translation processes (Reichertz 2015).

The paper understands time and timescapes (Adams 2005) as important means to execute power in that matter therefore gives special attention to time givers and practices. Especially the handling of the future, plays an important role in energy related policy goals, such as a XY% reduction or increase in efficiency until the year 2050 or even 2100. Barbara Adams and Chris Groves attest our current understanding of the future a transformative character, where we perceive – us humans as capable to influence and steer our future (2007). Applied on the EU level and the area of STI it becomes clear how this understanding of the future is already implicit in practices of today. Ulrike Felt conceptualises this phenomenon as an increased expectation of anticipation (2015). Within energy research this expectation is fulfilled mainly through excessive production of energy scenarios reaching far into the future. Furthermore, Felt speaks about tendencies of acceleration and projectification (ebd.). These three trends critically affect the way knowledge is produced and the quality of available knowledge. Under the pressure of producing more in shorter time, and clear expectations of the outcomes; there is little space for inter- and transdisciplinary experiments and failure. This paper therefore analyses, how throughout the process of governing European energy transformations through STI policies; power relations are influenced by pace and time and how it is inscribed into the structures and practices of the actors involved.

The analysis is based on expert interviews with representatives of several EU institutions, scientific institutions and national research executive agencies, participatory observation on EU and scientific conferences and events, such as the SET-Plan Conference or the EU Sustainable Energy Week as well as policy documents and scientific reports concerning the European energy transformations and accompanying research results. The empirical material is collected and accessed with Grounded Theory Methodology (Strauss/Corbin 1996) and Situational Analysis (Clarke 2012).

9.2.2 Disruptive innovation and industrial policy from the perspective of sustainable energy transitions: illustrations from the energy trajectories of Denmark, Germany and the UK

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Keywords: disruptive innovation, energy transition, industrial policy, innovation policy

'Disruptive innovation' is a key concept in innovation studies (1,2) building on Schumpeter's seminal work on 'creative destruction' (3,4). It focusses on how radical innovations providing new services or novel business models can profoundly reconstitute incumbent innovation trajectories. Analyses applying the concept tend to focus on strategic decision-making of individual firms, while there is less focus on more 'systemic' perspectives on disruption and the broader policy context in which disruptive innovations emerge (5). The field of industrial policy in the energy sector has received increasing attention in recent years, partly in response to recognitions of the need for more long-term and coordinated governmental interventions in reorienting energy systems towards more sustainable forms of supply and demand (6). In this paper we focus on the how industrial policies guide and are also shaped by evolving disruptive innovations in the energy system providing insights to a previously understudied aspect of sustainability transitions.

Disruptive innovation and its dependence on creative destruction is an increasingly discussed topic in the energy sector, where many renewable energy technologies in combination with storage, demand-side and smart control systems may form globally disruptive technological combinations (7–9). These technologies have potentially profound systemic effects on the broader socio-technical systems surrounding energy production and distribution, including increasing demand response, active rather than passive networks, increased flexibility, and greater reliance on data sharing between a range of actors. It is well known that innovation policies play a key role in driving or controlling these changes. Different targeted policy responses can inhibit or promote the kinds of transformative change required for disruptive innovations contributing to environmental and social sustainability to develop and diffuse in energy systems. Yet there is insufficient research on how industrial policy-related factors enable or constrain disruptive innovation and hence influence the socio-technical system in adapting to the disruptive effects of emerging energy technologies.

‘Green industrial policies’ (10) can include features such as subsidies in their many forms—from production to lower interest rates; public procurement rules (e.g., “domestic sourcing” requirements), targeted public investments, for example in infrastructure; and cluster policies and other forms of innovation policies (11–13). Also recent decisions and consultation on ‘phasing out’ coal or nuclear (14,15) can be seen within this broader frame of green industrial policy in which some dominant trajectories are closed down to create space for new industries. Yet, disruptive innovation in the energy system has rarely been discussed from an industrial policy perspective despite the significant role that such policies may play in energy transitions. This may be partly due to the term ‘industrial policy’ falling out of favour within broader economic restructuring that had taken place since the 1980s, however these policies are increasingly being discussed by policy makers in recent years (16–19).

Countries vary considerably in terms of the kinds of interventions that governments are willing to make and the degree to which industrial policies are coordinated towards particular long-term sustainability agendas involving disruptive change (20). In the energy sector, industrial policies may influence the social behaviour and professional practices of the actors to varying degrees, often in subtle ways, which cannot be discerned without empirical research. Certain industrial policies may not be as easily discerned as conventional energy policies yet may have important long-term ramifications in directing energy trajectories. Through an in-depth empirical examination of Denmark, Germany and the UK we will provide important insights into how approaches to industrial policies differ between these three countries and what kinds of industrial policies seem particularly conducive to stimulating, coordinating and adapting to disruptive changes in the energy system.

Aims and Methods

In this paper, we aim to develop a novel understanding of what role industrial policy plays in energy disruption, and how it enables or hinders broader systemic change and the disruptiveness of the resulting socio-technical configuration. Given ongoing disruptiveness globally, in energy systems, the analysis will shed light on how the actors in the energy sector manage the disruptive effects unleashed by emerging innovations, and provide a basis for drawingpolicy recommendations.

Based on interviews with key stakeholders in Denmark, Germany, and the UK (covering all relevant actor groups e.g. state, knowledge institutions, civil society and business), and a literature review to to understand the character of energy transition in each geographical context, we analyse industrial policy-related drivers to understand divergences in policy approaches vis-à-vis disruptive energy innovation in these countries. Also drawing on sustainability transition studies, we assess what industrial policy-related factors promote or inhibit sustainability transitions through clean disruptive innovations in these countries, as well as what is the perceived disruptiveness by the stakeholders interviewed.

Expected findings

We expect to provide theoretical and empirical insights on the co-evolution and co-dependence of disruptive energy innovation with ‘greening’ industrial policy.

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9.2.3 Global innovation system life-cycles: country-level entry, innovation and leadership in wind turbine manufacturing

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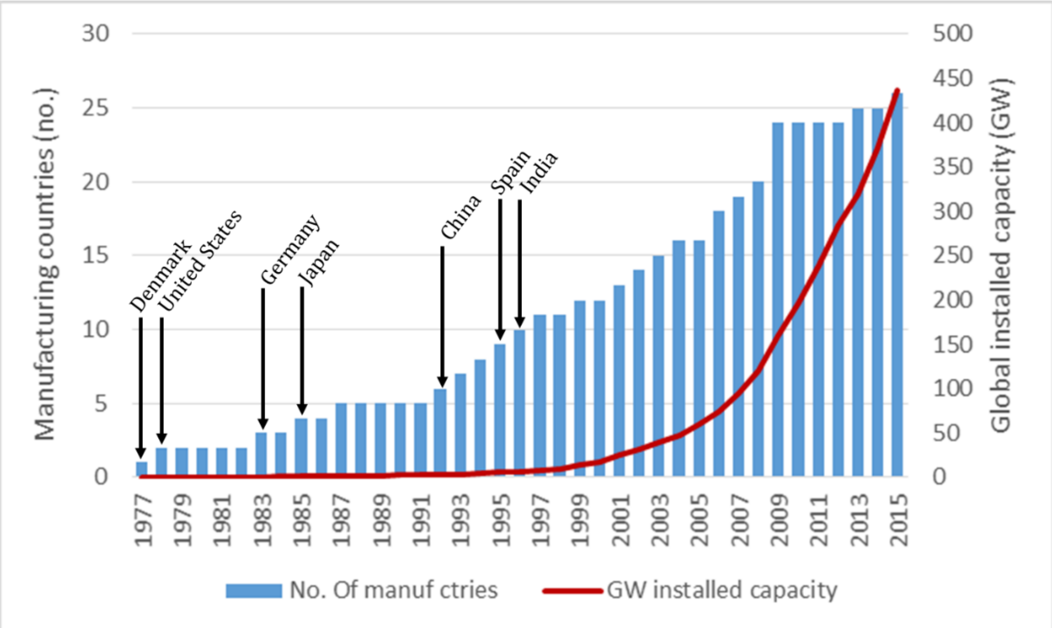
Keywords: Global innovation systems, Country specialization, R&D Manufacturing and deployment, Catching-up, Wind power

The greatest prospects for survival and industry leadership in a new growth industry largely accrues to early entrants. This has been described at the level of the firm in the literature on industry lifecycles, and at the level of countries in the literature on lead markets. Here, we perform a case study of the global wind turbine manufacturing industry at both country and firm level. We find that turbine markets were indeed dominated by the earliest of manufacturing firms for some time, but that waves of new entrants from the second half the nineties onwards have taken increasingly large shares of the market. These successful late entrant firms, however, did all originate from early entrant or early follower countries. Late entrants from late adopter countries have been altogether unsuccessful. It appears that the accumulated localized experience in early adopter countries provides a beneficial development environment for domestic manufacturers, in early as well as later phases of global industry development.

1. Introduction

By year end 2015, a total of 89 countries have deployed wind turbines, and 26 of these have at least one domestic turbine manufacturer. The number of countries that have with domestic turbine manufacturing industries has developed relatively linearly over time, with plenty of newcomers since the global market started to grow rapidly in circa the year 2000 (Figure 1).

Figure 1. Timing of country entry into wind turbine manufacturing



The literature on industry life-cycles has described patterns of firm-level entry, exit, survival, innovation and growth towards leadership positions in new industries. Key insights include that the greatest prospects for survival and industry leadership accrued to firms that entered early, or could be traced back to early entrants through mergers, acquisitions or similar mechanisms, or brought experience from related fields. With increasing industry maturity, entry becomes harder or even impossible, with increasingly short survival times and smaller market shares for later entrants. The literature on industry life-cycles has regarded international competition, but usually with reference to the entry and success of foreign manufacturers in a single national market that is the object of analysis in individual case-studies.

The literature on lead markets has had more attention for comparing the success of manufacturers from different countries in global markets. A key conclusion from this literature is that the creation of strong domestic demand, in a highly competitive market to create selective pressure, might accrue first mover advantages to domestic firms, ultimately improving their chances at outcompeting manufacturers from other countries in global export markets. The relevance of locational advantages have similarly been highlighted in analyses of 'cluster life-cycles', where it is argued that firms or industries benefit from clusters through the presence of 'a local pool of skilled labour, local supplier linkages, and local knowledge spillovers', amongst others (Potter & Watts, 2011: p417).

Here, we perform a case study of the timing of entry and leadership of turbine manufacturers at the national and firm level. We find that early entry both at the national and at the firm level is strongly connected with market share leadership. However, although turbine markets were dominated by the earliest of manufacturers for some time, waves of new entrants from the second half the nineties onwards have taken increasingly large shares of the market. The successful late entrant firms, did all originate from early entrant or early follower countries. It appears the domestic context provides a beneficial development environemtn for the manufacturing industry, even at later phases of global market and industry development.

2. Method and data

The literature on industry lifecycles and on lead markets share the notion that early entry is a key factor in successfulness, referring either to the entry of individual firms in national markets, or to national industries in a global market.

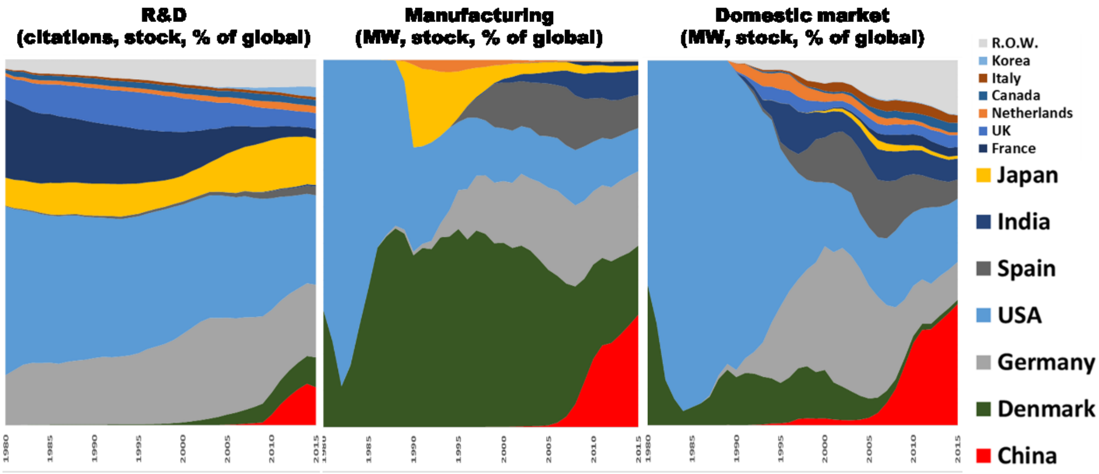
Early entry by itself is likely not a sufficient condition, as (national level) analyses of lead markets or innovation systems have also stressed the need for R&D and market creation (Griliches, 1985)(Bergek & Jacobsson, 2003; Edler & Georghiou, 2007). When assessing successfulness, we will also regard the effectiveness of creation of domestic manufacturing industries, given a level of domestic R&D activity or domestic market creation.

We have compiled a dataset of three national innovation systems output variables: knowledge production, market creation, and manufacturing output. Knowledge production is measured as citations to patents. This data was collected from PATSTAT Online, version of Autumn 2016 (EPO, 2017). Market creation is measured as MW of wind turbines installed in the domestic market, with data sourced from (EC, 2015) and (United Nations, 2015). Manufacturing output is measured as MW of wind turbines installed. Data is sourced from 'The Wind Power' global database of wind farms (The Wind Power, 2016), with entries for China, Denmark, Germany, Sweden, the Netherlands and the US replaced with data from more complete national datasets (Bundesnetzagentur, 2017; CWEA, 2016; Diffendorfer, Kramer, Ancona, & Garrity, 2015; Energistyrelsen, 2016; Vindlov, 2017; Wind Energie Nieuws, 2017).

3. Results

A total of 89 countries have deployed wind turbines, and 26 of these have at least one domestic turbine manufacturer. Out of these 26, seven countries dominate turbine manufacturing, having produced 98.3% of installed capacity by year end 2015 (Figure 2). Manufacturing output has more overlap with domestic market sizes than it does with R&D activity (Figure 2). Further, the seven leading countries were all early adopters or early followers in the establishment of domestic manufacturing industries (Figure 1).

Figure 2. Wind turbine R&D, manufacturing and markets, by nationality, 1977-2015



3.1 National level innovation system entry, innovation, and leadership

3.1.1 R&D intensity

The development of R&D intensity (citations per MW of manufacture output) shows a number of trends (Figure 4):

First, early adopter and early follower countries tend to have started with relatively high R&D intensity, which has dropped off over the years. This is expected; early phase technology development requires strong R&D input.

Second, late adopter countries start off with similarly high R&D intensities, but fail to see the drop as experienced in the early adopter countries. Late adopters have an R&D intensity of approximately 50 to 100 times higher when compared with early adopter countries.

Third, there is a flattening out or a rise of R&D intensity for both early and late adopter countries since circa the year 2000 or 2005. It appaeras that manufacturers increase R&D efforts when faced iwth increased competiton the newcomers.

3.1.2 Net imports or exports

The development of export intensity (manufacturing output divided by domestic market size) shows the following trends (Figure 5):

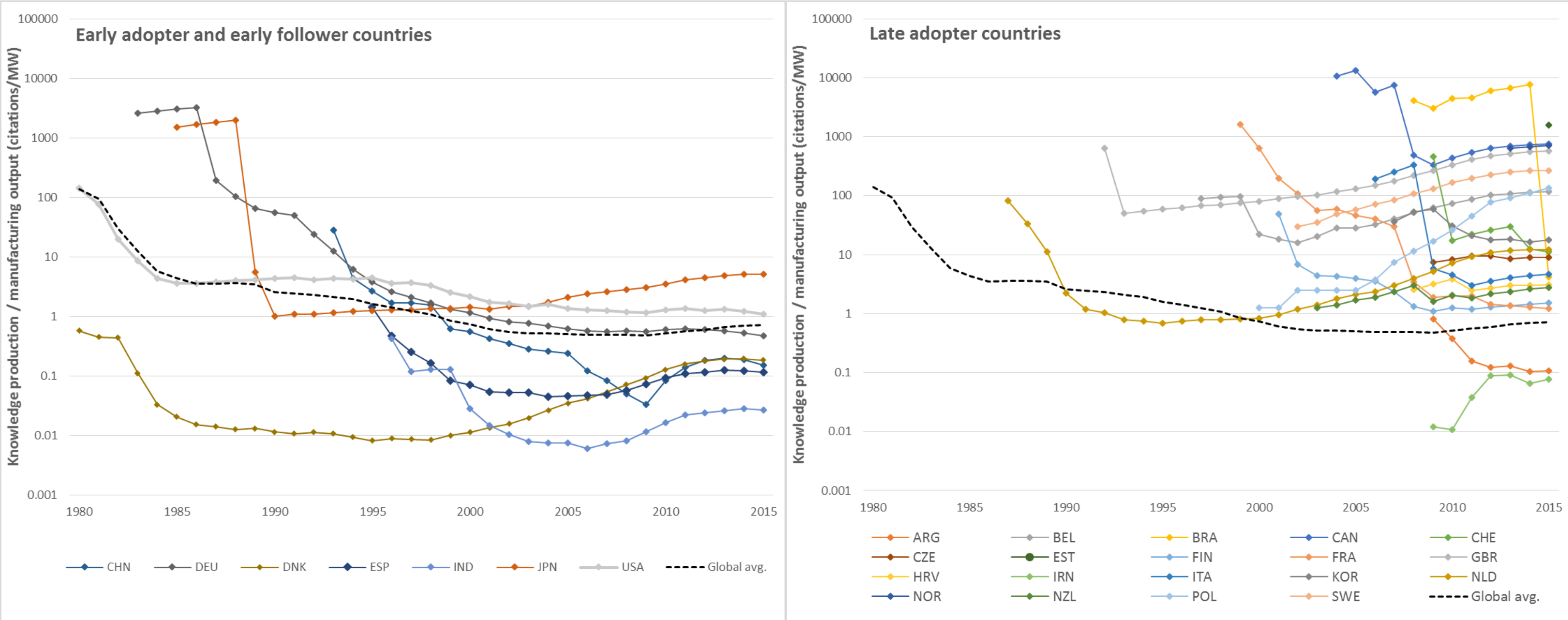
First, early adopter and early follower countries have tended to have started with larger domestic markets than manufacturing output, making them net importers. The only exceptions are Denmark, the most successful wind turbine manufacturer by any measure,

and Japan, which is the only country that has managed to develop a turbine industry without any domestic deployment (in the early years). Early development phase markets appear to provide more demand for foreign turbines than for domestic manufacture.

Second, early adopter and early follower countries have all managed to increase their manufacturing output, relative to domestic market size, to the point where they have become net exporters.

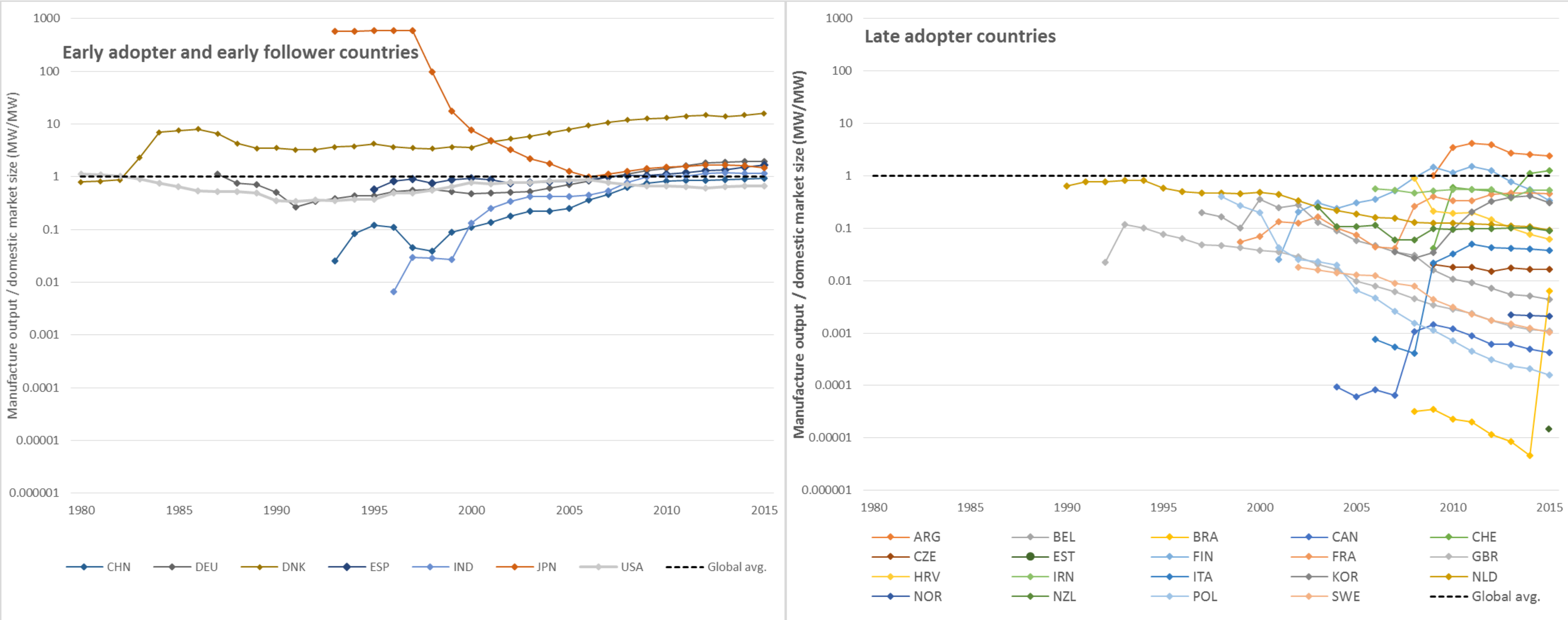
Third, late adopters have lower manufacturing output, relative to domestic market size, and this factor has been falling over time for the bulk of these late adopters. This indicates that these new markets provide a space of experimentation for newly created domestic manufacturers, but that these are outcompetede by established manufacturers when markets start growing.

Figure 3. Knowledge production versus manufacturing output, late vs early adopter countries



Notes: knowledge production as citations to patents, manufacturing output as MW of manufacture (both in cumulative stock). Adoption here means domestic manufacturing of wind turbines. Note that left- and right-hand figure axis have the same scale and range, and a global average line, to allow for easier comparison between the two.

Figure 4. Manufacturing output versus domestic market size (MW per MW), late vs early adopter countries

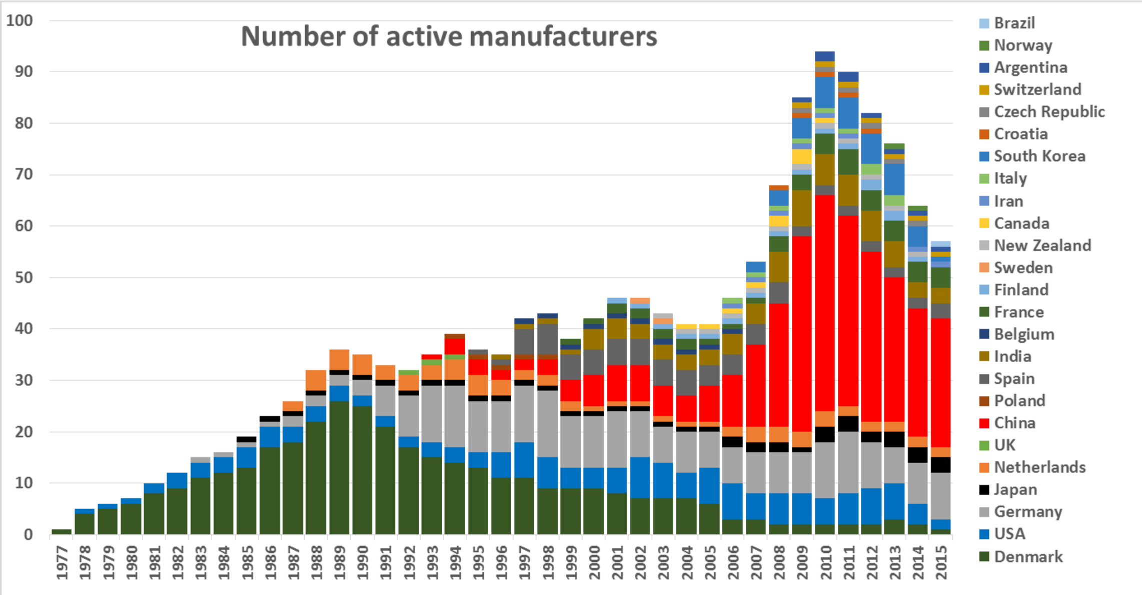


Notes: Manufacturing output and domestic market size in MW (both in cumulative stock). Adoption here means domestic manufacturing of wind turbines. Note that left- and right-hand figure axis have the same scale and range, and a global average line, to allow for easier comparison between the two.

3.2 Firm level entry and leadership

Here we turn our analysis to the level of individual firms. The number of active manufactures peaked in 2010, at around 95 manufacturers, but has since fallen to about 55. The rapid growth and fall in recent years is mostly attributable to an industry growth and consolidation in China (Figure 6).

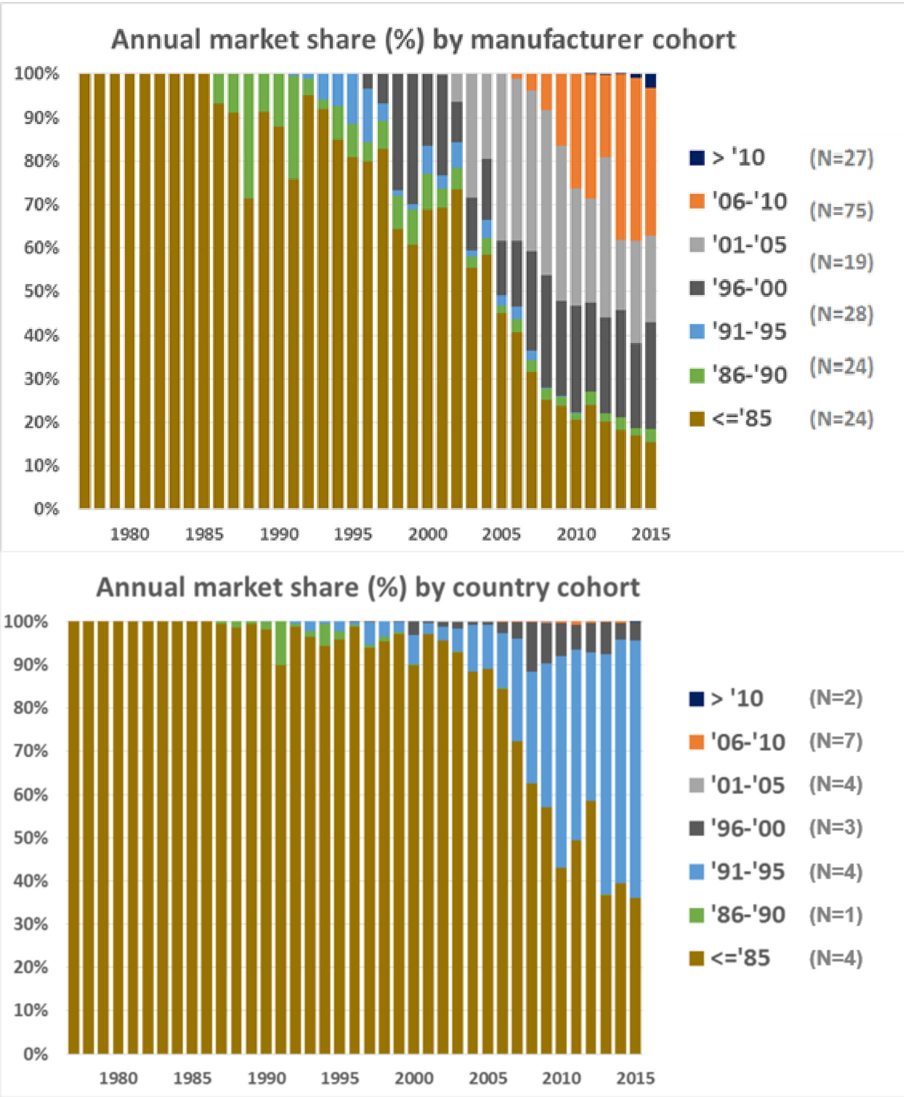
Figure 5. Number of active manufacturers, by country and year



Turbine markets have long been dominated by the earliest of manufacturers from Denmark, the US, Germany, and Japan (Figure 7, top). Manufacturers that entered into the industry prior to 1985 managed to retain the bulk of the market with the rise of large groups of competitors in the second half of the eighties and first half of the nineties. Three waves of entrants from the second half the nineties and first and second half of the noughties, however, have eaten away at the market share of the early entrants. Market shares in recent years are divided up roughly equally between several cohorts of firms entering the industry at relatively early and relatively later periods.

If we look at the nationality of these firms, however, the picture is different (Figure 4, bottom). The two parts of Figure 7 together highlight that there is plenty of potential for late-entrant firms to capture market share, but that this potential predominantly exists for firms that hail from countries that were amongst the first to grow a domestic wind turbine manufacturing industry.

Figure 6. Global wind turbine market share (annual), by manufacturer cohort (top) and country cohort (bottom).



Cohorts in terms of years manufacturer or country entry into wind turbine manufacturing, here measured as the first year of installation of a turbine with a brand name or nationality

4. Conclusion & discussion

Results from our case study of the wind turbine manufacturing industry are very much in line with the claims of the lead market literature. Early establishment of a domestic manufacturing industry is a strong determinant of survival and leadership of domestic brands in the more mature turbine markets that developed decades later. The creation of early, and rapidly growing domestic market demand for wind turbines was also found to be strongly connected to future leadership, whilst high volumes of R&D activity were less of a determinant for such leadership.

When comparing the leadership of individual firms, results are only moderately in line with claims of the industry lifecycle literature. Although turbine markets were indeed dominated by the earliest of manufacturers for some time, waves of new entrants from the second half the nineties onwards have taken increasingly large shares of the market. These successful late entrant firms, however, did all originate from early entrant or early follower countries.

These results suggest that there is multi-scalarity in industry life cycles: the maturity of the firm, as well as of the domestic environment it is located in, help determine a firms chances of survival and leadership at the global level. Firms with equal years of entry into the industry have strongly improved chances of survival and leadership if the countries they hail from had earlier entry into the global innovation system. It is likely that accumulated localized experience in early adopter countries, in aspects such as ‘a local pool of skilled labour, local supplier linkages, and local knowledge spillovers’ (Potter & Watts, 2011: p417), provides a beneficial development environment for domestic manufacturers, in early as well as later phases of global industry development.

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10 Track 10: Innovation Ecosystems – a Governance Challenge for Companies and Policy Makers?

Track 10 was organized by Kornelia Konrad, Faculty of Behavioural, Management & Social Science, Technology and Policy Studies (STePS), University of Twente, Lisa Dale-Clough, Manchester Institute of Innovation Research, Alliance Manchester Business School, University of Manchester, Kathrin Hahn, Faculty of Behavioural, Management & Social Science, Department Science, Technology and Policy Studies (STePS), University of Twente, and Chiara Marzocchi, Manchester Institute of Innovation Research, Alliance Manchester Business School, University of Manchester, and included three Sessions.

Innovation system concepts have become a major reference for innovation policy and proven to be a useful lens for capturing features of innovation processes which transcend the boundaries of innovating organizations, such as institutions or networks. Innovation system concepts have been used to analyze innovation dynamics and the specific conditions for innovation at national or sectoral levels, or in particular technology fields. In doing so, they have been productive for deriving innovation policy approaches (Wieczorek & Hekkert 2012; Smits et al. 2010a; Smits & Kuhlmann 2004).

While these concepts are useful for capturing systemic features at highly aggregated levels, they are arguably less tuned towards capturing the dynamic evolution of innovation systems (Smits et al. 2010b) and how the organizations within an innovation system make use of and interact with this system in their innovation processes and strategies, or how they actively contribute to shaping these systems (for exceptions see Planko et al. 2016; Musiolik & Markard 2011). Empirical research shows that companies cannot typically manage the challenges of adapting new technologies, introducing innovations, establishing and sustaining business interrelations, and maintaining competitiveness using just internal resources and capabilities. Companies are systematically shaping their innovation environment to improve innovation capabilities and processes (Coombs and Georghiou, 2002). These interactions are both directional, such as creating more or stronger co-operations, and reactionary responses to environmental change or changing positions within an innovation value chain, which create new system boundaries e.g. insourcing specialised innovation activities.

The concept of an innovation ecosystem (IES), which emerged from the innovation management literature (Autio & Thomas 2014; Adner & Kapoor 2010; Moore 1993), has received increasing attention because of its potential to addresses system-level phenomena from a company perspective, respectively the interface between companies and 'their' innovation (eco)system. This idea pays particular attention to the flows of money, knowledge, people and services between organizations, to identify interdependency, as in a biological ecosystem.

"The added value of thinking of this system as an ecology is the focus it brings to the distribution and abundance of research performers and knowledge and their interactions with each other and the broader environment." (European Commission 2008: 23)

A company's innovation ecosystem (IES) is not limited to an industry sector or specific region as implied by concepts such as sectoral, regional innovation systems or clusters (Malerba 2002; Braczyk, et al., 1998, Porter 1998), or to a particular technology as implied by the technological innovation system concept (Carlsson and Stankiewicz 1991). It is comprised of all the contacts and inter-linkages to other organizations around specific products or technologies, and thus companies may have to manage and manoeuvre within multiple or overlapping innovation ecosystems. The innovation process involves suppliers and customers but also competitors or universities, investors and policy actors, each of whom may control important resources or dependencies in a specific IES. This perspective has new implications for Governments, whose policy concerns will encompass the stability/change in populations and configurations of actors within IES'; facilitating interactions across sectors, geographies and value chains; ensuring effective flows of ecosystem resources, and addressing systemic imbalances.

We invite contributions which discuss conceptually or empirically:

- Strategies: the ways that innovating organizations strategically mobilize their innovation environment and/or try to shape it as part of the innovation process and/or anticipate the future environment.
- Ecosystem change: how do ecosystems change? What strategies can companies and governments use to respond to or induce ecosystem change?
- Concepts: what are the conceptual merits and shortcomings of the IES concept? How does the concept relate to other innovation system concepts?
- Governance and policy implications: how are innovation ecosystems governed and by which actors? What is the role of policy-makers within innovation ecosystems and what are the approaches and policy instruments for supporting and directing innovation within IES? How is the tension between the diverging boundaries of often international and highly dynamic innovation ecosystems, and national and regional innovation systems and policy frameworks, and how may policy address this challenge?

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10.1 Session 10.1

10.1.1 Implications of an Innovation Ecosystems Framework for Innovation Policy Design and Mix

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Keywords: Innovation ecosystems, Innovation policy design, Innovation policy mix, Innovation ecosystem governance

This article develops a framework to identify policy interventions flowing from an innovation eco-systems perspective and assesses the degree to which they correspond to corrections of deficien-cies in innovation identified by firms. We start by reviewing the main elements of an innovation ecosystems perspective, then identify innovation policy deficiencies using in-depth interviews with Chief Executives, Chief Technical Officers, or senior innovation managers in 694 innovative firms in 11 European

countries[52]. This data is used to compare the taxonomy and the innovation policy deficiencies identified by firms to draw conclusions on whether the design and mix of innovation policy measures meets the needs of firms, and the distance between existing policy measures and those required to support dynamic innovation ecosystems. Conclusions are drawn on the implica-tions for the role of the policymaker in conceiving and implementing innovation policy.

1 Distinguishing the Innovation Ecosystem perspective

The now well-established 'systems of innovation' framework (Lundvall, 1992; Freeman, 2004; Edquist et al, 2001) has been extended by new perspectives such as challenge-based approaches (Eisenhart et al, 2016; Georghiou, 2013), systems transformations (Geels, 2002) and the new 'mission-oriented policy framework' (Mazzucato, 2016). All highlight deficiencies in institutional support for innovation, particularly coordination failures pointing to an enhanced government role. A further overlay is that of government failure where the actions of the state may act to inhibit innovation.

The open innovation concept highlighted the use and provision of external ideas by firms to im-prove success in innovation, and a literature has developed around the methods and strategies for achieving this (Huizingh, 2011). Extending the scope of firm innovation to the innovation ecosystem p emphasises the dynamics of the wider environment for innovation, including the role of institu-tions. The focus on interdependencies and flows between actors is a distinctive feature of the inno-vation ecosystems approach:

"The added value of thinking of this system as an ecology is the focus it brings to the distribution and abundance of research performers and knowledge and their interactions with each other and the broader environment" (European Commission 2008: 23)

An innovation ecosystem perspective requires a focus on three categories of 'flow' or distribution, that of people, finance and knowledge. But what are the implications of these categories for innovation policy, and how does the ecosystems concept help us to evaluate and develop "systemic" poli-cy measures (e.g. see Smits and Kulhman, 2004)?

1.1 Mobility

Regarding the mobility of people, lack of capability to innovate is often associated with insufficient absorptive capacity in firms to take advantage of externally available knowledge (Cohen and Levinthal, 1990; Sptihoven et al., 2011). Absorptive capacity is partly determined by routines in the firm which can in turn result in organizational deficiency linked to the inability to recruit or train people with appropriate level of skills or talent in technology or management. At the ecosystem level, poli-cy concerns include ensuring the population of skills in relevant technologies and appropriate en-trepreneurship capability using training and advice and specific measures to encourage recruitment into deficient firms. Effective functioning of an innovation ecosystem requires levels of mobility that match talent to opportunity. These are often restricted by structural issues in the labour market such as portability of pensions. Other instruments may be designed to increase mutual understand-ing, inter-organisational learning and knowledge exchange, thereby supplying "system building" provisions.

52 The research was part of the Horizon 2020 project "IIT – industrial innovation in transition" (No 64935) focusing on changing patterns and strategies in industrial innovation and their implications for European and member state innovation policy. The project team consists of five partners from University of Aalto (FI, co-ordinator), Joanneum Research (AT), University of Manchester (UK), University of Twente (NL) and Zabala Innovation Consult (ES)

1.2 Finance

Finance remains critical for innovating firms and is often a constraint for younger and growing firms. Assessing the right amount of public support is rarely (if ever) calculated on the basis of aggregate social returns, and capital markets and therefore company management may also un-derestimate returns on innovation (e.g. Christensen et al., 2008). Subsequently, it appears likely that innovation ecosystems typically run with sub-optimal finance available at key points. Nonethe-less, finance is the focus for much innovation policy with grants, loans and fiscal incentives ac-counting for the bulk of public support. There are also policies designed to mobilise private finance through co-investment, risk-sharing or measures to facilitate venture capital provision. However, approaching finance through the ecosystem perspective suggests greater emphasis on policy measures that increase rewards to innovation investors and ensuring private and social benefits flow back to the source of investment. The financial contributions of intermediary actors (e.g. incu-bators) also takes on new relevance.

1.3 Knowledge

That innovating firms require access to knowledge is self-evident, but the nature of that knowledge and the means of acquisition may vary considerably. The traditional distinction between tacit and explicit knowledge emphasises that knowledge flows between (or within) organisations goes well beyond that which is formally published. For decades innovation policy has focussed on promoting collaborative links between organisations to facilitate knowledge exchange and joint production, most frequently targettingscience-industry links using funding and incentives to bring universities and research organisations closer to business. Less visibly supported is the natural flow of knowledge between customer and supplier, but nonetheless initiatives have targeted supply chains and public procurement to provide demand-pull for innovation. A wide range of policy instruments also seek to stimulate technology diffusion to raise the productivity or competitiveness of lagging firms. The impact of the intellectual property system on knowledge flows is complex, as it brings knowledge into the explicit domain but then restricts flows to transactional arrangements. Adjusting the balance between investor rewards and benefits from knowledge diffusion has also been the subject of policy intervention (e.g. the patent box).

2 Firm perspective on innovation ecosystem and on barriers to in-novation

Our research explored firm's knowledge of innovation ecosystems as a concept and practical approach to innovation. Allowing for linguistic variation, 94% of the 694 firms interviewed considered the concept relevant and, depending upon the sector between 26% and 40% saw it as increasing in relevance in the past 5 years while none saw a decrease. As one firm put it:

"We see ourselves in the centre of an eco-system. That is what we do. We integrate technologies and capabilities together because the trick is, which is the challenge for the R&D manager, the R&D manager's job is to create that eco-system which best feeds our central hub."

Figure 1 confirms that the firms recognise the ecosystem flows discussed and displays their rela-tive importance by sector. Firms were asked about their primary innovation barriers, which in rank order were:

1. Lack of capabilities or skills,
2. Regulation,
3. Access to finance,
4. Access to markets,
5. Access to knowledge,
6. IP system,
7. Establishing standards, and

8. Establishing partnerships.

There was a close correspondence between these barriers and firm's perceptions of policy defi-ciencies. Hence, skills deficits were related to to the inability to recruit people with the right tech-nical or managerial skills, while issues with regulation and standards included the existence of challenging frameworks such as REACH or clinical trials regulation and the costs of compliance. Lack of stability in regulation, and varying levels of compliance prevent a level innovation playing field. These are articulated further in Table 1.

3 Core precepts of policy

An ecosystem approach requires us to understand the ways actors and institutions co-evolve and moderate or direct flows of knowledge, people and finance. Subsequently, policy directed at innovation ecosystems contains the following core precepts.

1. *A concern for the population of actors in ecosystems*. Is there a balance between large multi-product, multi-technology firms who can act as system integrators and a dynamic population of smaller companies who can provide innovative ideas and products? What is the role for es-tablished SMEs? How different does this ecosystem look across sectors and are those differ-ences driven by technology and/or market factors or historic drivers? Policymakers conclud-ing there are insufficient innovative firms in a particular ecosystem, may add diffusion measures within particular settings. A need for more integrators may require policy focussed on inward investment. Following from the population issue is the matter of entry to and exit from the ecosystem – what are the patterns of birth, growth, acquisition or death of relevant firms and does this enable effective selection of innovation opportunities?
2. *The adequacy of intermediary institutions.* These provide support for innovation, normally without taking the innovations to market. Research and technology organisations, standards bodies, measurement and testing services, consultancy support and broader services from innovation and business support agencies are all relevant here. Services for innovation may be characterized as the 'fourth flow'.
3. *Finance for innovation and providing institutions*. The most commonly perceived gaps are seed funding and second stage venture capital. This may reflect risk culture but can also be a fea-ture of the scale of the ecosystem – large volumes of transactions (as in the USA) can allow specialisation and potentially higher returns on investment deriving from larger home markets. Similarly ecosystem concerns may pick up on the mobility and supply of people and skills, with shortages identified as targets for policy intervention. There may be clashes with wider restrictions on international mobility, which have consequences for highly skilled labour.
4. *Addressing insufficient demand for innovation in a system*, because of lock-in to existing solutions or issues like rigid procurement or supply chain managment. This is particularly im-portant when innovations require system transformation (e.g. to low carbon transport). Regula-tions and standards determine the incentives for innovation and structure markets, and regula-tion is especially important in the clean technology sector while standards are core to competi-tiveness in the ICT industry. Both can act as barriers to as well as drivers of innovation.

4 Addressing barriers and policy deficits

Table 1 relates barriers and policy needs/deficits with examples of policy that partially or fully address them. While most, if not all, are recognisable elements of the innovation policymaker's toolbox, we imply that the ensuing policy mix would reduce the present emphasis on financial in-struments, important as they are, and increase emphasis on addressing the wider environment for innovation and directing the flows of people and knowledge using diffusion measures. Ecosystem measures also address population through concern for entry and growth of new firms and a sys-temic perspective towards activating demand for innovation and a mission-oriented focus towards systemic transitions. How to apply these policies depends upon the role of the policymaker.

5 Role of policymakers

An overarching question is whether the innovation ecosystems approach requires a different role for policy makers compared to their role in other types of innovation system (e.g. spatial or techno-logical). As policy makers, regulators etc. are considered as active players in an innovation eco-system, does this offer new opportunities to develop and apply systemic policy measures, and what capabilities do policy-makers require? Conversely, an ecosystems approach implies a less di-rective role than in a territorial innovation system, oriented towards providing frameworks over specific instruments and support programmes? Key to establishing successful innovation ecosys-tems is understanding the strategic considerations of different actors within the ecosystem and providing platforms from which ecosystem leaders can develop (Cusumano and Gawer, 2002). The time dimension is important as policy needs vary as systems evolve: the early stages of ecosys-tem genesis are potentially volatile and viable networks may not form without the right conditions, resources and activities (Dedehayir et al., 2016).

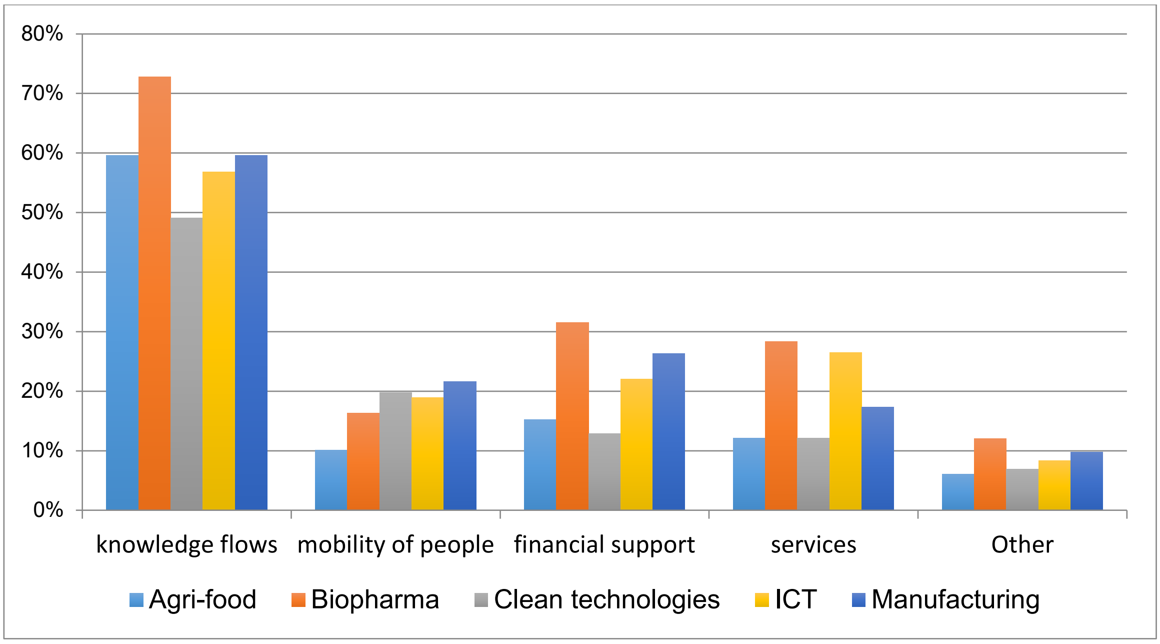
Furthermore, how are boundaries to be addressed in innovation ecosystems policy? National and regional innovation systems create boundaries that map onto geographies of policy responsibility, while technological innovation systems follow technologies, which often resonate with the boundaries of sectoral or industry based innovation policy. If innovation ecosystems are often international and not always clearly focused on a particular technology field, this creates challenges for organising innovation policy to address certain ecosystems. Can this challenge only be resolved at company level?

These questions are part of the more general question of who governs an innovation ecosystem and how. Does whoever is in the governance role have the resources and capabilities to deploy the ‘initiation’, ‘maintenance’ and ‘developer’ roles required for innovation ecosystem functionality? Governance requires ecosystem leaders to design the roles of different actors, coordinate internal and external interactions, and orchestrate resources flow between different partners as the system evolves (Adner, 2012). In whose interests are these activities undertaken, and when are specific levers required to change innovation ecosystem leadership? One pattern of evolution may see a transition of leadership from public to private actors over time. Licensing, corporate venturing and scaling-up new firms may drive that process and offer a target for policy interventions. If the per-formance of a mature ecosystem appears to be declining (e.g. stultified flows between actors) a policymaker may apply incentives to change framework conditions such as a reduction of barriers to mobility, whilst companies may seek to establish new ecosystems.

To design the right mix of instruments, policy makers should understand the value blueprint of dominant innovation ecosystems within their jurisdiction that results from the location of, and links between, innovation ecosystem actors. This will enable policy makers (and others) to foresee risks to value creation; to determine the value of ‘leader’ and ‘follower’ roles within the different innova-tion ecosystems’ in their jurisdiction, and understand the likely timing of the ecosystem lifecycle and potential reconfigurations (Adner, 2012). This would be associated with a differentiated ap-proach to innovation policy in which different types of instrument are deployed in different places and directed towards different types of actor based on ecosystem performance and evolution. It may be that the best way to support a deficiency in one actor is to target a policy at another. For example, insufficient innovative activity amongst SMEs in a supply chain might be remedied by incentivising higher tier firms or public actors to activate demand for innovation from their suppliers using the tools of procurement for innovation (Uyarra et al, 2014; Georghiou et al, 2014).

A key conclusion is that the policymaker’s role is not one of Olympian overview, both because of the lack of any objective position and because the essence of an ecosystem is shared governance. Rather, the policymaker becomes an active player and through certain instruments is able to adjust the balance and enhance or moderate flows. Complexity means that change cannot always be theo-ry driven and may better be derived from an evolutionary and experimental approach.

Figure 1 Relative importance attached by firms to types of ecosystem flows by sector (% of firms)



Source: own data (IIT Project Interview Survey)

Table 1 Barriers, Gaps and Policy Instruments in the Innovation Ecosystem Perspective

Ecosystem		Barriers to Innovation (survey based)	Policy challenges and gaps (survey-based unless indicated)	Policy measures (examples)
Flows	People	Lack of capabilities or skills	*Skills deficits* – the ability to recruit people with the right technical or management skills including wider criticisms of the education system	Training and advice in capabilities Measures to encourage recruitment of skills into deficient firms Reduction of mobility barriers
	Finance	Access to finance	*Access to finance* – insufficient funding for innovation	Grants, loans and fiscal incentives Policies designed to mobilise private finance through co-investment, risk-sharing or other measures to facilitate the provision of venture capital
			Conditions and priorities for public funding – bureaucratic processes for obtaining funding, risk-aversion, delays, inconsistency between policies, the requirement for more strategic investments, disagreement with priorities for funding (eg technical areas, company size)	Simplification Foresight on priorities
	Knowledge	Access to knowledge	*Partnership issues* - affecting transfer of knowledge from the research sector	Promotion of science-industry links Diffusion measures
			IP system	Patent box
	Services	Exchanges enabling innovation	*Heavy reliance on external knowledge for innovation and increasing importance of innovation ecosystem approach, creates a greater role for services that enable connectivity and exchange*	Support for Research and Technology Organisations, standards bodies, measurement and testing services, consultancy support, and professional services (including Professional Technical Services Businesses)
				Digitalisation and adoption of ICT within business and innovation planning and implementation.

Systemic considerations	Regulation and Standards	Regulation	*Regulatory environment* - existence of challenging frameworks such as REACH or clinical trials regulation and the costs of compliance. Concerns about a lack of stability in regulation and of varied levels of compliance preventing a level playing field	Simplification Proactive regulation
		Establishing standards		Support for standards projects
	Insufficient *demand* for innovation	Access to markets	*Market barriers* in the public sector – including failure of public procurers to adopt innovations and other barriers to purchasing such as defence competition requirements for suppliers. Also international trade issues	Procurement for innovation Pre-commercial procurement Supply chain measures
	Intermediary institutions		[Lack of middle TRL R&D] [Lack of technology infrastructure] [Lack of capacity to assist firms]	Support for Research and Technology Organisations, standards bodies, measurement and testing services, consultancy support and more broadly services from innovation and business support agencies
	Populations of actors and entry/exit conditions		[Deficiencies in anchor firms] [Lack of entrepreneurship]	Promotion of technological inward investment Support for scale-up firms Support for start-ups Student entrepreneurship education & support
	System transformation		[Lock in] [Coordination failure]	Challenge-based initiatives New mission-oriented research

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10.1.2 Conceptualizing Ecosystem Emergence and Evolution: insights for innovation policy from innovation ecosystem and transition literatures

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Introduction: the innovation ecosystem concept

'Ecosystems' have been labelled as the next buzz-word in big business, with an increasing use of the terms 'business ecosystem' and 'innovation ecosystem' documented over the past decade (Gobble, 2014). Although it has been gaining currency in management literature, Autio and Thomas (2014, p. 1) note that "a cursory reading of the literature would certainly suggest ample reason to be sceptical" as the term is mostly found in practitioner literature, and its use in the academic literature show a proliferation of difficult to reconcile definitions with little "cross-fertilization between domains and levels of analysis". Indeed, the conceptualisation of the ecosystem in many ways resembles that of an innovation system coined by Lundvall (1992) and Edquist (1997) in the 1990s. Innovation ecosystems have been described as a network of interconnected organisations creating and appropriating value from innovation (Autio and Thomas, 2014) by engaging in dynamic processes (Oksanen and Hautamäki, 2014). Does it than offer some new value for innovation policy?

Neglecting its traditional natural science heritage, the terms also pops up in usages such as 'knowledge ecosystem', 'industrial ecosystem', 'technology ecosystem' and 'entrepreneurial ecosystem'; predominantly applied to high-tech industries (Adner and Kapoor, 2010), such as: software, biotechnology and internet services (Iansiti and Levien, 2004). The reason is most likely situated somewhere between a 'fad' of its interchangeable and indifferent use with words such as 'cluster' or 'network' (Gobble, 2014) and its attractiveness as a metaphor for describing "range of value creating interactions and relationships between sets of interconnected organizations" (Autio and Thomas, 2014). As a metaphor to natural ecosystems, does it somehow imply tighter interconnections than mere 'innovation systems'?

Moore was the first to use the 'ecosystem' term in the management literature, suggesting that "in a business ecosystem, companies co-evolve capabilities around a new innovation: they work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations" (Moore, 1993, p. 76). Innovation ecosystems, by contrast, have been defined as " a network of interconnected organizations", not just companies, "connected to a focal firm or a platform, that incorporates both production and use side participants and creates and appropriates new value through innovation" (Autio and Thomas, 2014). Most of the emerging literature agrees that innovation ecosystems arise, or are created, around a central node, sometimes a technology platform and sometimes a set of social or economic conditions that draws key players together (Gobble, 2014). We pose a question, if such a node could also be what is known in the Strategic Niche Management literature as a niche technology (e.g. Schot and Geels, 2007; Smith and Raven, 2012) or a niche business model.

Ecosystem vs. niche emergence and development

It has been suggested that aspects such as the 'design', 'building' and 'operation' of innovation ecosystems and frameworks to measure their performance are either lacking or that linear deterministic approaches have been adopted (Wallner and Menrad, 2011). Furthermore, the innovation ecosystem

concept appears to exist as a solitary—and rather flat—unit of analysis, with the links to exogenous influences left under-addressed.

In contrast, the transitions literature takes a much broader approach in its understanding of socio-technical change. Strategic niche management (SNM) takes a quasi-evolutionary perspective of technical change "to understand and influence the early adoption of new technologies with high potential to contribute to sustainable development" (Schot and Geels, 2008, p. 538). A niche is conceptualised as a protected space that allows for radical path-breaking innovations that deviate from the status quo. The concept suggests three internal processes for successful technological development: the articulation of expectations and visions, the building of social networks and learning process at multiple dimensions (Schot and Geels, 2008). Smith and Raven (2012) also identify processes and patterns concerning niche shielding, nurturing and empowering for path-breaking innovations. Such may occur when: (a) niche- innovations build up internal momentum, (b) changes at the landscape (the exogenous context influencing socio-technical regimes) create pressure on the socio-technical regime, and (c) destabilisation of the regime creates a window of opportunity for niche innovations, i.e. in the interplay of multiple levels (Geels and Schot, 2007).

Aims

Approaches within transition studies have been described as middle range theories; allowing for the accommodation of investigation in the social sphere and theoretical enrichment through the mobilisation of insights from other fields. Since the concept of business and innovation ecosystems is a fairly new and undeveloped field of inquiry (Durst and Poutanen, 2013), our motivation is to contribute to the academic discussion on how the change in innovation ecosystems, such as emergence and evolution, is conceptualised; and could it be more useful to innovation policy when combined with strategic niche management.

We pose the following questions: What insights can transition concepts, such as strategic niche management and the multi-level perspective, lend to how the innovation ecosystem concept conceptualizes ecosystem emerge and evolution? What are the similarities and differences in the conceptual grounding of transition and innovation ecosystem concepts? In what ways can insights from strategic niche management and the multi-level perspective be used to complement the innovation ecosystem literature?

This paper aims at exploring and enriching the concept of innovation ecosystem change and emergence. We provide an overview of the business ecosystem and innovation ecosystem literature and analyse conceptualisations of innovation change processes, and outline some key criticisms of the concepts. Hence, it contributes to the academic discussion on the dynamics of innovation emergence and change by assessing the suitability of transition theories to contribute to the emerging innovation ecosystems literature.

A literature review of business ecosystem and innovation ecosystem literature will be used to identify and compare: the theoretical underpinnings, innovation focus, objectives, unit of analysis, conceptualisation of actor networks, and understanding of change processes in the innovation ecosystem, and strategic niche management literature.

Preliminary insights

The paper will provide insights from the concept of strategic niche management such as niche internal processes, niche shielding, niche nurturing and niche empowering and transition pathways on how these ideas may be able to enrich the innovation ecosystem concept of ecosystem emergence and evolution. Drawing on the concept of both niche and regime, we show how the analysis (and policy support) for innovation ecosystem can benefit from a less flat depiction. Emerging innovation ecosystems are likely to contain business actors from both an emerging technology and service niche as well as incumbent regime actors who are willing to expand or change to new business areas. In addi-

tion, they may exist in the boundary of two or more socio-technical regimes. This suggests that innovation policy orienting to support innovation ecosystems should take into account the plurality of companies involved as well as the supportive/hindering policy effect from the several regimes, highlighting the need for improve policy coordination.

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10.1.3 The Interplay between Institutional Entrepreneurs and Regulations – implications for STI policy

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Introduction

Grand societal challenges we face today, such as environmental (e.g. depletion of resources, pollution etc.) and global healthcare issues (e.g. neglected diseases, low access to medicines etc.) call for institutional change (Geels, 2011; Markard et al., 2012). Institutional contexts are described as an important influence on such transition processes (Coenen et al., 2012; Garud et al., 2002). Institutions are then both an outcome as well as a structural influence on initiatives to address societal challenges. Due to pressure of the United Nations, that conceptualized these challenges in the Sustainable Development Goals, countries are stimulated to direct policy towards solving these issues (Lu et al., 2015). Policy and subsequent regulatory efforts are thus important to guide necessary processes of institutional change (Smith et al., 2005).

Institutional entrepreneurs play a creative as well as disruptive role in innovating for addressing societal challenges (Westley et al., 2011). Dimaggio (1988) described institutional entrepreneurs as organized actors – with sufficient resources – who identify possibilities for new or transformed institutions that aid in realizing their specific interests.

Existing regulations or a lack thereof may hinder or stimulate the process of institutional change inspired by institutional entrepreneurs (Jolly & Raven, 2016). In some cases institutional entrepreneurs may even defy or alter regulations, if they possess the power to do so (Greenwood & Suddaby, 2006). These actors could be considered as a different type of institutional entrepreneur than those who do not alter regulations.

Simultaneously, policymakers are ill at ease with institutional entrepreneurs. On the one hand they recognize their creative potential and contributions to addressing societal issues. On the other hand institutional entrepreneurs in their very nature break existing laws and disrupt the level playing field in sectors by neglecting rules which their competitors have invested in conforming to.

Identifying which role institutional entrepreneurs play within institutional change processes related to societal challenges and how they interact with regulations is interesting to understand in order to formulate applicable policy. STI policy built on insights from this research may then contribute to the acceleration of institutional change processes that meet societal challenges.

The main research question of this paper is therefore: “what types of institutional entrepreneurs can be discerned, how do they interact with regulations and under which conditions can they contribute to meeting grand societal challenges?”

Theoretical background

Current theories in the field of STI studies as well as subfields of sociology and management literature have so far not provided a clear understanding of the interaction between institutional entrepreneurs and regulations.

First, innovation policy studies have mostly focussed on the influence of regulation on innovation and innovative activities (Blind, 2012). Empirically, regulation and innovation are treated at a fairly high

level of aggregation (sector or country) and studies have used outcome measures such as R&D productivity to determine the influence of regulation on innovation. There is a consensus that regulation can have a positive impact on the level of innovation (Porter & van der Linde, 1995), but that the relationship is moderated by differences in sector, time horizon, company characteristics and type of regulation (Ambec et al., 2013; Blind, 2012). With this level of analysis there has not been much emphasis on the actions and motives of individual actors like institutional entrepreneurs (Nielsen & Parker, 2012).

Second, in science and technology studies (STS) attention is paid to 'regulatory science', especially focusing on the way in which regulatory agencies assess products as a combination of scientific and political considerations (Irwin et al., 1997; Jasanoff, 1995). As part of STS, constructive technology assessment literature underlines the inclusion of a diverse range of actors and scrutinises contestation (Dorbeck-Jung & Shelley-Egan, 2013; Schot & Rip, 1997), but it lacks interest in the precise involvement of these actors in the development of regulatory practices and it has a prescriptive focus.

Third, institutional studies provide us with relevant concepts on the strategies and characteristics of institutional entrepreneurs and the influence of contextual factors such as degree of heterogeneity and institutionalization on their strategies (Battilana et al., 2009). It however does not provide in-depth insights concerning the institutional entrepreneurs' relationship with regulations either.

To understand this relationship, the institutional entrepreneur should be understood as an actor embedded within a structure or system. This is a challenge as the main critique on institutional entrepreneurship is a lack of adequate embeddedness of their agency (Heugens and Lander, 2009; Meyer, 2006).

As Hung and Whittington (2011) described, this leads to studies either neglecting the influence of agency, such as organizational ecology studies (e.g. Ruef, 2000) and complexity theory based studies (e.g. Peterson & Meckler, 2001), or largely overlooking the influence of institutions and emphasizing an inadequately embedded institutional entrepreneur (e.g. Dodd & Anderson, 2007).

Innovation scientists have made the first institutional inroads. They have started to adopt institutional entrepreneurship as a source of agency within their research. It has for example been identified as "a form of agency within a national innovation system" (Hung & Whittington, 2011: 526), as an influential factor within regional innovation systems (Sotarauta & Pulkkinen, 2011) and a driving force within technological innovation systems (Bergek et al., 2008; Kukk et al., 2016).

These studies suggest that innovation theories rooted in system thinking may benefit from properly embedding institutional entrepreneurship within their mainly structuralist theoretical grounds to account for agency within the system. Simultaneously, such theories provide a useful theoretical framework to embed the institutional entrepreneur, without disregarding its agency.

A consolidated conceptual model taking institutional theory concepts into account, that may describe institutional change processes for innovation scientists in a more encompassing way, has however not been constructed. This model would consist of both specified institutional entrepreneurs, as well as a classification of the structure or innovation system within which they are embedded, including a regulatory framework. Constructing such a model may lead to a better understanding of institutional change processes and the role of institutional entrepreneurs therein, specifically the interaction they have with their embedding structure and regulations.

Methodology

Data has been derived through a systematic literature review of 93 articles on the topic of institutional entrepreneurship published after Battilana et al.'s influential 2009 article 'How actors change institutions: towards a theory of institutional entrepreneurship'.

The type of institutional entrepreneurs and agency (strategies) – including strategies concerning regulation – mentioned in these articles, as well as specifications of institutional context have been mapped systematically. Results are related back to innovation sciences literature, in particular to concepts of innovation systems. Overall emerging trends and concepts within the institutional entrepreneurship literature have also been noted.

Expected Outcomes

We firstly specify the different type of actors within institutional change processes. Multiple articles describe institutional entrepreneurship as a collective, rather than an (heroic) individual, endeavor (e.g. Gurses & Ozcan, 2015; Van Bockhaven et al., 2015), much like the earlier notion that institutional entrepreneurship may require coalitions of actors to "run in packs" (Van de Ven, 1993). Several studies have also indicated that this collective agency comes from dispersed actors, that may not have the same goal as the institutional entrepreneur, but influence the institutional change process nonetheless (Szkudlarek & Romani, 2016).

We then identify institutional entrepreneurs or challengers, institutional defenders, regulators and policymakers as actors of influence on the institutional change process. Special emphasis is put on the interaction between institutional entrepreneurs and regulations.

Secondly, these actors are contextualized by identifying either emerging or mature institutional embedding contexts, based on the distinction made by Battilana et al. (2009). Both type of contexts come with specific implications on the institutional change process and the interaction between institutional entrepreneurs and regulations. We conceptualize this structural context by using concepts of innovation systems theory to position and embed the actors of influence in a broader system's perspective.

Emerging institutional context are for example often characterized by a lack of regulations, which poses challenges as well as opportunities for institutional entrepreneurs as it provides room for experimentation but complicates legitimizing the institutional change (Jolly & Raven, 2016). In such a context, institutional entrepreneurs are more likely to contribute to the formulation of regulations. Contrarily, mature institutional contexts and (outdated) regulations cause barriers for institutional entrepreneurs to go about things differently and often favor established parties (Lakshman & Akhter, 2015). Institutional entrepreneurs then need to focus more on lobbying to alter or circumvent regulations.

Describing how institutional entrepreneurs interact with regulations and other agents under different circumstances will provide relevant insights for policymakers. Applying these insights to construct specified and effective policy recommendations aids in meeting societal challenges which constitutes the practical contribution of this research.

The theoretical contribution of this research is specifying the notion of institutional entrepreneurship to innovation processes that require institutional change to make it a more applicable concept for innovation scientists. It simultaneously strengthens the notion of agency within institutional change processes by not overlooking structural influences conceptualized by innovation literature theories.

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10.2 Session 10.2

10.2.1 Innovation Ecosystem Strategies of Industrial Firms

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Introduction

Innovations that impact the world are no stand-alone novelties created by single companies, but combinations of new products and services, produced by a multitude of firms (Iansiti & Levien, 2004). Innovations are created in networks, in which contributions of different parties are brought together to create value for customers. As a consequence, companies can only partly influence the odds of success of their innovations by internal management practices. They are to a large extent dependent on others' efforts and the dynamics in the broader network (Van de Ven et al, 1999). These networks do not only comprise the supply chains and innovation alliances of focal firms, but also producers of complementary innovations, user communities, research institutes, governmental agencies, standard setting bodies, financiers, and other actors (Coombs & Georghiou, 2002). To capture the complexity of these networks, the strong interdependencies among actors, and the non-linear dynamics of innovation processes, the analogy of ecosystems has been introduced (Moore, 1993), which has gained popularity in both practice-oriented and theoretical management discourse (e.g., Adner & Kapoor, 2010; Gawer & Cusumano, 2014; Ormala et al., 2014; Adner 2017). There are different ecosystem concepts, including regional knowledge ecosystems, broader business ecosystems and innovation ecosystem, with different foci and boundaries (Clarysse et al., 2014). In this paper we will focus on innovation ecosystems, which can be seen as sets of actors, relations, and rules, which are needed to conceive, create, sell, and embed innovations. These ecosystems do normally not coincide with regional, sectoral or national innovation systems, as they are confined to a certain area or industry but comprise all parties directly or indirectly involved in innovation and subsequent value creation.

Operating in innovation ecosystems comes with challenges of management and governance. These relate to strategic questions, including with whom to cooperate and with whom to compete (Van de

Ven et al, 1999), how much to invest in the ecosystem as a whole versus investing in your own position within it (Autio & Thomas, 2014), and how to align internal innovation activities with technological progress in the ecosystem (Adner & Kapoor, 2010). Current literature pays attention to these and other questions, but this attention is fragmented and often based on a limited number of cases. No systematic and comprehensive research has been done on how firms act upon innovation ecosystems, and how they use these for their innovation efforts. A better understanding of the strategies of innovating firms will contribute to filling a theoretical gap in this emerging field (Autio & Thomas, 2014), and help managers to face ecosystem challenges.

In this paper we analyze how companies act upon innovation ecosystems. In this, we will take a dynamic perspective. Rather than seeing ecosystems as self-reproducing, gradually evolving, connected systems to which individual companies have to adapt in order to be successful – which is a contested view (Papaioannou et al., 2009; Oh et al, 2016) – we stress the fluidity of the system and the role of 'agency'. Innovation ecosystems are in constant transformation – loosening and tightening, expanding and contracting, merging and splitting – and co-evolve with the technologies, organizations, and institutions that constitute it. These dynamics are not due to the internal logic of the system, but the result of a great many visible hands (Rip & Groen, 2001), of engineers, scientists, policy makers, managers, and others. This implies that managers do not only adapt to innovation ecosystems, but also have opportunities to shape it, and that these opportunities alter in the course of time. In their innovation journeys (Van de Ven et al, 1999), managers cope with dependencies from the past (Garud & Karnoe, 2001), they envision and anticipate future environments, and engage in reflective actions of shaping and adaptation in the present.

Research design

For this paper we will build on the conceptual and empirical work done within the Horizon 2020 project 'Industrial Innovation in Transition' (see www.iit-project.eu). This project is carried out by a consortium of Aalto University (Finland), University of Manchester (UK), University of Twente (the Netherlands), Joanneum Research (Austria) and Zabala Innovation Consulting (Spain). It aims to advise managers and governmental agencies on innovation strategies and policies, based on a mapping and analysis of state-of-the-art industrial innovation practices, thus stimulating innovation-based growth in Europe. The project started in 2015 and encompasses a large series of semi-structured interviews with CTOs and innovation managers of established industrial firms in 11 EU-member states, spread over different sectors (manufacturing, IT, cleantech, agrofood, and pharma). Interviews took 1.5 to 2.5 hours. They were transcribed and coded in MAXQDA. In this paper we will draw on 310 interviews conducted in the Netherlands, Germany, Austria, Ireland and the UK.

Results

Understanding how companies act upon their ecosystem requires an understanding of their scope: Which parties are considered to be part of the relevant ecosystem? Some have a narrow view, limiting it to the supply chain and direct collaboration partners, while others include universities, companies creating complementary products, lobby clubs, etc.. Scope also concerns the innovation-related flows within the ecosystem, including products, knowledge, people, and finances. The scope of a company is related to its place in the value chain and the characteristics of the industries, but historically grown myopia sometimes also plays a role.

Related to the scope is the position of the company in the ecosystem. Companies may have grown into roles such as keystones or niche-players (Iansiti & Levien, 2004), component suppliers or system integrators. These roles impact the scope and the opportunities to actively shape the ecosystem. For instance, an industry platform provider has potentially more influence than a designer of niche applications. Role and power position are related to the roles and positions of other players, and to the overall structure of the ecosystem. Innovation ecosystems can be centralized around a single hub, contain competing hubs, or lack a center. These structures, and their dynamics, have influence on how companies act upon the ecosystem.

Considering the most important players in the ecosystem, and the related resource dependencies, companies adapt their innovation processes in many ways (Christensen & Bower, 1996; Pol &

Visscher, 2010). This materializes in, for instance, customer-centered innovation practices, strengthening relationships with hub companies (Nambisan & Baron, 2013), or monitoring innovative moves of competitors, but also in adaptation to the structures on a regime level (Kemp et al., 2001), such as adherence to industry standards, and incorporating new national and European regulations. Adaptation further includes attempts to anticipate future developments in the ecosystem. Corporate foresight can play an important role in this (Rohrbeck and Gemuenden, 2011), especially when it is approached as a networked effort, which allows different partners in the ecosystem to contribute (Heger & Boman, 2014).

Companies do not only adapt to ecosystems, but also actively use it for their innovation efforts. By forming strategic alliances, acquiring IP, crowdsourcing, and other forms of 'inbound' open innovation, companies draw on the ecosystem for exploring and exploiting innovations. Interesting from an ecosystem perspective are especially collaborations with multiple parties from different parts of the system, and collaborations around ecosystem hubs. Profiting from ecosystems does not only entail finding the right partners and being good at handling collaborative projects, but also requires building a position in which others wish to cooperate with you. Hub companies become 'obligatory passage points' (Callon, 1986) for innovations, and niche players may grow into preferred partners for innovation processes.

On a higher level, companies may also attempt to shape a whole ecosystem and improve its robustness and productivity, in order to favor the chances of innovation processes within it (Iansiti & Levien, 2004; Adner, 2017). This includes orchestration activities of individual companies (Dhanaraj & Parkhe, 2006), such as creating and opening up industry platforms, hosting conferences, and facilitating regional networks, but also collective activities, such as lobbying, agenda building, and joint roadmap creation (McDowall, 2012).

In our paper we will elaborate and empirically illustrate the adaptive, anticipatory and active ecosystem strategies industrial firms deploy. Which specific strategies are used seems highly dependent on the structure of the ecosystem and position of a company, and on the perspectives of the management. In many companies, ecosystem strategies remain closely related to their regular (open) innovation, foresight, or public relations activities. Only a few companies have shown to deal with ecosystem challenges as part of their overall strategy.

Conclusion

This paper contributes to the emerging literature on (innovation) ecosystems by providing a comprehensive analysis and discussion of the strategies of industrial firms for dealing with and profiting from innovation ecosystems. It also offers valuable insights for policy makers. It identifies opportunities for facilitating innovation processes in ecosystems and for strengthening these systems themselves. The paper concludes with limitations and suggestions for further research.

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10.2.2 Anticipating in innovation ecosystems: from internal to collaborative forms of corporate foresight?

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'What is going to be innovative in the future and how will this future look like?', is a crucial question for companies and policy makers to ensure competitiveness and growth on a long-term perspective. In recent years it has become more and more obvious that innovation is a collaborative process based on distributed knowledge from inside and outside the company (Smith and Robertson 2008). As previously described (Adner and Kapoor 2010; Oh et al. 2016) and confirmed by the ongoing IIT project, companies rely more often on their innovation ecosystem for their current innovation activities. This raises the question whether companies also take collaborative approaches to anticipate on their environment.

There are various ways how companies can anticipate on future developments and make use of these insights for strategy-building and innovation processes. There are dedicated methods and tools supporting corporate foresight conducted at the level of the firm, partly organized by specialized departments (Rohrbeck et al. 2015; van der Duin 2016). Furthermore, companies may gain insights from policy-induced foresight involving corporate actors. Martin and Johnston (1999) famously described the role of national foresight as being to wire up the national innovation system. More recently, also in corporate foresight research it has been suggested to pay attention to collaborative forms of so-called networked foresight – foresight which is conducted at the level of innovation networks and ecosystems (van der Duin et al. 2014; Heger and Boman 2015). Contributors and users of such a foresight approach are not confined to one organization, as is assumed in the majority of corporate foresight studies, and they do not necessarily include or are induced by policy actors (though this may be the case), but predominantly rely on diverse actors from an innovation network of large and small companies, public research organizations, and partly public agencies. Georghiou postulated already 20 years ago that, as firms become increasingly dependent on complementary and external sources of technology, they need to collaborate in their thoughts about the future (Georghiou 1996, p.361).

While most foresight studies describe rather structured processes and projects, the general understanding of foresight as a forward-looking (organizational) ability, not defining the specific ways how this is achieved, suggests to include also more informal ways how organizations develop an understanding of their future environment. Especially since sophisticated foresight methods and processes may not be accessible to all, particularly smaller companies. It seems more likely that a lot of information is gathered, interpreted, and made sense of via discussions within organizations, but also with partners, in professional communities, at conferences and fairs, following various media, scanning of literature, etc. (Reger 2001). This is in line with an understanding of foresight and future-oriented expectations as anticipatory knowledge which emerges at the crossroads of various anticipatory practices, and which exhibits different degrees of collectivity (Konrad 2006; Van Lente 2012; Alvial Palavicino 2016).

Thus, in our paper we want to shed light on the various forms how innovating companies anticipate on their future environment by way of diverse sets of anticipatory practices. In particular, we examine the role of external partners and sources which belong to the innovation ecosystem of a company. In line with this, we consider not only how these practices and insights are used within the companies, but also how value is created for the network respectively innovation ecosystem as a whole (Konrad et al. 2012; Musiolik et al. 2012; van der Duin et al. 2014; Heger and Boman 2015).

Our study is based on an exceptionally broad dataset built on approximately 700 semi-structured interviews with high-level managers in innovative European companies (e.g. chief technology officers, R&D managers), collected in the H2020 IIT project (Industrial Innovation in Transition, http://www.iit-project.eu/). Interviews addressed the innovation practices of the company, inquiring among other issues into the forms, scope and uses of mapping future environments, the role of innovation ecosystems and of policy frameworks. Due to the size of the sample we are able to estimate the relevance of certain practices for European innovative companies, and by delving (selectively) in more detail into the qualitative interviews we get a richer understanding of the concrete forms and relevance for the company and its ecosystem. (A small set of additional more in-depth case studies is currently in process.)

In the paper, we specifically study the ways how companies make use of their innovation ecosystem for anticipating on their future environment, be it via dedicated joint foresight processes or by more informal ways, such as participating in networks and associations deemed as important for forming an idea of future developments. We will describe how ‘active’ companies are in e.g. initiating anticipatory processes, circles etc. and which types of actors are involved, e.g. companies along the value chain, but also other actors in the sector, research organizations, policy makers etc. Secondly, we report our findings on the uses and effects of these foresight activities, either within the company, for instance for strategy-building, initiating or challenging of innovation projects, as well as for the innovation ecosystems, for instance for agenda-building or network formation. Collaborative forms of foresight turn out to be not only a tool to improve corporate innovation foresight but also to position the company within an innovation ecosystem and shape or even steer its development.

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10.2.3 Technology Leadership and Solution Provider: two innovation strategies in the German photonics and micro-electronics industry

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Introduction

The fast pace of today's innovation cycles and the increased productivity put particular pressure on knowledge-based industries that are highly dependent on a high degree of research. This trend manifests itself in increasing research and development (R&D) budgets in such industries. In Germany, expenditure for research and development doubled over the last 20 years (BMBF, 2016). The high-tech industries photonics and micro-electronics have come into focus of German innovation policies as they are perceived as central to drive and respond to the trends of digitization and industry 4.0. Both industries provide key enabling technologies for diverse application scenarios such as automotive, medicine, and industry. Companies spend on average around ten percentage of their revenue on R&D (Spectaris, VDMA, ZVEI, & BMBF, 2014; Zentrum für Europäische Wirtschaftsforschung, 2016). Besides an increase in R&D activities, the character of these activities has also changed. Since the mid-1990s, companies in Germany have spent an increasing share of their R&D investments externally and thus established innovation networks (Dolata, 2015). In microelectronics, R&D is particularly close connected to universities and research institutes as more than 80% of all companies cooperate with academic research (VDE, 2005, p. 7).

These changes in R&D expenditures indicate that industry companies have adapted or developed new R&D strategies and operations. Addressing this issue, this paper aims to analyse how companies respond to the global changes in their industries and adapt their strategic orientation towards R&D and innovation processes.

The R&D activities in these sectors are not confined to the companies' boundaries but are part of an innovation ecosystem (Adner & Kapoor, 2010; Autio & Thomas, 2014). The innovation ecosystem approach highlights interdependencies between organizations within an ecosystem and the co-evolution of value. It stresses that companies do not innovate individually but depend on the capacity and know-how of other organizations (Autio & Thomas, 2014; Moore, 1993). In order to be innovative, companies must "attract resources of all sorts, drawing in capital, partners, suppliers, and customers to create cooperative networks" (Moore, 1993, p. 75). Such a perspective captures thus a wide range of participants "that specializes in the development, discovery, delivery, and deployment of evolving applications" (Autio & Thomas, 2014). These participants do not necessarily belong to one specific industry but to an evolving community which provides a set of inter-related technologies and transdisciplinary knowledge.

A central advantage of an innovation ecosystem perspective is that it allows for analysing the specific challenges a company faces and the responses it takes when trying to innovate (Adner & Kapoor, 2010). Companies participate in specific innovation ecosystems and actively seek to take advantage of, to shape and to influence such an ecosystem. By reviewing the relevant literature on innovation ecosystems, Autio and Thomas (2014) argue that, so far, little has been said about the strategies companies apply to influence and shape ecosystems. We address this research gap and analyse the innovation strategies companies apply in the German photonics and micro-electronics industry given the aforementioned challenges and changes. We specifically analyse how companies position themselves in the ecosystem and which economic and technological strategies to innovate they derive from such positioning.

To this end, we conducted 20 qualitative interviews with senior management from research, strategy and product management departments of both SMEs and large companies as well as 6 interviews with interest groups and cluster organisations in these sectors. The interviews took 60 – 120 minutes. We analysed the interviews with in-vivo codes as well as a theory led codebook in order to generate ideal types of innovation strategies distinguishable in terms of the following criteria: the organization of R&D within the ecosystem and the company itself; the degree and character of external knowledge involved in innovation processes; the cooperation with different stakeholders; and, ultimately, the use and relevance of public R&D funding. The analysis, thereby, allows for a differentiation of innovation activities and of distinct positions an organisation takes within innovation ecosystems.

Preliminary findings:

Technological leadership and solution provider strategies in innovation ecosystems

The interviews revealed that R&D departments in both sectors nowadays face similar external challenges, i.e. digitization, short-innovation cycles and global competition, albeit in differing intensity. These trends force companies to reflect on their innovation activities and develop strategies to adapt to their respective innovation ecosystems. We identified two ideal types (Weber, 1986 [1922]) of innovation strategies in response to these trends: (a) technological innovation and (b) solution innovation.

Type A: Technological innovation (TI) implies somehow traditional innovation strategies, applied mainly by SMEs. They position themselves as technology leaders in the market and therefore need to conduct R&D to always provide leading technologies to their customers. They provide highly specialized technologies, often in a market with only few competitors. Demand to innovate comes from clients and innovations are incremental, concerning technical improvements. They create a strong, personal connection to a few research organisations and universities which provide the necessary resources as well as the knowledge capacities the companies do not have available themselves. The innovation ecosystem that technology innovation companies perceive and seek to influence is limited to suppliers, customers and research organizations. Patenting and non-disclosure agreements are central to gain and maintain market share; open innovation activities do not fit to their strategic orientation.

Type B: Solution innovation strategies (SI) are characterized by less linear innovation processes. Clients, suppliers, research organizations, competitors and policy actors interact throughout the entire innovation process. The relationship between two companies in such an ecosystem can also change, meaning that company A can be for example both, client and supplier to company B. SI companies do not seek market share by merely providing leading-edge technologies but by providing solution systems which encompass more than a single technological product and respond to the individual needs of their clients. These packages can comprise hard- and software, processes and services. Such solution innovations are increasingly accompanied with the development of new business models or new applications. Often large companies with a broad portfolio of products apply such a strategy. They use open innovation activities as well as mergers and acquisition (particularly of start-ups) to generate new ideas. For solution innovations, data generation and analysis is central.

Thus, new actors such as start-ups as well as new knowledge such as IT knowledge become important in such an innovation ecosystem.

Conclusion and discussion

Scientific outcome:

- This study reveals two ideal types (Weber, 1986 [1922]) of innovation strategies which companies apply in the German photonics and micro-electronics sector. In both sectors we could identify SI and TI strategies. Both strategies cross companies' borders and include research institutes, clients and suppliers. As the innovation strategies cross also sectoral borders, it reveals the added value of such a perspective compared to e.g. a sector-specific approach (Malerba, 2002). The study adds to the literature on innovation ecosystems two ideal innovation strategies on the levels of technological and business strategies (cf. Autio & Thomas, 2014).

Policy outcome:

- We used this approach to build ideal types of strategies to respond to changes in innovation ecosystems. Such ideal types allow for a better understanding of the two industries as well as for the development of STI policy recommendations. The study's results highlight that a differentiated STI policy is necessary to foster innovation for technology innovation companies and solution innovation companies. Whereas current R&D policies and public funding activities address to a certain extent TI companies' demands of innovation support and subsidy , SI companies require different and new forms of innovation support as their ecosystems involve, for instance, diverse (transdisciplinary) partnerships for which adequate and appropriate formats of transfer and cooperation are needed. Therefore, based on the presented typology of innovation strategies we suggest that public R&D and innovation funding programs must consider differences in innovation ecosystems and deviating innovation strategies respectively. Thereby, policy makers may respond to governance challenges emerging through changes in today's innovation systems.

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10.2.4 Conceptualising open innovation systems: a framework for analysing global competitiveness of local industries

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Introduction

The paper addresses the need to expand the prevalent innovation policy framing focused on the national innovation systems model to embrace the increasingly global character of innovation processes and to reflect the role of business ecosystems in this process. While the concept of business ecosystems has gained increasing attention in innovation policy thinking over the last years, the practical application of this notion is still quite unclear. Too little is known about the dynamics of how business ecosystems evolve and about the possible levers how their transformation could be influenced.

The main contribution of this work is a guidance to policy makers and practitioners how to better understand and analyse innovation driven global competitiveness of local industries and consequently identify appropriate RDI and industrial policy support measures. The paper offers an **expanded conceptual framework for describing an open innovation system**. It is developed as a visual scheme outlining connections and interactions between the building blocks of a national innovation system, which generally are more intuitive to policy makers, and the external landscape of factors, whose impact is beyond the control of national governments. This logical model has been applied in the analysis of Finnish business and industry. The framework has helped to identify areas where Tekes, the Finnish Funding Agency for Innovation, as part of Team Finland, can focus on to support global competitiveness of local business ecosystems.

Global competitiveness of local industries

Competitiveness is a concept that is frequently used and in many cases abused: it is defined in a myriad of ways by economists; politicians promise to maintain 'national competitiveness and jobs' while the media spin stories about the ups and downs of major firms. For the citizen, competitiveness may seem like a threatening idea when their job is 'on the line' due to global market or technological trends.

Initially the concept was associated mainly with a 'nation's ability to sell' (Orlowski, 1982) or equated with the ability to achieve certain national outcomes, such as higher living standards, job creation and increased welfare, etc. (e.g. Fagerberg, 1988; Aiginger, 2006; Kohler 2006; Janger et.al., 2011). A **productivity-based approach** to competitiveness is also strongly featured in the literature (Porter, 2000; Delgado et.al, 2012) and in the agendas of international organisations (e.g. OECD Growth Agenda 2020). More recently a growing emphasis is given to the **link between natural resources and national competitiveness** (Schneider, 2012). Resource constraints are increasingly recognised as significant drivers/barriers to economic performance and social stability. Hence, resource efficiency and environmental sustainability become part of a more balanced competitiveness concept (UNDP, 2011).

There is a broad consensus that **policy frameworks and institutions** play a central role in national competitiveness (Garelli, 2004; Porter and Ketels, 2003; WEF, 2007). In the national innovation system school of thought, competitiveness depends on the way in which societies create, store and transfer the knowledge, skills and artefacts that contribute to innovation. Hence innovation performance depends not only on how individual organisations perform, but on how they interact with each other and on their interplay with social institutions (values, norms and legal frameworks). Schwab

(2004) argues that, as today's economy is ever more globalised, countries need to be increasingly creative to maintain a competitive edge. Thus, creativity and innovation are decisive factors of national competitiveness.

Below the macro level, patterns of industrial specialisation and trade composition highlight that specific sub-sectors or **clusters** are an important factor in successful economic development (Hausmann and Klinger, 2006; Delgado, Porter and Stern, 2012). The premise is that businesses are faced by constantly evolving relationships and conditions to which they must adapt to survive. Drawing parallels with biological systems, the concept of **business ecosystems** has emerged. Autio & Thomas (2014) define an innovation ecosystem as "a network of interconnected organisations, organised around a focal firm or a platform, and incorporating both production and use side participants, and focusing on the development of new value through innovation".

The key premise of this article is that innovation systems do not function in isolation, but are open to global influences and interactions. **Technological upgrading** is highly dependent on the extent to which key national businesses are positioned in **global value chains** (GVC). A related factor is the ability to attract **foreign direct investment**, particularly firms in knowledge intensive activities or those well-positioned in GVCs (Garelli, 2000). Hence, global competitiveness is not only measured in terms of export growth but the capacity to gain a strategic position in GVC (Brennan and Rakhmatullin, 2015). Similarly, involvement in international R&D networks can favour learning and adaptation (Mathews, 2002). This raises the question of the extent to which policy interventions lead not only to value creation but, in particular, **'value capture'** in an economy.

To sum up, the national competitiveness debate has oscillated around a number of economic concepts, which Berger (2009) grouped under four broad headings:

Ability to sell: costs and trade performance orientation

Ability to earn: productivity and performance orientation

Ability to attract: place attractiveness for investment and talent

Ability to adjust: innovation, flexibility and openness.

This paper takes up the last two angles as the main guiding notions to frame competitiveness through the lens of innovation, integration in global value chains and knowledge flows.

Framework of an open innovation system

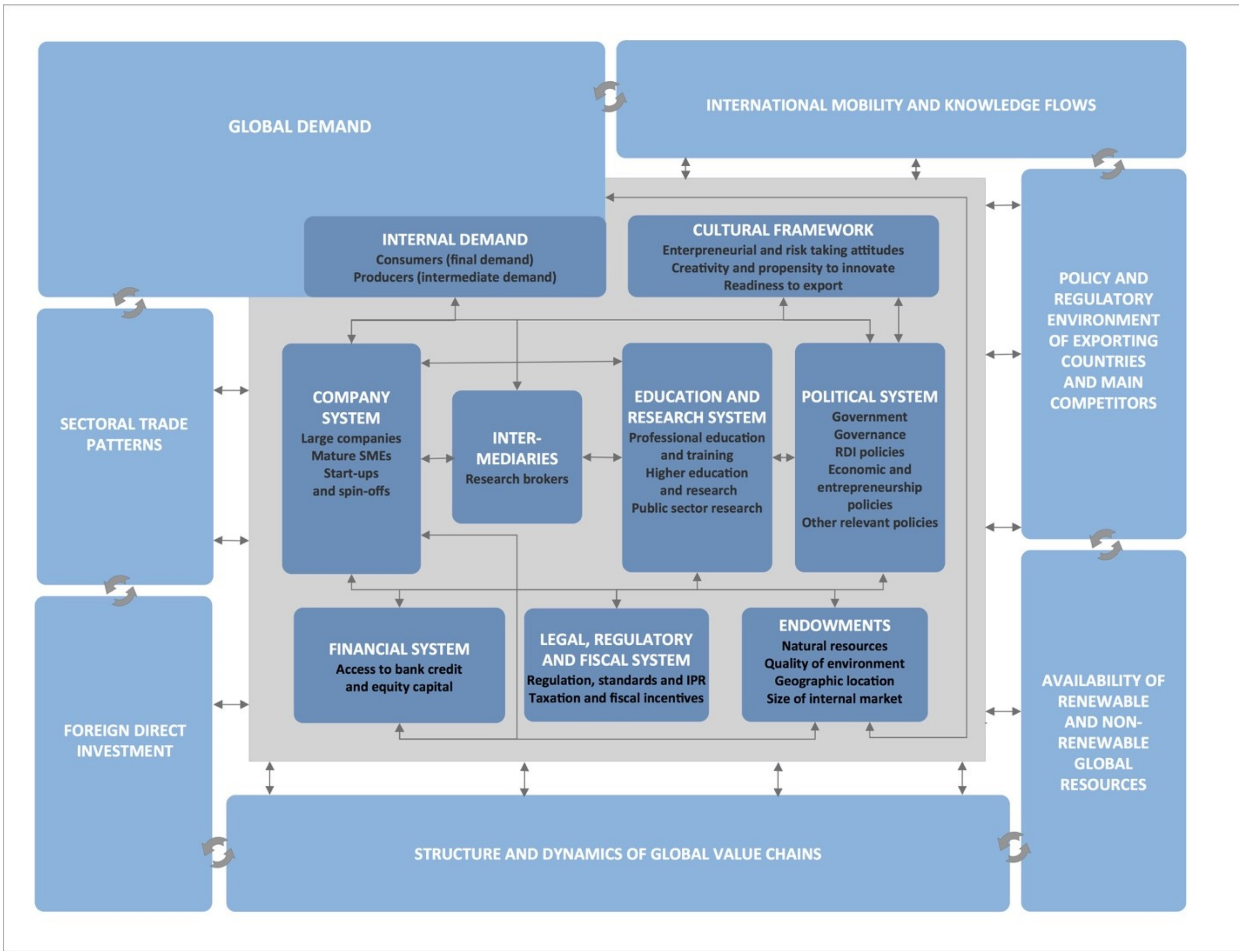
To enable analysis of the highly-intertwined aspects that determine innovation-driven global competitiveness, the proposed conceptual framework distinguishes two dimensions.

The internal dimension (see Figure 3**Fehler! Verweisquelle konnte nicht gefunden werden.** area in dark blue) includes the factors that are managed/influenced 'directly' by the core actors of the national innovation system, namely: companies, the political system, the education and research system, research intermediaries, and wider framework conditions (e.g. financing, legal, regulatory and fiscal system, endowments, internal demand and cultural framework). Each component of the system needs to work at least at an acceptable quality and efficiency and the inter-linkages between them need to function well. Business enterprises are principal actors in the system and the articulation of effective demand is central to stimulating entrepreneurship and innovation.

The external dimension (see Figure 3 area in light blue) conveys the principle of openness of the national innovation system but also underlines that a series of factors are beyond the direct control of national governments or agencies. Policy interventions can only mitigate the negative and/or incentivise the positive effects of external determinants such as global demand, global value chain dynamics, resource prices/availability, etc. Export-driven growth that is based on innovative business activities is highly dependent on inward and outward flows of knowledge and ideas, hence mobility and

supportive frameworks that facilitate knowledge circulation are crucial. The ability of a country to attract foreign direct investment, particularly in knowledge intensive activities or key players in GVCs, depends on how well it can foster new emerging high-value activities.

Figure 3 Conceptual framework of an open innovation system



The open innovation model for the analysis of Finnish industry

This framework has been empirically applied drawing together an analytical overview of the current global positioning and future opportunities for competitiveness of Finnish business and industry. The model was used to assess the overall Finnish competitiveness (macro-level) but also four specific ‘business ecosystems’. Since the mid-2000s Finnish competitiveness policy has focused on four priority areas: bioeconomy, cleantech, health and digitalisation. The Finnish Funding Agency for Innovation Tekes has dedicated significant investments to help develop business ecosystems in these four target areas. Specifically, the analysis aimed to assess the impact of Tekes support in the last decade on fostering the global competitiveness of Finnish business and industry.

To do that, an extensive literature review for the four main priority areas was carried out. It was complemented by an econometric analysis of data of companies which received Tekes funding in each priority area. A range of interviews were conducted with companies, stakeholders and experts to gain deeper insights and validate the emerging findings. In depth case studies on specific business ecosystems that had received significant support from Tekes were carried out in each of the four priority areas. The case studies included analysis of bio-based chemicals, smart grids, game industry and self-care and monitoring.

The Finnish economy is dependent on a few large companies and more generally has a weakly diversified export base. Such challenges are not unique to Finland and external shocks are unavoidable. However, maintaining global competitiveness depends on whether new business ecosystems develop to replace declining industries and can position themselves rapidly in foreign markets. In this respect, while there have been some positive trends especially in service sectors (e.g. digital), turnover and employment in the manufacturing industry sector has dropped sharply. To date, despite their promise, the new emerging ecosystems have not been able to compensate the decreased exports (or jobs) of manufacturing.

Regarding the **internal competitiveness factors** of Finland, the empirical analysis showed that three are particularly problematic: limited internal demand, economic/export structure and the regulatory/tax environment. In response, the direct interventions of Tekes are focused on the renewal and diversification of the economic structure through targeted programmes in the priority areas. Various Tekes programmes seek to develop 'upstream' in the 'policy value chain' new ecosystems or foster new business models which can be tested nationally (by the relatively sophisticated Finnish consumer, government services, etc.), potentially stimulating demand for new products or services. The limited internal demand is addressed more directly through the internationalisation activities either embedded in specific Tekes programmes or as related downstream 'policy value chain' services of other Team Finland agencies.

The assessment of **external competitiveness factors** underlined that Finnish businesses are particularly sensitive to external factors and shocks. The sectoral trade patterns (intermediate goods, declining trend in high-tech exports, etc.) mean that external shocks due to global demand or global value chain repositioning can have particularly severe economic impacts. Another drag on competitiveness is that Finland performs, surprisingly, poorly in attracting foreign investment in high-value added or technology intensive (R&D functions, etc.) businesses or skilled individuals to pursue advanced studies or careers. In response to these issues, Tekes, and Team Finland partners, have given increasing emphasis to activities designed to anticipate such shocks, favour market access and rapid internationalisation and attract key foreign investments.

Finnish companies continue to view Tekes' main role as funding technological development. Support for early-stage investment in technology solutions is critical, not only in monetary terms but also because Tekes provides a quality label ('proof of concept') in the eyes of (foreign) investors and partners. Tekes has been less effective in fostering collaboration or value chains linkages both nationally and, particularly, internationally. Some initiatives including, the Tekes funded Strategic Centres for Science, Technology and Innovation (SHOKS), have helped to structure value chain relations within Finland. However, the Finnish ecosystems miss key competences (e.g. in industrial biotechnology) that requires complementary investments or linkages with international partners.

The ecosystem cases underlined the significant role of larger or leading 'anchor companies' in the creation of ecosystems and their evolution. Incumbent large firms (e.g. in biofuels) may be critical for the development of new value chains but slow to shift towards new business models (e.g. due to cost of adapting to new processes). The quality of interaction between such large or lead firms in ecosystems and smaller/start-up companies is critical. Across all four ecosystems, converting 'national rising stars' into 'global players' proved challenging, with exceptions (e.g. gaming industry). The obstacles differ but common themes included access to international market intelligence, regulatory differences/approval (e.g. self-care, smart grids), early integration/positioning in global value chains, or securing opportunities for piloting or testing products or 'platforms' in foreign markets.

Concluding remarks

The 'open innovation system' framework expands the traditional notion of a national innovation system reflecting better the inherent influences from the global dimension. It underlines the limited capacity of policy-makers to steer the development of innovation ecosystems, yet can help to highlight those factors and linkages, where intensified policy attention can prove critical for fostering global competitiveness of local industries.

The application of the framework suggests that policies to ‘boost exports’, ‘accelerate start-ups’ or build ‘growth companies with global ambitions’ only succeed if rooted in a highly performing national innovation system and the component business innovation ecosystems. In other words, **national and global competitiveness are two sides of the same coin**.

A key lesson from the empirical analysis is that to achieve global competitiveness, the business ecosystems require tailored and diverse forms of support that often stretch beyond the remit and resources of one policy implementation agency. This applies in terms of the development of the new business models nationally (e.g. regulatory or policy changes lagging technology) as well as internationally (e.g. attracting strategic investors, etc.).

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10.3 Session 10.3

10.3.1 European Institute of Innovation and Technology: Governance Experimentation for Pan-European Entrepreneurial Innovation Ecosystems

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Developed economies face major challenges in renewing their industrial bases, particularly apparent in Europe that has struggled over decades how to turn research into innovation (Fragkandreas, 2015). A shift from project-based innovation funding towards innovation partnerships could alleviate the problem, specifically if channelled to form vibrant Pan-European entrepreneurial innovation ecosystems. Towards this end, policy experimentation in the periphery of government and power structures may offer opportunities for developing radically new policy and governance models and practices. Herein, the 'European Institute of Innovation and Technology' (EIT) is a relatively new policy experiment intended to get the EU back on track for entrepreneurial innovation. Created in 2008, the EIT operates through so-called 'Knowledge and Innovation Communities' (KICs) which integrate partners from the Knowledge Triangle of higher education, research and business, encompassing bottom-up 'co-creation' of novel innovation models for Pan-European entrepreneurial innovation ecosystems. This is facilitated through Co-location Centres (CLCs).

Due to its novelty, the EIT has been covered only partially in academic literature. The few papers published so far focus largely on the period around its foundation till 2008, when the first EIT Regulation was passed by the European Council and Parliament (Jones, 2008; Jofre et al, 2009; Gornitzka and Metz, 2014). Notwithstanding the intense debate which preceded that initial political agreement (Didier, 2010; Tindemans and Soete, 2007; Huisman and de Jong, 2014) there is no substantive research about the EIT's "setup" (2009-2010) and "consolidation" (2011-2014) periods. Further, few research efforts so far address specific aspects related to the EIT, but no overarching analysis on the EIT governance and management is available. For instance, Rohrbeck and Pirelly (2010) built on a literature review and stakeholder analysis to propose a multi-level framework of key performance indicators for the EIT to steer its operations. Haegeman et al (2012) discussed a foresight process coordinated by the European Commission (DG JRC & DG EAC) to develop thematic priority areas for a new wave of KICs. Heger and Boman (2015), in turn, explored the value of networked foresight in one of the KICs, EIT ICT Labs (later on renamed 'EIT Digital'). Despite those earlier efforts, the academic contributions miss the 'insider view' from the EIT Headquarters to learn from the EIT governance model and management practices as a European entrepreneurship and innovation policy experiment. We position our governance analysis on complex systems, entrepreneurial innovation ecosystems and experimental governance concepts.

Theoretical premises and rationales

Decades ago addressed the challenge of governing highly complex systems and suggested that they must be governed by a decentralized "spontaneous order" and systemic coordination in the form of behavioural rules, principles and shared visions. Kuznetsov (2009 proposed, in turn, that escaping from the old paradigm requires new governance structures and policy experimentation via 'Schumpeterian developmental agency'. Breznitz and Ornston (2013) have characterised such agencies

where radical policy innovation is more likely to occur: at the periphery of the governmental structures, in low-profile set-ups with relatively few hard resources and limited political prestige and less vulnerable to political interference. At the European-level, EIT has tried to experiment by setting up new governance and management structures.

Stakeholder networks or physically-anchored clusters can be directed to accelerate innovation through interconnected hubs working closer together, not necessarily locally. Moore (1993) applied the notion of "ecosystems" to complex configurations of agents making an analogy between the business ecosystems and the biological ecosystems observed in nature. Such a system can also be characterised as complex and adaptive to their broader environmental conditions (Richter et al. 2014). Herein, Ács et al. (2014) consider that the "National System of Entrepreneurship is the dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures." Elsewhere, Russell et al (2011) define the concept of innovation ecosystem to entail: "the inter-organizational, political economic, environmental and technological systems of innovation through which a milieu conducive to business growth is catalysed, sustained and supported. An innovation ecosystem is a network of relationships through which information and talent flow through systems of sustained value co-creation." To build the bridge between these two streams (the one on entrepreneurship and the other on innovation), we define the entrepreneurial innovation ecosystem as the dynamic, inter-organizational, political, economic, environmental and technological milieu of interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, mediated by institutions, which drives knowledge and value creation towards a structural change and the enhanced allocation of resources."

In line with Hämäläinen (2017), we consider international collaboration crucial for enhancing cognitive variety. Herein, we consider a Pan-European entrepreneurial innovation ecosystem the one that wires up local ecosystems across Europe (see also Pombo-Juárez et al, 2016). The EIT exemplifies an experimental shift from today's EU-level interventions and current emphasis in trans-national collaborative projects (in R&D) to a new paradigm in fostering Pan-European entrepreneurial innovation ecosystems that stresses human capital and attitudes enabling innovation spaces. Hollingsworth (2009) provides further rationales for such co-location centres for radical innovation by way of bringing together financial resources, diverse disciplines and leadership.

The case study and methodology

The EIT offers an opportunity to learn from European innovation policy experiment to promote the formation of Pan-European entrepreneurial innovation ecosystems and to innovate in policy more generally in connection with European Union institutions. According to Sabel & Zeitlin (2012) experimentalist governance is a recursive process of provisional goal-setting and revision based on learning from the comparison of alternative approaches. Framework goals and metrics for gauging their achievement are provisionally established by the combination of 'central' and 'local' units, of which the later are given broad discretion to pursue their goals with dynamic accountability. This is what is exemplified in the governance of EIT in its monitoring and simplification practices vis-à-vis the KICs. Furthermore, the EIT Headquarters providing guidance to the KICs resembles the original ideas of Hayek (1945) on governance of complex systems, wherein, instead of decentralisation, the central units provide invaluable guidance to local units. In what follows, we examine the EIT as a policy experiment, its managerial practices and derive some initial implications for policy.

This paper aims at filling the above mentioned gap by codifying EIT practices and reflecting on the lessons learned for a broader scholarly debate. Our empirical analysis on the EIT builds on the action research paradigm that subsumes a variety of methodologies such as Checkland's soft systems analysis (Checkland, 1981) and Argyris' action science (Argyris et al., 1985), which are inherently cyclic, participatory, qualitative and reflective. The authors are former EIT employees, which allowed engaging in action research over the period of 2011 and 2014.

While the authors engaged in numerous open-ended and semi-structured interviews across the EIT community, the core of the gathered insights were constructed mainly in day to day interaction and engagement in the development of the EIT and building upon testimonials and experience gathered from EIT's constituencies, namely, EIT Governing Board members, KIC CEOs and EIT staff in Budapest. However, while action research, and the case study methodology in more general, is suitable for describing new phenomena, it is also subject to interpretation biases and contingency factors not present or transparent in the final case description (Yin, 2003). Therefore, in our research the findings are attested by proofs documented in empirically grounded materials developed by the EIT and its stakeholders.

Results and policy implications

Our research shows that while the high profile of the EIT has constrained partly its freedom to experiment, European-wide networked excellence approach and business logic in its KIC management has created new insights and governance models to be explored further. The paper codifies some if these developments and opens up an avenue for further work on governance of Pan-European entrepreneurial innovation ecosystems. In short, EIT KICs have still to demonstrate their ability to accelerate the pan-European growth of new start-ups. This will require a strong interaction between co-location centres to fulfil their role in the European innovation landscape in accessing knowledge, markets, finance, talent, etc. Furthermore, the sustainability of KICs after the seven years commitment is an open debate as their theme and dynamics will dictate to what extent and when this is feasible (ECA, 2016). Much more effort is needed to attract investments and to give their individual activities (e.g. master or doctorate programmes) enough interest to survive and develop by themselves.

Breznitz and Ornston (2013) note that radical policy innovation is more likely to occur at the periphery of the governance structures, in low-profile agencies with relatively few hard resources and limited political prestige, less vulnerable to political interference. At the European-level, the EIT can be considered only partly to meet such conditions, especially because the EIT was proposed by former President Barroso and this created high expectations leading to risk averse governance sometimes over innovation and experimentation. Hence, with hindsight, similar kind of initiatives could benefit from some more distance to political spheres and from higher autonomy to operate.

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10.3.2 Experimenting in and with the city in the Netherlands: towards a typology of living labs

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Keywords: Living labs, urban experiments, open innovation, governance of innovation

Introduction

Cities are seen as the places where both the problems and solutions of the twenty-first century societal challenges can be found (European Commission, 2016; OECD, 2015). These societal challenges call for transformative change processes that require collective and sustained efforts of various actors (Schot et.al, 2016). Cities offer ideal conditions for these actors, being companies, universities, governments and citizens, to work together in quadruple helix arrangements to develop innovative solutions for societal challenges, often in constellations labelled Living Labs (Carayannis & Campbell, 2009). Living labs come with a strong rhetoric, yet little is known about their concrete logics, settings, activities, foci and temporalities (Marvin & Silver, 2016). The living lab seems to be a label that is pasted on a diversity of initiatives with different goals and objectives, leading to confusion about the results that can be expected. This is especially relevant because many city governments are promoting and funding living labs to achieve societal goals. In practice, however, not all living lab initiatives may have societal goals as their core focus, and it is often unclear which actors reap the benefits.

In this paper we will add to current knowledge on living labs by presenting a typology of living labs, based on our desk study and mapping of the goals, activities and involved actors of livings labs in the Netherlands. To understand the phenomenon of living labs, we explore briefly how and why this mode of innovation in an urban setting has emerged. We will then develop a typology of living lab characteristics based on the literature, which we will use to define living labs and map Dutch examples. We use this mapping exercise to develop a conceptual framework distinguishing between four different types of living labs. We conclude by discussing the modes of urban innovation of each of these types and the desirability of public support for them.

Living labs as a new mode of innovation

Increasing urbanisation, accompanied by decentralisation policies, makes city administrations face new responsibilities and challenges in a diversity of policy domains from the transition towards a low carbon economy to the question of growing inequality. Cities are seen as change-agents for these challenges because they can act swiftly and pragmatic whereby their actions sort effect on short term (Hamers, 2016). Cities are also the places where the people with innovative and specialized knowledge work and live, and where this knowledge can be most easily exchanged (Florida, Adler, & Mellander, 2017). But because municipalities' budgets are limited and they often lack in-house expertise, Maarten Hajer concludes that they need to innovate and experiment in order to function (Evans et al., 2016).

The promise of such an experimental setting is that it would increase the attractiveness of a city for innovative companies and investors, while at the same time providing valuable solutions to societal challenges (Evans et al., 2016). Experiments can let people experience alternative possibilities and solutions, thereby bringing together different interests or creating shared values (Naylor et.al., 2012). Experiments also provide innovators with a quick feedback-loop and intensified contact with potential end-users, thereby possibly accelerating the innovation process and improving the outcome. The quick learning curve that experimenting at a smaller scale, and with many actors involved, offers also reinforces the 'change-agent' status of cities as a whole (Hamers, 2016).

Living labs are an important vehicle in which actors try new things and explore new avenues. They can be viewed as a form of open innovation (Chesbrough, 2003), where various actors innovate together in an experimental setting, embedded in a real-world - often urban - environment. Next to being a new form of innovation, Voytenko et.al. (2016) envision living labs as a new, experimental, form of urban governance. In their analysis on the emergence of living labs as a research infrastructure, Schliwa and McCormick (2016) note that the term living lab refers to both an approach where users get a more central role in the innovation process and an arena for experimentation. They build upon the definition offered by Evans and Karvonen, and state that: *"Living labs can be defined as a physical arena as well as a collaborative approach in which different stakeholders have space to experiment, co-create and test innovation in real-life environments defined by their institutional and geographical boundaries*" (Schliwa & McCormick, 2016, p. 174).

Evans and Karvonen (2014) identify three central characteristics of living labs. Living labs are (1) confined to a geographically and/or institutionally bounded space, in which (2) intentional experiments and (3) iterative learning takes place. Marvin & Silver (2016) mapped living lab initiatives in the UK on the basis of which they distinguished between a set of characteristics. First, they see a difference in 'lab logics' which refers to different drivers and rationales for the establishment of living labs. Second, different settings can be observed ranging from the university campus to a community space. Third, there are different types of activities carried out in each of the labs. Fourth, the labs are focused on different themes and interventions. Finally, there is a difference in the temporality of the labs. According to Schliwa and McCormick (2016), two forms of living labs can be distinguished: user-centric labs, where the focus is on product-service system development (mostly in ICTs) and people are involved in their role of users, and citizen-centric labs, where people are involved as citizens, but not necessarily direct users of the innovation that is being developed (Schliwa & McCormick, 2016). Based on these characteristics we have developed our own characteristics and typology for the Netherlands

Methodology and empirical material

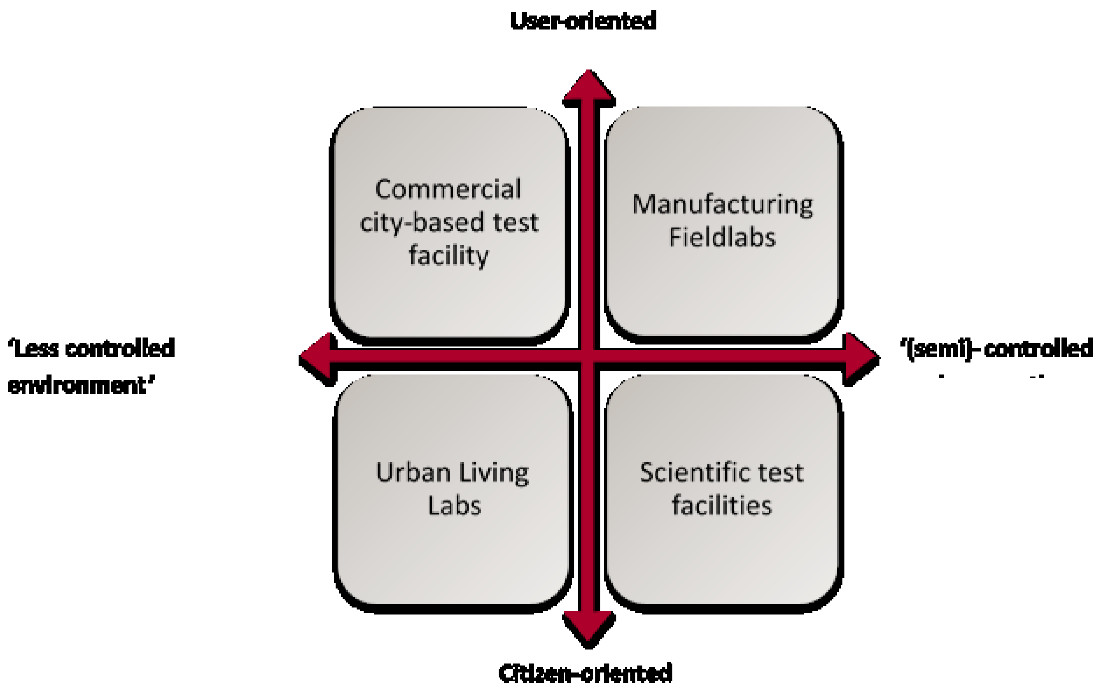
A combination of desk study and interviews is used to map and analyse living lab initiatives in the Netherlands. We have limited our first search to the five largest cities in the Netherlands and the cities hosting a university as we expect to find most living labs in these cities. This mapping exercise is theoretically guided which allows us to distinguish between the initiatives that are labelled living lab and those that fit with the definition of a living lab. We aim to be as complete as possible, but because of time constraints and the possibility that certain initiatives are hard to find online we will miss some initiatives. To minimize this we used different search terms and will ask respondents whether

they know of other initiatives. In addition, we will ask experts and the general public to review the list of living labs and check whether important initiatives are missing. On the basis of the mapping exercise we develop a conceptual framework.

Based on our inventory of Dutch living labs, two dimensions emerge. First, the Dutch living lab cases echo the literature differentiating between a focus on people in their role as citizens, envisioning a bottom-up type of engagement, and a more top-down view where people are involved as users of technologies or services. Secondly, the level of control of the real-life circumstances differs. On the one hand there are living labs in a relatively controlled environment within a building or a specific test area. On the other hand there are labs located within a real living environment such as a neighbourhood. Based on these two dimensions we have made a preliminary conceptual framework, distinguishing four types of labs (see figure 1).

On the basis of the conceptual framework we also aim to draw conclusions on the justification of public policy and investments depending on the nature of living labs and their inclination to support societal issues.

Figure 1 Preliminary conceptual framework



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10.3.3 Innovation environments and their misalignment with the envisioned age-friendly housing eco-system: insights obtained and lesson learned from a European consultation process

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Keywords: management of innovations, age-friendly housing, innovation environments, emerging technologies, ecosystem development

Due to advances in health care and healthier lifestyles, Europeans live longer and in 2060 almost one in three Europeans will be 60 years or older. As a result of this ageing population, combined with increasing numbers of chronically ill patients, availability of new and often expensive care products, rising demands for the best available care at any cost, and a required increase of labour force to fulfil all future care tasks, Europe is facing major health and care challenges (e.g. Broerse & Bunders, 2010). At the same time, Europe's ageing population is often positioned as a major opportunity for new jobs and growth, referred to as the Silver Economy. This is the economic opportunity that arises from public and consumer expenditures driven by the needs of the population over 50 (European Commission, 2015).

To keep the cost and increasing labour demand for health and care under control, many countries face the challenge of letting people function in their daily environment as long as possible. Better age-friendly housing is envisioned to be a solution to help people live longer independently, thereby reducing costs of long term care and responding to the needs and demands of the population over 50 at the same time (WHO, 2015). However, at present the European housing stock and built environment is not fit for purpose to support independence, integrate digital innovations, and enable Europeans to lead healthy, meaningful and active lives across the life course. Over the last decade, many regional, national and European initiatives invested in numerous research and innovation projects to support active and healthy ageing. These initiatives have substantially increased the knowledge relating to technical opportunities and their feasibility. There is extensive knowledge about how new sensor systems, robotics, wearables, infotainment, and gaming, to name a few, can support independent living and wellbeing. However, many innovative solutions face major barriers when meeting market forces and the muddled complexities of everyday life, which has hindered innovation and broad implementation so far. Apparently these innovations do not become embedded in the dominant cultures, structures and practices of everyday life and thus failed, at least partially and on the short-term, to realise scale beyond the niche level in which they are currently being explored. This begs the questions: what hinders current investments and developments to break out of niches? What factors hinder change at the regime and social-technical regime or system level? What actors and factors drive the changes that are currently perceived? How can changes at the regime level be shaped, stimulated and managed, including the role of policy?

This paper describes insights obtained from a European stakeholder consultation process driven by the European Commission in collaboration with the authors. The process aimed to explore and identify barriers and opportunities that currently characterize innovation eco-systems in the domain of age-friendly housing. Here we present how involved actors across countries and sectors aim to shape their innovation environment, how this relates to the (potential future) ecosystem of age-friendly housing and the lessons that can be learned by analysing the results from a multi-level perspective.

Methodology

A consultation process comprising ten interconnected workshops, staged in seven different European countries was co-created with local partner organisations to gain insights in and understanding of the perspective of different relevant stakeholders regarding scenarios of desirable future homes and neighbourhoods, including barriers for innovation and possible actions to overcome them. The aim was to organize events that reflected national expertise, innovation ecosystems and resources to obtain a diverse yet instructive set of recommendations and insights how to realise age-friendly housing. Additional information was gathered from background documents and interviews with selected stakeholders for further clarification and detail.

Notes were taken during all workshops and interviews, and together with additional documents analysed with the help of ATLAS.ti. Via thematic and open coding we identified, coded, described and categorized topics in the data obtained. To gain understanding how innovating organizations shape their environment and their relation to the (future) age-friendly housing ecosystem, we made use of the multi-level perspective (e.g. Geels, 2004; Loorbach, 2007). Placing the results in this framework enabled a contextualized analysis of the articulated challenges and barriers from a multi-level perspective, resulting in understanding of the up till now unsuccessful large-scale implementation of innovations beyond the niche level and the identification of opportunities how to realise more, and perhaps better, age-friendly housing at larger scale.

Preliminary results

Placing our results in a multi-level perspective shows that although participants were stimulated to think out-of-the-box by formulating their desirable future of age-friendly homes and neighbourhoods, many showed to struggle with thinking beyond current ways of doing and organizing and beyond the own professional practice. All participants would like to see age-friendly, smart, inclusive, empowering homes and neighbourhoods to become a reality across Europe, and are seeking support in how to make that happen. However, barriers to implementation of age-friendly housing innovations and solutions to overcome these barriers are mainly formulated from within the professional practice of an actor, and attributed to the practices and regimes of other actors. In other words, organisations shape their innovation environment informed by their own perspective about what is needed and desirable without informing or aligning their perspective and resulting actions with the culture, structure and practice of other actors who are envisioned to apply or support the technology in practice.

Formulated challenges and barriers relate to technical impossibilities and knowledge gaps or to barriers that are the result of uncertainties about the culture, structure and practice of the (future) age-friendly housing socio-technical regime. As age-friendly housing contains a ‘care’ and a ‘housing’ aspect that to a certain degree overlap with current regimes, it contains parts of both the current health and housing socio-technical regime, but it is unclear how the age-friendly housing regime will look like. According to some actors consulted age-friendly housing innovations will optimize the current health and housing system, others envision a completely new system. However, regardless the future vision of what the age-friendly housing system should look like, barriers arise at the interface between the health and housing system that relate to the combination and integration of knowledge, experiences and structures of both systems. In our presentation, we will elaborate on the specific challenges this constellation poses for scaling up strategies.

Preliminary conclusion

This research shows that many innovating organization in the field of age-friendly housing shape their innovation environment informed by a perspective formulated from within their professional practice of what is needed and desirable without considering the perspective of other practices and regimes. As a result, solutions articulated to overcome barriers focus on the own professional practice and might fail due their mismatch with other involved practices and by not considering the resilience of the current housing and health socio-technical system into account. We suggest that by taking a multi-level perspective, that is viewing innovation environments not as separate entities but as interdependent part of a larger socio-technical system, or eco-system, insights in and understanding

of barriers to large-scale implementation of innovations can be gained. Understanding the context from which barriers arise might result in effective solutions to overcome barriers.

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10.3.4 Organizational practices around technology transfer - perceived barriers and enhancers

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Keywords: technology transfer, TTO strategies, professor's privilege

Relevance and aim of the study

The utilization of university discoveries through commercialization or diffusion of knowledge benefits society and drives economic growth. As a response to their increasing importance in the regional and national innovation system universities have set up specific infrastructure around technology transfer units, often under the name of technology transfer offices (TTOs). Much literature on TTOs has focused on productivity using indicators such as disclosures, licenses, patents, spin-offs and industry collaborations and to identify factors that influence these outputs (see Rothaermel et al., 2007 for an overview). Since universities vary in size, resources, scientific focus, location and human resources it is difficult to make direct comparisons between universities, and many researchers view technology transfer and the role of the TTO as a complex process. Individual university TTOs may focus on different aspects of the process which could explain some of the variations in TTO output across universities. Earlier literature has often been limited to study TTO strategies when it comes to the legal aspects and overlooked other organizational routines along the commercial pathway (for an exception see for example Siegel et al., 2003). To further understand the role of TTOs within the innovation eco-system this study will therefore investigate current technology transfer strategies employed by TTOs and routines in place to implement these strategies.

The extent to which a TTO develops entrepreneurial competence is influenced by the willingness of academics to commercialize their results (Pries and Guild, 2011) and to utilize the TTO to do so. A stream of literature has identified that a share of academic entrepreneurship is carried out outside the formal university IP system (Balconi et al., 2004; Fini et al., 2010; Meyer, 2003; Saragossi, 2003; Thursby and Thursby, 2007). In addition (Siegel et al., 2004, 2003) find that TTOs provide little incentive for faculty involvement and that researchers have difficulties in negotiation and transacting with the TTO (Link and Siegel, 2005). These findings suggest that a number of barriers exist along the technology transfer pathway.

Previous studies have interrogated the motivations and opinions of researchers or TTOs (Abrams et al., 2009; Aldridge and Audretsch, 2011; Di Gregorio and Shane, 2003; Fini et al., 2010), but have not directly compared the two groups of actors, whose interactions are critical for successful technology transfer from universities. Hence, the second aim of this paper is to identify perceived enhancers and barriers (researchers and TTOs) when it comes to technology transfer. This will provide insights into the human factors that are inseparable from the innovation process.

To shed light on the effects that institutional differences might have on different strategies but also perceived enhancers and barriers, we study TTOs and researchers in two highly innovative coun-

tries, namely Sweden and USA. These two countries differ in the regulations governing inventor ownership at universities. US universities own the rights to inventions made by researchers, who have to disclose inventions to the university technology office according to the Bayh-Dole Act. In contrast, Sweden is in favour of inventor patent ownership (Professors privilege or Teachers' exemption), meaning that publicly funded research is owned by the individual researcher and not the institution where the research is carried out. These differences are expected to provide different incentives to universities and inventors (Freeman and Lundvall, OECD report).

The results from this study will provide further insights how universities can improve existing routines when it comes to translation and enhance the process of commercialization of ideas originating from academic research.

Previous research

Earlier studies have suggested that TTOs are not necessarily driven by profit making. Feldman and Desrochers (2003) studied John Hopkins University and explained the limited visible economic benefit by the fact that it was never one of the university's objectives. In a 2009 survey, only 11.5% of TTO managers ranked revenue maximization as their most important driving factor (Abrams et al., 2009). Thus, TTOs are involved in other activities not covered by output metrics generating profits such as patents, spin-offs and licenses. Also organizational differences exist resulting in TTOs engaging in different activities. Bercovitz et al. (2001) found that universities that have high interactions with industry often apply a decentralized model of technology transfer where responsibilities for transfer activities are located close to research groups. Other strategies identified to increase industry engagement include the offering of incentives (Debackere and Veugelers, 2005; Derrick, 2015; Friedman and Silberman, 2003); education programs (Hatakenaka 2006); active participation of university inventors (Markman et al., 2005); visibility and flexibility to adapt to researchers need (Derrick, 2015).

According to contingency theory there is no best way of structuring and organizing since the optimal organization depends on various internal and external constraints (Lawrence et al. 1967, Burns and Stalker 1969). In this study we investigate how environmental and institutional differences may affect TTO strategies and the routines around the technology transfer process. In the context of university technology transfer, there has been little research on the possible contingency effects of particular institutional structures or organizational processes. Using contingency theory we will illustrate how both external and internal factors influence TTO strategies and organizational practices and how these in turn affect the output of TTOs.

Material and methodology

We combine quantitative data and interviews with star scientists and senior staff of technology transfer organizations in both Sweden and USA. Semi-structured interviews were carried out in the field of biomedicine. Open-ended and targeted questions were asked, covering the development of the innovation system/TTO, major activities, interactions with industry and university inventors, and perceived blockers and enhancers of the commercialization pathway. The focus on star scientists can be justified by the fact that they differ from ordinary scientists in several ways: they publish more articles, are cited more often, apply for more patents, and obtain greater funding (Azoulay et al., 2014; Cole and Cole, 1972; de Solla Price, 1963; Zucker et al., 2001; Zuckerman, 1977, 1967). The quantitative data included information regarding number of disclosures, patents, licenses, spin-offs, R&D investments from both private and public sources. The US data was mainly compiled from the Association of University Technology Managers (AUTM) database and annual reports but also from the interviews, as for the Swedish data the main sources were annual reports, UBI Global and data from interviews.

Outcomes

We found that structural differences exist between TTOs in US and Sweden. These differences can mainly be explained by regulatory differences due to the Bay-Dohle Act in the US and the teacher's exemptions in Sweden. In the latter the innovations system is scattered with many actors involved in

the translational process. Support mechanisms such as outreach to researchers, innovation advice and corporate alliances were mainly taking place within the university system while activities and support related to start-ups and licensing were mainly taking place within external organizations in the form of holding companies. The US system was less scattered with TTOs carrying out activities also related to commercialization.

Based on our interviews and earlier literature we identified seven mechanisms/activities that TTOs can be involved in during the translational process and on which they build their business model and activities around. Our qualitative data showed that the intensity to which TTOs are involved in the different mechanisms can rather be explained by contingent factors such as resources, entrepreneurial culture, and the external entrepreneurial environment than by regulatory factors that are unique for a specific national innovation system. With one exception, in accordance with earlier literature we find that US TTOs favor licensing to established firms rather than startups, whilst in Sweden there is rather a focus on university startups while licensing activities are limited. Further, we link identified strategies with quantitative output data and find that there is not always a direct linkage between organizational practices/business models/strategies and the number of disclosures, licenses, patents, spin-offs and industry collaborations.

Lastly in our preliminary results we find that the perceived barriers and enhancers when it comes to the translational process differ between actors within the university system. Researchers consider good science an important factor when it comes to enhancing the innovation performance while TTO personnel point out that “successful” innovations do not necessary have to be based on great science. While researchers in US consider the TTOs an enhancer Swedish sees the teachers’ exemption as an enhancer to the translational process.

We can conclude that the organizational practices and the outcomes from TTOs is thus contingent on a complex set of organizational, cultural and environmental factors that should be taken into account when comparing and evaluating the performance of universities involvement in commercialization. In addition, TTOs are involved in other activities not covered by output metrics generating profits such as patents, spin-offs and licenses.

10.4 Session 10.4

10.4.1 Understanding Innovation Ecosystems: a framework to analyse meso-level techno-economic dynamics

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Innovation Ecosystems

Although there is incoherence in the definition of "innovation ecosystems" in the literature, innovation ecosystems fall into the multi-actor perspective category of a recent review of innovation ecosystems (Tsujimoto et al 2015), where a variety of actors interact in a bounded "interaction space" where socio-economic value is created through research, novelty creation, traditional market activities. This perspective is neither macro nor micro, but more meso, where individual firms are part of a broader network of firms with whom they cooperate and compete (Robinson, 2014). From the meso-perspective, the network of actors and their relationships – not the firm – is the unit of analysis (Chesborough et al. 2014, Rohrbeck et al. 2009). Autio et al. 2014 broaden this to include the demand side actors too centred around a product or platform.

The definition taken in this paper broadens that of Autio et al. and thus defines an **Innovation Ecosystem as** *"the network of interconnected actors, organized around a particular value chain / industry where the actors include public agencies, firms, intermediaries and any other actor that contributes to the production and use of a product or service stemming from that value chain / industry".* In our definition, innovation ecosystems can be geographically bounded to a city, region or nation state (as described by Clarysse et al. 2014) or global.

In this definition, innovation ecosystems consist of customers, subcontractors, infrastructure, suppliers, competencies, or functions and the links or relationships between them. The competencies that generate innovation are part of a collective activity occurring through a network of actors and their links or relationships. Green et al 1999, describe this as an intermediary zone between broad techno-economic paradigms (Perez 1983, Freeman 1994, Perez 2004) and techno-economic networks (Callon et al 1992, Laredo et al. 2001) where "construction of particular constellations of public and private institutions, such as campaigning groups, government agencies, academic scientists and business firms" and "the meso-level techno-economic might involve analysis of the inter-related processes involved in the construction of markets and the evolution of demand" (Green et al. 1999, pp29).

The ecosystem approach complements the systems of innovation perspective because it focuses on the nature of the relationships between actors (Mazzucato and Robinson 2017). These can be, for example, parasitic (or even predator-prey) or mutualistic. In natural ecosystems, symbiotic relationships can take one of three forms: (i) mutually beneficial relationships in which each partner benefits (mutualism), (ii) relationships in which one partner benefits and the other remains unaffected (commensalism), and (iii) relationships in which one partner benefits whilst negatively affecting the other (parasitism) (Offenberg 2001,). An innovation ecosystem does not stay static; it is built on the nature of the linkages and partnerships between actors (Mazzucato 2013). Moreover, the strategies of the actors may change, for example for large public agencies, the nature of the investments in partnerships with other actors changes when their core mission changes (Mazzucato and Robinson 2017).

Such a meso-level perspective captures the nature of the relationships between actors, and captures the essence of the system which shapes the micro and relates to the macro.

This paper, describes the application of an innovation ecosystems perspective as a meso-level approach, drawing on a number of case examples: for innovation ecosystems around the nano-electronics and the internet of things, for marine biotechnology and for the space sector.

The objective of the paper is to further the discussion on the notion of an innovation ecosystem, reflect on its usage both by analysts and stakeholders and propose next steps for the further articulation of the "innovation ecosystem" as a conceptual framework.

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10.4.2 Exploring the role of Open Innovation in Innovation Ecosystems: Intrinsic and Systemic Factors and Company Innovation Strategies.

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Keywords: innovation ecosystem, open innovation, innovation strategy and management, governance of innovation ecosystems

This paper explores the links between open innovation and innovation ecosystems by asking the following:

1. Which types of company are using open innovation and in what direction?
2. Are intrinsic company characteristics (closed business model) such as size and main business activity better predictors of open innovation use and application than systemic characteristics like value chain position, innovation partners outside the production chain (open business model)?
3. What are the implications of the different patterns of open innovation use for managing, shaping or governing innovation trajectories within innovation ecosystem?

Innovation Ecosystems

The concept of innovation ecosystem is increasingly used to analyse how sets of companies, suppliers, customers and others actors interact and self-organise to realise value creation through innovation (Oh et al., 2016). Such perspective is linked to the shift in production practices where adapting new technologies, introducing innovations and maintaining competitiveness often can't be managed solely with internal resources and capabilities. This interdependence on the external setting, leads to theories that companies increasingly shape their external innovation environment to improve their innovation capabilities and processes, by reconfiguring processes and actors and (re)positioning themselves within the innovation value chain using external collaborative R&D (Coombs and Georghiou, 2002). The environment is one of co-opetition: members compete, cooperate and co-evolve (Moore, 1993). Some companies will

seek to shift the focus of the system in favour of their competitive advantage, others will try to gain access to or maintain their position within an IES through cooperation, and over time the different system entities will collectively evolve along a technological trajectory.

A recent review by Oh et al., (2016) highlights value chains as underpinning dynamics of innovation ecosystem creation and cohesion (citing Frenken et al., 1999; Geels, 2002; and Raven, 2005). Under the value chain logic, each actor's ecosystem role is based on their position and model for creating and capturing value in the production of goods and services, relative to other ecosystem partners. However, this perspective is challenged by the 'opening up' of value creation by changes in information technology and other developments driving increasingly collaborative innovation and extending beyond the production cycle (Adner and Kapoor, 2010). Subsequently, the innovation ecosystems approach requires new understandings of strategies for value creation and capture (Adner, 2006; Letaifa, 2014; Gummesson, 2008; Vargo and Lusch, 2008) and how firm's manage innovation as in an internal and external activity.

The ERA Rationales group (European Union 2008: 23) state innovation ecosystems operate through four key flows at European, transnational and trans-regional levels:

4. Money (Funding for research and investment in innovation);
5. Knowledge (IP and informal knowledge transfer);
6. People (e.g. Researchers);
7. Services (Scientific services such as metrology).

Actors within an innovation ecosystem may have different roles: there may be a focal company acting as a system orchestrator or integrator, other companies along the value chain (suppliers and customers), as well as independent actors like universities. These different roles imply a specific division of innovative labour, power constellations and dependencies that govern distribution of risks and rewards and control processes within the ecosystem. Whilst system capabilities are shaped through collaborations (Teece, 2007), not every collaboration enhances each collaborator's internal capabilities: some provide opportunities for learning and improving competitive advantage since imitations are difficult, others develop complementary technologies that slow learning and encourage competitor imitation (Adner and Kapoor, 2010). Additionally, disruptive innovations with high technology and high modularity open the ecosystem for new actors, and low-end innovations appear to subtract actors from the system (Dedehayir et al., 2014). Subsequently, the type of innovation processes being applied within the ecosystem affects its shape and boundaries.

Open Innovation

Open innovation has been widely adopted as desirable innovation management practice (Chesbrough and Brunswicker, 2013 cited in Chesbrough and Bogers, 2014), based on the idea that firms can and should use methods, strategies and business models to increase the exchange of knowledge between different parts of organisations, networks, value chains and markets to improve the success rate of innovations (Chesbrough, 2003a,b; Chesbrough et al., 2006; Enkel et al., 2005; Gassmann and Reepmeyer, 2005; von Hippel, 1986). West et al., recently updated the definition of Open innovation to: "*a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model*" (West et al., 2014, referring to Chesbrough and Bogers, 2014). The core dimension is the direction of the innovation activity, and Chesbrough and Crowther (2006) distinguish two primary flows:

1. Inbound: companies use results of external R&D activities.
2. Outbound: bringing new ideas to the market using processes mediated with other companies.

Inbound practices are more commonly found and more frequently investigated (Chesbrough and Brunswicker, 2013; West et al, 2014). Whatever the activity, it should be understood in relation to a firm's business model (Vanhaverbeke and Chesbrough, 2014) – see Table 1.

Table 1: Open innovation and business models

	Closed/Standalone Business Model	Open/Linked Business Model
Outside-In Open Innovation	Use other‘s knowledge to develop new offering	Use other’s knowledge to develop new Business Model
Inside-out Open Innovation	Unused knowledge generated by others	Internal knowledge accessible to others to develop a new Business Model
Closed innovation	Closed Innovation Model	Search for assets owned by others to develop a new Business Model

Source: Vanhaverbeke and Chesbrough (2014: 54)

Most examples in the literature sit within the left hand column, while the open business models in the right hand column have received less attention. Nevertheless, open innovation should be understood as a purposeful strategy for organising multi-actor innovation. This is logical as open innovation comes with certain costs involved in developing relevant competences; managing diverse expectations, cultures, and objectives, and obstacles in interoperability and integration of solutions (cf. Bender/Laestadius 2005). Open innovation does not always positively affect firm performance (Belderbos et al., 2010) and in the short term costs may exceed value generation (Faems et al., 2010). Companies of different sizes can tolerate different levels of openness and assess risks, costs and benefits differently (Lee et al., 2010; Ullrich and Vladova, 2016; van de Vrande et al., 2009). However, knowledge of practices, motivations and strategies of companies largely stems from case studies of high-tech multi-nationals and may not be representative of different company sizes and types (see van de Vrande et al., 2009 and Laursen and Salter, 2006 for exceptions).

Linking open innovation and innovation ecosystems

Oh et al (2016) identify open innovation as a common feature of innovation ecosystems as it facilitates knowledge exchange, bottleneck resolution and resource allocation. Some research indicates the presence of a connection between open innovation management and ecosystems value generation and extraction (Van der Borgh et al., 2012). We can analyse open innovation based on the four flows in innovation ecosystems (knowledge, people, finance and services), asking how open innovation facilities movement across the boundaries of the firm and the boundaries of the ecosystem.

1. Firstly, open innovation mediates the actors interacting within ecosystems. One fundamental motive for engaging in open innovation is the recognition that ‘not all of the smart people work for us’ (Chesbrough, 2003a). Companies engaging in open innovation can introduce new actors to their innovation ecosystem, or remove others from the distribution of innovation labour as a result of new trajectories stimulated by open innovation.
2. Secondly, open innovation is chiefly about facilitating flows of knowledge using processes that enable companies to capture value from knowledge produced externally, or internally produced knowledge that is not being fully exploited – i.e. as a means of overcoming blockages (Oh et al., 2016).
3. Thirdly, these processes potentially alter the flows of finance within and between innovation ecosystems where open innovation leads to new innovation trajectories, new routes to market or new ecosystems – working as means of increasing the efficiency of innovation assets and redistributing investment (Oh et al., 2016).
4. Fourthly, open innovation may create new services or involve collaboration facilitated by services such as intermediaries or professional technical business services (to regulate intellectual property and appropriation for example).

Consequently, open innovation affects the evolution and functioning of innovation ecosystems: connecting individual constituent members through flows of knowledge and people across firm boundaries, and establishing constellations of actors that influence ecosystem boundaries. If open innovation processes should be linked to company business models, how companies apply open innovation illustrates whether the open business model is being adopted - reflecting the increasing popularity of the innovation ecosystems approach – and illuminates the relative importance of systemic and intrinsic factors in company innovation management and strategy.

Research data and methods

The work is based on primary data collected from 694 interviews with Chief Technical Officers, Chief Executives and Innovation Managers in innovative industrial companies in 11 European countries[53]. Each interview lasted 1-2 hours and followed a detailed interview guideline that collected a holistic account of each company, its business and innovation strategy, ecosystem and innovation management practices including interactions with ecosystem actors and use of open innovation. Data was also collected about the position of each company in their respective value chains, their business model and size, sector, market position and main activity. The interviews were carried out in the native language of the interviewee, and coded using a standardised coding framework to ensure reliability and comparability of results. The codes were compiled into a single database for statistical analysis[54].

To understand open innovation activity, we asked each company whether open innovation was part of their innovation strategy. If so, we asked how it is used, coding responses into three categories: to 'solve technical problems' (inbound), to expand market prospects' (outbound), and 'other' (a mixture of inbound and outbound or another purpose).

To understand company engagement with their innovation ecosystem[55] we asked each interviewee: what their ecosystem position/role was; how they maintain / strengthen their position; whether they influence the ecosystem as a part of their strategy; how they respond to the efforts of other players to alter or influence the ecosystem, and the main levers available to do so. These questions establish to what extent each company's innovation strategy is orientated towards the innovation ecosystem (and the likelihood that their use of open innovation forms part of an open/linked business model).

Factor analysis is used to understand the correlation between different company characteristics (intrinsic and systemic) and the use of open innovation. The analysis will contribute to efforts to distinguish the explanatory power of an ecosystem approach from alternative explanations of the use of open innovation (such as capacity and resource based explanations) by comparing the strength of correlations between open innovation practices and a company's intrinsic characteristics (such as size and main activity) and systemic characteristics (such as the competitive structure of the company's main markets and dominant ecosystem actors).

Findings

By examining the factors influencing company strategies for exchanging innovation-related knowledge and resources, the analysis illuminates some underlying dynamics of company relations in innovation ecosystems. Given innovation ecosystems are not spontaneous phenomena, but designed and managed by large companies or platforms, patterns of open innovation adoption and application by different types

53 Austria, Czech Republic, Estonia, Finland, Ireland, Italy, Germany, Netherlands, Portugal, Spain and United Kingdom

54 The research was part of the Horizon 2020 project "IIT – industrial innovation in transition" (No 64935) focusing on changing patterns and strategies in industrial innovation. The project team consists of five partners from University of Aalto (FI, co-ordinator), Joanneum Research (AT), University of Manchester (UK), University of Twente (NL) and Zabala Innovation Consult (ES).

55 As the term innovation ecosystem is not necessarily well-known or understood in the same way in all 11 countries, the interview protocol dictated that interview questions about innovation ecosystems were introduced with the following preface in every interview: "Analysts today regularly refer to the concept of an 'innovation ecosystem' to describe the interdependencies firms have with collaborators, suppliers, customers, public research bodies, other infrastructure, finance and regulators. These typically involve flows of knowledge, people, finance and services. These may be international, national, sectoral or specific to a market. We have some questions about your interactions with this extended network."

of company provide an indication of ecosystem boundaries, and levels of openness (knowledge exchange, bottleneck resolution and inter-organisational resource allocation).

Discussion

We explore the correlations between company value generation and use of open innovation as a route to articulating how company innovation strategies affect the design and management of innovation ecosystems. Closed innovations are a reasonable way of innovating when costs and risks of open innovation exceed their benefit. So companies may opt for in-house innovation and also to vertically integrate new businesses. Keeping this in mind helps to contrast and identify specific conditions for open innovation and their practices.

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10.4.3 Combining New Business and Societal Models in Emerging Technologies: Challenges and SME Strategies in Synthetic Biology

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Keywords: Emerging Technology, Commercialization, Responsible Innovation, Business Model Innovation, Small and Medium-sized Enterprise (SME)

Small and medium-sized enterprises (SMEs) have been long considered as a central component of a dynamic and successful economy due to their roles in pioneering and developing emerging technologies (Shapira, 2010). However, they face formidable challenges in commercialization and realizing the potential value of these technologies (Hemert et al., 2013). These challenges include uncertainty relating to both the newness of the technology and the market (Maine and Garnsey, 2006), the need for substantial financing and complementary assets for commercialization. Challenges are exacerbated in the context of incumbent technologies where SMEs with emerging technologies face fierce competition. In this paper we argue that addressing these challenges in a fast moving competitive business environment requires business model innovation and attention to issues of societal and public concern.

The development and commercialization of synthetic biology epitomizes the challenges faced by SMEs active in the field of emerging technologies. Synthetic biology (Synbio) is heralded as a new avenue for delivering significant economic benefits, as well as providing innovative technological solutions for societal challenges such as those in environmental and health domains. In the commercialization of synthetic biology, SMEs not only have the potential to offer disruptive solutions but also can sense new societal needs in the marketplace (Andersen, 2011) and embed societal values as a major building block of their business model.

Building on the literature on responsible research and innovation, corporate social responsibility and business model innovation, this study examines the business and societal models of a group of 60 synbio SMEs in the UK and US. Both countries provide suitable research contexts to study commercialization of synthetic biology as an emerging and fast-developing sector, each with distinguishing government frameworks and market conditions. The UK has a formalized synbio roadmap that emphasizes responsible research and innovation, and responsibility criterion is embedded in UK public research and innovation funding for synthetic biology. Moreover, UK companies that apply for European synbio funding are often required to pay attention to responsible research and innovation as well as ethical, legal and social implications (ELSI) as essential components of these applications. However, in the US, while there is societal discussion, there are (not yet) formalized synbio roadmaps or responsible research and innovation frameworks. So, this study compares Synbio SMEs' strategies and approaches in these two countries to unveil potential new responsible business models with or without the influence of government frameworks.

We draw on publicly available online information on enterprise websites and social media feeds. Web content mining and other analytical techniques are used to investigate synbio SMEs' development and commercialization activities, firms' characteristics, business and societal models, and factors associated with responsibility at commercialization stage. Web mining provides valuable information on SME strategies, linkages and relationships where other data sources are lacking (Shapira et al. 2016; Gok et al., 2014). We extract information from enterprise websites and their Twitter feeds to discover a range of variables including their value propositions, approaches to responsible research and innovation, value stream propositions, types of products, locations, R&D activities, linkages with government, universities and other businesses and access to finance. Subsequently, we build a quantitative model through a regression and factor analysis to explore the factors influencing the emergence of new responsible business models.

The findings of this study will enhance our understanding of distinctive ways that SMEs combine new business models and societal models for addressing the challenges in commercializing emerging technologies. In particular, the findings will shed light on the strategies and challenges for responsible commercialization of synthetic biology by UK and US SMEs. The research also informs SME managers' strategies and choices related to addressing societal challenges by utilizing emerging technologies. It provides further insights for policymakers regarding the commercialization approaches of SMEs and in this way assists with devising policies for encouraging and facilitating addressing responsibility issues.

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10.5 Session 10.5

10.5.1 Innovation and knowledge transfer in a complex Innovation Ecosystem: The Example of Lightweight Forging Innovation in the Automobile Industry

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Up to now, lightweight forging solutions have not been widely distributed in innovation processes of the automobile sector. In contrast, lightweight solutions have been implemented in the car body for some time now. In this paper, we analyze the factors that impede the implementation of lightweight forging solutions in the automobile value added chain in Germany. The analysis has been done as part of the lightweight forging network in Germany.[56]

We look at know-how transfer and innovation restraints in the innovation ecosystem of the automobile industry, focusing on the transfer mechanisms of new lightweight solutions into production. We ask, (i) how knowledge transfer works in the innovation ecosystem of lightweight forging solutions in the automobile sector, (ii) what firm-internal and network factors determine and impede innovation transfer, and ask for (iii) possible solutions both for the actors (firms, research institutions, universities) in different positions the innovation ecosystem and for a possible contribution of public policy.

Networking and combination of different capabilities in value creation, which are core factors behind knowledge creation and diffusion in lightweight forging are important characteristics of innovation ecosystems (Adner/Kapoor 2010). Our analysis contributes to our understanding of how knowledge diffusion works within a complex multi-actor innovation ecosystem. The paper is innovative in two respects: Firstly, by looking at steel forging solutions, we address an innovation ecosystem that has not been analyzed before. Secondly, we utilize an innovative micro approach that is based on identifying typical patterns of innovation transfer and innovation obstacles which looks both at resources and routines the sub-firm level and at networks between firms and firm divisions.

Our analysis was based on several sources: (i) a survey of interviews with firm representatives from the network. The survey address 64 firms, 39 questionnaires were completed and could be used (return rate of 60%). (ii) Semi-structured interviews with 12 representatives from firms that are located in different positions of the value-added chain. (iii) Semi-structured interviews with representatives from 9 research institutes involved in the lightweight forging network. The analysis is qualitative, identifying relevant factors and patterns that show how and why innovation transfer has or has not been successful in the value added chain.

Our analysis indicates that multiple factors influence the use of new knowledge. We show that beyond cost effectiveness, firm-specific factors (training of employees, experience with new materials) as well as communication between core actors of the innovation ecosystem prove to be important for the success in implementing new lightweight solutions. Especially the length of the communication channels is important for communication and cooperation and thus determines the success in implementing new solutions. At the same time, possible ways for improving the use of new know-how result from the analysis.

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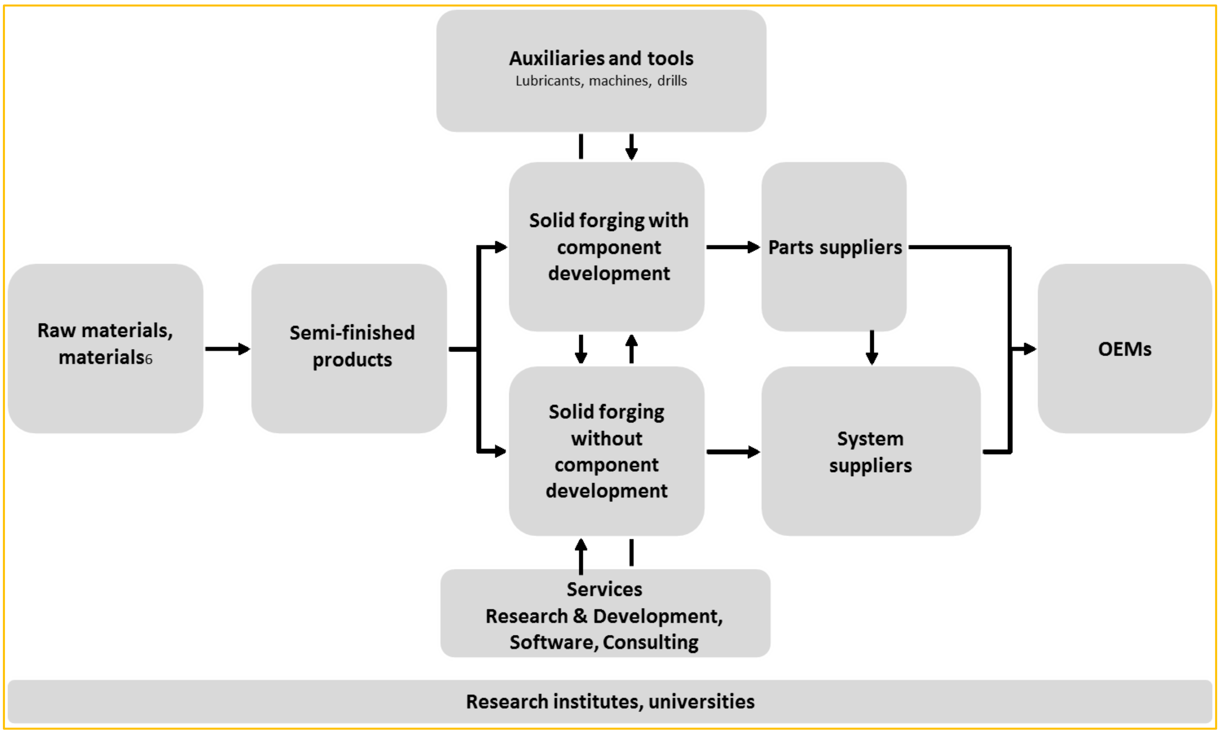
Knowledge Transfer in the Innovation Ecosystem of Lightweight Forging Solutions

Figure 1 shows the innovation chain in lightweight forging which also constitutes the relevant innovation ecosystem. Many companies in the forging industry are connected to domestic suppliers to producers who assemble and/or transform those components into a final product and sell it to the end consumer. In the past, it was an almost vertically organized structure with mainly components flowing through the supply chain while Today, manufacturers are part of a new value chain that is a more complex matrix of interdependent corporate relationships and the workforce that makes them succeed. Innovation and value are created at all levels of the chain and in collaboration with external partners. In the new value chain, SMEs are more than just “build-to-print” suppliers. As this representation is simplified, the value-added chain can be much more complex when it comes to single parts.

For our analysis, we derive the following conclusion: As the length of the value chain increases, the costs of coordination also increases. Each link in the chain can become an obstacle, unless all parties have a common goal. A decisive challenge is the coordination between the levels within the value chain.

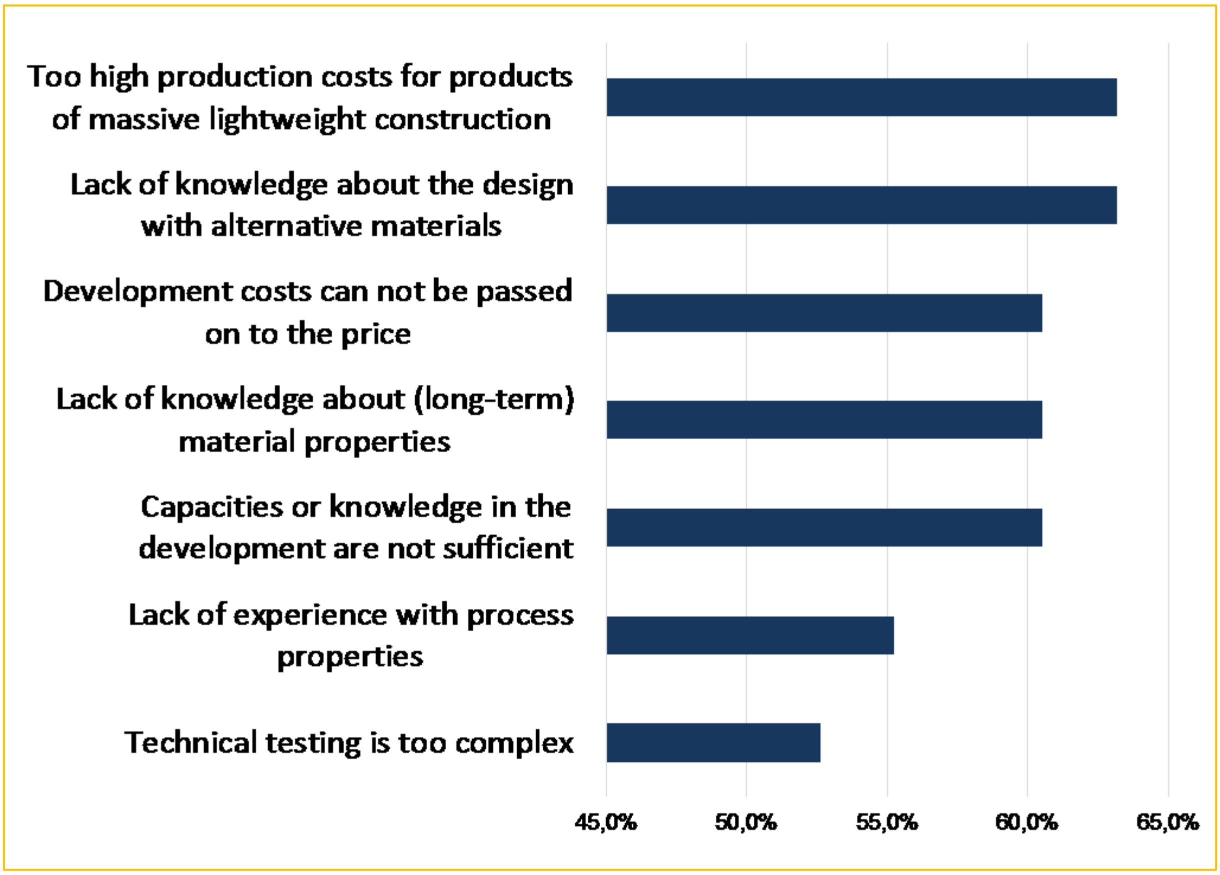
On that basis, we addressed the innovation barriers that exist in the value-added chain both in our survey (figure 2) and in our expert interviews. The answers showed that there is a substantial number of different factors that have been observed by firm representatives. They can be related to three different aspects: (i) technological factors (e.g. missing knowledge of material characteristics or possibilities for the automatization of production). (ii) Structural factors (e.g. a lack of acceptance of new solutions along the value-added chain, deficits in knowledge about lightweight solutions); (iii) Economic factors (e.g. investment and process costs, which are rather high in the beginning, uncertainty about the long-term economic prospects of lightweight solutions). According to our analysis, economic efficiency was rated as most important followed by information and coordination deficits along the value-added chain.

Figure 1: Innovation ecosystem in automotive forging



Source: own figure.

Figure 2: Barriers in the value chain



Source: Standardized firm survey, Q 7: n=38.

What determines the implementation of Lightweight Forging Solutions?

In this section, we analyze the factors that determine the implementation of lightweight forging solutions based on an analysis of firm behavior in the innovation ecosystem. Based on a view of rational decision making on a firm level that also takes into account the findings of evolutionary economic theories that identify firm competences and routines as core factors of firm behavior, we identified three core factors that determine the use of lightweight solutions in the value added chain which are discussed below.

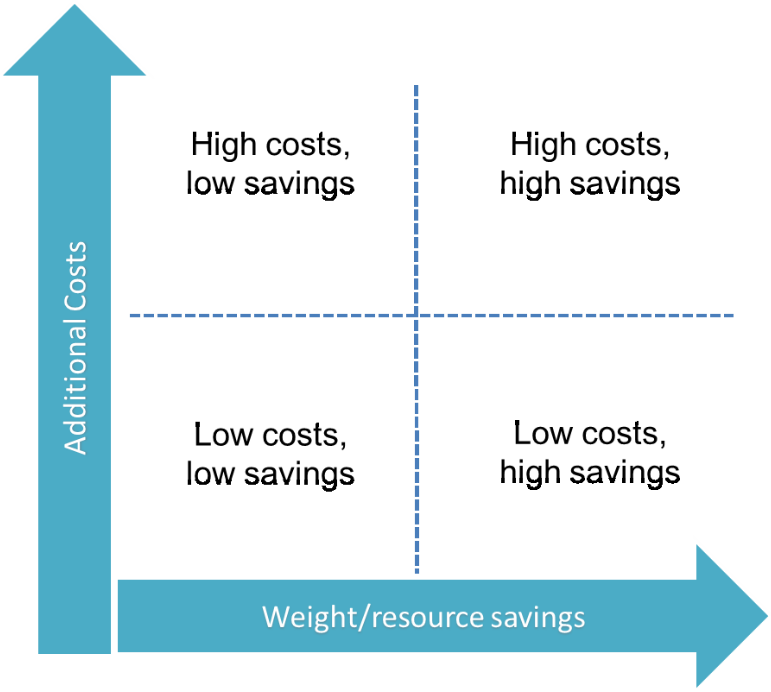
2.1 Benefits and Costs of Individual Solutions

As the decision to implement a lightweight solution (e.g. a new component part) is not only relevant to an individual firm but the total value-added chain, this decision would require a coordination of different firms along the value-added chain to compensate for individual losses of one firm that is more than balanced by gains from other firms. As there are multiple lightweight forging parts in an automobile, not an individual decision has to be made in order to reach an efficient solution. Rather, a complex of several decisions on changing multiple parts has to be made. These decisions

- are partly made by different individuals in different firms and
- are made on parts that exhibit different combinations of costs and benefits.

Whether it is rational to implement an innovation in the value-added chain is then dependent on the individual combination of benefits and costs as shown in figure 3.

Figure 3: Possible benefit/cost-combinations of lightweight solutions



Source: own graph.

Thereby, benefits of a lightweight solution are the weight saving of an innovation and directly related to this the resource protection due to a decreased use of steel as resource. The costs comprise especially changes in material costs and costs that are due to changes in the production process. These costs can accrue not only in the firm that produces the lightweight part but also prior in the value-added chain (additional pretreatment if necessary) and subsequently as after-treatment of the parts may be necessary. Additional aspect have to be taken into account if the part is not developed to exhibit the same characteristic as the original part.

2.2 Uncertainty about costs and benefits

Making a rational decision on the implementation of lightweight solutions as described in section 2.1 requires that the net benefits and costs of new solutions are known to all relevant decision makers. This is, however, by far not the case. In fact, it is first of all not known, which possibilities for lightweight solutions exist. Thus, identifying possibilities and individual benefits/costs requires additional efforts:

- Identifying possible solutions requires first of all to resort back to the knowledge of different experts in the firms that develop lightweight forging solutions. This has been done in two studies of the lightweight forging initiative that brought experts from different firms together.
- In order to decrease uncertainty of the actual potential and the challenges to produce new lightweight forging parts, additional research has to be done. This is done by different research institutes in other subprojects of the research network “lightweight forging”.
- The expected actual benefits and costs of new solutions have to be estimated. This is also done within the research networks.

So, the research initiative on lightweight forging sets the preconditions for rational choices in respect to implementing lightweight solutions in the value added chain.

It is important to note that the result in is no clear estimation of different aspects of benefits and costs. This is due to several factors:

- When looking at individual lightweight solutions, decisions have to be made on several factors: The material(s) to be used, design of the component part and handling procedures. These decisions are made in close contact to the forging firms. However, there are multiple factors to be decided on. Thus,

the decision which combination of the different factors to choose is substantiated and experience driven, but not the only feasible solution.

- The prototypes are developed in the context of research facility. When Solutions are transferred to production at firm level, an adaption has to be made to serial production which is quite different from laboratory conditions. The adaptions that are necessary also determine the overall costs that accompany the new part (which occur in the forging firm, but often also prior and subsequently in the value-added chain). Estimating these costs requires additional effort. And, as the firms involved follow different procedures in production, the change in cost will not be the same for all firms planning to implement a new production process.

The initiative can give substantiated indications in respect to cost potential benefits of lightweight forging solutions within an overall effort to reduce the weight of automobiles and increase the efficiency of resource use.

2.3 Coordination of market decisions and innovation activities along the value-added chain

While the factors that have been discussed in sections 4.2 and 4.3 can be tackled in principle without analyzing market behavior and innovation activities at firm level and between firms, some important factors that hinder the implementation of lightweight solutions seem to be due to market and innovation behavior as well as coordination along the value-added chain. The observed patterns can be explained from an evolutionary perspective (Nelson and Winter 1982). In this section, we discuss these factors based on knowledge on firm behavior from the literature. Core aspects that can be observed are:

1. Cooperative creation of lightweight forging solutions as a public-good
2. Routines, resource endowment and individual behavior along the value-added chain

All of the factors that have been observed in our analysis lead to a sluggishness of the value-added chain and prevent the implementation of new lightweight solutions. The fact that the value-added chain is rather long for some parts contributes to the difficulties in adapting products and processes along the value-added chain. At the same time, these factors also give hints as to what can be done to facilitate knowledge transfer along the value-added chain.

What can be done? Possible solutions to increase technology transfer along the value added chain

As our analysis shows, there are multiple starting points to improve innovation activities and technology transfer along the value-added chain that increase efficiency of the implementation of lightweight solutions. Successful improvements have to consider the dynamics of the total innovation ecosystem. The most important aspects are (i) supplying additional information on the positive aspects of lightweight solutions, (ii) Improving coordination of precompetitive innovation activities along the value-added chain and (iii) Improving the knowledge on process technology of lightweight forging in university and research institutes. In respect to an improvement of innovation activities along the value-added chain, these different kinds of measures are highly complementary. At the same time, they address both long-term and short-term aspects of innovation transfer.

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10.5.2 Analysing the role and function of bioclusters from a transition perspective: towards a research agenda

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1. Introduction

The growing global population that will be increasingly affluent combined the projected effects of climate change requires a major shift in the way food, energy and raw materials are produced, consumed, processed and disposed of. The concept of the bioeconomy has received increasing attention as a potential solution for these problems. The bioeconomy encompasses the production of renewable biological resources (biomass like wood, plants and algae) and the conversion of these resources and waste streams into value added products, such as food, feed, bioplastics, pharmaceuticals and bioenergy (Brunori 2013). The ultimate goal of the bioeconomy is to replace our current fossil-based sources of carbon with renewable sources of carbon that are based on processes of photosynthesis.

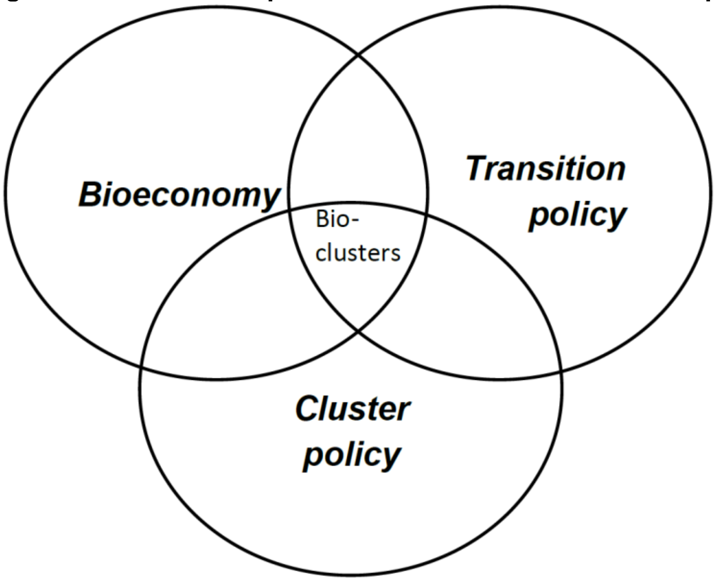
Cluster initiatives have become an important tool for governments to establish, promote and strengthen economic collaborations, learning, innovations and employment within a certain region (Lindqvist *et al.* 2013, Sölvell 2008). Clusters can be defined as geographic agglomerations with a specialised set of economic activities that get their economic advantage from strategic knowledge and learning flows. Such clusters form economic agglomerations that can range from small geographical areas (within a city, e.g. Wall Street or Hollywood) to larger geographical areas (e.g. Sillicon Valley) and even across nations. In our contribution to the EU SPRI conference 2017, we will focus specifically on bioclusters: clusters that specialise in the various fields of the bioeconomy. In these bioclusters a number of different economic sectors and activities can be found: agriculture, forestry, paper and pulp, green chemistry, and industrial biotechnology. The exact combination depends on the geographical context and historical development paths of the region in which the biocluster is embedded (PriceWaterhouseCoopers 2011).

As a result the STI policy approach applied on bioclusters is characterised by a strong emphasis on the linear 'science-push model' of innovation, focussing on the stated goals of the bioeconomy as knowledge creation, employment and new business opportunities, but somewhat neglecting terms of sustainability and environmental innovations (Ramcilovic-Suominen & Pülzl, Schmid *et al.* 2012). In our contribution, we aim to explore what would be the implications for the establishment and operation of bioclusters from a perspective of transformative STI policies.

2. Theoretical framework

We view bioclusters as operating on the intersection of a number of different policy fields: environmental transitions, the bioeconomy and cluster policies, see Figure 1. Table 1 provides a (incomplete) comparison between some of the most important overlaps and differences between the study and governance of transitions, the bioeconomy and clusters. Below we will shortly describe these three policy fields and their associated research paradigms. Due to the limited extent of this abstract we will only describe some of these elements.

Figure 1: bioclusters operate on the intersection of three policy fields



The bioeconomy promises to contribute to the creation of new economic opportunities for instance through new business formation and entrepreneurship, increased resource efficiency, energy independence and employment creation in 'knowledge based' sectors related to biotechnology and genomics, plant breeding and plant-based processing. The concept of the bioeconomy is therefore not only closely associated with goals of environmental sustainability and energy independence but also with innovation and the valorisation and commercialisation of scientific knowledge (Bugge *et al.* 2016, Cooke 2002, Zechendorf 2011). Detailed policy plans to promote the bioeconomy have been made at the national, regional and sectoral level (Bosman & Rotmans 2016, de Besi & McCormick 2015, European Commission 2012, OECD 2009). Important focal points of these policy plans are the promotion of innovation, especially related to biotech, through interaction between researchers and corporations, the promotion of biomass production and (more) efficient conversion techniques and the facilitation of new markets by creating demands (de Besi & McCormick 2015)

The profound changes that are required for a successful shift from a fossil based economy to a bioeconomy are called system innovations, or transitions and the relatively new scientific field of transition studies or transition theory has emerged to study them (Grin *et al.* 2010, Markard *et al.* 2012). Transition theory studies long-term processes of transformation that require a combination of technical, organisational, economic, institutional, social–cultural and political changes (Van den Bergh *et al.* 2011). Within transition studies there are two relevant analytical frameworks are of interest for the study of bioclusters: the (technical) innovation systems approach (Hekkert *et al.* 2007, Markard *et al.* 2015) and the multilevel perspective (MLP) (Geels 2011, Smith *et al.* 2010). Both hold a systemic perspective on innovation that focuses on the network of social relations and it views innovation as an inherently social and interactive learning process (Coenen & Díaz López 2010).

Finally, clusters as a government intervention tool were popularised in particular by the work of Michael Porter (1990). Although the work of Porter has been very popular, especially with policy makers, the scientific community has been far more critical (Martin & Sunley 2003). Recent contributions of cluster theory come from the field of Evolutionary Economic Geography which focusses more on the development of clusters from a perspective of Regional Innovation Systems (Boschma & Fornahl 2011, Frenken *et al.* 2014, Trippl *et al.* 2015). In the following section we will highlight some of the contributions that the study of bioclusters can make to the three various fields.

Table 1: Schematic overview of important elements for the study of transition, clusters and the bioeconomy

	Transitions	**Bioeconomy**	**Clusters**
Scientific fields	• Science and Technology Studies, • Evolutionary Economic Theories, • Institutional Theory	• Agronomy • Chemical engineering • Biotechnology	• New Economic geography • Evolutionary economic geography
Analytical level	• Provisions of functions: "Food provision" or "Energy" or "Health"	• Supply and demand of natural resources at global, national and regional levels • Value Chains	• Connected economic activities within certain geographical boundaries, local and regional
Dominant research paradigms	• Multi-Level Perspective • Technical Innovation Systems	• Life Cycle Assessments & Social Impact Assessments, etc. • Trade-off assessments	• Porter's Diamond model • National and Regional Innovation Systems
Policy aims	• Development and breakthroughs of (radical) sustainable technology	• Substitution of fossil-based sources of carbon with renewable ones. • Develop the 'knowledge economy' • Biotech as a goal and a means at the same time.	• Stimulate economic agglomeration processes and their effects on competitiveness and employment
Governance approach	• Strategic Niche Management: shielding, nurturing and empowerment • Transition Management: creation of arena's	• Focus on bringing together (biotech) research institutes and industry, especially on the regional level • Public-Private Partnerships, platforms, networks, etc. • Creation of new markets • Demonstration projects	• Public-Private Partnerships • Creation of clusters and cluster organisations
Knowledge development	• Experimentation and knowledge co-creation in niches (bottom-up)	• Triple Helix model, • Top-down linear innovation models	• Knowledge diffusion through knowledge spill overs and mentoring

3. Towards a research agenda

3.1 The role of power and politics in bioclusters

A biocluster can be viewed as a protected place where innovations are (temporarily) shielded from the mainstream selection pressures, nurtured through experimentation and learning and eventually become empowered (Smith & Raven 2012).

However, a difference with the niche concept is that in bioclusters, the players from the socio-technical regime might play a more important role and the actors in a biocluster don't necessarily have such an 'outsider' status as compared to a many niches in the MLP. Many innovations (biofuels, but also bioplastics and pharmaceuticals) that are being developed in a biocluster are designed to compete with existing fossil based alternative into the existing value chains. In this regard McCauley and Stephens (2012) classify bioclusters as operating somewhere in between niches and the socio-technical regime. They hypothesize that cluster initiatives have the potential to either accelerate or inhibit regime level change. These concerns echo some of the objections of other authors that have been critical of general cluster policies who warn for the threat of established interest to hijack cluster policy for their own sectoral benefit (Duranton 2011, Nathan & Overman 2013).

Therefore what is necessary is to also study the process of innovation coalitions aim to 'stretch and transform' the institutional context. Although it is acknowledged that the establishment of a cluster requires the strategic operation of government at various levels (Fornahl *et al.* 2010) there has not been that much attention paid to the strategies of bioclusters to influence policy and shape the institutional environment.

Transition Theory and especially the Multi-Level Perspective of transitions can be helpful is to disentangle the role of the established industries within bioclusters. The role of power and politics in transitions has received an increasing amount of attention in the literature (Avelino *et al.* 2016, Avelino & Rotmans 2009) and the study of bioclusters is likely to provide an excellent opportunity to enrich this element of transition theory.

3.2 Both transition theory and cluster research neglect the role of human agency

Transition theory struggles with the issue of agency because the contribution of individual decisions and actions remains hidden in many accounts of typical transitions (Berkhout *et al.* 2004) and insufficient attention is paid to the specific role that individuals play in a 'transition in the making' (Alkemade *et al.* 2011, Farla *et al.* 2012, Markard & Truffer 2008). A somewhat similar argument is made with regard to cluster studies. According to Trippl *et al.* (2015) there is a need to study the 'purposeful actions' of entrepreneurs within a cluster in more detail. These purposeful actions consists of the way individuals contribute to innovations and knowledge development, reframe institutional rules and regulations through institutional entrepreneurship and network with other organisations through gate keeping, bridging and brokering (Giuliani 2011, Hermans *et al.* 2013, Klerkx *et al.* 2012). An important question in this regard is how local actors can reach beyond the borders of their own biocluster and achieve transformative change on higher scales. For instance: Martin and Sunley (2012) discuss upward and downward causation where firms and individuals influence higher-level institutional scales but at the same time are influenced in their behaviour and actions by these same of institution.

3.3 System boundaries of bioclusters and the interaction of multiple scales and levels

The study of bioclusters offers a chance to enrich transition theory with a chance to work out the role of space and place better. It has been argued by various authors that the spatial dimension has not been treated systemically within transition studies. Niches are often assumed to be local, but the importance of the different geographical contexts in largely ignored in the literature (Coenen *et al.* 2012, Raven *et al.* 2012, Truffer & Coenen 2012). The study of bioclusters offers an opportunity to incorporate the spatial dimension of transition theory by focussing on how economic input output relations are localised along the whole value chain: from the agricultural production of biomass, to its processing, consumption and disposal.

Martin and Sunley (2003) criticize the subjective and arbitrary nature of many cluster studies. Bioclusters are no exception in this regard. Biotechnology connects vastly different sectors as pharmaceuticals, but also agriculture and food and there is no single technology to focus on, making it diffi-

cult to draw the boundaries of a biocluster either from the perspective of a Technical Innovation System or from a Regional Innovation System. Bioclusters are embedded in regional innovation systems in which multiple scales and levels interact: institutional scales, administrative scales, geographical and ecological scales and their effects should be assessed on the relevant scales: on ranging from micro level effects on firm innovativeness and competition to meso level effects on employment to macro scale effects on learning and knowledge generation. For instance clusters and especially clusters that operate in high tech fields such a biotechnology, depends on national and international scales to obtain specialised knowledge (Binz *et al.* 2014, Geels & Deuten 2006). Bioclusters can have positive regional environmental impacts (Deutz & Gibbs 2008), but also negative impacts at higher scales for example expressed in terms of indirect land use (Overmars *et al.* 2011) and biodiversity losses (Lenzen *et al.* 2012). Studying the interaction between these multiple scales and levels ('scale dynamics' (Hermans *et al.* 2016) over the different stages of the life cycle of a bioclusters can help to bring the different types of boundaries of bioclusters into more focus.

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11 Track 11: Public-Private Partnerships in Research and Innovation: State of Play and Ways Ahead

Track 11 was organized by Frans van der Zee, TNO Expertise group Strategy & Policy, and Thomas Stahlecker, Fraunhofer ISI, and included two Sessions.

Public-private partnerships in research and innovation (PPPs in R&I) have become a key element in the research and innovation policy mix in many advanced economies, in Europe and elsewhere. The term PPPs in R&I has been used as a broad header for collaborative arrangements between private and public institutions already since the 1980s. Policy instruments to stimulate PPPs in R&I have evolved over time and transformed themselves to meet the changing challenges of our time. Recent years have witnessed a renewed interest in PPPs, not only at the European policy level with large size PPPs in R&I such as the JTIs and the EIT KICs entering the stage during the late 2000s, but also at national level where new policy instruments and new PPP practices – in terms of virtual or 'physical' collaborations – have been or are being designed and introduced (see for instance Austria with the COMET programme, Germany with the "Forschungscampus" and the Netherlands with the Topsectors Policy). New modern flexible PPP formats are arising with entry and exit being organized in new ways and intellectual property arrangements are presented in an 'a la carte' type of way. Moreover, the coverage of PPPs has been broadened and extended to include also the higher end of the TRL (technology readiness level) scale – or 'experimental development' in state aid framework terminology. Typically such PPPs are intended to boost the development of existing and new innovation ecosystems and meant to offer testing and experimenting platforms for SMEs and startups, with the objective to help breed the scaleups of tomorrow. But also in the lowest TRLs - in basic research – we observe new developments, with large PPPs in R&I taking on a key role in the search for solutions to societal challenges, multidisciplinary, high risk endeavours usually requiring high investment.

The aim of the research session is to explore and highlight new directions and arrangements for PPP in R&I, with the choice for track participants to take one of two following distinct different perspectives: i) the policy instrument perspective, ii) the PPP governance perspective (design and functioning of one or more 'real-world' PPPs in practice), or iii) the regional perspective. The first – policy instrument - perspective applies to the rise of new policy instruments in PPP in R&I, which are built on or around triple or quadruple helix notions, involve new creative ways of financing and pool and secure resources in a longer term collaboration on a certain theme, topic or challenge. It seeks to explore, analyse and/or compare different policy instruments, with an emphasis on new challenging and/or experimental ways of collaborating in a public-private setting. Possible questions could be: how to incentivize and stimulate PPPs from a policy perspective? Where do PPPs for R&I and societal challenges meet? Whether and how to align European and national PPP in R&I policies? Do we need another generation of PPP instruments in times of deglobalisation, EU skepticism and fragmentation? The second – PPP governance - perspective looks at ways and modes of how PPPs in R&I can be governed and managed in practice ('real-world'), focusing on smart partnership arrangements in terms of knowledge production during the course of the PPPs existence, the handling of intellectual property, and its smooth, effective and efficient collaboration. The governance perspective can either take the form of an individual (1 to 3) case studies comparison or take a broader, encompassing form in which different governance types are compared, quantitatively or qualitatively, or a combination of both. Possible questions could be: what form could/should a PPP take (virtual organization, 'physical' institute) vis-à-vis its goals and expected impact? How to retain flexibility and continuity of a PPP in the course of time? To what extent is IP a leading principle in the design of PPPs in R&I? The third perspective puts emphasis on the regional implications of PPPs in R&I, with questions relating to the impact of PPPs in R&I on strengthening regional technological competitiveness, their contribution to strengthening the regional research and innovation profile, and their possible role as R&D service provider for companies in the region. The regional perspective can take the form of a comparative case study or analysis using quantitative indicators.

The approach taken by track participants is in principle free, although a rigorous individual or comparative case study methodology involving appropriate qualitative or quantitative methods/techniques or a combination thereof is preferred. This applies to both the policy perspective (policy / institutional

/ economic analysis), the governance (innovation management), and the regional perspective. Theoretical underpinnings, such as neo / new institutional economics, transaction cost economics, behavioral economics, policy sciences, regional science, etc., might add to the value of the contributions. Contributors are invited to use performance, structural as well as input and output indicators/variables, depending on the nature and purpose of their particular research at hand.

Expected outcomes (in scientific and policy terms) to be achieved

- An up-to-date overview of and insight in recent approaches and practices towards PPP in R&I, both in terms of policy-making and in the governance of PPPs in R&I
- An increased insight and understanding of which PPP in R&I governance constructs arrangement work best (and which do not) in which domains/sectors, in which institutional context and under which circumstances/conditions
- An increased insight and understanding of which PPP in R&I policy instruments work best (and which do not) at which level (European, national, regional) and under which circumstances/conditions
- An increased insight and understanding of how PPP in R&I approaches impact the regional level (European - national - regional linkages, competitiveness, innovation performance)
- The generation of new ideas and new conceptual approaches to PPPs R&I for:
- Approaching and solving grand societal challenges
- Coping with/in a changing world of deglobalisation, fragmentation and populism
- Addressing European competitiveness and societal needs
- Messages and recommendations to policy-makers, industry, universities and RTOs to improve the design and performance of PPPs in R&I now and in the near future.

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11.1 Session 11.1

11.1.1 Comparative analysis of strategic PPPs and industrial transformation in Europe: where theory and current practices meet

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Over the last decades public-private partnerships in research and innovation (short: PPPs in R&I) have become increasingly popular, both at national and EU level. Not only have public-private partnerships shown to be an effective instrument in organising research and innovation efforts, in tackling existing market failures, and in offering promising avenues to solving grand societal challenges. But PPPs have also been instrumental in strengthening competitiveness, by reaping the rewards of (economies of) scale and scope in research and innovation, the speeding up of time-tomarket (from 'idea' and concept to actual innovation) and the generation of new knowledge/technologies with strategic importance and the potential of strengthening the industrial base and creating new employment.

The recent surge in PPPs in R&I coincides with a rise in novel, more 'strategic' PPPs characterized by public support that is longer term oriented (duration of 4 years and beyond), consisting of multiple partners and with substantial partner funding commitments over their lifetime, being strategic in their science, technology and innovation objectives, from achieving technological leadership, mobilizing and enhancing technological and innovation capabilities to 'solving' societal challenges (e.g. OECD, 2014; Koschatzky and Stahlecker, 2016). Many of these strategic PPPs are large-scale, multidisciplinary nature, characterised by high investment/high-risk profiles and a hybrid complex financing structure, and revolving around emerging scientific and technological fields, often in close alignment with national innovation and industrial strategies. PPPs can be market oriented, mission oriented, transfer oriented or a mixture (hybrid) of the three. Examples of strategic PPPs at national level include, inter alia, the Forschungscampus (Germany), Competence Centres (Czech Republic), Catapult Centres (United Kingdom), Advanced Research Centres and Joint Innovation Centres (Netherlands), Carnot Institutes (France) and Christian Doppler Laboratories (Austria). At EU level we have witnessed the emergence of contractual PPPs (cPPPs) such as Factories of the Future, Energy-efficient Buildings, and Cybersecurity, the Joint Technology Initiatives such as Bio-based Industries or Clean Sky, and the Knowledge and Innovation Communities (KICs) of the EIT. A parallel development, also in the strategic PPP domain, is the emergence of innovation hubs and field labs. A prominent and very recent example are the EU's Digital Innovation Hubs (DIHs) that offer services to test and experiment with advanced technologies, manufacture innovative products and act as broker between user companies and technology suppliers. Innovation hubs and field labs are typically positioned at high technology and market readiness levels 7 or 8 (TRL, respectively MRL, scale: 0-9), whereas many of aforementioned PPPs find themselves at lower TRLs.

The aim of the paper is twofold: i) to provide an overview and analytical comparison of recent strategic PPP in R&I initiatives at EU and national level, drawing on empirical evidence from North-Western Europe (Member States) and the EU (Van der Zee et al., 2016) and contemporary management and innovation perspectives/paradigms (see next), and ii) to analyse and explain the rationale and the rise of PPPs in R&I. In the latter contextual elements play a role, such globalization and growing dependencies/interconnectedness, the financial and economic crisis, increasing complexity and the importance of scale and scope, international competitiveness, and growing (awareness of) societal challenges. The comparison part will concentrate on the UK, Germany, the Netherlands and the EU, based on recent research (see earlier references). Criteria for comparison include on the one hand intrinsic PPP attributes such as governance, financing, intellectual property treatment, and entry and exit, and on the other hand performance criteria including economies of scale and scope, time-to-market, problem solving capacity, and effectiveness. The explanatoryanalytical part will build on and try to link the current trends in PPPs to theoretical perspectives, offering different and alternative entries for explanation (e.g. Van der Zee, 2016). These include lessons and insights from transaction cost economics (Williamson, 1975; 2002); recent conceptual perspectives such as open innovation (Chesbrough, 2003) and triple helix (Etzkowitz and Leydesdorff, 1995); market failure and system failure literature (e.g. Aghion et al., 2009); and new public management (e.g. Osborne and Gaebler,1992). Empirical material is derived from two recent studies, notably Van der Zee et al. (2016, in Dutch) and Koschatzky and Stahlecker (2016), in addition to ongoing European projects on PPPs in R&I, including I4MS and XS2I4MS.

The expected outcomes in policy terms are to improve the insights/grounds for selecting between existing different PPP for R&I models/modes and their potential benefits, and to provide an overview of the variety of existing – often hybrid – PPP models. The expected outcomes in scientific terms include a better understanding of the rationale behind the ongoing strong growth in PPPs for R&I across various countries as one of the dominant forms of public policy intervention in research and innovation, and how competing theoretical perspectives could explain for this surge, building on existing theoretical perspectives and explanatory frameworks.

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11.1.2 Non-financial PPP for participatory priority-setting in R&I policy: the case of the Italian National Technology Cluster policy

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Keywords: Public-Private Partnership, Governance, R&I policy, Priority-setting,Italian National Technology Cluster

Introduction

National governments are required to develop research priorities and specialize decisions through priority-setting processes, in order to comply with many solicitations among which we observe the European Smart Specialisation Strategy, shrinking budgets, and the need to demonstrate the benefits of publicly funded science and technology. We build on the Public-Private Partnership (PPP) literature and on the particular subset of PPP for Research and Innovation (R&I) to address the issue of how to perform a stable and effective priority-setting process in this policy area. We argue that a particular type of PPP, the "non-financial PPP", when characterized by participatory governance represents an effective and legitimized architecture for defining national investment priorities in R&I. We adopt and individual case study methodology and provide preliminary empirical evidences on the case of the Italian National Technological Clusters (NTCs), the policy launched in 2012 by the Ministry of Education, University and Research (MIUR). The analysis offers an increased insight and understanding of the original role that specific PPPs may take in R&I domain, and some suggestions about a possible evolution of high-tech cluster policy. We conclude by offering preliminary results of the case study connected to specific policy recommendations, and suggestions on further research directions.

Priority-setting for R&I policy

Setting priorities for R&I policy is an arduous task as the underlying process, typically hampered by information asymmetries, not only implicates exact knowledge of current scenarios, but also the ability to estimate future technological trajectories in a context marked by continuous changes and discontinuities (Dosi 1982, Antonelli 2008). The efficient development of R&I priorities is thus limited by several obstacles (Salo and Liesiö 2006) caused also by the fragmented governance of innovation ecosystems, which fails to engage all relevant actors in the decision-making and implementation processes at the different levels. Moreover, while in complex systems the practice may gradually overlook priorities, in the case of R&I policy priority-setting is usually coupled with resource allocation, and therefore keeps a pivotal role in the decision-making (Stewart 1995).

From an historical perspective, we may identify three main trends in priority-setting for R&I policy for most of the OECD countries (Havas et al. 2010). During the first phase, in the post war period, governments adopted “science-push” and “picking winners” approaches, often driven by national interests primarily related to defense or industrial policies needs. The acknowledgement of several critical aspects hampering this approach, lead to a weakening of governments’ direct intervention, with an increasing policy focus on the framework conditions enabling R&I, as suggested by the emergenging “systems of innovation approach” (Edquist 1997). In this context, governments delegated the selection of R&I investments to intermediaries (universities, funding agencies, research institutions), and established different national public project funding schemes (Lepori et al. 2007). In the third and most recent phase, national and regional governments, motivated also by the new wave of demand-

side innovation policy, are rietrieving their direct control on priority-setting in order to design and implement strategic long-term decision-making on specialization strategies.

This policy line integrates considerations relative to the role of stakeholders, which are increasingly recognized as important contributors in the policy-making process (Kuhlmann, 2001), and consulted on R&I perspectives mainly through the adoption of national foresight programmes (Koschatzky 2005, Georghiou and Harper 2011) or “entrepreneurial discovery” processes (Foray et al. 2009). The establishment of the European policy “Research and innovation smart specialisation strategies (RIS3)” (Foray et al. 2011) as ex ante conditionality for the EU’s Structural and Investments Fund Programmes, is pushing governments to configurate more stable, neutral and efficient processes of priority-setting, which we argue shall be embedded in a specific typology of PPP for R&I.

The PPP framework and our proposal

In this respect, R&I policy domain is marked by the so-called PPPs for R&I, i.e. policy mainly aimed “[…] to the development of scientific and technological potential and the formation of a competitive industry for the functioning of the domestic and global markets.” (Akhmetshina and Mustafin, 2015, p.36). Koschatzky (2017) defines PPPs for R&I as long-term cooperative institutional arragements in which publicly funded research organisations and corporations pursue complementary research goals. Specifically, there rely on three building blocks: the State, acting as enabler of instutional environment; the ‘Knowledge producers’, typically universities and research centers; the Business world, that transfers the knowledge advancements into new thecnology and products (Akhmetshina and Mustafin 2015).

Even if the body of literature dealing with PPPs for R&I has the merit of providing new framework and empirical evidences on the type of research collaborations between industry and academia implemented since the early ‘90s (see among others: Koschatzky 2015; Koschatzky et al. 2017; Robin and Schubert 2013), it does not explicitly address the issue of prioritization in R&I. We enrich this body of literature by proposing another form of PPP for R&I, namely a "non-financial PPP” aimed at priority-setting in R&I. Such PPP for R&I is based on a non-financial partnerships among the State, the “Knowledge Producers” and the “Business World” and in our view represents an effective policy instrument for priority-setting. That is a non-financial PPP - “where financing is not the primary purpose“ (Vanelslander and Farrell 2015) - applied to the R&I domain. Specifically, it can work as a neutral soft-governance infrastructure for technological roadmapping aimed at enabling more informed (and effective) R&I public investments.

In more details, building on Bovaird’s work, we adopt a broad definition of PPP as “working arrangements based on a mutual commitment (over and above that implied in any contract) between a public sector organization with any organization outside of the public sector”, and offer a framework based on a “policy design and planning” purpose (Bovaird 2004). We then explicitly define non-financial PPP as a partnership aimed at the sharing of information, rather than at the matching of financial resources, and that is not based on a purchaser-provider arrangement, as a simple outsourcing of foresight services. Morover the constituencies of the R&I ecosystem are mutually committed to a common goal (i.e. creating mutually agreed research agendas/roadmaps). The fundamental element that legitimize such partnership is the inclusiveness and the transparency of the governance structure, which responds fully to some of the main pittfalls of R&I priority-setting processes highlithed in the literature (Salo and Liesiö 2006). This peculiar typology of PPP for R&I, in fact, shows the ability to recompose the fragmented governance of innovation ecosystems, and engage constantly all relevant actors in the priority-setting activity.

Case study: the Italian National Technological Clusters

In 2012, the Italian Ministry of Education, Universities and Research (MIUR) launched a policy establishing eight NTCs, which cites among NTCs’ missions the production of mutually agreed national research agendas (see Clar and Sautter 2014 on a similar experience in Germany). This policy took up the old framework of industrial districts (Pyke et al. 1990; De Marchi and Grandinetti 2014) with

the aim of selecting and coordinating their activity in strategic technological fields and of aligning national and regional actions. As a result, eight new high-tech clusters were formed through a hybrid process mixing bottom-up with top-down approaches. NTCs were defined as “permanent intangible infrastructures for the cooperation between universities, public research bodies and enterprises, and between central and local authorities” (MIUR, PNR 2015-2020). The national government identifies NTCs as the main instrument to achieve the public-public coordination (State-Regions-Local administrations) and public-private objectives on R&I, and suggests that they may contribute to the national research strategy by proposing technology roadmaps and investment priorities.

NTCs represent an original form of high-tech clusters, a new model enriching the list of different conceptualizations and implementations of cluster policies (Stahlecker and Kroll 2012) and, in our perspective, suggesting a significant evolution. First, they fit only partially with Porter’s idea of co-located, interdependent actors (Porter 1998), as the geographical proximity has been replaced by the knowledge proximity (Antonelli and Calderini 2008). Besides, these clusters are better described in terms of PPPs characterized by the cooperation between private and public actors, which, instead of engaging only on short- or mid-term projects aimed at market-oriented development (Kroll 2016), cooperate on a long-term strategic partnership aimed at producing mutually agreed research agendas.

The evidences emerging from a first analysis of the 8 NTCs’ governances show that NTCs cope in a broad sense with the principles suggested by the literature for PPP of “equity and pluralist representation; opportunities for, and commitment to, participation; and transparency (related to various operational aspects of the partnership as well as to the policy outcomes)” (Brinkerhoff and Brinkerhoff 2011). In fact, the statutes’ analysis shows for instance that there are no explicit barriers to the entry of new partners, which in most cases is deliberated in the assembly or the governing body by majority rule. Nevertheless, the distinction among categories of associates adopted by some of the NTCs indicates substantial differences among the partners in terms of prerogatives (right to vote, participation in government bodies, or active role only in operative activities). Such differences are mirrored in the process of priority-setting, which in most of the NTCs is genuinely participative, even when generated by a hybrid model mixing top-down and bottom-uf approaches, while in others are non-transparent and not based on technology roadmaps developed conjunctly by all clusters’ associates. Quite intuitively, such differences reflect the characteristics and the degree of development of the industry and technological domain in which the clusters operate.

Our case study shows that NTCs have different internal arrangements and governance settings, and that, consequently, not all of them are producing the expected results. In particular, the analysis allows to highlight how differences in the NTCs governance models, both in the internal structure and in the technological trajectories formulation process, can be associated with their ability to contribute to the priority-setting process in the R&I policy.

Conclusive Observations

By leveraging on these preliminary results, we theorize the main characteristics needed by this PPP model in order to contribute efficiently and legitimately to the priority-setting. We suggest that, given specific conditions and functioning mechanisms, governments’ partnership with high-tech clusters relying on “inclusive” governance settings, may result in legitimate and efficient support for priority-setting in R&I policy, and provide a soft-governance service by aligning R&I national and regional agendas. Consequently, public authorities may bring in a novel idea of non-financial PPP in R&I as a tool to specialize policy through a participative process based on clusters’ knowledge and inclusive governance, which combine the ‘entrepreneurial discovery’ and priority-setting process envisaged by the smart specialisation approach. Moreover, we conceptualize and propose a new role for high-tech clusters as stable and inclusive “focussing devices” for R&I policies, and explain some of the practicalities about the design and implementation of PPP in this domain at the national level. Building on interviews with the main actors and on publicly available information, we will further analyse the 8 NTCs, provide details about how they are governed and managed in practice, and offer elements on the first interactions with the national government.

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11.2 Session 11.2

11.2.1 More meeting or mating? The relationship between incubator support mechanism and weak problems in the entrepreneurial ecosystem

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Keywords: Innovation system, Social network, Network problems, Incubators, Entrepeneurial ecosystem

Technological entrepreneurship is seen as an important means to contribute to economic growth (Wong et al., 2005; Ahmad and Ingle, 2013) and to engage in transformative change to overcome societal challenges (Geels and Schot, 2007). Policy makers try to create an environment that is conductive to technological entrepreneurship. This environment increasingly often referred to as the entrepreneurial ecosystem, and consists of all factors that affect the founding, growth an survival of start-ups (Spigel, 2015; Stam, 2015). Many regions in Europe still cope with systemic problems in their entrepreneurial ecosystem, like a lack of capital or an entrepreneurial culture (Van Weele et al., n.d.). Incubators encompass a wide array of programs and organizations that support new technology based start-ups to boast the performance of these businesses (Hackett and Dilts, 2004; Bergek and Norrman, 2008; Bruneel et al., 2012). Moreover, they can be used as tool by policy makers to alleviate the problems in the entrepreneurial ecosystem (Van Weele et al., n.d.).

There are various support mechanisms that incubators employ to these ends (Bergek and Norrman, 2008; Amezcua et al., 2013; Patton, 2013). The most prominent is infrastructure support, which is the transfer and sharing of tangible resources like subsidized (office) space. Second, there is the transfer of intangible resources from the incubator to the start-up, like business courses or coaching (Eveleens et al., n.d.). Networking refers to the activities of incubators that give start-ups access to contacts that can provide them with resources (Davidsson and Honig, 2003), like investors. Finally, field building (Amezcua et al., 2013) refers to connecting start-ups with each other which to increase knowledge sharing community building and legitimacy (Van Weele et al., n.d.).

The effectiveness of the each mechanism depends on the conditions of the entrepreneurial ecosystem. For example, when there is already a high level of cooperation, the added value of the field building mechanism is likely limited. There is currently no research that systematically assesses how systemic conditions in the entrepreneurial ecosystem affect the effects of separate support mechanisms on the performance of their tenants. It is thus unknown when incubators should pursue what mechanism.

This is especially true the network support mechanism, which is seen as a the key task of modern incubators (Eveleens et al., n.d.; Hansen et al., 2000). If an incubator connects a tenant start-up to an investor, the tenant start-up also becomes a potential intermediary who can broker relationships between other start-ups and that investor. Hence, incubators can be tools to overcome network formation problems, also called weak network problems, (Klein Woolthuis et al., 2005; Wieczorek and Hekkert, 2012) in entrepreneurial ecosystems. Hence, this research poses the following research question: what is the effect of combinations of support mechanisms by incubators on the performance of start-ups and the occurrence of weak network problems under different conditions in the entrepreneurial ecosystem?

Theory

This paper combines insights from the related literatures on entrepreneurial ecosystems (Spigel, 2015; Stam, 2015), social networks (Watts and Strogatz, 1998; Albert and Barabási, 2002) and innovation systems problems (Klein Woolthuis et al., 2005; Wieczorek and Hekkert, 2012) to understand

network problems. We derive that network formation will only take place is two conditions are met (Verbrugge, 1977; Flap and Völker, 2004): meeting and mating. Meeting means that actors need to find each other. For this there must be sufficient actors in the system that seek potential partners and that can be found. Moreover, they must have a large enough chance to meet each other. In entrepreneurial ecosystems this meeting takes largely place through the existing social network (Spigel, 2015). Especially investment relationships are established via introductions through the social network (Shane and Cable, 2002; Fritsch and Schilder, 2008). In this network there are two processes that influence the meeting chance.

- Direct brokerage relates to the extent to which there are actors present in the system that can serve as direct network brokers. This is typically the case when there is a culture of paying it forward (Van Stijn et al., n.d.; Ready, 2012), which in the entrepreneurship context means that the start-up shares parts of the benefits of an investment deal with other start-ups, usually in the form of advice, or referrals. After being invested the start-up remains available in the ecosystem as to serve network broker. This increases the meeting chances between investors and start-ups that are looking for funding.
- Indirect brokerage refers to the extent that start-ups are willing connect to each other. It requires a certain level of trust and cooperation between start-ups, which is commonly observed in entrepreneurial ecosystems (Feld, 2012; Spigel, 2015; Stam, 2015). The If one of the start-ups in the network becomes connected to an investor, then this start-up can share this connection with others through direct brokerage. Indirect brokerage thereby increases the meeting chances between investors and start-ups that are looking for funding. Mating implies that after meeting, actors actually form a relationship. The most prominent relationship in entrepreneurial ecosystems is the one between investors and start-ups. Investors do not only transfer funds to the start-up. Both partners engage in a long-term relationship also often involves the transfer of valuable market and business knowledge, and relevant network contacts from the investor to the start-up. These intangible resources are seen to contribute most to a comparative advantage (Eveleens et al., n.d.). In return, the investor receives shares or influence in the start-up, which solidifies the relationship further. For mating to occur both actors types must see the benefits to form a relationship, and trust each other to hold their end of the bargain (Roos and Klabunde, 2014). Moreover, actors require capabilities to engage and manage relationships (Schilke and Goerzen, 2010; Niesten and Jolink, 2015), or to absorb (Cohen and Levinthal, 1990), and combine the knowledge and resources that can be acquired (Kogut and Zander, 1992). This problem is applicable to start-ups, as they often to lack the business knowledge, networking skills and ambition to make their business successful (Van Weele et al., n.d.).

Next, we argue how the four support mechanisms that incubators can improve these conditions and enhance start-up performance under different conditions of meeting and mating. Moreover, we discuss the empirically found effects on performance.

Methods

The paper applies these insights in an agent based model that simulates the number of relationships between start-ups and an investor as a function of combination of support mechanisms and ecosystem conditions that represent different problems. The relationship between start-ups and investors is a suitable case as these relationships are primarily established through the social network (Shane and Cable, 2002; Fritsch and Schilder, 2008). By using an experimental design we can precisely estimate how much each mechanism contributes to start-up performance and overcoming weak network problems under different conditions in the ecosystem. A histogram of the data revealed that the dependent variables are distributed in a peculiar way. There were 28616 simulations that yielded zero investments. The remaining 68584 simulations yielded between one and 96 investments, that were distributed according to a bimodal distribution (e.g. it has two peaks), which could indicate that there are specific factors that substantially increases the number of investments.

Further, to explain this distribution, we fitted a zero inflated negative binomial regression model. The zero inflated negative binomial regression model consists of two parts. The first part is a binary logit model and predicts if there are zero investments (e.g. network problem) or not. The second part is a

negative binomial model that predicts the investment count. It is conditional on the binary logit model part. As independent variables the models contained the levels of the independent variables plus two-way interactions that are of theoretical influence.

Results and conclusion

Overall, the results suggest that incubators can be effective tools in preventing weak network problems, especially when there is a paying it forward culture. However, this leads to an ecosystem with a limited amount of transactions that are mainly concentrated in incubators. When there is a viable network, institutional conditions in the ecosystem like a paying it forward culture and the level of co-operation mostly drive the number of investment deals in a system. The only support mechanism that disproportionally benefits incubated start-ups is a shared infrastructure. Direct support can give an a small boast to ecosystems where there are already many transactions, but it does not benefit incubated start-ups more than other start-ups. There is no theoretical effect from field building.

Theoretically, this paper contributes to a theoretical understanding of how the mechanisms employed by incubators and similar intermediaries operate under different ecosystem conditions. Incubator managers can use these results to further optimize their strategies, while policy makers gain more insights in the role of incubators as system builders.

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11.2.2 Is there a pathway towards more complex, long-term collaborative projects? The case of the Competence Centres Programme in Czechia

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Keywords: science-industry collaboration, science-industry partnership, competence programmes programmes, research funding

Relevance

Sectoral cross-fertilisation through science-industry links is often considered an important competitiveness factors (Cooke 2001, Etzkowitz and Leydesdorff 2000), especially in industries where technological innovations tend to rely primarily on the STI mode (Parrilli, Heras 2016). To overcome relevant market failures, national research and innovation policies introduce measures to stimulate collaborative activities of research organisations and private companies. Facilitating interaction of varying maturity, public support takes various forms, from innovation vouchers to highly complex competence centres programmes. While innovation vouchers focus on links initialisation and short-term bilateral collaborative projects rather result in dedicated, single-use product/process innovation, the competence centres programmes are a policy instrument focusing on formation alliances of actors that undertake both fundamental and applied research creating knowledge of more general application potential. In Czechia, a whole sequence of support programmes has evolved in the last decade. Therefore, an investigation if the policy has succeeded in entering a pathway towards more complex collaborative projects becomes strongly relevant evaluation element.

Research aim and questions

The Competence Centres (CCs) Programme was introduced in Czechia in with a goal to concentrate critical RDI capacities in priority research directions and a mission to improve the competitiveness of Czechia. In contrast to support measures stimulating joint science-industry projects in order to convert short-term effort in often narrowly defined product or process innovation, the CCs aim to establish permanent relations in virtual RDI centres by combining academic excellence with industrial and public needs. Evaluating the CCs Programme, the paper aims to characterize a qualitative progress in collaborative research projects from simple bilateral actions towards complex CCs. We aim to find the main “value-added” of the CCs Programme (if present), e.g. main qualitative differences of the CCs in comparison to previous programmes supporting science-industry cooperation. The paper contributes to debates on importance, suitability and impacts of more complex programmes for development science-industry links, especially with respect to a transfer of the best practices to innovation followers with lower absorption capacity of the business sector (Biegelbauer 2007) and inherited deficiencies in science-industry linkages (Marek, Blažek 2016).

Theoretical Framework

The paper is based on an evolutionary approach (e.g. Boschma, Martin 2012), according to which companies are constantly innovating in order to maintain or increase their competitive advantage, building on general innovation systems framework (Lundvall 1992). In this sense, collaborative knowledge production evolves towards “Mode 2” focused on mutual integration of university research and business R&D (Gibbons et al 1994). CCs combine academic excellence with the needs of the business sector and focus joint research on areas of high innovation potential. They differ from other collaborative projects by higher levels of capability required to participate and an increasing share of fundamental research (Arnold et al 2004). In this context, we can consider the CCs as the highest

form of collaborative projects, i.e. the end of a succession of joint projects beginning with innovation vouchers.

Methodology

Our analysis is based on a combination of a questionnaire survey, in-depth interviews with managers of CCs and a quantitative analysis of collaborative projects recorded in the RDI Information System. The questionnaire survey was addressed to all institutions involved in CCs. We contacted 330 participants, apart from the managers selected for in-depth interviews and received a significant number of responses, reaching 46%. There were at least two respondents in each of the 34 competence centres. The questionnaire survey was used to get information on constitution of project consortiums, formulation of strategic research agendas, projects implementation, and projects impacts. Structured interviews were carried out with representatives of 10 CCs. They aimed to deepen our insight into relationships evolution or functioning and clarify information acquired from the questionnaire survey.

The quantitative analysis of collaborative projects recorded in the RDI Information System was carried out to track the pathway from short-term bilateral projects towards more complex projects on the system level, and also to show changes in research topics and projects targets.

Discussion

The investigated CCs mostly follow-up previous collaboration of research organizations and enterprises. According to the questionnaire survey, formation of a consortium was in 88% built on existing cooperation, often, but not exclusively, supported by public sources (programmes Research Centres 1M, ALFA, TIP, TANDEM, etc.) and was rather of a bilateral nature. Therefore, a kind of institutional lock-in can be found, hindering cross-fertilisation that stems from diversity of newcomers. Knowledge and trust between partners predominate over other factors when the decision on composition of the consortium is made.

The initiating role for the new cooperation is, according to the respondents, very weak. However, data from the RDI Information System show that in average one-third of the consortium members did not cooperate with research organisations or other private firms before entering the CCs (this ratio varies from 0 to 58%). The newcomers were exclusively small and medium-sized enterprises. Thus, previous cooperation between private companies and research organisations has not only been formal in nature (and captured in the RDI Information System), but some degree of direct or indirect personal awareness is seen as vital newcomer to be trusted.

The formation of the consortium was initiated by its later leader (almost half of the cases) or a narrow group of 3-4 key partners (a quarter of cases) that formed the core of the project team. Then, depending on the needs and focus of the CC, they addressed other potential members (businesses and research organisations) on the basis of their specialisation and previous experience with cooperation.

The main recipients play a crucial role in a consortium formation process. They have already cooperated with the majority of partners. New cooperation is established almost exclusively for other participants with complementary expertise. New partners are dominantly business companies. The structure of participants can be seen as a hierarchy of three levels – the first level is formed by either a leader or a small group of core organizations, which are central nodes in cooperative networks (consortia). The second level consists of a group of primary partners with whom the leader has a direct and personal experiences. The third level of the participants are recruited from the individual contacts of the second group and do not have direct links with the leader (leaders). They participants are in a partially subordinate position within the consortium.

The survey revealed that the most important motives to participate in the CCs were development of own research capacities, access to knowledge/facilities of partners and innovation of own products/processes. Development of own research capacity was the main motive for enterprises as the

main recipients. Innovation of products/processes was less important for them. On the contrary, enterprises in the position of other participants targeted more on innovation. In the case of other motives, research organisations have repeatedly mentioned the setting up of long-term cooperation with industry partners and the creation of competent working groups, acceleration of research and its transfer into practise, or interest in the complementary knowledge existing in the research field.

CCs research activities were defined in the Strategic Research Agendas, which usually integrate current research topics of individual partners. According to the interviews, needs of participating companies were decisive in the formulation of the Agenda. However, the survey shows that the Agenda was rather formulated by research organisations, regardless of their position in the consortium. Interviews also showed that the development carried out by enterprises tended to shift from the strategic nature to the current requirements of production. On the contrary, research organisations inserted into the Agenda research topics that were beyond the direct commercial applications. Therefore, activities of science and industry respectively lie to some extent in parallel rather than permeate each other. This may reduce system-level benefits of activities undertaken by the consortia.

The survey indicated the functional division of labour among the members of the consortium, which corresponds to the nature of cooperation. About a quarter of the participants (mostly research organisations as main recipients) participated across the centre's activities. On the other hand, answers related to purely bilateral nature of cooperation had the same frequency. The most frequent (half of the respondents) characterized the cooperation as multilateral in specific topics (i.e. usually within one work-package). The other participants were involved into competence centres activities exclusively through bilateral cooperation with the leader.

Multilateral cooperation on specific topics is also confirmed by the interviews – individual partners are integrated into work packages on the basis of their research focus; with multilateral cooperation among the partners within work packages. As for other participants, regardless of their form, participation in the competence centres is more frequent in the form of bilateral cooperation with the consortium leader. This can be considered a form of subcontracting and it can be assumed that the know-how is rather drained from these participants.

In comparison with other programmes supporting science-industry collaboration, the CCs Programme is perceived positively as the most important programme the recipients participate in (69% of respondents). Only 7% of respondents reported that this was the only programme to get involved. The programme is therefore designed primarily to organisations that already have experience with inter-sectoral collaboration.

The effect of the CCs on development of cooperation among actors from different institutional sectors seems to be very positive. However, the perception of the specific sectors varies slightly – while 91% of companies consider that cooperation development with research organisations in the consortium is of medium or high importance, the share of research organisations giving the same weight to cooperation with participating companies is only 82%. The same applies to the potential for ongoing cooperation after the project termination, where 97% of enterprises (cooperation with research organisations) and 88% of research organisations (cooperation with enterprises) expect cooperation follow-up after the completion of the project. The impact on barriers to cross-sectoral cooperation is therefore substantial in the CCs. Data from the RDI Information System show that there is now at least 18 follow-up collaborative projects dealing with partial research topics that emerged during research carried out within CCs.

Besides the benefits in relationship consolidation, the Programme allows for more strategic research orientation and higher interdisciplinarity than other existing or previous programmes. Half of respondents consider these assets to be highly significant and 4/5 to be at least of moderate importance.

Compared to previous programmes, the CCs concentrate research capacities of research organisations and private enterprises and allow to build a widely applicable knowledge base, which makes it

possible to cope with additional challenges apart from those originally foreseen. At the same time, it makes the evaluation exercise more complex fand call for specific evaluation framework in order to capture a whole spectre of effect stemming from the CCs.

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12 Open Track

The Open Track covers a broad spectrum of research questions, but with a specific emphasis on future challenges for STI policy research. The following topics are encouraged:

The future of science – society relations

- Responsible research & innovation – new concepts, experiences and policies
- New forms of participation in the governance of science and technology
- Citizens, scientists, industry and policy-makers: the role of different stakeholders in STI policy making
- Gender-specific policies as drivers of Science, Technology and Innovation

The challenges of globalized knowledge production

- Knowledge production between global networks and local skills
- The future of collaborative R&I: New arrangements between private and public institutions
- New forms of entrepreneurship and pathways for firm growth
- Globalized knowledge production and economic development

Digital science and innovation

- New institutional frames for digital science
- The future of science 2.0 and policies towards digital research
- ICT-enabled innovation in manufacturing and services

New concepts for STI policy

- New innovation system concepts
- Agency and entrepreneurship in STI policy making
- Transformative STI policy
- Transformative innovation in mature industries
- Smart STI-policies for manufacturing SMEs

The governance of STI policy – new players, new processes, new instruments

- STI policies and new patterns of innovation: Social Innovation, Open Innovation, User Innovation, Frugal Innovation
- New mission-oriented STI policies: Triggering foundational breakthrough research at the service of society
- Policy coordination and next-generation policy instruments
- New forms of STI policy advice

New indicators and approaches for assessing the impact of STI policy

- Measuring the dynamics of STI systems
- Beyond established STI policy evaluation and impact assessment methods
- Modelling STI system dynamics

The three Sessions that emerged from the Open Track were chaired by Karl-Heinz Leitner, Susanne Giesecke, Anna Wang, and Michael Dinges, all from AIT Austrian Institute of Technology, Center for Innovation Systems & Policy.

12.1 Session 12.1: The role of Scientists

12.1.1 Attracting the best and the brightest: policies and mobility behavior in the academic 'war for talent'

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Keywords: International mobility, Mobility behaviour, Global war for talent

International exchange has characterized the academic community for centuries (Charle & Verger, 1994). Students have moved to other countries to attend classes at universities with a good reputation and researchers have visited each other to collaborate. Today, the field of higher education is increasingly international. Students are becoming more internationally mobile (Findlay et al. 2011; EP-Nuffic 2015), researchers are increasingly collaborating internationally (e.g. through co-publications (Kamalski & Plume 2013)) and international mobility has become a very common phenomenon among researchers (Børing et al., 2015).

Policy makers at the European, national and university levels increasingly focus on the process of internationalization within the field of higher education. It is regarded simultaneously as an opportunity (brain gain and diffusion of knowledge), a threat (brain drain) and a necessity (ongoing globalization) for their future development. A common aim at the national and university level is to attract the best and the brightest researchers in order to make their respective economies and institutions competitive in a perceived global 'war for talent'.

On various levels policies are put in place in order to raise the attractiveness for good researchers and to prevent a brain drain. This raises the question how researchers' mobility behavior can be influenced and to what extent policies may raise the attractiveness of countries and their institutions.

In the academic and grey literature scholars have studied the mobility behavior of researchers in various ways. In most studies mobile researchers are asked in surveys about their prime motivation to make an international move (Franzoni et al. 2012; MORE2 2013; Conchi & Michels 2014). Their academic career and research come out as the most important reasons to be mobile. Personal reasons and terms of employment are significantly less important. Furthermore, other push and pull factors are in play to describe the mobility behavior of researchers. Geographical and cultural proximity is considered a good predictor of mobility behavior (Franzoni et al. 2012; Conchi & Michels 2014; Appelt et al. 2015). Economic decline is a push factor for many researchers, as shown by the recent researcher migration flows from Italy, Spain and Greece to countries in West and North Europe (MORE2 2013).

However, despite the attention for the motivations and the push and pull factors, there is still little understanding of how different factors for international mobility interact. The interplay between the more important and less important factors is rarely addressed. Furthermore, policies to stimulate international attractiveness are seldom part of the studies on mobility behavior. In this paper we will study the way in which various motivations of researchers to decide to be internationally mobile interact and the role internationalization policies play in these motivations.

We study the motivations for international mobility in the Dutch policy context. This context is characterized by several politicians, policy makers and university directors who have showed their concern about a rising war for talent and the perceived Dutch inability to attract and retain the best researchers. To prevent this from happening universities have set goals to attract more international staff. Although universities differ in their mobility policies, the common measures can be classified as:

- instruments to explicitly promote international mobility, such as international recruitment, international offices to offer mobility support, and financial support for short term outbound mobility;
- instruments for the wellbeing of international personnel, such as cultural awareness and spousal programs;
- more general human resources instruments to select and develop the most talented researchers, such as a tenure track system and incidental starting packages for new professors.

The national government has implemented a number of general measures to attract highly educated foreigners and a number of specific instruments to stimulate mobility. Two general measures are the international ‘marketing’ or ‘branding’ of The Netherlands as an attractive destination for highly skilled workers and a significant tax benefit for highly educated foreigners. More specifically the national funding agency is expected to promote inbound mobility, by means of the national excellence funding schemes. To promote outbound mobility the funding agency has implemented a grant that is only eligible for young researchers who want to do research abroad for up to two years. Short term incoming mobility is stimulated by means of a visitors grant for travel and accommodation expenses.

In order to understand the interplay of different factors of the mobility behavior of researchers and the role of internationalization policies, we make use of three data sources. First, we performed a document analysis of internationalization policies at the European, national and university level. Second, in addition to the document analysis, we interviewed 12 policy makers, covering almost half of the present Dutch universities, about their experiences with a global war for talent. We selected faculty policy makers that are said to experience the strongest competition on the academic labor market. And third, we interviewed 19 foreign researchers that have come to work in The Netherlands in the last twelve years. They were asked about their decision making process concerning their move to their current research institution in The Netherlands. They were asked about their experiences with internationalization policies as well.

Our results suggest that factors influencing mobility behavior are both intertwined and segmented. The reasons for researchers to be mobile form a complex iterative process involving several types of motivations at once. International mobility occurs in a ‘window of opportunity’ where every factor falls in place or it occurs when one of the factors is so dominant that other factors are trumped.

We distinguish three choices a mobile researcher makes before deciding to move abroad. They do not make up a chronological or linear process, but are, in practice, entangled. We find that in these three choices different factors play a more dominant role or are of minor importance.

- Researchers choose a specific research group they want to work in. For this choice the most dominant factor is the content of the research position and the circumstances in which the research shall be carried out (with excellent new colleagues, state of the art facilities etc.). Besides these dominant factor, important considerations involve the career of the researcher (tenure/job security, better prospects, advancing the career ladder), personal considerations (can I see myself and my family living in this city?) and other conditions, that are often related to the country

the research group is in (salary, science system and research funding, child care, mobility support provided by the new employer etc.).

- Researchers choose a country or region they want to work in. Although the most important choice for researchers is their choice for a specific group, the choice for a country or region is a crucial part in their decision making process. In most cases researchers have an implicit list of suitable countries to work in. This preference list only manifests itself once a job opportunity occurs. The partner, children and other family are important to define the suitability of a country, next to the culture and living conditions and the academic reputation of the (national) science system.
- Researchers choose to be internationally mobile. Although the international mobility of researchers is rising, the decision to leave one's country is still a difficult one. Researchers choose to go abroad for several reasons: international experience is an enrichment of the professional and/or personal life of the researcher (especially for early career researchers); if a researcher wants to advance in her career it is sometimes necessary to move abroad; and, most important, international mobility is dependent on the job opportunities that pass by.

Furthermore, we find that the global war for talent and the academic labor market is segmented. In general terms the process of supply and demand is segmented by disciplines and by positions. This means that academic disciplines all compete with different types of organizations over research talent. Similarly, the competition for excellent and recognized professors is different (war *for* talent) than the competition for young and inexperienced postdocs (war *between* talent (Van Arensbergen 2014)). The former can be described as a seller's market, the latter as a buyer's market.

The question remains to what extent the decisions of researchers are perceptive to specific internationalization policies. We find that some policy instruments are having a positive effect on the considerations of mobile researchers, for instance the tax benefit is an often mentioned compensation for wages that are considered relatively low. Other policy instruments are of no significant importance. The national excellence funding schemes do not offer the prospect of a stable and certain academic career for which a talented researcher wishes to migrate. Other measures are only appreciated after they have made their decision. Most of the new international researchers are unaware of the support universities offer when making their decision, and only experience the benefits from the support after their move. Nevertheless, the mobility behavior of researchers can only be influenced to a certain degree by policies explicitly directed at attracting foreign talent. More important factors are the presence of high profile researchers and unique facilities, or general factors like the reputation of a university, the standard of living, a researcher's social and cultural preferences and the proximity to family and friends. All those factors can at most be influenced indirectly through policy measures and are long term investments.

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12.1.2 When the going gets tough: Exploring migration intentions of doctorate holders to industry or abroad

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Keywords: doctoral degrees, labour market, industry employment, foreign employment

Research questions

The paper focuses on the labour market for employees with a doctoral degree in their endeavour to safeguard research opportunities. Roach and Sauermann (2010) find that doctorate holders are academically trained persons to perform research. The relevance of migration of doctorate holders lies especially in its enhancement in the flow of knowledge across different economic sectors, and in particular in the context of university-industry interactions (Lenzi, 2010). Job migration, therefore, drives knowledge flows (Agrawal et al., 2000). Various scholars focused on aspects of migration from university to industry. Their potential relevance for industry is difficult to underestimate because innovative activities in industry have become more science-based and information intensive, and more open to external knowledge flows (Chesbrough, 2003). Moreover, doctorate holders maintain ties with the academic community for quite some time, keeping them informed on the most recent techniques and knowledge (Sauermann and Stephan, 2009).

In the past two decades, policy makers stimulated universities to enlarge opportunities to start a doctoral education in the hope the acquired knowledge and skills would spill over to other sectors of the economy, notably the industry. An aspect of hiring doctorate holders is that skills and tacit knowledge are embodied in them (Crespi et al., 2007, Roach and Sauermann, 2010, Fritsch and Krabel, 2012). Due to this tacit knowledge the mobility of researchers – and doctorate holders as the highest skilled subset – is an efficient way to transfer knowledge (OECD, 2001). The logic underlying this reasoning is the creation of a knowledge-based economy that is able to cope with increased international competition. But this transfer is deemed to be more valuable for the country that invested in the education of the doctorate holder if those who have successfully completed their doctoral trajectory can work in a research capacity and remain in the home country. Otherwise the acquired knowledge embodied in the doctorate holder is not applied in research and/or flows out of the country. To examine whether both conditions are met, the perspective of the individual doctorate holder is analysed.

Transposed to the individual context, we presume that recent doctorate holders, having the ambition to develop a research career in the home country, encounter at least two challenges when they enter the labour market. First, there is an ever growing number of people with a doctoral degree, while the number of positions in university grows less. Because of this imbalance between supply and demand, most doctorate holders are obliged to make a career switch to other labour market segments (Dany and Mangematin, 2004). The dominance of industry in the total economy implies that a large share of them are stimulated to take a job in this sector. But what happens when doctorate holders who have the ambition to continue their research activities after their doctorate do not find enough research jobs in industry? Or what happens when they prefer fundamental research at universities over more applied, industrial research? Second, the labour market in Belgium has inherent geographical limitations: not all scientific disciplines are equally in demand in university and industry.

Doctorate holders with a research background in less popular scientific disciplines will be more often confronted with an insufficient number of job offers. To examine how doctorate holders cope with these challenges, we study a cohort that is working abroad and analyse what factors determine their choice to move abroad.

Method

The paper builds on the large scale survey of the careers of doctorate holders for Belgium. In 2010 the number of new doctorate graduates in Belgium rose to a peak of 2,126 (Eurostat, 2013). We use path analysis with two logistic regression models to test our research questions. In the first part of the path model we test the propensity of doctorate holders to work in one of two sectors (industry versus university). The second part of our model tests the propensity of doctorate holders to work abroad. Both parts take into account three groups of covariates to check for potential influences on both propensities. The first group consists of person-related characteristics: gender, age, marital status, family composition and scientific discipline of the doctoral degree. The second group of covariates is related to job specific elements such as salary, type of labour contract (permanent or temporary), research capacity, and previous sector of employment. The last group focuses on general labour market trends: the evolution of GDP/capita and GDP/capita growth in Belgium. Finally, we model the relationship between both propensities, more concrete we examine if the choice for a specific sector influences the likelihood that a person goes abroad to find a research job.

Main findings

Most factors in the first part of the model have a significant positive impact on the likelihood to work at a university. Personal, job-related and macroeconomic factors affect the sector of employment. Especially the positive influence of performing a research job on university employment is important in the context of our investigation. Although there is a sustained demand for scientifically skilled workers in industry, especially for researchers with a degree in the natural sciences or engineering, industry might hold less research opportunities than universities.

The second part of the model shows that doctorate holders who move to another country are more often employed as a researcher and at a university, certainly those that do not have a permanent position. Macroeconomic circumstances also determine why doctorate holders search for opportunities abroad. An increase in GDP reduces the likelihood to move to another country.

Finally, linking both parts of our model, we observe a strong relation between a preference for research, working in university and going abroad. When a doctorate holder prefers to stay in research, (s)he chooses to work at a university and (s)he is more inclined to accept employment abroad in this sector. This could be an indication for a deadlock within the labour market, if a person strives to develop a research career and is confronted with a suboptimal level of job offers, (s)he can escape this obstacle by working in a foreign country.

Conclusion

From a policy perspective it is encouraging to see that doctorate holders with research ambitions have opportunities in industry to find a research job. This finding proves that skills and knowledge acquired during doctoral training can be used outside university. This is in line with the envisioned policy: it was never the purpose of policy makers to offer more students the possibility to start a doctoral education and at the same time create more jobs in academia. But nevertheless doing research might still be easier at university than in industry. This implies that the outflow of doctorate holders from university is hindered by a lack of research jobs in industry or a pronounced preference of doctorate holders for academic research. This takes us to the second point of our analyses: can working abroad be a coping strategy to stay employed in university and thus in research? Answering this question shows that doctorate holders who want to develop an academic career are more inclined to go abroad in order to escape limited domestic career opportunities. In terms of the brain drain debate we can state that we need more brain drain from universities to industry and less brain drain from domestic to foreign universities.

When high-skilled workers move abroad because they cannot fulfil their research ambitions in their home country, this has a negative impact on the human capital of a country. This loss could be attenuated by luring them back to their home country with attractive research opportunities not only in academia but also in the business sector. The Back to Belgium Grants of the federal Science Policy to encourage talented researchers doing R&D in a foreign research centre to return to Belgium are an example of how governments can manage their human capital.

12.1.3 Sourcing Upstream or Downstream? Exploring Knowledge-Based Antecedents of Academic Entrepreneurship and Technology Transfer

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Keywords: spin-off, licensing of IPR, academic entrepreneurship, technology transfer, commercialization

Introduction and Aim

Academic researchers often contribute to new technological developments and economic growth through inventions and advanced technologies (Shane, 2004; Clarysse et al, 2011). These technological contributions have often led to the formation of companies - academic spin-offs - and to the transfer of technology to nonacademic actors - patent licensing. Research on academic entrepreneurship has investigated the antecedents of these different types of commercial contributions from scientists, suggesting that information asymmetries and idiosyncratic prior knowledge are at the heart of the individual capacity to identify and exploit entrepreneurial opportunities. In particular, entrepreneurship research has convincingly argued that combining 'technological' and 'market' knowledge favors entrepreneurial behavior by enhancing the capacity to identify and exploit entrepreneurial opportunities (Shane & Venkataraman, 2000).

Drawing on this stream of research, we propose two contrasting knowledge-based antecedents of academic entrepreneurship: (i) 'upstream knowledge sources', which refer to insights for commercial opportunities gained as a result of outstanding scientific contributions (Zucker et al., 1998); and (ii) 'downstream knowledge sources', which refer to knowledge gained through direct interaction with potential research beneficiaries (Shane, 2000). In this study, we examine the extent to which these two knowledge sources exert a significant influence on scientists' commercialization behavior. Our main contention is that the influence of upstream and downstream knowledge sources is contingent on the type of commercialization pathway: firm creation and technology transfer.

First, we argue that firm creation (i.e. spin-offs) is dominantly associated with upstream knowledge sources, while technology transfer (i.e. patent licensing) is mostly associated with downstream knowledge sources. Regarding the former, scientists who have significantly contributed to breakthrough scientific discoveries have been found to expand the pool of inventions with potentially high commercial value, and tend to perceive firm creation as an achievement that reinforces academic reputation (Landry et al., 2006; Lowe & Gonzalez-Brambila, 2007). In contrast, we contend that scientists who have built strong direct interactions with research beneficiaries are particularly likely to

develop inventions which are closer to market applications, and therefore more readily transferable and suitable for arm's length negotiations in markets for technology (Jensen & Thursby, 2001).

Second, we argue that the interplay between upstream and downstream knowledge sources is likely to work differently for the two commercialization pathways analyzed in this study. We expect a complementary relationship between the two sources of knowledge in the case of firm creation, such that downstream sources of knowledge are expected to positively moderate the relationship between upstream knowledge sources and firm creation. The rationale for this claim is that upstream sources of knowledge are likely to enhance the chances of opportunity identification, while downstream sources enhance the capacity for opportunity exploitation, by providing a greater understanding of the context of application (Gittetlman & Kogut, 2003). Conversely, we expect a substitution effect in the case of technology transfer, such that each knowledge source may compensate for the absence (or low presence) of the other. For instance, scientists with a remarkable record of scientific contributions will attract interest in their inventions from potential buyers by virtue of their academic reputation, regardless of whether these scientists exhibit little or no direct interaction with the potential beneficiaries of their research.

Research Methodology

This research combines data from a large scale survey of scientists from the Spanish National Research Council (CSIC), which is the largest public research organization in Spain, covering all fields of science. We draw upon information from 1295 respondents to a survey conducted on a population of 3,199 researchers (40% response rate). Additionally, we have collected data from two secondary sources: administrative information on past engagement in knowledge transfer activities at the individual level; and bibliometric information, drawing from publications and citations from the Web of Science.

Information on the different commercialization activities in which scientists were involved over the period 2009-2011 - i.e. spin-offs and licensing of patents - come from survey responses. About 2.5% of scientists in our sample report having engaged in firm creation over the period examined, while about 14% report having succeeded in licensing technologies to third parties. These constitute the dependent variables for this study.

Our key independent variables capture the two knowledge-based antecedents examined in this study: a) the extent to which scientists have been able to contribute with breakthrough publications (i.e. proportion of articles included in the 5% top cited publications in their respective fields) over a period of 5 years prior to the survey ('upstream knowledge sources'); and b) the extent to which scientists have engaged in R&D contracts and consulting activities over a period of 5 years prior to the survey ('downstream knowledge sources').

We consider a wide number of control variables, which include variables accounting for the individual propensity to engage in commercialization activities, such as: previous involvement in patent licensing, research motivations (intrinsic and extrinsic), and demographic features (professional status, gender, and age). We control for disciplinary field of scientists, taking into account that our research includes scientists from areas ranging from Physics and Chemistry or Engineering, to Social Sciences and Humanities. Finally, we conduct a statistical analysis using a bi-variate probit regression model to test our propositions, given that firm creation and technology transfer (our two dependent variables) cannot be considered as two uncorrelated events.

Preliminary Results and Conclusions

Our study advances entrepreneurship research by examining the effects of two contrasting sources of information and knowledge on scientists' commercialization activities. We find strong empirical support for the proposition that both upstream and downstream sources of knowledge are strongly associated with commercialization. However, our findings challenge some widely-held assumptions in entrepreneurship research.

First, we find that downstream sources of knowledge exert a more pervasive influence on scientists' commercialization activities, having a significant and positive association with both firm creation and technology transfer. This contrasts with our findings that upstream knowledge sources only happens to be positively associated with firm creation. Thus, rather than supporting the science-push logic as a dominant paradigm for academic entrepreneurship, our results indicate that greater interaction with research users and beneficiaries dominantly shape commercialization action among academics. These results provide greater granularity about the importance of individual knowledge-based antecedents on entrepreneurship. We find that, while prior technological and market knowledge are relevant explanatory factors, their relevance is contingent on the type of commercialization behavior examined. Firm creation is more dependent on technological knowledge, while market knowledge seems to exert a more horizontal influence on multiple forms of commercialization action.

Second, we find no evidence of a complementarity relationship between upstream and downstream knowledge sources. In this sense, our findings provide support for the existence of three entrepreneurial archetypes of academic scientists. The first one corresponds with the profile of a 'star scientist', exemplified by scientists who exhibit outstanding contributions to science as the knowledge-base antecedent to frame entrepreneurial opportunities. The second archetype is aligned with the model of the 'engaged scientist', represented by scientists who identify and act upon entrepreneurial opportunities as a result of their involvement in interactions with research beneficiaries and user communities. And finally, the profile of the 'bridging scientist', as scientists who engage in entrepreneurial action by drawing upon both upstream and downstream knowledge sources simultaneously, exhibiting a pattern of outstanding contributions to science and a frequent interaction with research beneficiaries.

In sum, these results advance existing research on the role of a knowledge context approach on academic entrepreneurship, by expanding our understanding of how differential knowledge sources shape individuals' decisions to engage in firm creation and technology transfer. Moreover, the three proposed archetypes of academic entrepreneurs highlight the heterogeneity of knowledge–based antecedents of commercialization behavior within the scientific community.

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12.2 Session 12.2: Foresight

12.2.1 The Role of Foresight in Shaping the New Production Revolution

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Keywords: Potential roles and impacts of foresight, Public policies, Decision-preparatory processes, Participatory vs. expert-based prospective analysis, S&T vs. systemic focus, The next production revolution, Finland, Germany, UK, US

Prospective analyses can be conducted in various forms to pursue different purposes. The best-known forms include forecasting, critical (or key) technologies exercises, foresight, strategic planning in the private sector and indicative national planning. This paper focuses on foresight. To highlight its major distinctive features, foresight processes are based on the assumption that the future can be shaped by deliberate present-day actions: at least some unfavourable trends can be altered (redirected, slowed down, or stopped altogether) to some extent and new, desirable ones can be set in motion. Foresight, therefore, explores different possible futures. In uncertain times, thinking in terms of multiple futures is a necessary precondition for devising strategies to cope with unexpected developments.

To realise foresight's potential to shape the future, major stakeholders need to be involved not only to identify, but also to assess, the major (current, emerging and future) trends, consider a set of feasible futures, and select the most favourable one. In this way, values and interests play a decisive role in foresight processes, and thus it is crucial to make the entire process inclusive and transparent. Given its participatory nature, foresight can incorporate different perspectives when exploring possible futures and bring to the fore a range of relevant influences and impacts of the issues in question. The process itself can have systemic impacts: due to intense dialogue, existing networks of major actors are likely to be strengthened, new ones created, a future-oriented way of thinking reinforced. The novel, participatory methods also reshape the overall decision-making culture in the affected policy domain.

The next production revolution (NRP) – also called Industry 4.0 – is likely to trigger complex changes given the interactions of new technologies (such as 3D printing and scanning, the Internet of Things, machine-to-machine (M2M) and person-to-machine (P2M) communications and interactions, and advanced robotics); new materials (in particular bio- and nano-based materials); new processes (for example, data-driven production, artificial intelligence and synthetic biology); as well as new business models (exploiting mass customisation, sharing and the platform economy, and servitisation of manufacturing). These changes would affect research, technological development and innovation activities (direction of search, allocation of funds, commercialisation, ethical concerns); the labour market (via job creation and job destruction); income distribution and well-being; skill requirements (and thus formal training via the education system, retraining, life-long learning); and, several fields of regulation (for instance intellectual property rights, privacy, security and safety investment). Furthermore, digitalisation can be a major enabler of the circular economy (for instance, via mass customisation, smart logistics, smart cities, and smart homes). The policy implications of the NRP are so wide-ranging that it would be difficult to mention a major policy domain, which will be untouched by the sorts of sweeping changes noted above.

The need for policy orchestration is, therefore, rather strong. Foresight would assist policy-makers in dealing with these complex changes and challenges in three ways. First, it would facilitate a systemic approach, consider multiple futures and draw on the diverse set of knowledge and experience of participants. Furthermore, a strong sense of ownership among participants could work as an additional

factor to keep up the momentum of orchestrated policy design and implementation. Second, the NPR is likely to increase uncertainty. Yet, a shared vision, developed – and thus “owned” – by the major stakeholders participating in a foresight process, can reduce uncertainty. Third, the NPR is also likely to induce systemic changes, for instance, in the form of emerging innovation ecosystems or radically overhauled national, sectoral or regional innovation systems. A transformative foresight process, aimed at considering and assisting these systemic changes, can contribute to reshaping the prevailing power structures (which might constrain the desired changes) and rejuvenating policy rationales, the overall decision-making culture and methods, and thus the efficacy and efficiency of policies.

Prospective analyses can take many different forms, varying in their specific aims, thematic coverage, geographic scope, focus, methods and time horizons. They also vary in their breadth of thematic coverage (a focus on science and technology [S&T] issues versus a broader focus on innovation and production systems) and their breadth of participation (confined to topic experts versus broader participation). Combining these distinctions, four different archetypes of prospective analysis will be identified – and illustrated by short descriptions of actual cases – in the paper.

We also consider the potential roles of foresight in shaping and implementing polices. These include: providing the foundations for more robust policies; fostering systems thinking; new framing of policy issues; turning long-term concerns into urgent policy priorities; facilitating the mobilisation and alignment of key stakeholders; supporting policy co-ordination.

The potential roles and expected impacts will vary by type of prospective analyses. Participatory processes mobilise a wider set of knowledge, experience, aspirations and worldviews compared to an expert-based project. Hence, more novel and unconventional ideas can be expected, which can be better substantiated given the diversity of viewpoints, since ideas would be more thoroughly tested and contested from various angles. Furthermore, a deeper, more thorough understanding of major long-term challenges and their social, environmental and economic repercussions is more likely to stem from participatory processes. Policies, therefore, would be better substantiated and their credibility and legitimation strengthened. A wider set of policies could be more consciously orchestrated, increasing the effectiveness of their implementation.

Clearly, prospective analysis focusing on innovation and manufacturing systems would consider a broader set of issues than S&T-centred projects, with benefits for both policy preparation and implementation. Given the complex issues – interrelated technological, economic, societal and environmental opportunities and challenges – brought about by the NPR, a systemic approach seems to be more appropriate as a foundation for devising policies aimed at tackling these far-reaching and profound changes. Yet, in certain contexts, an S&T-centred prospective analysis can also be useful, but it should be clear from the outset that different and only more limited benefits and impacts can arise from this approach.

The systemic view of manufacturing has confirmed that successful innovation processes exploit many different types of knowledge. These pieces of knowledge are generated by various actors and activities, and hence rarely – if ever – are available inside a single organisation. It is, therefore, a major policy task to support the generation, diffusion and exploitation of all types of knowledge, as well as various types of collaborative efforts among different types of partners, across sectors, countries and world regions. The blurring boundaries between manufacturing and services reinforce this conclusion.

To reap these potential benefits of foresight, several preconditions need to be created:

- It is essential to embed foresight appropriately in decision-making processes to make it effective. This requires changes to both organisational structures and strategy formation processes.
- Foresight processes need to be orchestrated with policy cycles to ensure that futures intelligence is available at the right moment in time.

- Foresight is about more than delivering a report. The participatory elements of foresight are demanding in terms of both time and resources, but they cannot be spared: the interactions among stakeholders and decision-makers are essential for triggering change processes in policy governance, society and economy.
- A sustained effort is needed to create the competences and a conducive environment for conducting foresight effectively and efficiently. One-off exercises are unlikely to yield the expected impacts on policy-making. It takes time, and possibly specific measures, to nurture and widely diffuse future-oriented thinking.
- Some form of institutionalisation – through regular programmes and/or the establishment of dedicated organisations – is needed to create a foresight culture and thus exploit its benefits in a sustained manner. As electoral cycles tend to be significantly shorter than the time horizon of the issues considered by foresight, this condition is of particular importance.
- Without intellectual autonomy in developing new insights, foresight could not fulfil its key function of pointing to major emerging challenges and opportunities and novel ways to address them.
- Context – in particular the perceived policy needs, the overall decision-making culture, and the domain to be analysed and subsequently shaped – not only matters, but is decisive when planning and conducting a foresight process. A general blueprint for devising and running a foresight process, therefore, would not fit anyone's needs. Learning from experience of others is highly beneficial, but it would be a great mistake to search for a "one-size-fits-all" guide or copy any country's practices, regardless of how successful a certain methodological and organisational model has been in that country.

To sum up, foresight can be a highly useful tool to address the opportunities and challenges triggered by the NPR. Given its participatory nature, key actors are mobilised to form shared views about the future, negotiate their future stakes and interests, and agree on actions aligned to their shared vision. The NRP requires quick and proactive policy-making, as well as better orchestration across different policy domains. Foresight can assist policy-makers by providing foundations for robust policies, fostering new framing of policy issues, as well as translating long-term concerns into aligned policy priorities. Further, policy implementation is likely to be faster and more effective when key stakeholders are involved early on in shaping these policies. Foresight benefits, however, are far from being automatic: the paper considers eight critical factors to achieve those. An astute embedding of a foresight process into policy-making enhances the likelihood of impact, but foresight recommendations are no substitute for policy decisions and actions.

12.2.2 Policy lensing of futures intelligence: connecting foresight with decision making contexts

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Keywords: Policy Lensing, Research and Innovation Policy, Scenarios, Foresight, Innovation Systems, European Research Area

The challenge

Foresight practitioners, both in academic and professional spheres, have developed a wealth of tools, techniques and applications of foresight for forecasting science and technology developments, up to and including technology transitions and innovation system transformations. Futures intelligence, such as scenarios, has proven to be a valuable catalyst for strategic conversations in various stakeholder groups such as universities, research funders, industry and civil society. Futures intelligence holds particular relevance for policy makers active in research, innovation and technology policy. However, the often very rich and complex exploratory scenarios that are incorporating policy as an endogenous element are difficult to translate into policy relevant intelligence. In fact, we have found the literature rather lacking in this regard.

The struggle in connecting futures intelligence to policy making can be read as a basic challenge in foresight: working on futures intelligence has emerged as a way to improve policy shaping, but once it is delegated to professional foresight analysts with attendant quality and quality control, it also introduces a distance to policy making. Whilst independence and methodological rigour is desirable for high quality futures intelligence, bridging this intelligence with the policy context is essential for its use.

Thus, there is a need for amplifying or translating these scenarios with respect to a policy perspective.

With this in mind, in this paper presentation we offer “policy lensing” as a tailored approach to sense making and linking exploratory scenarios to future oriented strategies for policy shapers. Policy-

lensing is an additional step to help transform futures intelligence, particularly scenarios, into a form that speaks to questions and choices faced by policy shapers.

Scenario building as a first step not and end point

Scenario building is one of the most widely established methods to create futures intelligence. Most foresight scholars refer to scenarios as “consistent images of possible futures” (Ringland 2002, p. 2). It is argued that rigorously imagining different future pathways forces us to stretch our mental models and confront our collective and individual clichés, biases (Godet 2001) and anticipatory assumptions (Miller 2007). Furthermore, scenario building is expected to enable organisations to generate projects and decisions that are more robust under a variety of alternative futures (van der Heijden 2005, p. 5) but also to better unlock the potential of the present by reaping the potential of the complexity of our surroundings (Miller 2007).

Part of the benefit of scenario development is expected to emerge through the collective process of developing the scenarios themselves, which has been termed a “strategic conversation” (van der Heijden 2005). Accordingly, in several scenario exercises the development process is deemed as important as the scenarios developed (van Asselt, et al. 2010 p. 29). Benefits that are mentioned most often include deliberation of expectations, forming of shared language and common ground across diverse actor groups, raising awareness about upcoming challenges (da Costa et al 2008) and opening up of perception filters (Schirrmeister and Warnke 2013).

While these benefits may well emerge within the scenario development process the generation of policy actions from scenarios is less obvious. The way the link is conceptualised between scenarios and strategies widely differs for different types of scenarios (van Notten et al. 2003).

Some scenarios already incorporate a certain strategy. Often in these cases one scenario describes an optimum strategy and a desired outcome such as the “Flight of the Flamingos” in the famous “Mont Fleur” scenarios on the future of South Africa (van Asselt, et al. 2010 p.30). This type of scenario is often called “normative” and does not require a specific strategy development phase. Rather, the scenarios can directly be used to discuss strategic options.

In many cases however, scenarios do not directly describe the system at stake but different possible contexts or environments of the system. In some of these cases there is no best or worst case scenario, but all scenarios combine different elements into a consistent image that will be perceived to be positive or negative depending on the readers’ perspective. This type of exploratory context scenario has been widely used to underpin strategic decision making ever since it was introduced by Pierre Whack for Shell in the early 1970s (van der Heijden 2005, p. 3). In these situations, the scenarios create a conceptual wind tunnel where strategies can be tested under various conditions.

The route from the scenario exercise to strategy building or the development of policy actions involves several additional steps (Ringland 2002, p. 185). Most crucially a vision of the organisation’s or systems’ foremost goals, as well as an assessment of the current situation, needs to be developed. In a second step, assets and barriers for achieving this vision can be assessed for each scenario. Depending on the organisation’s attitude towards risk, different types of strategies can then be developed. A robust strategy will e.g. cater for several scenarios whereas a high risk/high return strategy may focus on a scenario with a particularly high gain. In any case, the scenario exercise enables the adoption of an adaptive strategy by monitoring the evolution of the critical factors highlighted in the scenario exercise. Finally, depending on the power of the organisation it may be decided to attempt actively influencing the context towards a certain desirable outcome.

The struggle in connecting futures intelligence like scenarios to decision making can be read as a basic challenge in foresight. Working on futures intelligence has emerged as a way to improve policy making, but once it is delegated to professional foresight analysts with attendant quality and quality

control, it also introduces a distance to policy making. Whilst independence and methodological rigour is desirable for high quality futures intelligence, bridging this intelligence with the policy context is *essential* for futures intelligence to be used in decision making.

To address this challenge, we will present an experimental approach to bridge futures intelligence with the policy context. The process proposed in the remainder of this article requires the analyst to put herself in the "hot-seat" of a policy shaper and interpret the futures intelligence from this perspective. This requires an understanding of the policy context, the policy interests and room for manoeuvre for policy action. The analyst has to interpret and further elaborate the futures intelligence through "policy lenses", which must be based on an understanding of policy shapers' room for manoeuvre and an understanding of policy interests.

The presentation will present the process of policy lensing and illustrate this with a concrete example, which takes four independently developed scenarios of the European research and innovation system in 2030 and transforms them into policy landscapes. We describe how these policy landscapes can then be used to backcast to the present day situation, and in so doing, reveal policy options.

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12.2.3 Is Science and Technology a main driver in the evolution of environment up to 2100?

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Keywords: Prospective, Scenarios, Driver, Environment, Science and technology innovation, World, Europe, 2030, 2050, 2100

The French alliance for research in environment (ALLENVI) made a systematic review of ninety nine foresight studies about environment at the world or Europe scale in 2030, 2050, 2100, so called ScenEn-vi. The two first drivers of the 307 scenarios analyzed according the typology of main drivers proposed by Cornish in 2004 (Demography, Environment, Governance, Economy, Society, Science and technology) are clearly Governance (40%) and Economy (25%). Environment appears among the two first drivers in only 22% and Science and technology innovation in only 15% of the scenarios mainly as sustainable technologies, place of science and technology innovation in the society, spends and dynamics in R&D and digital technologies.

The 307 scenarios were gathered in eleven families of scenarios that cover the different representations of the future in international environment foresight bibliography

Eleven families of scenarios, corresponding to contrasting visions of the future

Relying first of all on forms and intensity of goverrnance, and assembling additional geopolitical, econom-ic, social, environmental, and technological factors in various ways, these 11 families of scenarios can serve as “reference visions,” with varied environmental consequences.

By initially classifying the 307 scenarios according to the nature of their two principal driving factors, we could then use an iterative process to place each scenario within the 11 scenario families. Although the societal trajectories described by these scenario families are varied, they can nevertheless be divided into 3 groups (Fig 1).

The 3 scenarios families of decline (72 scenarios; 23% of the total). These scenarios describe dark futures with strongly negative consequences for the environment.

In “Chaos” scenarios (33 scenarios), failure and lack of planning on the part of the governance bodies lead the world into a downward spiral of negative effects, resulting in more or less generalized conflict and, in extreme cases, the extinction of the human race.

In “Retreat” scenarios (18 scenarios), economic difficulties, resource competition, and increased migra-tion lead to a rise of nationalist ideologies, exacerbating tensions and resulting in a marked withdrawal of nation states into political and eco-nomic isolation.

“Fragmentation” scenarios (21 scenarios) depict a multi-polar and unegalitarian world built on individual and group identities and marked by strong divisions; archetypal examples are oppositions between North and South and between rich coun-tries and poor countries.

The 3 scenarios families not assigning priority to the environment (98 scenarios; 32% of the total). These scenarios either foresee a continuation of existing trends without predicting any kind of breaking point, or give precedence to non-environmental priorities.

In “Growth at any price” scenarios (49 scenarios), the environment is clearly sacrificed to economic growth based on economic liberalism and active policies of deregulation as supported by a strong state or policies of “profitable” innovation.

Scenarios of “Inertia” (34 scenarios) typically describe a prolongation of existing trends without major disruptions and the absence of strong engagements in favor of the environment due to a lack of financial capacity or because of major political or societal blockages. This type of inaction can lead to serious environmental damage.

In “Social priorities” scenarios (15 scenarios), the reduction of social inequality provides the central strat-egy and policies of inclusion and redistribution are put in place. These trajectories can have posi-ive ef-fects on the environment without this being a direct objective.

The 5 scenario families giving deliberate priority to the environment (134 scenarios; 44% of the total) combine, to varying degrees, state direction and the mobilization of various constituent groups of civil society.

In “Reaction” scenarios (30 scenarios), recurrent crises and disasters prompt governing entities to take urgent steps in favor of the environment, because they no longer have any other choice.

Scenarios of “Green growth” (33 scenarios) are based on strong public policies seeking to reconcile eco-nomic growth with environmental protection, to bring about an energy transition, or to put in place en-lightened global governance structures that are favorable to the environment.

In “Proactive” scenarios (33 scenarios) states coordinate among themselves to anticipate problems and make environmental protection a priority, with citizens supporting a decoupling of growth curves for con-sumption and general well-being.

“Positive synergy” scenarios (17 scenarios) go further, relying on a social consensus in favor of environmental protection and long-term global sustainability. These scenarios lead to changes in values, more modest lifestyles, and greater social solidarity.

At the other end of the spectrum, “Local” scenarios (21 scenarios) develop as a reaction to the failure or the refusal to act of national or supra-national levels of governance. Citizens organize themselves to act in favor of the environment at the local level and based on local dynamics, with greater or lesser success but can not solve global environmental challenges.

Among these eleven families the three most concerned by science and technology innovation are “Growth at all costs” (digital technology and high investments in short term innovation), “Proaction” (sus-tainable and energy technologies) and “To a sustainable growth “(sustainable technologies all fields; high spends in R&D). Anyway to be effective science and technology innovation must be mo-bilized by the governance towards their priorities.

A limited role for science and technology within scenarios families

Although minimally present among the driving factors shaping the futures described in the 11 sce-nario families, science and technological innovation receive little explicit attention in these foresight studies. They are recognized as a driving factor in only 15% of the scenarios. When technologies are taken into account, it is usually considered as a provider of solutions to problems encountered by so-cieties. More than a main driver of the future representations technology appears as a way to imple-ment public policy and achieve their priorities. Science’s role is rather to understand phenomena of environmental degrada-tion, and alert societies to the risks incurred if nothing is done to address cur-rent trends. This alarm func-tion of science is most explicit in prospective exercises such as those led by the IPCC about climate change (Moss & al., 2010) but only emerging about biodiversity, for exam-ple

Sustainable technologies (energy, biomass, etc.) are of course often cited among the drivers of change for scenarios considering scieznce and technology (44%). Then the second rank is given to “R&D spend-ing and dynamics” and “the role of science and technology in society” (24% each). Ulti-mately, digital technologies, including big and open data are often cited.

Without surprise, technologies are not consirered in the families of decline as security and survival are vital priorities. The most numerous family (Growth at any price) allows a major importance to technology with strong investments, notably in digital networks and short term innovation. A minor attention is paid to the technologies for sustainability, such as biomass production, biotechs or en-ergy. In “Proaction” and “Green growth”, technologies play a major role in quite all sectors, with a sig-nificant priority given to en-ergy and Internet of things. But, surprisingly, families of “Reaction” or “Synergies” do not rely on technol-ogies to stimulate changes and positive dynamics. In most stud-ies, it seems to be easier to imagine a technological vision of the future than to describe a vision of the future of technologies.

More than main drivers of the future of environment representations science appears as warning tool and technology as a way to implement public policy and achieve their priorities.But these two instru-ments have to be activated by the governance to be fully useful.

The usefulness of this study for policy makers in STI

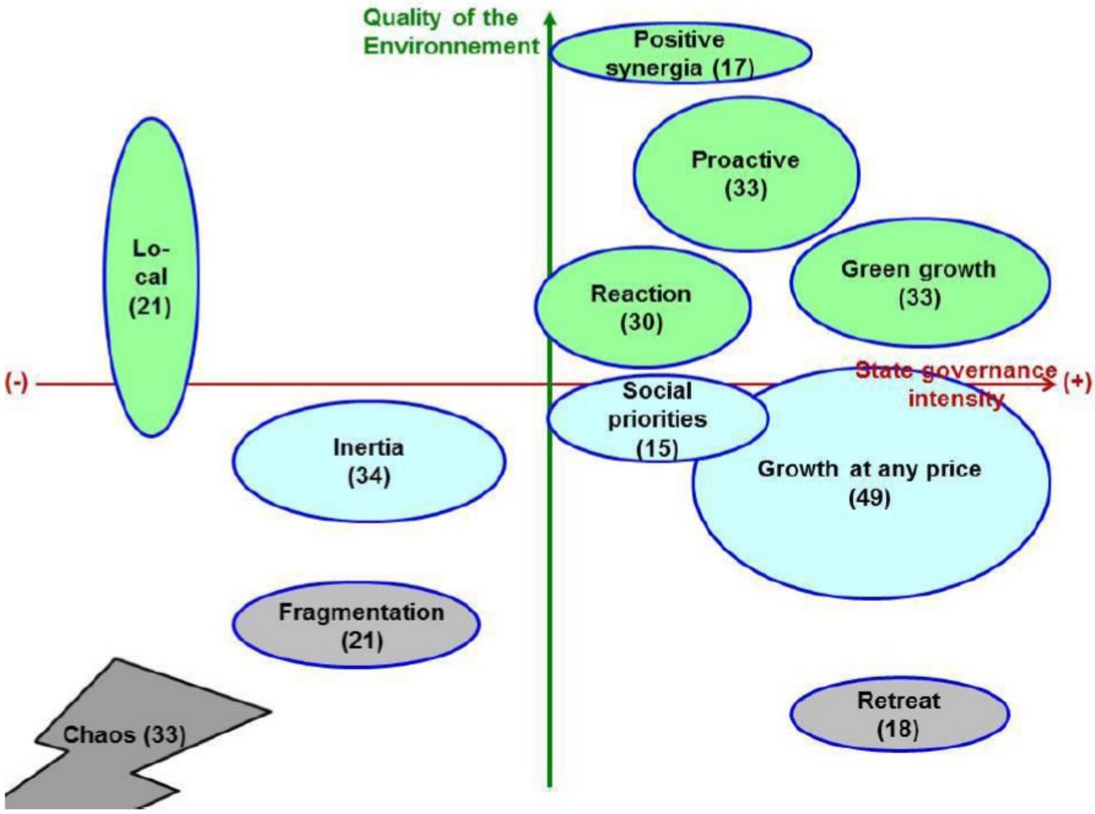
The main results of this study had been published through various means, including relevant interna-tion-al bodies (European Union, FAO, Plan Bleu,GFCM…), ministries, research institutions, universi-ties, pri-vate companies in the fields of insurance or energy and NGOs, notably those involved in en-vironment issues (IUCN, WWF…). More and more frequently, the executive level of those institutions are asking the experts involved in this study to draw a set of global pictures of the next decades. This expectation is

presented as a necessary tool for the projections of strategies, whatever the domain. Indeed, policy mak-ing and governance processes are changing. Facing fast changes and complexity they do take into ac-count scenarios instead of extrapolating linear trends in their field of expertise. Recent shocks in the po-litical world demonstrate the usefulness for all decision makers to envisage various scenar-ios in their strategy selection, and not to stick to traditional patterns. A new exercise is now frequently practiced afer the presentation of this study: few scenarios are selected by the audience from the 11 families; then, small separate working groups identify suitable strategies for research and technology development for each scenario. When the results are collected, people are asked to determine the

wishful scenario and the related decisions to take. Finally, people are asked to screen all the strategies for all the scenarios (even the worst), and to identify the nucleus of common decisions, the “measures without regret” be-cause they show to be unavoidable. The philosophy of the game is to learn how “to reduce an unbeara-ble situation and to manage the unavoidable evolution”.

Another asset of the presentation of this global overview to STI policy and governance research commu-nity is the opportunity to imagine which could be the real emergency priorities in 2030. This question makes sense as the building of a world class R&D team takes at least 10 years. If a country, research institution wants to secure its leadership in a given field, it has to face this question and anticipate in a rapid changing world. Therefore, assessing the robustness of priorities through this type of test is con-sidered more and more as a useful exercise although foresight has long been considered as a free gadget. In addition, this exercise provides systematically new ideas to the participants and this is not a minor interest as the products of intelligence are the key of competitiveness in our century.

Figure 1: Positioning of scenario families according to the intensity of state-level governance and changes in environmental quality



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12.3 Session 12.3: S&T Capabilties

12.3.1 Internationalization of business R&D investments. A responsiveness score analysis

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Keywords: Business R&D investments, Internationalization, Responsiveness score

Introduction

The aim of the article is to explore the main determinants of the business R&D investments of MNEs with a novel approach that allows to add new elements on the topic debate.

Traditionally the literature tends to distinguish between two basic motives for firms to internationalise their R&D activities: “asset-exploiting” strategies according to which high incomes and a large local market act as a major incentive for enterprises to start R&D activities in a particular country; and “asset-augmenting” for which enterprises wish to create new knowledge and technologies abroad, which is facilitated by excellent knowledge infrastructure and the presence of knowledge-spillovers from universities, clusters and enterprises in the host country. Using a responsiveness score model (RSCORE) this article tries to shed new lights on the sector and country determinants of business R&D investments of MNEs. In particular, by making use of a Random Coefficient Regression we are able to rank countries and sectors according to their driver responsiveness and to detect more influential drivers.

In addition, the model also yields the distribution of the responsiveness, providing interesting information about the characterization of the heterogeneity of the reaction of inward BERD to each individual factor both at country and sectoral level.

State of the art

The literature on determinants of business R&D investments is vast and heterogeneous. Traditionally drivers are divided in sector, country and firm level determinants.

A first important regional or country driver is income and market size. Income is an important driver, because high income and high income growth attracts FDI (Ekholm and Midelfart 2004; Blonigen 2005; Jensen 2006, Athukorala and Kohpaiboon 2010, Hall, 2010). Another important attractor of R&D of MNEs is a skilled workforce and the quality of the education system. In turn, a growing demand for engineers and scientists in the home country is often a motive for firms to go abroad with R&D. The presence of spillovers as a determinant for R&D location decisions point to the importance of the quality of university research as a driver of R&D internationalisation at the country level (Belderbos et al. 2009, Siedschlag et al. 2013).

Differences in labour cost between the home country and locations, in contrast, does not play an important role as a driver for the internationalisation of R&D (Thursby and Thursby 2006; Kinkel and Maloca 2008; Belderbos et al. 2009).

A number of empirical studies has investigated the role of policy for R&D location decisions (Cantwell and Mudambi 2000; Kumar 2001; Cantwell and Piscitello 2002; Thursby and Thursby 2006; De Backer and Hatem 2010; Athukorala and Kohpaiboon 2010). There is a consensus from this work that special financial incentives and a positive discrimination of foreign-owned firms in general are not an appropriate instrument to attract foreign R&D. Governments that want to attract R&D of foreign multinational firms should instead focus on the economic fundamentals and provide political stability, good public infrastructure, reasonable tax rates, and a stable legal system including the protection of intellectual property rights.

Besides locational factors, characteristics of the sector and the firm are also positively related to R&D internationalisation.

Methodology

We apply two methodologies. In the first part we use an OLS model without fixed-effects. Dependent (BERD inward) and independent variables (drivers) are all expressed in log, since a simple log (partially logarithmic) model didn't give robust results. A log-log expression can be referred to as a Cobb Douglas model, linearized from a product to a sum of factors (drivers). In the second section, as to provides additional information to the previous model, we use of a Responsiveness score approach (RScore). The basic econometrics of this model can be found in Wooldridge (2002, pp. 638-642). The application of RCR follows this simple protocol:

- Define y, the outcome variable, “Inward R&D investments from 2000 to 2012”.
- Define a set of Q factors thought of as affecting y, and indicate the generic factor with xj.
- Define a RCR linking y to the various xj, and extract a Country-specific responsiveness effect of y to the all set of factors xj, with j=1, ..., Q.
- For the generic Country i and factor j, indicate this effect as bij and collect all of them in a matrix B.
- Finally, aggregate by country (row) and by factor (column) the bij getting synthetic Country and factor responsiveness measures.

Findings and interpretation

In both the model we obtain similar results. The factors that ‘attract’ inward BERD are:

- the size of manufacturing industry, which is a more precise indicator of market size than GDP, given also that we consider inward BERD at the sector level;
- patents of residents on GDP, as an indicator of country innovativeness;
- labour cost intensity, which is an indicator of labour quality;
- domestic BERD.

Public investment in R&D, proxied by GBAORD, and GDP turn out negative. Our interpretation is that this tendency reflects the fact that the period include years close to the economic crisis. In EU13 group of countries there aren't significant factors, probably due to the low data availability.

The Rscore analysis points out the importance of the sector-size, of labour cost, of resident patenting, and of the domestic R&D factors on inward BERD in general. “Sector size” and “Labour cost” are the factors that register the highest Rscores in median terms. GDP, GBAORD, and education level (tertiary graduates in ST) register low responsiveness score both at sector and a country level.

Conclusions, policy implications and directions for further research

Our analysis of the drivers of R&D internationalization shows that the strength of the manufacturing basis, a high level of innovativeness, and high R&D intensities of domestic firms attract inward BERD. A conclusion from this result is that policies aimed at fostering domestic R&D capabilities in the business sector also attract foreign R&D investments. Still an open question is on the right mix of policy interventions that may increase the attractiveness of a particular Country. Surely, general innovation policy that promotes innovation capabilities of all firms in the economy are necessary, regardless of ownership status. In this sense, an unexplored topic for further research is on the effect of tax incentives for R&D on location choices of MNEs.

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12.3.2 Evolving technological capabilities of firms; Complexity, divergence, and stagnation

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Introduction

Innovation is what drives competitive advantage of firms, and productivity growth in the economy as a whole. Firms draw on the globally available stock of technological knowledge to innovate. To remain competitive, firms have to keep developing and acquiring new knowledge. However, since the late 1990s the productivity growth has slowed markedly for many of the world's largest economies. While there are many more researchers and engineers, in more locations around the world than ever before, and much more money is spent on technological research, the pace of innovation, the production of new knowledge that will feed the pipeline of future progress, appears to be slowing (OECD Compendium of Productivity Indicators 2016, 2016). Much work before now has found that slower technology growth is the main driver of this productivity paradox (Brynjolfsson, 1993; Cowen, 2011; Gordon, 2016).

However, (Andrews, Criscuolo, & Gal, 2016) showed that the top ("frontier") firms in OECD member countries have continued seeing productivity increases while the others (the "laggards") haven't, contributing to a growing productivity divergence between the top and the bottom. The study also suggests that differences in the ability of firms to develop new technological knowledge is an important reason for this pattern of divergence. However, the study did not identify the firms at the head of its productivity frontier, nor did it study the knowledge base of the firms, which could provide information about how the changing technological portfolio of firms drives performance.

In this paper, we address the question how the characteristics of the technological knowledge base of firms might explain the innovative performance of firms over time. For the period 2000-2010, we first establish how the composition of the global patent portfolio of the world's top 2000 R&D performing companies can explain patterns of entry and exit of new technology domains for these firms. Second, we study how patterns of divergence among firms can be explained by the diversity, complexity and growth of the technological knowledge base of firms. Furthermore, we investigate how different sectors, general purpose technologies and countries of origin contribute to the performance of frontier firms.

The starting point of our analysis is that technological progress is reliant on recombinant innovation (Arthur, 2007; Malerba & Orsenigo, 1996), the recombination of existing technologies where firms combine prior art with their own ideas to form new patentable technologies - now more than ever (Wuchty, Jones, & Uzzi, 2007). Because of bounded rationality, search for new technological knowledge is highly uncertain. As a result, firms tend to draw on knowledge acquired in the past, which provides opportunities but also sets limits to what can be learned (Atkinson & Stiglitz, 1969). As (Cohen & Levinthal, 1989) argued, agents are more likely to understand, absorb and implement external knowledge when it is close to their existing knowledge base. This also implies that knowledge is widely dispersed among many heterogeneous agents, and that the process of knowledge creation heavily depends on combining different capabilities of agents (Nooteboom, Van Haverbeke, Duysters, Gilsing, & van den Oord, 2007).

While the global stock of available technological knowledge keeps on expanding, it has been suggested that all the 'low hanging fruit' has been picked (Cowen, 2011). As a consequence, it becomes increasingly complex to develop new technological knowledge and to bring together the necessary skills and capabilities required to bring about new technological combinations (Chesbrough, 2003; Jones, 2009). According to some observers technological progress appears to be concentrated in general purpose information and communication technologies (Brynjolfsson, 1993; Gordon, 2016). While there seems to be stagnation in the world of atoms (supersonic travel, space travel, new forms of energy, new forms of medicine, new medical devices, etc.), the world of bits has seen a lot of innovation in computers, information technology, Internet, mobile Internet.

It is remarkable how little is actually known about the characteristics of innovative firms that operate at the technological frontier. In this paper, we wish to address this gap in our understanding. The novel contribution of this paper is that we provide insights in the underlying patterns of technological development. More specifically, this study uses the Corporate Invention Board (CIB) dataset. This sample of patents analysed for constructing the global map of technology encompasses all priority patents (over 6 million documents) applied for worldwide between 2000 and 2010 by the 2400 largest private R&D performers – i.e., the corporations monitored in the EU Industrial R&D Investment Scoreboard. CIB represents a significant share of private R&D investments as the industrial corporations included in the project account for 80% of world total private R&D (Alkemade, Heimeriks, Schoen, Villard, & Laurens, 2015).

Data and Methods

The patent system grants a firm monopoly rights over an idea for a fixed period, with the aim to provide monopoly rents to improve incentive to innovate (Schumpeter, 1943), because there will be under-investment due to the public goods nature of ideas (Arrow, 1962; Nelson, 1959).

This paper relies on a unique database, the Corporate Invention Board (CIB). The CIB combines patent data from the PATSTAT database with financial data from the ORBIS database about the 2033 companies with the largest R&D investments (Alkemade et al., 2015). The CIB builds on patents as a measure of the inventive activity of multinationals. In general, patents provide a well-archived source of information for mapping developments in technological knowledge production. However, patents represent a heterogeneous set of inventions in technologies, applications, and processes. As such, they do not fully and accurately represent innovation (Archibugi & Planta, 1996; OECD, 2009). Furthermore, not all inventions are patented and there are differences in patenting behavior across industries and countries, and over time. In addition, patented inventions differ in terms of their quality, and their economic significance.

While patent classification systems provide a starting point for identifying patents that belong to a specific technological domain, they do not constitute a classification of technological fields (OECD 2009). In order to overcome this problem, we developed an original classification of technology that distributes all inventions in 401 non-overlapping classes. This classification is based on the well-es-

tablished WIPO hierarchical classification that distinguishes, at its finest aggregation level, 35 technological fields, these 35 fields, being grouped in 5 technological domains. The global technology map depicts how these technological fields are connected.

The distance between areas of technology is based on the analysis of the co-occurrence of IPC codes assigned to individual patent documents. The more often a code is assigned to patent documents within one area together with codes from another area, the stronger the relationship between those codes and the shorter the (technological) distance between the technological areas to which these codes belong. The global technology map thus provides a “bottom up” measure of the technological distance between different technological fields.

Results

First, Figure 1 provides an illustration of the global map of technology. The map illustrates that some technological fields are more central and more connected that other fields.

Projecting the technological knowledge bases of individual companies on the map provides insights in how the knowledge bases of firms relate to the global knowledge base at a given time. Figures 2a and 2b illustrate this for a portfolio.

Figure 2 Distribution of diversity of the knowledge base of firms also taking into account balance and distance

Second, concerning the role of technological relatedness in the diversification strategies of firms, Figure 3 suggests a relationship between the relatedness density at firm level and the entry of new technological fields.

Figure 3. Relatedness and technological change in CIB corporations. The rate of entry is the number of new technological fields that entered an MNCs knowledge base divided by the total number of possible entries. Average density is the average percentage of related technological fields for the MNC. Correlation between density and entry is 0.84 (Pearson's product-moment correlation) and significant.

Discussion and Conclusion

The results provide new insights about the mechanisms underlying the global productivity slowdown and patterns of technology divergence. In general, the entry of technologies of firms can be explained by their relatedness to the existing technological portfolio. Related technologies are more likely to enter the portfolio of a firm than unrelated technologies. However, differences among firms and sectors are pronounced. New public policy lessons can be articulated.

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12.3.3 Characterising Heterogeneity in Public Research Organisations (PROs): A Taxonomical Approach

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Aims and relevance

Research and development (R&D) is performed in various kinds of organisations across countries including higher education institutions, hospitals, firms, and the so-called research centres, which is a heterogeneous set of organisations whose main mission is the performance of R&D, where public research organisations (PROs) play a predominant role.

Recent studies have called our attention to the increasing heterogeneity of the population of research centres in Europe. New organisational forms have emerged and changes in existing organisations have been identified (Gulbrandsen, 2011; Cruz-Castro and Sanz-Menéndez, 2007). Finding out how organisations are classified and evaluated is relevant to understand these dynamics. At the same time, recent research on the classification of organisations has highlighted the effect of establishing categories in social structuration (Pontikes, 2009). Categories structure social domains; they locate actors in comparative sets and delineate standards for evaluation. Social agreement about what constitutes membership in categories imposes constraints that induce actors to conform to categorical types, but at the same time shapes the way in which actors develop practices to construct identities. Individual organisations should be considered as a part of their sectors and populations of reference.

Drawing on a review of the different approaches taken since the 1960s in the field of science and technology policy studies to the classification of research organisations, the objective of this research is to explore how taxonomies developed in the past could be improved if informed by organisational theory. We also review some recent proposals of ideal types (typologies) of public research organisations (See, Crow and Bozeman, 1987; Laredo and Mustar, 2000; Gulbrandsen, 2011; Sanz-Menéndez et al., 2011; Cruz-Castro et al., 2012).

Therefore, the aim of this paper is to classify a set of PROs according to different organisational features. With this aim, we adopt an inclusive definition of public research organisations and we propose a methodology to develop a taxonomical tool that relies on publicly available information about their structural organisational features. We test our methodology on a set of research centres from different European countries using multivariate and data mining techniques. The design of an empirical taxonomy of PROs will allow us to make comparisons with typologies and to establish homogeneous groups that can guide the drafting of tailor-made R&D public policies.

Analytical background

Despite the profusion of recent theory and empirical analysis on the general topic of the classifications of organisations (Hannan, 2010; Hsu et al., 2009; Polos et al., 2002, among others) far less attention has been paid to policy-oriented fields, such as research activities, where the needs for classification have usually become limited to the practice of the official statistical procedures set up many years ago, e.g. Frascati Manual (see, OECD, 2015 for its last version).

While the classification efforts based on the Frascati Manual have been mainly empirical, they continue to rely on the top-down or a priori approach that comes up with mutually-exclusive categories that structure distinctions among types of entities, rather than allowing the data to drive their own cat-

egorisations. This raises some concerns: First, this approach to classifications has become decoupled from recent organisational research, which offers a range of theoretical perspectives and tools for better understanding the landscape. Second, the a priori imposition of categories may be inappropriate to capture emergent organisational forms, e.g. new types of research centres Pasteur quadrant type, etc…, owing to the institutionalisation and taken-for-granted the elements of the existing classification system. Third, recent work in organizations has recognized that membership in categories is often fuzzy and partial (Hannan 2010), rather than conforming to the crisp boundaries proposed by traditional approaches to classification. This is especially relevant when organizational fields are changing, boundaries become transformed and audiences struggle to make sense of new organizations. Finally, existing approaches to classification of research organizations are based on the intuitions of consultants or academics, rather than rigorous approaches and models.

Different typologies of public research centres can be found in the literature, depending on the scopes chosen for the classification and the approach of the research (See, Crow and Bozeman, 1987; Cruz-Castro et al., 2012; Arnold et al., 2010; Sanz-Menéndez et al., 2011; Cruz-Castro et al., 2015). The previous typologies provide some basic dimensions on which to build a taxonomy of public research organisations. Taxonomies, unlike typologies, classify the subjects of analysis on the basis of empirically observable and measurable characteristics (Bailey, 1994). Therefore, we will complement the features used in the typologies in literature with organisational features to establish an empirical classification of public research organisations.

In the framework of the current research, we focus on PRO adopting a multidimensional and inclusive definition. In brief, we define a PRO as a legally independent institution, either founded under private or public law i.e. regardless their legal form, established with the main goal of providing basic or applied research, technology and innovation services to other agents. PROs will be somehow linked to those other actors (firms, universities, public authorities or society) through several channels as training, publication production, technology transfer, cooperation in research or advisory services. These organisations will be influenced to a greater or lesser extent by the public sector either through their financial structure, their ownership or the type of mission and vision established in their statutes.

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Therefore, based on the theoretical background, we construct and inductive quantitative approach to the classification of PROs that aims to meet three criteria of data collection (inclusive sampling of organisations, inclusive sampling of attributes and attention to external and internal stakeholders) as well as two criteria of analysis: a statistical derivation of homogeneous categories and the possibility of partial category membership.

Data and methods

Using data on nearly 200 research organisations from different European countries, we illustrate how our approach can generate categories of research centres that confirm or differ from those identified in common taxonomies. We selected organisations in the following countries: Austria, France, Germany, Italy, Netherlands, Norway, Poland and Spain; this set of countries represents a significant share of the total research performed in Europe, and at the same time provides national context diversity.

To guarantee the heterogeneity in the selection of PROs we have combined two criteria: size and relevance of centres in terms of number of publications, patent applications and EU R&D projects. In this way, we identified, at least, the most important research centres in each of the countries. For each PRO included in the sample data are extracted from institutional sources of information; i.e. derived from secondary internal data sources like annual reports, webpages, or financial statements. The information in the database is analysed through a cluster analysis with two purposes: 1. Design a classification tool for PROs based on empirical analysis and 2. Describe the attributes that characterized the different types of organisations. Additionally, we check the power of our taxonomy as a classification tool through a decision tree.

Preliminary findings

In a changing context for the management and governance of public research, traditional categories of research organisations are not useful anymore to address and represent the dynamism of this population. In this regard, establishing new categories allow us to capture a more detail representation of the PROs and to open a window for partial membership. Indeed, policy-makers can not propose tailored policies for homogenous groups when traditional typologies are not able to identify the current panorama of public research organisations. The design of an updated taxonomy opens a venue for improving the adjustment between policy-making and the actors subjected to the proposed policy.

A cluster analysis has been carried out with the result of five-group taxonomy of PROs that have differentiating characteristics. Although our effort is empirical, the classification tool has been fed by the concepts used in typological efforts in literature (See Sanz-Menéndez et al. 2011). Variables related to the structure, the role played by the institution, the R&D main orientation, the legal status, the ownership and the field of sciences to which most of the R&D funds are dedicated allow us to distinguish five types of PROs: RECs, GOLs, TOCs and Nac. and Reg. Hybrids i.e. NAHs and REHs respectively.

In particular, RECs tend to be the largest organisations and TOCs and NAHs the smallest ones. Central government exerts a direct power through ownership in RECs, GOLs and NAHs while HEIs, Private companies and regional governments have an important role in TOCs and also in REHs. These latter are mainly focused on applied research and basic research respectively in the fields of engineering and natural sciences and sometimes also in health, relegating basic research mainly in social sciences and humanities to an exclusively government's responsibility in RECs and NAHs.

Secondly, we have checked the power of our classification through an Exhaustive CHAID classification tree. The percentage of correctly classified cases for varies from 89.7% in the training sample to 87.8% in the testing sample. The number of correctly classified cases is therefore more than acceptable with a risk of 0.103 (0.025) and 0.122 (0.051) in the training and in the test sample respectively.

Although we are aware that the sample selection procedure can generate some bias, we argue that the conceptual framework and methods presented, as well as the results of the first empirical tests undertaken, can help better understand the dynamics of the evolving field of PROs in Europe and can open fruitful avenues for further research.

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