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Towards Transformative Governance? Responses to mission-oriented innovation policy paradigms

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Towards strategic management of complex systemic innovation environments: Integrating foresight, assessment, system dynamic modelling and societal embedding into a coherent model

Toni Ahlqvist, Mika Nieminen, Anu Tuominen

VTT Technical Research Centre of Finland, Finland

The motivation

The recent innovation policy discussions have emphasized the need for a deeper understanding of the systemic nature of innovation processes. Especially the differences in types of innovations, as well as their varying impacts, set challenges for the traditional "one size fits all" innovation policy (OECD 2010; Ministry of Education & Ministry of Employment and the Economy 2009). This calls for a better understanding of innovations, their drivers and obstacles in different contexts. How are we able to make right strategic decisions regarding ST&I investments, support likely "winner technologies" and be certain that also users utilise new innovations whether they are technological, service related, organizational or social innovations? The traditional "technology push" or "supply side" policies do not function any more as the scope of innovations and the processes leading to innovations (and our understanding of those processes) have broadened. Innovation policy is neither limited to one sector or "silo", but the decisions made at one policy sector are increasingly interlinked to the processes of the other sectors and form a complex network of feedback loops within policy-making.

Technological, economic and political changes have also created an environment where economic, social and political changes are transmitted faster than ever. Globalization emphasizes intertwinement of diverse sub-systems (e.g. firms, public administration, third sector, and various administrative sectors) across local, regional, national, and transnational scales. A part of the development is the increasing volatility of markets where technological development is fast, capital markets are global, and competition has become extremely tight. (e.g. Castells 2000) These technological, economic and social changes are, in turn, interlinked in complex socio-technical systems, which develop through continuous interaction and structuration at socio-spatial scales (e.g. Geels 2002, 2004).

The dynamics briefly depicted above call for a more systemic innovation policy approach, a holistic way to understand and analyse the complex interaction in networked socio-technical systems. In addition, these developments put more emphasis on strategic leadership and management of innovation policy and related decisions in various organizations from public to private sector. In practice this necessitates new kinds of

methods, which strengthen horizontal approaches and steering mechanisms, and which are adaptive and able to respond to the rapidly changing situations (cf. OECD 2005). While there are good attempts to create more comprehensive information generation and management tools for the use of strategic decision-making and management (e.g. Rotmans & Loorbach 2009), there is still a need for more systematic and integrative methods. In this paper, we describe one solution by suggesting a combination of foresight, impact assessment, system dynamic modelling and societal embedding for understanding and managing the complex socio-technical systems.

The approach

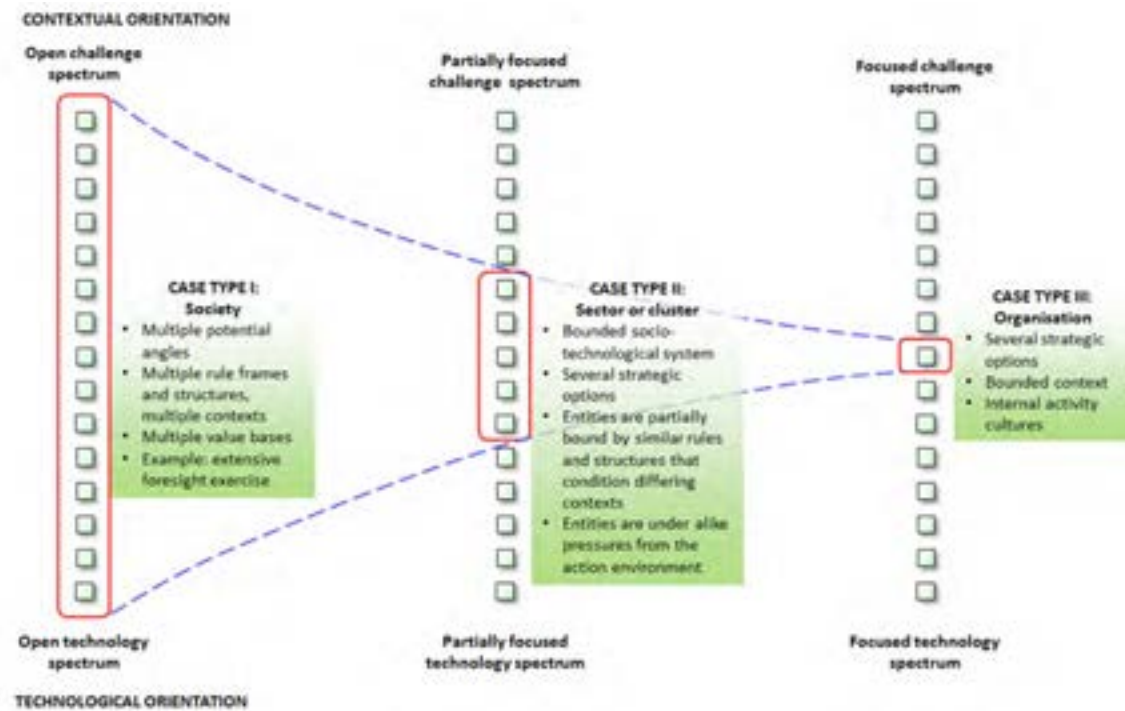
The systematic combination of foresight, assessment, system dynamic modelling and societal embedding is the key novelty of our model. Each of the approaches has a distinctive function in the model. Firstly, foresight produces knowledge about future transformations in the system and endorses the setting of long-term targets. Secondly, assessment, both *ex ante* and *ex post*, provides knowledge about anticipated and realised impacts of decisions. Thirdly, system dynamic modelling and simulation provide formal analysis of interdependencies and feedback loops among the actors and their environment. Fourthly, the societal embedding emphasises the creation of shared targets through horizontal and networked decision-making that integrates public, private and third sector parties. All the aspects are needed to understand and manage highly complex and evolving socio-technical systems. We also integrate aspects of the theory of socio-technical change (e.g. Geels 2002) into our model in order to understand the interaction between the existing system, its' context and innovations. These three levels are used in the model as analytical dimensions to clarify the complex whole.

In the following Figure 1 we present a general integrative framework for analysing different socio-technical contexts. The framework is based on an idea that innovation-related strategic decision-making situations vary by their contextual and technological orientation. The core idea is that varying combinations of societal and technological dynamics form distinctive contexts. The two kinds of societal orientations – based either on "grand challenge" spectrum or on technological spectrum – can differ from more open to a more focused scope. The first orientation, i.e. societal challenges, can vary by their scope e.g. from global to local level. The second orientation, i.e. technologies, includes the existing and potential technologies that enable solutions for societal challenges.

In the following we describe three ideal typical cases that enable us to discuss the role of different elements in the model when moving in the axes of contextual and techno-

logical orientation. It should be noted that these case types present archetypes that can be studied either as singular or systemic cases.

Figure 1: Outline of strategic knowledge creation in complex systemic environments



The first case type is the most open and consists of multiple potential perspectives, contexts, values, rules, and structures. The core questions are the identification of challenges, scoping of imaginable socio-technological solutions and initiation and channeling of the societal transformation processes based on strategic decisions. As the situation is open regarding challenges and potential solutions, the case should be foresight-oriented. However, modelling and assessment are integral elements of the case analysis as we need to understand the present state of the system and how different decisions may transform it. Especially the assessment of the numerous interlinked decisions and their cumulative impacts require modelling. Without formal modelling the management of several constantly evolving systemic aspects (existing system, its' environment and innovations) could prove impossible.

The second case type is 'sector or cluster', referring to a bounded socio-technological system, where actors are partially bounded by similar rules and structures. The core questions are identification and evaluation of potential socio-technological solutions, charting strategic options for a sector or a cluster (like technological alternatives), or engaging key actors. Foresight, modelling and assessment have more balanced roles in this case type. There are, however, various possible perspectives from which the

whole can be approached. Analysis of a socio-technological system (e.g. sector), or an analysis of a particular activity environment (e.g. market) are the most obvious ones.

The third case type takes place in the most bounded context – yet with several strategic options. The core questions accentuate embedding and implementing of a socio-technological solution or endorsing strategic decision-making under systemic transformation phase. At this level, the societal embedding has a key role. Foresight, modelling and assessment endorse the setting for the embedding. The process emphases could include the following: co-creation of the socio-technological solutions with the key actors (identification of key actor and topics; mobilisation; activation; empowerment); mapping the organisational dynamics and tensions (different frames of interpretation); or implementation of the socio-technological solution (process target has evolved during the process of co-creation and therefore the implementation phase is important).

Expected results

We demonstrate the model by analysing the case of electric vehicles in Finland. In the European Union, there are strong intentions to bring electromobility into urban transport systems. However, very little progress towards actual implementation has been made due to lacking understanding of e.g.: (1) possible EV (electric vehicle) concepts and their impacts, (2) the requirements, challenges and opportunities with EVs and the surrounding infrastructures and (3) how to introduce EVs into the transport system in order to reach the best possible results concerning economic, environmental and social sustainability. The case depicts the type II in our model (Figure 1). We approach the case of EVs as a complex decision making environment, where the new technology and social dimensions intertwine and form a complex socio-technological entity. With the analysis we indicate how using a multi-method approach may support decision-making.

Conclusions and policy implications

The development of our model is currently on-going and has potentially high policy relevance. Firstly, there is an apparent need to understand better the complex societal contexts where innovation and related decision-making takes place. Our approach produces comprehensive information from several complementing perspectives for the use of strategic decision-making and steering. Secondly, the approach may produce shared understanding, learning and commitment among the key actors. This is of utmost importance in the strategic management and steering of complex systems and organizations. The future is made by committed actors. Thirdly, by putting the phenomena into the core, the approach supports horizontal policy-making and collaboration over traditional boundaries. This supports the systemic reach and effectiveness of policy-making.

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Anticipatory knowledge and epistemic policy communities: Exploring future-oriented strategic activities in the context of transformative governance

Toni Ahlqvist

VTT Technical Research Centre of Finland, Finland

The motivation

The notions of systemic interrelatedness and complexity are increasingly discussed in the context of innovation policies. As Smits and Kuhlmann (2004: 11) argue, innovation is a systemic activity that "involves a variety of actions within the system, of which the innovating organisation or innovator forms part". The systemicity sets challenges not only to the researchers, developers and policy-makers, but also to the policy-making processes as such. Concomitantly, Weber et al (2009: 955) argue that policy processes have gone through a conceptual shift in which a linear model of policy-making has been replaced with a more learning-based cyclical model. In the learning-based model, foresight has a catalysing role. Therefore, not just innovation activities, but also the policy-making process could benefit from the use of "systemic instruments" (Smits and Kuhlmann 2004: 11–12) in fostering forward-looking aspects. In the systemic settings, policy processes are increasingly processes of forward-looking policy design (Ahlqvist et al 2012).

Based on this, the paper has three aims. Firstly, it discusses the idea of anticipatory knowledge and introduces a notion of epistemic policy community, adapted from Håkanson (2010), in context of the "mission-oriented turn" in governance. Paper argues that utilisation of anticipatory knowledge, presupposed in an idea of "mission-orientation", sets challenges to the concepts and frames of governance. Paper proposes that an idea of epistemic policy communities could be useful in understanding and conceptualising the actor assemblages engaging the systemic policy practices. Secondly, the paper introduces a framework to integrate anticipatory knowledge and strategic activities in an epistemic policy community or an organisation. Thirdly, the paper discusses two empirical cases in the context of VTT Technical Research Centre of Finland. The first case is a roadmapping study on an emerging systemic field environmentally sustainable ICT, the second case is about specific types of epistemic communities that are created to endorse the strategic development at VTT.

Approach

The first base of the paper is to elaborate the role of anticipatory knowledge in the systemic and mission-oriented context. Firstly, the notion of anticipatory knowledge builds on the commonplace definition of foresight as action-oriented, participatory and focused on alternative futures (e.g. Havas 2007). However, anticipatory knowledge, as defined here, has three basic differences with this definition. Firstly, contrary to the participatory orientation in foresight, anticipatory knowledge emphasises different forms of knowledge, e.g. codified, tacit, embodied, articulated, and combined. Secondly, anticipatory knowledge emphasises knowledge in a spatio-temporal continuum. The anticipatory knowledge accentuates the role of knowledge in a certain spatial context and in a particular temporal context, as part of the evolutionary continuum. Thirdly, the notion of anticipatory knowledge underlines practical aspects of knowing (see e.g. Anderson 2009: 158).

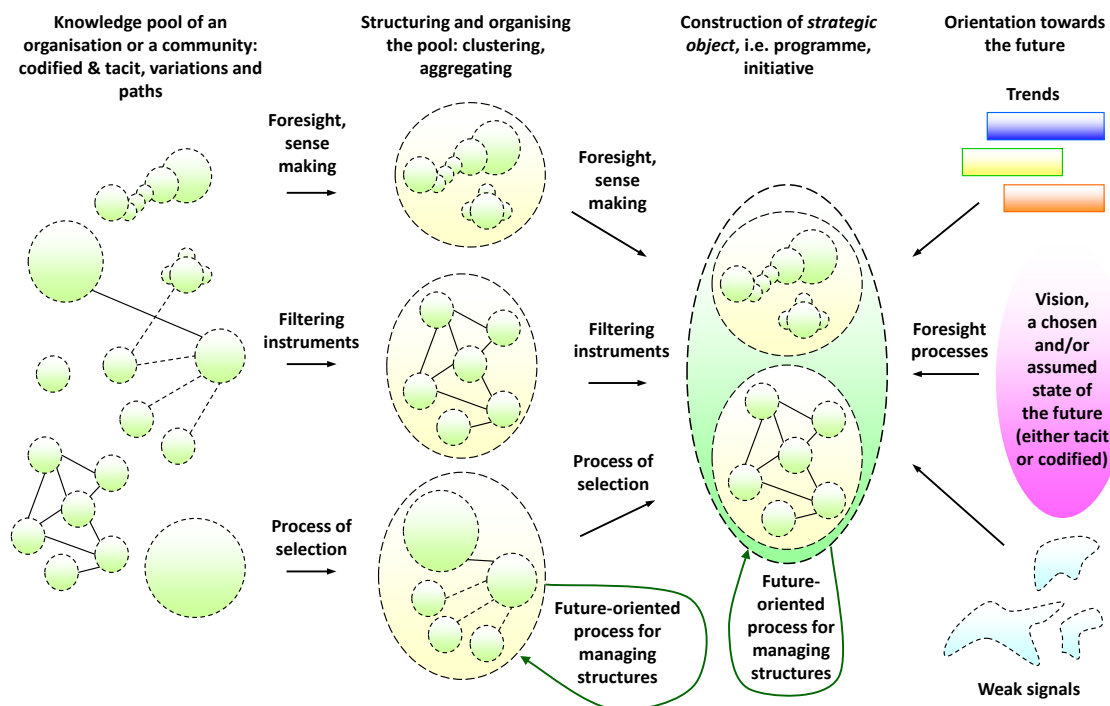
The second base of the paper is to link the notion of epistemic community to the context of transformative governance. Håkanson (2010: 1809) defines epistemic community as "groups of people mastering the theories, codes, and tools of a common practice ... regardless of their geographical location and the intensity of mutual contact that they may maintain". The basis for epistemic community is maintenance and development of particular theory, codes and tools (see Håkanson 2007).

On these bases, the paper proposes widening the notion of an epistemic community towards more organisational direction. The paper suggests a notion of *epistemic policy community* that can be defined as: a community of actors (e.g. organisations, companies, third sector) that aim at building common policy practices through deploying different theories, codes and tools, and applying different knowledge processes (articulation, replication, combination, integration). The epistemic policy community is explicitly oriented towards future(s), and anticipatory knowledge plays a specific role. In the community, the knowledge perspective and interest have specific relevance.

Furthermore, the paper suggests an ideal framework how foresight and strategic research could be integrated in the context of an epistemic policy community (Figure 1). The framework starts with characterisation of a knowledge pool that includes varied knowledge components. These knowledge components are of varying magnitude, they are in a different development stages and they have variegated links with each other. These components could be codified, i.e. components that are explicitly identified (like competencies in electronics, forest industry and printed intelligence), or they could be tacit, i.e. some combination of components or activities that are more "silent" (like an organisational capacity to run advanced multidisciplinary projects). The framework

identifies three levels of future-orientation in an epistemic policy community. The first level is the orientation of entire knowledge pool towards the future. The second level is structuring the knowledge pool to create strategic research objects, i.e. programmes, initiatives or a shared knowledge setting. The third level of future-orientation is future-oriented management of structures, i.e. articulating the entire managerial process through explicit visions and future alternatives.

Figure 1: An ideal framework for integrating anticipatory knowledge (future-orientation) and strategic activities in an epistemic policy community



Expected results

The paper discusses the practices linked to anticipatory knowledge and epistemic policy communities through two empirical examples from VTT Technical Research Centre of Finland. The first example is a roadmapping study on an emerging systemic field environmentally sustainable ICT (see Ahola et al. 2010). In the case, the notion of green ICT is positioned in the context of innovation policy roadmapping (cf. Ahlqvist et al 2012). The idea of innovation policy roadmapping is to integrate the analysis of technological change and the analysis of the wider societal setting and to enable systematic analysis of future-oriented ideas that could spring either from technological development, policy practices or more generic societal development. The case aims at showing how the anticipatory knowledge can be, firstly, embedded as part of a knowledge base of a RTO and, secondly, how this knowledge can be up-scaled from the

organisational level towards the societal level. In the context of green ICT, several types of "novel" policy activities, like systemic policies or actor-based policies, could be proposed.

The second case considers specific types of epistemic communities in creation at VTT. The case examples are *service science and business network* (SSB) and the emerging *foresight network* (FORNET). The aim of SSB was to establish a service research network at VTT. Service research is an emerging field of research requiring intensive collaboration across disciplines and lines of business. The network was built in a series of workshops that combined foresight and organisational learning methods. FORNET is an emerging network at VTT aimed at stimulating foresight expertise in the organisation, across different technology fields. Therefore, a tailored workshop process is designed that focuses on building up an organisational network that includes actors in different roles (core expert, agent, technology expert). Also, a setting for intensive learning process in three fields is initiated: 1) particular technology-based foresight approach, 2) foresight methods, and 3) organisational collaboration.

Conclusions and policy implications

As a conclusion, the paper wraps up three strands that have some relevance to the emerging transformative and mission-oriented governance. The first strand is to advance the understanding of the polyvalent role of anticipatory knowledge in fostering societal transformations. The anticipatory knowledge, as defined in the paper, is co-created and contextual form of strategic knowledge. It is always interpreted, i.e. dependent on a perspective and an interest, and therefore it does fit easily in the normative models of "evidence-based policies". Thus, anticipatory knowledge should be approached as a specific type of policy knowledge.

The second strand is to present the concept of *epistemic policy community* in order to understand the collective processes that are connected to the creation, mobilisation and utilisation of anticipatory knowledge. The epistemic policy community is an assemblage of different actors that aim at co-creation and articulation of future-oriented knowledge to some strategic purpose. It could be suggested that transformative governance, especially in the context of systemic "grand challenges", requires the mobilisation of these kinds of communities.

The third strand is to propose a framework to understand the integration of anticipatory knowledge and strategic activities in a specific organisational or communitarian context. Framework features steps that integrate different modes of knowledge production and different levels of future-orientation. The framework is demonstrated through two empirical cases.

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Evaluating systemic innovations: The case of clean energy technologies

Floortje Alkemade¹, Gaston Heimeriks¹, Antoine Schoen²

¹*Utrecht University, Copernicus Institute for Sustainable Development; the Netherlands*

²*Université Paris-Est, LATTIS, ESIEE, IFRIS, France*

1. Motivation

In recent years European innovation policy has increasingly focused on stimulating innovation to address grand societal challenges such as climate change and demographic ageing (Alkemade et al. 2011). When successful, these policies influence the direction of innovation. Scholars have argued that the innovations needed to address these grand societal challenges are characterised by an interdisciplinary and systemic nature (Smits and Kuhlmann, 2004; Wieczorek, 2012; Farla et al. 2010). Stimulating systemic innovation is difficult as it requires the combination of different technological and/or application fields. As technological change is cumulative and path dependent and new technologies are often closely related to older technologies in the same field (Atkinson and Stiglitz 1969, Nelson and Winter 1982; Dosi 1982), the stimulation of systemic innovation might be more successful in countries or for companies that already have a strong position in the relevant technology fields.

Due to the inherent complexity of systemic innovation and because the desired societal transformations are long term processes it is difficult to evaluate European innovation policy. Insight in the patterns of systemic innovation and innovation policy are however an import element of the policy cycle and needed in order for policy learning to take place. In this paper we aim to gain such insights by analyzing clean energy patents as an (intermediate) innovation indicator. In a recent study the European patent office has identified the set of patents related to clean energy technologies (UNEP/EPO/OECD, 2010). In this paper we analyze this patent set in order to evaluate the systemic character of these patents. In order to evaluate the properties of the clean energy technology patent set we focus on two related measures, technological diversity and technological distance.

When a set of technologies has a more systemic character this might be reflected by a larger *technological diversity* of the technologies in this set. That is comparing the technological diversity of the set of clean energy patents to the technological diversity of energy patents in general can provide insights regarding the systemic nature of clean energy technologies. The general diversity index proposed by Stirling (2007, 2010) distinguishes three aspects of diversity: variety, balance and disparity. Variety

described the number of different classes of elements in the system. Balance describes how the different technologies are divided over the different classes. The most difficult aspect of diversity to calculate is the disparity that describes how different the different technological options actually are. An adequate measure of technological diversity thus relies on a classification of technologies and a measure of the distance between classes, that is, a measure of *technological distance*.

2. Approach/Results/Conclusions

Although technological distance is acknowledged as important in the study of technological change it is difficult to measure and most approaches are technology-specific (Stirling 2010, Markard and Truffer, 2006). In this paper we use a general measure of technological distance: the global technology map (Schoen et al, 2012). As our classification of technologies we use an extended version of the WIPO classification of technological fields, unfolding the 35 classes to 389. 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 of another area, the stronger the relationship between those codes or the shorter is 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. As a next step we project the clean energy technology patents on the technology map. More specifically we are interested in (1) the extent to which the clean energy technology patents are so-called "bridging patents" that is patents that connect different technological fields, and (2) the extent to which clean energy patents build upon a more diverse set of patents than overall energy patents. Subsequently we consider which countries and companies are able to establish such bridges.

Projecting the clean energy technology patents on the global technology map gives an indication of the systemic character of these patents, by comparing the average technological distance (shortest path on the technology map) of the clean energy technology patents with the average distance between all patents in this field.

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Competitiveness Policy Evaluation as a Transformative Process: From Theory to Practice

Mari José Aranguren, Edurne Magro, James R. Wilson

Orkestra - Basque Institute of Competitiveness and Deusto Business School, Spain

Competitiveness policy has undergone fundamental evolution during recent years. This is related to the relatively recently-acknowledged centrality of innovation for territorial competitiveness, alongside recognition that innovation is in fact a systemic rather than linear process. In response, competitiveness policy rationales have evolved from predominantly neoclassical approaches to evolutionary-systemic frameworks (Laranja *et al.*, 2008; Magro, 2011). This has resulted in a large increase in policy complexity, whereby it is common for a mix of innovation policies from different administrative levels (regional, national, European...) to exist within the same territory, based on different rationales, employing different instruments, and operating to different timescales (Koschatzky and Kroll, 2007; Aranguren *et al.*, 2010; Flanagan *et al.*, 2010; Magro and Wilson, 2011).

Designing and implementing competitiveness policies in this context is a highly complex, constantly evolving and innovative process, with the key pretext that there exists no unique and optimal system of policies (Nauwelaers and Wintjes, 2008; OECD, 2009; Koschatzky and Stahlecker, 2010). Moreover there is a strong inertia built into the policy process, as present and future policies are introduced alongside (and conditioned by) past and existing policies. This complexity and inertia of interactions offers important learning opportunities at all stages of the policy process that implicate different types of agents from both within and outside a given territory. Indeed, one of the principal features of place-based competitiveness policies is that the knowledge necessary to construct appropriate institutions and policies for the territory is produced through interaction between actors that are both endogenous and exogenous to that territory (Barca, 2009). Learning in policy processes is therefore based on 'learning by doing' and 'learning by interacting', and policy intelligence is a result of combining these types of learning.

The policy learning concept has become increasingly popular in the light of this new complexity in competitiveness policies. Moreover, growing reference to policy learning in the literature corresponds with significant changes in the purposes of competitiveness policy evaluation, at least in theory. From evaluation being previously seen an *ex-post* step in the policy process associated above all with providing accountability, there is now widespread acknowledgement of the importance of formative evaluation that constitutes an integral part of all stages of the policy process. In this sense policy

evaluation is increasingly seen as 'transformative' and as such is inextricably linked with processes of policy learning. What is missing in much current analysis, however, is greater reflection on how the theoretical benefits of such transformative evaluation actually play out in practice. In this sense policy learning remains a relatively fuzzy concept that requires further grounding in practice.

In terms of how policy learning takes place in theory, Barca (2009) points to two specific aspects: learning about 'what works', and learning about the implementation process. From a certain perspective these can be seen as of relevance primarily to policy-makers. However, policy learning in the systemic context that characterises innovation policy today cannot be isolated among policy-makers; it also takes place among the range of actors that are touched in some way by the policies: firms, universities, training organisations, firm associations, technology centres, cluster associations, *etc.* Moreover, Smits and Kuhlman (2004) point to different typologies of learning processes associated with the different agents that comprise the innovation system (policy-makers, industry, researchers). When such communities of actors learn together there are possibilities for transformations and developments that are much wider and deeper than those that might be expected when learning only takes place among policy-makers. Indeed, Nauwelaers & Wintjes (2008) suggest that policy learning with the objective to improve policies has various sources: learning derived from the experiences of policy-makers (intra-organisational), learning originating from the experiences of others in the system (inter-organisational), and learning between different systems (inter-systemic).

In terms of how policy evaluation techniques can contribute to these learning processes and play a transformative role, from our theoretical understanding we can highlight approaches that combine quantitative methods with participative processes involving the agents of the system. There remains, however, a significant gap between the complexity of contemporary competitiveness policy systems and the development of conceptual and practical knowledge around how to evaluate policies in this context of multi-level, inter-related policy interactions (Arnold, 2004; Molas-Gallard and Davies, 2006; Edler *et al.*, 2008; Magro and Wilson, 2011). This gap is even greater with respect to how to ensure that evaluation techniques support the transformative role of evaluation in a policy learning context (Smits and Kuhlman, 2004).

The motivation of this paper is therefore to build on existing theoretical knowledge that highlights the significance of transformative evaluation processes in the context of competitiveness policies, to explore in greater depth what this means in practice. We seek to reflect on questions such as: what policy learning as a theoretical concept really means in practice; how it is related to evaluation and to evaluation techniques; in

which contexts and under which conditions it can be successful; whether different types of policy learning are possible; who are the main groups of agents involved in policy learning; and whether there are specific types of policy instruments that facilitate or obstruct policy learning; and what does all of this imply for evaluation design.

Our approach combines conceptual development with case-based reflections. The paper first brings together a review of existing theoretical understanding of the policy learning concept with literature on policy evaluation to clarify the justification for transformative evaluation in the competitiveness policy context. This raises the question of bringing theory into practice, which is explored through reflections on three distinct evaluation processes relating to R&D policy, cluster policy and the overall competitiveness policy framework in the Basque Country region of Spain. Alongside the conceptual contribution of the paper, the results of the case analysis show that the translation of commonly used terms such as 'policy learning' and 'formative evaluation' into practice is far from straightforward. A number of barriers are identified, together with insight into how they can be addressed over time to gradually create a change in perspectives and evaluation culture. As such the paper seeks to develop a clearer understanding of the practical aspects of applying a fuzzy theoretical concept (policy learning) to a complex real world context.

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The Impact of International Research Joint Ventures on SMEs Performance

Ascensión Barajas¹, Elena Huergo², Lourdes Moreno²

¹Department of Impact Analysis. CDTI; Spain

²GRIPICO - Department of Economic Analysis, Universidad Complutense de Madrid, Spain

1. Motivation

In general, empirical literature on R&D cooperation concludes that big companies have a greater probability to cooperate, due to their higher technological capability and the considerable scope of their R&D projects. Nevertheless, the current trends indicate that cooperation is taking a relevant roll within corporative strategies of innovative firms, regardless of their size. The increasing dynamism of SMEs in intensive industries, such as biotechnology and ICT, cooperating with other companies and with research institutions, illustrates this fact. Although the percentage of firms cooperating on innovation activities is much higher considering large firms, the available data (OCDE, 2009) show a relevant activity of SMEs in some countries such as Finland (28% of all SMEs cooperate), Austria (18%) or France (24%, considering only manufacturing SMEs).

Public policies aiming to encourage cooperation between SMEs and research centers have been implemented by the R&D Framework Programme of the European Union (FP) since its third edition, being strongly reinforced in the fifth and the sixth ones. According to qualitative analysis carried out under the auspices of the European Commission, a high percentage of supported firms reach their own goals. Nevertheless, this approach is not able to quantify at what extend R&D cooperation improve SMEs performance.

The objective of the present study is to analyse if technological cooperation has a positive impact on SMEs performance considering three dimensions: technological results, economic results and productivity. With this integrated approach, we analyse a set of key competitiveness indicators.

2. Approach

The empirical research is divided in two phases. First, through the estimation of a selection-equation, we calculate the theoretical probability of a firm to participate in consortia. Second, we analyze whether the "Participation in R&D consortia", approached by the predicted value of the previous estimation, has a significant impact on technological output (measured by intangible assets by employee) and on three economic output indicators: EBITDA, labour productivity and sales.

These estimations permit to analyze whether R&D cooperation supported by the FP has not only a direct effect but also an indirect effect on SMEs economic success. Specifically, if we find that FP participation has a significant effect on our measures of economic success, a direct effect of cooperation on economic performance would be corroborated. In addition, if we find a positive relationship between the proxy of technological output and labour productivity, EBITDA per employee or sales, this would suggest the existence of an indirect economic impact of R&D cooperation.

For this purpose we integrate two data sets. The first one, provided by the CDTI (the public organism in charge of monitoring the participation of Spanish firms within the FP), contains much relevant information about the SMEs-specific measures of the 6th FP (rejected and supported projects) and the participants. The second one is the SABI database, that consists of company accounts for over 1000 000 Spanish firms. The SMEs-CDTI-SABI database could be considered an original and powerful instrument to measure the impact of the FP on economic performance for a period large enough to capture the medium and long-term effect of the FP R&D projects.

Overall, we compile a homogeneous sample that consists of an unbalanced panel of 41.800 observations, 10,450 companies, and 1,526 proposals. Available data allow us to consider variables related to the characteristics of consortia (leadership, geographical origin of partners, technological area) and the economic performance of SMEs.

3. Results

The European Commission points out that the nature of R&D activities supported under SME-specific measures of the sixth FP focuses on finding solutions to technical problems that SMEs identify, that mainly constitute applied research. Specifically, the most important objective for SMEs in this kind of projects is the development of a new or improved product. In this sense, we experiment by including alternatively our dependent variable referred to the periods $t+2$, $t+3$ and $t+4$ relative to the awarding year.

Preliminary results corroborate a direct and positive impact of SMEs-specific measures on profitability and technological assets of participants. In particular, we find that: (1) being a cooperative SME increases the ratio of intangible fixed assets over employment almost 55% and (2) the impact of intangible fixed assets on economic performance, measured alternatively by productivity, EBITDA per employee or total sales, is clearly significant. Nevertheless, all effects are significant three years after the end of the project ($t+3$), confirming that SMEs participating in the FP have shorter-term objectives than big companies.

These results are in line with previous empirical evidence on cooperation, although our methodology allows us to go a step forward and demonstrate that economic impact of RJVs should be analysed as a consequence of increasing technological capabilities. This evidence could be relevant regarding future impact assessment activities of cooperation programmes, and specifically of the FP.

4. Conclusions and policy implications

Considering that those small firms with limited or null technological capability are the target recipients of the SMEs specific measures, we can conclude that this programme has reached one of its main goals: results show that firms obtain significant gains in intangible assets. Under the sixth FP, the evaluation criteria established by the European Commission stress the business interest of the project. However, descriptive analyses (European Commission, 2010) show that firms do not exploit technological results as expected. Probably, SMEs need an additional support for the post-cooperation phase, in order to overcome commercialization barriers. Also, R&D performers should be involved in this phase, to guarantee that the final output of the project meets all the market needs.

However, empirical evidence obtained in this paper indicates that the effect of collaboration on performance indicators is similar for SMEs than for big companies, although the extent of R&D projects, and consequently the time period for their impact, tends to be shorter. Assuming that SMEs with low or almost null technological capabilities are involved in different kind of consortia, it seems appropriate to support these companies with specific measures.

Policy and Governance for Research Institutes in a Time of Renewed Mission Orientation

Kate Barker², Erik Arnold¹

¹*Technopolis Group; UK*

²*Manchester Institute of Innovation Research; UK*

Motivation

Just as Mode 2 is not the 'new' mode of knowledge production but the original form, so for many research institutes mission orientation is 'business as usual'. The new mission orientation implicit in the extension of interest in European research policy from blue-skies and industrially focused types of R&D to encompass 'Grand Challenges' plays to the strengths of the institutes.

The Research Institute (RI) sector is the 'neglected stepchild' of the research and innovation system – largely ignored in the literature and policy discussions, which tend to focus on the university-industry axis. Yet this is in many respects the institutional form of knowledge generation that led the way from artisan-based innovation to a more scientific and technological approach and was the dominant form of knowledge production for economic and societal use well into the Twentieth Century. The Soviet-style academies that have largely been dismembered in the period since 1989 represented a late survival of this extra-firm institutional structure for knowledge production. Industrial research capacity spanned both basic and more applied work, with industrial basic research being an important source of innovation at least up to the 1950s. Since then, both the absolute volume and the proportion of knowledge production internal to firms has increased to become the dominant mode. The last 20 years or so have seen a further redivision of labour, with the university share of research continuing to increase while industry increasingly enters into 'open innovation' arrangements that transfer the costs of basic research back to the state.

Our paper focuses on the institutes with the explicit aim of providing a more rounded and historically accurate account of the role institutes in the 'knowledge infrastructure' of institutes and universities in generating the knowledge needed to tackle the Grand Challenges than is normally available, as a basis for proposing policies and governance mechanisms to address the Grand Challenges.

Approach

Our paper is based on a major research project funded by the European Commission and conducted by Technopolis, MIOIR and NIFU¹, to explore the history and future development of the research institute sector. We started by trying to understand the institutes via a literature review. We were especially interested in the driving forces that promote change, in order to understand how trends in the institute system relate to the development of the ERA. Based on the literature, we then selected six sectors for closer study, aiming to look at their history over the past two decades and from these histories to deduce further (possibly sector-specific) historical change drivers. In a third step, we invited people from each of the six sectors to foresight workshops in Brussels, to discuss their views on future trends, drivers of change and policy needs in their sectors. Based on these three components, we then analysed prospective changes in the institute system using scenarios and developed a series of policy options and recommendations. This paper extends that work by looking at the longer history of extramural R&D in industrial development and using that to explain the role of key types of research institutes.

Results

There are broadly three kinds of research institutes

- Scientific research institutes,
- Government laboratories,
- Research and Technology Organisations (RTOs).

Our paper focuses on the second and third of these.

Research institutes, variously defined, account for almost half of Europe's public expenditure on R&D, yet they are in many respects almost invisible. There are no systematic statistics about them. What they do is to a large extent undocumented. The institutes have been consistently ignored until very recently in ERA development and discussions, despite their key nodal role in the Framework Programmes. Very little reform has taken place in the institute sector, except for changes to bring former Soviet-style academies into line with EU practice and some privatization and quasi-privatisation. However, those reforms that have taken place generally aim to create better alignment between institute activities and societal missions.

¹ Arnold, E., Barker, K., Slipersæter, S. (2010) Research Institutes in the ERA. <http://ec.europa.eu/research/era/docs/en/research-institutes-in-the-era.pdf>

The terminology of institutes varies among languages and institutional traditions. Our definition is well captured in the German language as 'extra-university research institutes'. The other defining characteristic of research institutes is that they are at least in part state-financed in order to provide social returns by addressing market failures. In other words, they perform tasks that cannot be achieved by markets.

Europe-wide, research spending through institutes is slowly declining, while that through universities has been rising. There is a small number of very large institutes in Europe but most of the sector is nationally organised so that individual institutes are typically small. The proportion of income the institutes get from markets and from abroad has slowly been rising and they are increasingly cooperating with the universities, though the tasks that institutes and universities undertake are typically very different from each other.

Major change drivers affecting the research institute sector include

- Convergence among technologies and between technologies and science, so that the role of scientific knowledge in innovation is increasing,
- Hence, closer links with universities,
- Growing scientific and technological sophistication of the institutes' users,
- Globalisation of scientific knowledge and of the institutes' company customers,
- A growing proportion of more 'commercial' activity and greater participation in markets by the institutes,
- Increasing scale (in the RTO sector) and the building of more polytechnic organisations,
- Policy becomes an important driver – immediately at national level, where policy tends to be to reduce state funding; potentially at European level, where measures to promote a stronger and more international role for the institutes in the European Research Area have largely been absent, with some notable exceptions.

At the level of governance, some of the important consequences of these drivers are

- Reforms to bring proxy users into the governance structures of institutes,
- Increased contestability and steering of core ('institutional') funding,
- More explicit negotiation with institutes about their strategies and thematic foci,
- A clearer pattern of funding, where the proportion of institutional funding reflects the degree to which the institute addresses areas of market failure,
- A vacuum with regards to internationalization.

Policy Implications

Research institute governance and funding remain stubbornly national in character. In the light of the ERA objectives, which are ultimately to build a healthy 'research ecology' at European level, objectives for EU-level policy for the research institute sector should be to optimise the research institute sector towards European needs by

- Integrating European knowledge markets to create a common market for knowledge and knowledge services,
- Removing barriers to research institutes building globally competitive and naturally viable scale through competition and specialization,
- Exploiting the capabilities of the RTOs to tackle the grand challenges, once these are defined and integrated into EU research and innovation policy,
- Ensuring that Community provision of research infrastructure addresses not only the needs of basic research (ESFRI) but also of the institute sector,
- Supporting the self-organisation of research institute sectors at the European level via organisations such as Eurogeosurveys and their connection to areas of developing policy need at European level.

Supporting developments in the institute sector that are **disequilibrating**, ie that combat existing lock-ins and enable new and existing institutes or groups of institutes to build positions in competition with others that overall strengthen the 'offer' of the European institute sector and its global competitiveness.

Innovation subsidies in a federal system – innovation policy at different political levels in Germany

Lasse Becker

Georg-August-University Göttingen, Germany

1. Motivation

Governments at all levels claim the importance of innovativeness for the economic growth and competitiveness of their region and use different measures of innovation support in order to foster this innovativeness in their respective jurisdiction. The importance of innovativeness for economic development and growth is based on theories starting from Schumpeter (1942) who made the expression of the "creative destruction" popular as an engine of development and growth. Other more recent authors like Brouwer (2000, p. 149) proclaim the importance of innovation towards economic growth based on Schumpeter's theories.

As mentioned before, in order to enhance private companies' innovation activities government offers innovation support via subsidies, tax-cuts, protective legislation, or supportive infrastructure mainly for research and development but also for other innovative activities. With very few exceptions (like Busom/Fernández-Ribas 2007 for Spain) literature considers innovation policy to be homogeneous within a country (like Fier/Czarnitzki 2005 for Germany, Duguet 2004 for France, or Aerts/Czarnitzki 2004 for Belgium). This assumption, however, is questionable as several countries have a federal system like Germany or are closely linked to multi-level government structures like the European Union. The selected policy instruments to foster innovation have an influence on both the public spending and the coordination of policy instruments regarding innovation. There exists a lack of empirical studies to describe the impact of federalism on the field of innovation which this study will reduce.

Starting with the Federal Republic of Germany as a federal country, the influence of three different political levels handling innovation policy has to be addressed: Fifteen out of sixteen German states offer general innovation support in addition to support offered by the federal government and the supra-national European structures. Focusing on German innovation support, the consequences of different levels of support are to be assessed: Whether the different state innovation policies and the federal policy collide or complement to different targets of society can be examined by comparing the characteristics of recipients of innovation support.

This will create the basis to develop political implications regarding useful government structures at regional, national and supra-national level.

2. Approach

In order to examine the effects and target groups of either regional or national or supra-national innovation support an econometric approach regarding the empirical backgrounds of companies which receive innovation subsidies is an adequate approach. Most of the programmes supporting innovative activity tend to focus on small and medium sized enterprises, therefore this characteristic and other characteristics of companies, which might influence the reception of innovation support, are evaluated closely.

Focussing on innovation support in Germany the existing panel data of the Mannheimer Innovation Panel (MIP) of the Centre for European Economic Research (ZEW) builds a solid base for an analysis: Annually approximately 6,000 companies participate in the written questionnaire and further 4,500 companies answer to non-response calls. Every second year the questionnaire includes questions which refer to the political level which granted innovation support. As a combination of different waves of the unbalanced MIP would reduce the number of observations dramatically, the data of the last collection wave of the MIP from 2007 forms the general dataset for this paper.

Using the data of the MIP, all three different political levels, which offer innovation support in Germany, the regional state-level ("Bundesländer"), the federal level ("Bund") and the supra-national European level ("EU") have to be compared. This study examines the reception of public innovation support as dependent variable in an econometric model. This dependent variable is binary coded, which has the consequence that a binary model – in this case a Logit-regression – is chosen to evaluate which characteristics of a company influence on the reception of innovation support.

Expanding the basic setting which Busom/Fernández-Ribas (2007) used for Spain, additional variables are taken into account. Busom/Fernández-Ribas (2007) focused on the overlap between different levels with general independent variables like the wage-level for researchers or the share of high-skilled employees. By adding other explanatory variables like the detailed size of companies, intensity of exports, regional dummies for German states or the market share, the analysed influences are broadened. Three different models of dependent and independent variables are selected in order to show the different influences at all political levels.

3. Results

Considering the first empirical findings, substantial differences regarding the three different levels of public funding are visible: Small and medium sized enterprises are significantly put at a disadvantage receiving federal innovation support whereas the pos-

sible disadvantage at the state level is both remarkably smaller and insignificant. Regarding the support of the European Union, a disadvantage exists but is neither significant.

Other explanatory variables like the company's constancy of innovative activity as well as a higher share of employees with university degrees show a positive and highly significant influence at all three levels. The independent variables like the export share or the focus on international markets influence the reception at the state level, but far less at the federal or supra-national level.

Highly significant at all three levels is a dummy variable for companies from Eastern Germany. Companies from the former socialist German Democratic Republic have significantly more frequently access to public support at the state level but – with slightly smaller coefficient – also at the national level and even at the European level.

Based on this finding the dataset allows focusing on the differences between German states in order to compare state policies regarding innovation. In addition to the prior finding, companies significantly more frequently access state innovation support in those states which receive money from the German financial transfer system¹ compared to those states which pay into the transfer system. In contrast to the dummy variable to control for the influence in Eastern Germany, the reception of the German transfer system influences the state level, but neither the federal nor the supra-national reception of innovation support. As the data of the Mannheim Innovation Panel is not generally focused on studies regarding innovation policy of single German states, the number of observations only offers the possibility for a state comparison of the states of Bremen, Baden-Württemberg, Bavaria, Lower Saxony, North Rhine-Westphalia, and Saxony. The results show that gaining state innovation support is more likely in Bremen, Lower Saxony, and Saxony and more difficult in Baden-Württemberg, Bavaria, and North Rhine-Westphalia.

The influences of other variables like family ownership of a company, the intensity of competition and the market share are also included in the detailed regression within the paper.

¹ The German system of financial equalisation among the federal states ("Länderfinanzausgleich") is briefly subscribed as a financial transfer from economically stronger states like Baden-Württemberg, Bavaria, Hamburg, Hesse, and (at least in some years of our study) North Rhine-Westphalia to economically weaker states.

4. Conclusion

In accordance with economic theory that federalism leads to a stricter focus on the regional preferences (compare Oates 1972, p. 13), this study shows that regional innovation support addresses smaller companies better than federal or supra-national innovation programmes. These findings strengthen the importance of a federal innovative system. But regarding broadly discussed problems of the German federal system it is at least not easily explainable that those states which receive money from financial transfer systems seem to focus stronger on innovation support. A possible explanation could be the struggle to improve the own situation by innovation, but also a generally less restrictive budget policy might be relevant.

Innovation programmes of the three analysed political levels in Germany reach companies with different characteristics. The first policy implications already emphasise the importance of a special focus on regional comparative advantages as well as the general and independent evaluation of the goals of public innovation programmes. Especially the problems of smaller companies to reach federal innovation support challenge some federal programmes which are supposed to focus on these companies. A more defined structure of target groups of the different levels of innovation policy is supposed to be one consequence.

The goals of different innovation programmes are evaluated with regard to the findings that some of the goals are harder to achieve at the national or supra-national level. Therefore an inhomogeneous innovation structure like in Germany offers possibilities to broaden the range of innovation support in general.

Questions arising like lock-in-effects, goals of innovation programmes but also bureaucratic structures existing at all levels, and only few independent studies evaluating the innovation support in Germany show the importance of further research on the field of federal innovation policy in Germany and later on in the European Union.

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The eternal search for accountability and steering in Dutch humanities valorisation debates: From Baby Krishna To The Cohen Commission

Paul Benneworth

*Center for Higher Education Policy Studies (CHEPS), University of Twente,
the Netherlands.*

1. Motivation

The humanities experience an eternally precarious existence and struggle for survival and independence. There is an increasingly popular trend for governments to be justifying their considerable investments in higher education and research in terms of their immediate public benefits. This shift has brought with it a shift in the comparative valuation of disciplines dependent on their perceived capacity to deliver public benefits, and for those that are not seen as being fundamentally useful, they face a reduction in their funding or a redirection towards the supposedly useful areas. Nowhere is this more evident than at the level of Europe, where the Social Sciences and Humanities directorate is being dissolved. The net effect is pushing humanities and social sciences to the periphery of the main societal challenges, having a single challenge, 'inclusive, innovative and secure societies', and being eligible to compete with other disciplines for infrastructure, excellent research and mobility grants.

This is particularly evident in the case of the Netherlands, which has a long history of trying to accommodate the special needs and requirements of the humanities as academic disciplines during long-term reforms to the higher education system. The Dutch experience with stagflation in the early 1970s left policy-makers with a deeply-ingrained desire to ensure public expenditure was closely tied to useful outcomes, through introducing competition, co-payment and performance-based funding. This approach was also applied to higher education, and by the 1980s, at a time when the notion of usefulness of research started to emerge, there was considerable concern amongst certain disciplines, particularly in the humanities, that they were being neglected in these market processes. Since then a number of learned committees involving universities, government, politicians and societal stakeholders have been active in attempting to find a way to define usefulness in the humanities, and in particular in its research.

This paper conceptualises this process in terms of the result of a series of attempts to stimulate improved societal benefits from research, that have sought out an evidence base, and with the available evidence base subsequently becoming a justification and even a definition for societal benefits. This process has been influential in shaping the

evolution of research funding, in particular favouring certain disciplines which are perceived to be useful and disadvantaging those which are not. This paper seeks to explore the effects that this change is having on the way research systems are organised, and in particular, how research policy-makers have sought to accommodate the clear dissonance between these implicit and un-/sub-conscious value hierarchies, and an acceptance that these disciplines do have a value that is perhaps not necessarily fully understood and measured. This paper therefore seeks to contribute to debates about research valorisation by unpacking some of the assumptions present in debates, the mechanisms whereby they implicitly become embedded in research systems, and to therefore improve the rationality of understanding of those systems, and ultimately to more effective, productive, and socially beneficial research programmes.

2. Approach

The paper conceptualises the process of transformation in governance of science policy as taking place at a variety of levels. Two of the most salient in terms of these changes are the macro-(environment)level and meso-(system)level. At the macro-level, there is an understanding that there has been a change in the nature of policy-making from government in hierarchies towards governance in networks (Rhodes, 1997, 2003). In an attempt to solve increasingly complex societal problems, governments have opened up decision-making at all levels of public life – from state policy to the delivery of services, to network- and market-based decision-making processes. At the meso-level, these changes have also impacted on the way that science policy operates, with science funders seeking to encourage new organisational and behavioural norms (e.g. programming, collaboration, interdisciplinary, multidisciplinary & transdisciplinary ventures, infrastructure investments) to modernise and make more efficient the publicly-funded scientific endeavour.

The nature of these transformations as high-level public policy decisions and meso-level systems shifts have also had impacts at the micro-scale, including at the level of individual institutions and disciplines. These micro-scale impacts have been both homogenised but also highly differentiated. They have been homogenised through the results of the imposition of business models on the science sector as a whole, for example in terms of the definition of scientific quality in terms of the notion of serving the community through publishing in highly rated outlets. However, they have also been highly differentiated because of clear variation in how closely these micro-scale units fit with these macro- and meso-level models imposed through these modernisation-driven reforms, and hence by the overall impacts on these different units arising from modernisation.

So policy-makers seeking to rationalise their research funding are caught between a desire to maximise efficiency across the system, and a risk of directing funding to areas that are deemed excellent because of an artefact in the simple models of research activity used by policy-makers. In the field of societal value, there is a domination of definitions of social value in terms of narrow definitions of economic value, relating to easily measured variables around licensing, patenting and consultancy activity. Therefore, in an age where policy-makers are seeking to direct resources to those sorts of research that are most useful, there is a risk that they will instead their resources to the sorts of research that look most like particular kinds of past useful research.

3. Results

Because of its early adoption of modern, transparency-driven approaches to governance of higher education policy, the Netherlands has long been wrestling with the fact that certain areas of the humanities suffer intolerable pressures if exposed to a single resource allocation regime in parallel with other disciplinary areas. Since the late 1990s, the issue of relevance and usability of research has become a salient issue in Dutch research politics, and in particular, there has been an early recognition of the potential threat that this poses to the humanities because of the diffuse nature of by which its research is valorised into society. Governments and the Ministries have tried different kinds of institutional solutions to improve the sensitivity of researchers to users' demands, all of which have differentially impacted on the humanities.

It is possible to distinguish two kinds of behaviours emerging in attempting to solve those problems, between exceptionalism and participation. In exceptionalism, arts & humanities research stakeholders have attempted to make the case that there is something unique about their fields that demands separate treatment. Government ministries have been lobbied to hear the argument that arts & humanities research is uniquely dependent on government funding sources because of the absence of cultures of R&D in the cultural and creative sectors that eventually use the produced knowledge. The Cohen Commission on the future of sustainable humanities was able to secure €10m funding specifically for humanities faculties to help them reengage (*inter alia*) with schools and teachers as a means of diffusing their knowledge into the market. The Science Council NWO made funding specifically available for Ph.D.s in the humanities to address a shortfall in numbers of students coming through because of the absence of privately-funded Ph.D. research projects.

But at the same time, there has also been a strong element of participation by humanities stakeholders in engaging with the new norms of useful research. So in return for the additional funding coming out of Cohen, the ten humanities faculties are working to

develop an agreed indicator set and methodology for measuring the impact of humanities, wider than purely technology transfer measures, but which would also be applicable in other disciplinary areas. NWO's arts & humanities college has engaged actively with the idea of programming, ensuring that its programmes fit with NWO priority areas, and that its researchers can participate in programmes from other colleges. There have been the emergence of new disciplines and activities which have sought to exploit the opportunities arising from new behavioural norms, such as digital humanities as an overarching area, with areas such as computational linguistics. Partners across humanities are engaging, no matter how sceptically, with the idea of channelling business R&D subsidies into ten TOP sectors, ensuring that the creative sector is present as one of those ten areas.

4. Conclusion & Policy Implications

In the process of responding to these changes through parallel processes of resistance and incorporation, the landscape for the humanities is evolving, as is the Dutch scientific base in humanities fields. What has not happened has been a simple kind of instrumentalism, that more applied research has been encouraged, or more commercialisation activity. Rather, these pressures and intentions in one side have been drawn into a creative tension with the wider academic environment for humanities in universities, and this has produced interesting new forms. It is not clear how these forms relate to historical ideas of humanities but what is clear is that the norms of what it means to be a Dutch humanities academic are changing, not least through an evolving academic formation process reducing the possibilities for isolation in the field.

It is this emergence and dynamic evolution process which forms the core finding for the discussions in this paper, as there are clear implications both for theory and for the practice of valorisation policy in the humanities. A stylised representation of the Dutch case study is that a single long-term pressure for usability at the level of the science system was fragmented along disciplinary lines, and produced a series of changes differentiated by discipline, which remade the system in a way that could not have been predicted *ex ante*. A key feature of this process was that of complexity – so micro-level responses were not determined by the ecological variables – such as disciplinary background or institutional affiliation. Instead, the micro-responses created new sub-systems – such as new fields like digital humanities – which had their own internally-coherent take on valorisation. When the system coalesced around these new sub-systems the forms of valorisation that were present and possible were not necessarily the same as those articulated by interested parties in the process.

The policy implications are also clear, and in particular, the need to better understand the functioning of these sub-systems in increasingly complex science systems being steered towards a multiplicity of outcomes. A first step here is to develop a typology of the kinds of new sub-systems which are emerging with the transformation and fragmentation of universities' missions. What is not understood here is the role played by these sub-systems in the emergence of the valorisation mission, and the new sub-systems which are simultaneously emerging. From a policy perspective, what is necessary is to be able to have a more realistic of how these sub-systems hang together, and consequently which policy levers can be pulled to achieve which kinds of desirable outcomes.

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State Aid Regulation in the Nanoelectronic Innovation System

Clemens Blümel¹, Sven Wydra²

¹*Humboldt-Universität zu Berlin, Germany*

²*Fraunhofer Institute for Systems and Innovation Research ISI, Germany*

1) Motivation: The connection between innovation and industrial policy

Mission oriented policies have undoubtedly experienced a renaissance in recent innovation policy debates. In our view a critical success factor for related mission-oriented policies are a stronger connection between industrial and innovation policy. Several authors recently revealed the importance of these instruments for the diffusion and dissemination of innovations in society (e.g. Aghion et al. 2009; Soete 2007; Morrison/Potts 2007; Aiginger 2007). Public demand of "useful and problem solving science" has also changed attitudes of policy towards science, making science more and more accountable for their outcomes.

But the required coordination of policies is not an easy task. Especially the field of innovation policy has experienced a strong increase in actor heterogeneity. In Europe, we can observe interdependencies between different levels (regional, national and European policy making) and policy domains that interfere with national cultures, traditions and institutions. While it has been widely acknowledged that science and innovation policy making has to be negotiated and coordinated on a European level, existing transnational instruments can hinder the production of a consistent innovation policy. One of these transnational policy instruments is the European state aid control (Aghion et al. 2011). It has been particularly criticized as an obstacle for designing coordinated mission oriented policies.

The state aid regulation system, originally designed as instrument of competition policy, has been subject to several changes in order to meet priority goals of the European Commission. Various frameworks structure its application. Some of these guidelines and frameworks have been analyzed (e.g. OXERA 2007). What is lacking in our view is a detailed and comparative analysis of the effects of the state aid regulation system on the innovation system of a specific technological field. Such an analysis could be particularly useful in order to relate the role policy could play in dealing with the instrument. In our view, the construction of the state aid regulation has produced some structural problems in sectors where knowledge production and industry are highly coupled and societal impact should be important.

2) Approach

Understanding and designing policy instruments which regulate and stimulate the production and consumption are best understood by a relational perspective that takes actors, networks and institutions into account (Edquist 2006). Therefore, in our contribution we would like to provide some arguments as to whether state aid regulations are to be changed and reframed from an innovation system perspective. We will focus on the case of nanoelectronic innovation field where state aid regulation affects networks, institutions and actors. The nanoelectronics innovation system is integrated into the highly volatile semiconductor market with its applications in industries including machinery, energy, consumer electronics and automotive. Currently, the innovation system appears to be locked-in in the "more-moore path" with the aim of further miniaturization. Instead, the potential to address the grand challenges is believed to be higher in the development of new functionalities (more-than-moore-path). We aim to address the following questions: To what extent is the innovation system in the nanoelectronic sector affected by state aid regulation, given the integration of these industries? Which components and functions are affected? And finally: To what extent can the instrument of state aid regulation be reframed and changed towards enhancing research and innovation in the field? Our presentation is structured as follows: First we will analyze the nanoelectronics and semiconductor field from a system of innovations perspective. We will specifically concentrate on Europe and the structural changes that the region has undergone in order to derive in a second step which components and functions of the innovation are affected by the state aid regulation scheme. We will then try to analyze how these functions and structures of the field are affected by state aid regulation scheme and what chances of policy strategies exist in order to respond to these challenges.

3) Results

Relying on interviews with policy actors, industry experts and stakeholders as well as an analysis of state aid we argue that state aid regulation has an impact especially in very capital intensive science and technology fields. The nanoelectronic field meets these conditions and is extremely sensitive to government intervention. As the main reason we identified the prevalence of the capital intensive "more moore" path. This path is still dominant in the field and connected to exponential rising costs for each new technology step. It is obvious that the state aid regulation mainly affects investments in this part of the technology field. But beyond that there are some other shortcomings of the framework which come to the fore when the characteristics of the knowledge accumulation process and the regional setting are taken into account.

The analysis of the knowledge accumulation process shows that research, development and production are highly interdependent and connected merely from the production site. One can observe more hybrid and recursive types of innovation which challenge the appropriateness of the concept "research and development" [which is typically used by state actors to orient innovation policy]. The state aid regulation scheme mainly concentrates on the distinction between research and production in order to legitimate or delegitimize state intervention for investments. Therefore, the architecture of the framework stands in sharp contrast to field specific logics where research and production are highly coupled. The second finding relates to the regional characteristics of the industry in Europe. Our analysis shows that research and production is concentrated in a few highly industrialized regions of the European Union with a high skilled labour force and an already existing research infrastructure. On the contrary, the state aid regulation scheme is more sensitive towards structural aid which could to a disintegration of the main actors in the European Union and setting wrong investment incentives.

4) Conclusion/Policy implications

Summarizing, the state aid regulation affects several components of the innovation system such as networks, knowledge production and the capacity of policy to interact. Although it mainly aims at regulating investment stimuli, it affects different parts in the knowledge accumulation process. On a global scale, this transnational regulation has also weakened the position of the European nanoelectronics and semiconductor industry. Effects of the European state aid regulation scheme became specifically obvious in 2009 during the economic downturn when several governments prevented semiconductor firms whereas in Europe one of the few major companies could not be saved. At the same time research in the European Union in the nanoelectronic innovation system remains robust but is specifically connected to a non-dominant innovation path.

Relying on the above mentioned findings of our analysis, we argue that some aspects of the state aid regulation do not fit in the configuration of the nanoelectronic innovation system: Given the hybrid character of research and development in the technology field, the clear distinction between research and production as a criterion for acceptance of government intervention seems not be appropriate. We hold that such a construction affects the capability of policy actors to react on the most important challenges in the innovation field. Also, the highly concentrated regional structure of the research and technology landscape suggests that investments in nanoelectronics will not be made in structurally weak regions. On the contrary, the state aid regulation scheme is more sensitive towards structural aid which leads to a disintegration of the main actors in the European Union and setting wrong investment incentives. The re-

sults of our research suggest an integrated approach in the steering of technology domain in order to overcome regional dispersion which should be accompanied by a change of the state aid regulation schemes towards incentives for research and innovation.

That does not imply to allow any state subsidies and to join into the global funding race. In other words: We do not support abolition of the state aid regulation scheme but to change existing frameworks towards higher adaptation to innovation needs. Relying on the finding that the nanoelectronics innovation system is still dependent on the capital intensive "more moore" path we plea for supporting the creation of more and diverse technology paths which has once been mentioned as one of the main tasks of public innovation policy dedicated to semiconductor technology (Holbrook 1995). We argue that policy should concentrate on open innovation fields that make contributions to many economical and societal fields and at the same time fit into a mission oriented approach, for example on the so called "more than moore" innovation field which is less capital intensive, less concentrated and less oriented on high investments. Such an approach could orient towards societal benefits such as applications for the health system, eco innovations or the mobility sector which can be object of public innovation funding.

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Governance of learning processes in transdisciplinary climate adaptation research projects

Wouter P.C. Boon¹, Edwin Horlings¹, Peter van den Besselaar²

¹*Rathenau Instituut, the Netherlands*

²*VU Amsterdam, Faculty of social sciences, Organization sciences, the Netherlands*

Climate change is one of the Grand Challenges as identified by the European Union in their Horizon 2020 R&D policy plans. In the Netherlands research on climate change and adaptation is organised in a large mission-oriented research programme, Knowledge for Climate. In this programme knowledge producers, such as universities and knowledge institutes, cooperate with knowledge users, e.g. municipalities, water boards and companies in research projects. These projects are characterised as 1) involving a large array of scientific disciplines and societal actors; and 2) taking place in a local, context-specific setting. This approach, which can be characterised as transdisciplinary and contextualised, aims to have a transformative effect on the governance of knowledge production.

The scientific enterprise has long been regarded as researchers contributing individually to (parts of) larger-scale scientific questions in a specific discipline. This picture of a 'star scientist' solving scientific puzzles, thereby automatically improving societal issues as well, has been overturned since the Second World War. Mission-oriented initiatives, such as the Manhattan Project, putting a man on the moon, the war on cancer, and more recently large-scale project sequencing the human genome, contributed to that. In this light, the EU grand challenges can also be understood as being mission-oriented.

At the same time, these grand challenges are associated with high degrees of uncertainties and high stakes. Therefore, they could be regarded as 'wicked', complex or unstructured problems (Rittel and Webber, 1973). One of the main characteristics of these problems is that demarcating and defining what the problem actually is, is part of the research project. Most wicked problems are playing at such a large scale that the problem definition affects a large array of actors, not merely limited to scientific ones. These scientific projects should therefore be subject to an "extended peer community" (Funtowicz & Ravetz, 1992) involving scientists coming from different disciplines and all kinds of societal actors. The involvement of societal actors partly legitimises science but they could also be instrumental in the research process and even contribute with their experiential knowledge and creative potential (Boon et al., 2011).

Wicked problems also play on a local or context-specific level. For example, producing knowledge to help create proactive measures to engage with climate change for a

large part depends on the characteristics of the location under study. This leads to studies with specific knowledge that is not easily published in high-impact scientific journals, because 1) user- and context-specific questions form the basis of the research objectives, which might not align well with the main cutting-edge scientific questions; and 2) the specific aspects make generalisability harder and make the results and conclusions less appealing to top-tier journals (e.g. Hessels, et al., 2011). The incongruence between context-heavy results and cutting-edge issues in high-impact journals is problematic because academic groups are increasingly evaluated using publications in these journals. This development goes on in all disciplines and also applies to disciplines with low levels of reputational competition. The level of reputational competition means "the extent to which researchers seek recognition from their intellectual peers for the significance of their results in solving intellectual problems" (Whitley, 2003). With low levels of reputational competition, other audiences than the 'international invisible college' of scientific peers are regarded as more important, also because "goals and reputations are more local than national or international" (Whitley, 2003). At the same time, there is an increasing pressure on academic groups to include societal relevant research in their research project portfolio, and societal relevant research project account for – sometimes substantial – earnings. Therefore, research groups increasingly need to combine and align scientific and societal relevant studies. The question is how this can be managed?

The broadening of the scientific enterprise has been studied in the context of science and technology studies under terms like user-producer interactions (Lundvall, 1992; Von Hippel, 2005) and transdisciplinary research (Bergmann et al., 2005; Hirsch Hadorn et al., 2008). When focussing on research projects that deal with large, complex problems, the research project team should involve actors coming from different disciplines and backgrounds (science, businesses, government, societal organisations, etc.). These teams form the focal point of science of team science. This article specifically focuses on the knowledge producers involved in these research projects and how they interact with knowledge users who are part of the research team.

Team science is defined as scientific endeavours aiming at working on complex problems that call for a cross- and transdisciplinary approach. The science of team science often focuses on those initiatives that encompass a large range of scientists, disciplines and locations (Stokols et al, 2008). Part of these initiatives are initiatives in the form of large-scale multi-actor multi-level research programmes. Team science teams are hypothesised to be sensitive to peers from science as well as from society (cf. the extended peer community). They allow for this because they are either intrinsically motivated or they apply to incentives provided by the science system or society. When studying these teams it is therefore important to take into account the individual charac-

teristics, such as motivations and values, as well as interactional characteristics, such as interaction patterns previous to and during the project, and organisational and institutional factors, e.g. including the prevailing incentive systems.

Much is known about transdisciplinary interactions in the context of technological development, but the way in which this collaborative knowledge production is embedded in the individual, organisational and institutional backgrounds of the actors involved is not well understood. Moreover, the influence of these backgrounds on learning in these teams could benefit from more research. This boils down to the following central research question: to what extent do individual, organisational and institutional factors influence the effectiveness of teams consisting of a large range of scientists, disciplines and locations that aim to contribute to 'wicked problem projects'?

We studied the characteristics of actors involved in transdisciplinary teams in the context of Knowledge for Climate projects and compared these projects to monodisciplinary team projects in climate science in the Netherlands. Event history analysis (Van de Ven, et al., 1999) based on document research and in-depth interviews was used to capture the learning processes over time. The individual, organisational and institutional factors were mainly gathered from in-depth interviews.

Preliminary results show for example that science performed in transdisciplinary teams can be characterised by a high degree of willingness to collaborate, and frequent and mostly informal exchanges between team participants. Rapid learning about problem definitions and methodologies occur, as well as an increase in understanding of other parties' norms, values and objectives. Although team participants were knowledgeable of each other's incentive systems, differences in incentives can create tensions and decrease the team's effectiveness. There are also differences in the creation and fulfilment of expectations. The interviews in monodisciplinary teams are currently conducted and will soon be ready for analysis. The analyses will contribute to formulating recommendations on the governance of learning in multi-actor, transdisciplinary research projects

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Inside centres of excellence – funding schemes' effect on researcher identities and practises

Siri Brorstad Borlaug, Magnus Gulbrandsen

Centre for technology, innovation and culture (TIK), University of Oslo and the Nordic institute for studies of innovation, research and education (NIFU), Norway

1. Background/Motivation

The innovation literature has long emphasised the synergies between research excellence and innovation in universities, finding for example a positive correlation between researchers' entrepreneurial behaviour and the quality of their publications (e.g. Geuna and Nesta, 2006; Van Looy et al. 2006). These synergies are increasingly sought after by policymakers through funding mechanisms aiming explicitly at combinations of excellence and innovation. A clear sign is the increased attention to and development of mechanisms branded as 'Centre of Excellence' (CoE) and 'Centre of Excellence in Research and Innovation' (CoERI). Both aim at enhancing quality in new or existing research organisations to a world-class or state-of-the art level, termed excellence, and frequently also to promote the use of scientific research in industry and elsewhere, normally termed innovation. Often departing from the traditional department structure at the universities, these programmes promote collaboration that span organisations and institutions (Boardman and Bozeman, 2007,) resulting in multi-organisational and institutional research units that mesh together participants representing different disciplines and diverse organisations such as universities, industry, and public agencies. These research units are by name innovative and excellent, but how do they function in practise? This interplay between the quest for excellence and innovation (relevance) has received relatively little attention (Hessels and van Lente, 2011), and so has the institutional and organisational conditions under which such research is conducted (Heinze et al 2009). The paper aims at contributing to this literature through a study of eight centres in Norway and Sweden. Our research question is as follows: how do the different funding schemes affect the researchers' research orientation, identity and attempts at commercialisation?

2. Approach and methodology

Our empirical focus is the individual researchers that are embedded in an excellence and innovation framework through their affiliation with a CoE or CoERI. There are good reasons to believe that researchers experience tensions between their perceived researcher identity and the overarching policy goals of for instance innovation. Previous research has revealed that researchers in boundary spanning positions (Youtie and Shapira, 2008) that unite the world of science and industry often experience conflicts

and resentment (Atkinson-Grosjean, 2006). They are neither a full member of the scientific nor the industrial world, resulting in a buffering process against both (Gulbrandsen, 2005).

However, these tensions might play out differently in research organisations depending on the goal of the organisations, in our case excellence and the combination of excellence and innovation, and the strength of ties between the collaborating partners. In order to investigate this we compare four centres created with the purpose of research excellence and four that combine innovation and excellence. These differ when it comes to informal/formal cross-sector (university-industry) collaboration and other aspects. The CoERIs are contractually obliged to collaborate with other sectors, industry in particular, and the prime aim is to enhance the innovative capability of firms by focusing on long-term and high quality research founded in a close alliance between research-intensive enterprises and prominent research groups. As such, these centres have to manage two different types of portfolios (Bozeman and Rogers, 2001) – one in the scientific community and the other in the industrial/public community. The CoEs, on the other hand, manage a portfolio directed towards the scientific community only. However, assuming that excellent research environments also have extramural collaborations (as emphasised by the innovation literature), we can expect that these researchers also unite two worlds, but under different organisational and institutional conditions.

A comparative dimension additional to centre type is the national IP legislation. Sweden and Norway differ in this respect: Norway has transferred the right to exploitation of research results to the universities, while Sweden has kept the 'professors' privilege'.

All centres in the study are located at one university in Sweden and one in Norway. Both universities are the largest and among the oldest in each country and they are multidisciplinary. We have interviewed 3-5 researchers at each centre, in total 33 researchers in the period April 2009 to February 2010. This includes all centre directors and other researchers in leadership positions. We have used a semi-structured interview guide.

3. Results

The identity work of the researchers takes different form depending on the organisational and institutional context, and the overarching goal of the centre.

One such factor is the normative identity of the researchers. Several of the researchers characterise their research solely as 'basic' – those in CoERI as well. Some even distance themselves from the innovation aspect, motivating their role in the centre as being the scientific alibi, ensuring that the research is not too applied. Thus they identify

themselves with the excellence aspect of the funding scheme. However, researchers in centres that had strong ties to industry prior to the centre formation have less pronounced identity conflicts- being confident of their own researcher role. Some researchers in CoEs were also heavily engaged in cross-sector collaboration activities, but this does not affect their researcher identity – they are already 'branded' as excellent.

In centres with weak ties between the collaborating partners, issues such as problem choice are relative tension filled. The challenge is to combine the desires and needs of two institutional systems – the scientific community and industry. The researchers perceive these partners as desiring an immediate problem-solver and not contributing to the development of research questions with a long-term horizon. Researchers affiliated with CoERIs in fields characterised by strong and developed ties, experienced few tensions in this matter- the funding scheme posed a window of opportunity to formalise already established collaboration. Moreover, research questions in some CoEs are inspired by industry, but this is driven by individual researchers' interests and motivation. Collaboration is tension free and characterised by feeding back into research and generating new research questions.

Commercialisation of research is one aim of the CoERI scheme. The interviews reveal that the organisational and institutional context does not affect the researchers' practises or perception of commercialisation. Some CoERI leaders even disregard this activity while other researchers within the same centre are highly involved in for instance patenting activities. These heterogeneous practises are also evident in CoE. However, conflicts over the ownership of results at the centre level has resulted in a surpass of the existing regulation concerning ownership of IPR – the university's ownership is perceived as an obstacle to collaboration resulting in special contractual agreements for some of the centres out of line with national law.

4. Conclusion

The organisational and institutional premises for collaboration between university and industry affect the interplay between research excellence and innovation. It seems that top-down policy mechanisms create problems that the bottom-up and voluntary collaboration mechanisms avoid. Synergies between research excellence and innovation seem to excel in CoEs as these researchers do not need to adjust their identities – the collaboration is much based on the researchers own intrinsic motivation. The funding schemes affect especially the identity of researchers affiliated with centres characterised by weak ties between the collaborating partners. These researchers buffer institutional demands from science and industry struggling to achieve synergies between

excellence and innovation. However, for researchers affiliated with CoERIs with already strong and developed ties the funding scheme provides a "home" for and legitimate activities and practises that have been associated with the world of industry. The funding schemes have no effect on the researchers' commercialisation practises.

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The Quest for Mission-oriented Science-Society Relations – Studying transition cartographies at work in the field of sustainable energy research

Nicolaj Tofte Brenneche

Department of Management, Politics and Philosophy, Copenhagen Business School, Denmark

Introduction and motivation

In January 2012 80 researchers from across Europe and scientific fields gathered at the Copenhagen Research Forum (CRF) with the purpose of providing advice and input to "Horizon 2020", the EU Commission's proposal for a European research and innovation policy framework. The researchers were all recognized within their fields. Six expert panels were formed reflecting the six challenges of the Horizon 2020 framework (health, energy, food, transport, climate, society). One could easily imagine the rich potential for intellectual quarrel and rivalry in such a setting. *Health is not receiving enough funding! Climate comes before anything else! Energy is the cornerstone to solve all the challenges!...* This day however, the dialogue turned out differently. No sense of intellectual sarcasm in the air. The atmosphere was rather friendly and embracing. Maybe because the CRF-organisers had successfully constructed the event as the "unbiased voice" of scientists in relation to influencing future research policies. The President of the forum thus positioned the event as substantially different from the normal way of professional lobbying in the EU Commission. *We need to get scholarly knowledge back to the center stage of how we develop research policies*, the President proclaimed, – *and not leave it to management and strategists to form the framework conditions for us.*

The researchers' response to the Horizon 2020 proposal turned out quite unanimous: They embraced the idea of a mission-oriented research and innovation framework. And not only did they embrace it (the proposed budget is 80 billion Euro – the world's largest research funding scheme if accepted by member states), they warned against not going through with the rationale of a mission-oriented research framework. *Don't turn the framework into a new set of silos!* (hinting to the FP7).

In the energy panel, the challenge of combining a "technology-centered approach" with a "systemic approach" to energy research was forefronted as central to the future development of European energy research. The discussion reflected the growing focus in the field on how to contribute to systemic transition through research. The so-called systemic approach, as it was discussed in the panel, referred to the combination of problem-based, cross-disciplinary, cross-sectoral research with a substantial involvement of university students. Not very specified, but nevertheless interesting as an ex-

ample of how the strategic framing of energy research oscillates between different ways of formulating research problems along with different ways of organising the research process, emphasising the idea of a poly-centric process of collaboration between disciplines and sectors. The strategic framing of energy research is exactly what I am interested in. At the Eu-SPRI conference I would like to present empirical examples of how different strategic framings are at work in the organisation of sustainable energy research. I conceptualise these framings as *transition cartographies* hinting to the cartographic function of strategic framing which constitutes, from the point of view of research, the problem of systemic transition in energy as well as the proper organisation of energy research so as to contribute to the process of transition towards sustainable energy systems. The so-called "systemic approach" is one example of such a transition cartography. These transition cartographies are not carved in stone. But they are central to the process of interpretation of what role energy research should and can play in relation to transforming energy solutions in society. Empirically, the cartographic work becomes manifest in contexts where new research strategies are formulated and enacted, new partnerships are formed, and new institutional settings within energy research are constructed. Such events and processes constitute the empirical point of departure for my analysis.

Approach

The quest for mission-oriented energy research is an ongoing, unfinished process. My approach and empirical material reflect this processual reality. My approach has been to observe and participate in a variety of activities including the coordination of proposal for a Knowledge and Innovation Community (KIC) in 2009 in the field of sustainable energy, research funding activities, the development of a European innovation-oriented Ph.d. school in the field of sustainable buildings, and the organisation of a strategic partnership between research institutions and universities with a focus on sustainable energy research and education. Through this participatory approach I have gained access to processes of interpretation and negotiation of how to frame problems of energy research as transition-oriented, how to change institutional frameworks in order to organise research so as gain impact on systemic transitions. The empirical journey is inspired by the George E. Marcus' approach to multi-sited ethnography (see e.g. GE Marcus, 1995, *Ethnography in/of the World System: The Emergence of Multi-Sited Ethnography*).

My analytical foundation combines recent developments in the philosophy of science (in particular the work of Isabelle Stengers in *Cosmopolitics*) and recent developments in organisation studies focusing on the processual nature of organisation and the role

of strategic narratives and metaphores herein (e.g. Robert Chia, Barbara Czarniawska and Tor Hernes).

The concept of *transition cartography* is developed using Stengers' *ecologies of practice* that allows me to conceptualise transition cartography as that which connects *scientific legitimacy with an organising rationale*. This connection may be very different from one cartography to another. I argue, building on contributions from organisation studies, that transition cartographies play a central role in the process of reorienting strategies and translating quests into actions. Isabelle Stengers' philosophy of science is interesting, and important I believe, to operationalise analytically because one of her aims is to bridge the rivalry between traditional proponents of scientism and the post-modern deconstruction hereof. This allows her to invite problems of innovation into the core of how scientific practices work – not as a normative, transcendental regime arriving from 'outside' of science, but as a (possible) immanent part of how science works. The intellectual project of Stengers may help us underpin the discussions on how to develop a coherent approach to science and innovation as connected rather than each others' hostage.

Anticipated results

Being in my final year of my Ph.d. project I begin to anticipate some key findings. My research shows that a central aspect of the ongoing efforts at university level to orient energy research towards systemic transition challenges is to develop new topologies of science as a means to stage science as mission-oriented and collaborative. This means that the quest for mission-oriented research involves new ways of mapping problems and positioning research as a partner in approaching complex transition processes. The primary contribution from my research will be to show how the quest for mission-oriented research is a process in which the development of transition cartographies play an important role in interpreting and (re)defining research problems and organisational approaches. I also compare transition cartographies with regard to how each implies very different pathways for connecting certain understandings of scientific excellence with organisation and governance strategies.

Implications for management and research policy

The mapping of transition cartographies at work provides the reader with an overview of very different approaches to mission-oriented research strategies. This contribution should strengthen the level of reflection of practitioners in the field in need of ways of framing the problem of systemic transition and the role of research herein in a coherent manner. "The reader" could be the PI of future energy research programmes as well as the policy makers in the field trying to translate the quest for mission-oriented research

into coherent funding schemes and other instruments. In both cases, the concept of transition cartographies should help navigate between different approaches with different organisational and managerial implications.

One normative tendency in my interpretation of the implications of my research is to suggest that the organising role and managerial capacity of PIs in energy research programmes and projects should be given much more attention, in addition to their scientific accomplishments. Organising and managing mission-oriented research is fundamentally different from traditional approaches to energy research. Understanding the variety of transition cartographies can help expand the analytical language and managerial capacity of PIs and others involved in the organisation of energy research.

As such, the outcome of my research may be to further substantiate discussions, like those at the Copenhagen Research Forum, on how new purposes of science are translated and operationalised by research organisers, what competencies are needed in order to organise mission-oriented research, and which policy frameworks may support the unfolding of mission-oriented research.

Public Procurement for e-government services: Challenges and problems related to the implementation of a new innovative scheme in Greek Local Authorities

Yannis Caloghirou, Aimilia Protogerou, Panagiotis Panaghiotopoulos

Laboratory of Industrial & Energy Economics, National Technical University of Athens; Greece

The motivation of the paper is to provide empirical evidence on the role of Public Procurement for Innovation (PPI) in addressing social needs regarding the relationship of citizens and businesses with the public administration. In particular, this research aims at the examination of the innovation impacts of a pioneer public procurement practice for the provision of local e-government services in a specific country context. In general, the benefits of e-government consist in the upgrading of citizens' quality of life, the enhancement of businesses' productivity and competitiveness, and a more efficient public resources management.

Our empirical work is focused on the pilot project "Local Government Access Framework" ("LGAF") that has been coordinated by the Central Union of the Greek Municipalities (KEDE) and in which took part sixteen (16) Greek Municipalities. The objective of the project was the development of a centralized software system (platform) that would be utilized by the participating municipalities in order to provide high-level e-government services to citizens and local businesses. The LGAF project locates in the category of cooperative procurement practices as one central authority (KEDE) organizes and coordinates the project whose product will be used by other public authorities (municipalities).

The empirical part of the paper is based on case study work which was conducted using a semi-structured questionnaire trying to capture the objectives of the L-GAF project, its innovative characteristics and long-term potential, the relationships among different actors, the potential benefits and obstacles for success. This case study protocol guided a series of in-depth interviews with the founders or CEOs of the participating firms and the research centre officials that played a key role in the platform design and development.

Case study results indicated that LGAF can be characterized as an innovative project not only by Greek standards but also in the European and international context. Firstly, a main aspect of innovation is that the LGAF project is one of the public administration projects that follow the new rationale of e-government services delivery that EU strategy promotes i.e. an organizational-working model that is based on the common use of a central system by different public entities for the provision of e-government services (Software as a Service - SaaS).

A second design characteristic that favoured innovation is the modular architecture (Service-oriented architecture - SOA) of the whole system. This architecture can be considered as the main source of technological innovation as it fostered the combination of state-of-the-art technologies (sub-systems/components) for the development of a completely new integrated system. The extensive coordination requirements created the need for components' enrichment and modification by the specialized developers in a continuous learning-by-doing process.

A third innovative aspect of the project is the use of Open Source Software (OSS) for the development of the LGAF platform components. OSS favored even more technological innovation and the participation in the project of micro and small knowledge-intensive actors as it, generally, opens the market and constitutes a source of knowledge exploration. SOA also enhanced these actors' involvement as this modular architecture enabled the coordinated unbundling of the project and in consequence provided subcontracting opportunities for specialized knowledge-intensive developers.

The LGAF is a pilot project which has not been put in operation yet due to further organizational requirements mainly related to the need of unified modeling/automation of the internal processes determining the provision of services in the 16 municipalities participating in the project. However, the case study analysis indicated a wide range of potential benefits for public and private actors. The most important benefit would be the offer of e-government services of a high online sophistication level (level 4 and 5¹) to citizens (e.g. family record certificates, municipal tax payments, recycling of electrical appliances etc.) and local businesses (e.g. municipal tax payments etc.).

The design characteristics of the project (i.e. its modular architecture and working model) favour the reusability and transferability of the platform as well as the technical and organizational knowledge it incorporates. The LGAF platform can be ideally used by all Greek municipalities provided that their legacy systems are integrated to the platform. Moreover, additional services could be offered through the platform's enrichment with additional components and its integration with third systems (e.g. ministry of interior, ministry of finance, banks etc.). The utilization of the platform by the total of Greek municipalities would create large economies of scale for local government and offer much better services to citizens and local businesses. Furthermore, there are many opportunities for transferability of the accumulated technological and organizational knowledge to other individual public entities or group of entities such as ministries, re-

¹ Online Sophistication ranking assesses service delivery against a 5-stage maturity model: (i) Level 1: information, (ii) Level 2: one-way interaction, (iii) Level 3: two-way interaction, (iv) Level 4: transaction and (v) Level 5: targetisation /automation.

gional authorities, hospitals, courts, public utilities etc. The level of interoperability can be extended to the relations of municipalities with other organizations they may collaborate outside the country so that cross-border services to EU citizens/businesses can be provided.

Case study findings also indicated a number of obstacles that resulted in late delivery and partial failure of the project. In general, a major obstacle for PPI in Greece is the low level of public demand for innovative services and specifically the demand articulated by local government bodies. In the context of the LGAF project although the basic procurer (KEDE) has been recently formulating a policy for ICTs adoption and usage at the local government level it cannot be characterized as an "intelligent customer". This can be mainly attributed to the fact that it lacks the human resources required to monitor the design, development and implementation of such an innovative project, and further promote an active involvement of more end-users (municipalities). Therefore, although the procurement of the LGAF platform was a specific policy decision on the part of KEDE, KEDE does not seem to be able to fully support the implementation of this decision.

A second significant problem was related to the large, well-established in the Greek ICT market, company which was the project's prime contractor. This company does not seem to have the required technical capacity in order to act as a pole for innovation in the knowledge network created among the specialized developers and the research centre that were actually putting the platform components together. Therefore, there was insufficient project coordination in terms both of technical and project management which did not allow for flexibility and created great delays in the development of the platform leading to severe problems in the project's financing with a significant effect on the participating micro companies' survival. The fact that the prime contractor cannot foster innovation is tightly related to an inherent problem of the Greek ICT ecosystem where large firms usually act more as "box-movers" and "contract integrators of ready-made parts" and much less as creators or facilitators of innovative activities.

Service-oriented Government as a Driver for Regional Innovation: The Case of Suzhou and Wuxi, China

Xuanwei Cao

Xi'an Jiaotong-Liverpool University, China

The old debate about the role of government in economic development is returning back in post-crisis times. In the context of "large scale institutional transition" together with bureaucratic political system, transition economies bear particular characteristics which influence the entrepreneurial behaviors and activities (Bruton, Ahlstrom et al. 2008). Institutional theory has been used to investigate the entrepreneurship research (Bruton, Ahlstrom et al. 2010). Related research using institutional theory in the context of China are not in a few cases, such as legitimacy building by private enterprises (Ahlstrom, Bruton et al. 2008). However, as Child (2007) illustrated there is still relatively scant research from the perspective of institution entrepreneurship in exploring transition economy. Child and colleagues argue government as the institutional entrepreneur in building environment protection system in China (Child, Lu et al. 2007). As pointed out by McMillan & Woodruff (2002), "much of the task of devising the new ways of doing business in transition economies has been taken on by entrepreneurs". But we know less behind the successful practices and stories of those entrepreneurs, especially those who came back from overseas after decades of efforts on their professional development in advanced countries, lacking yet sophisticated knowledge about their home country's business practices and politics. Therefore, it should be a very interesting and important issue to find out the mechanism to induce the large scale innovative and entrepreneur activities in transition economy such as in China. Who on the earth drives and leverages institutional innovation and induced entrepreneur activities in China?

Our research settings are two cities in the east coastline of China. Since long time, Suzhou and Wuxi have been widely regarded as adjacent twin cities in China. Both have many common points in local culture, economic development level, experienced similarly processes of path dependency and path creation. In the past 30 years, both two cities have their ambitious plans to surpass the other, presenting fierce competition not only in economic field, but also including institutional competition, lobbying activities at Central Government level for kinds of resources and reputations. Under the transition of governmental driven regional development, both Suzhou and Wuxi were listed among "National Experimental Cities of Innovation" in 2010.

The process of investigating the dynamics and outcomes of government-driven institutional innovation required the gathering and analysis of data from multiple sources. We

utilize a *multimethod approach* consisting of historical case studies, content analysis and in-depth interviews. We sought to reveal the underlying mechanisms and social dynamics by using several complementary sources of data and methods of analysis (Vaara and Monin 2010). As for primary data, data collection was done mainly via the contacts and networks of the author and through local High-tech parks administration officers. We conducted in-depth interviews with governmental officials, High-tech park managers, High-tech entrepreneurs, investment managers from governmental venture capital fund in Wuxi and Suzhou based on a semi-structured interview approach. Fine-grained case studies can provide insightful information (Eisenhardt 1989; Eisenhardt and Graebner 2007; Yin 2009). The secondary data is drawn from archives, Searched archives from openly disclosed key policy documents in government agencies and departments in Suzhou and Wuxi.

Through our study, it is expected to disclose the mechanism of regional innovation under service-oriented government transition. Under "institutional competition" and "political pressure" (for merit and performance) local government in adjunct regions can take mimesis to react to uncertainty. This is particularly obvious during uncertain political environment when new institutional arrangements are not yet developed. In this case, local government would follow the routine and mimic adopted policies in other regions to avoid any possible political false in uncertain policy orientation. When political environment becomes transparent with clear signaling and orientation, local government would vie with each other to initiate institutional innovation for the sake of merit and performance. Thus, institutional innovation could be expected to emerge under institutional competition and political pressure.

With the rapid and successful economic development in the past 30 years in China, government both at central and local level are undergoing serious challenges to break their bureaucracies in the context of large scale institutional transition. In this context, government (officials) are suffering great pressures for maintaining social stability, which is the most prioritized political task for local government (officials); on the other hand, local government (officials) is challenged by seeking new development path and model to achieve sustained regional economic growth and a balanced development among economy, society and ecology. Recognizing that the continuously improving state capacity is the basis for regime legislation, governments in some regions, under those pressures, are transforming the functions of government to service-orientation, injecting a culture of innovation into their mission of promoting social development. Thus, government in transition economy has the motivation to conduct 'large scale innovation', especially in transformative societal aspects. Out of the consideration of legitimacy, societal stability and new model of development, government officials in China

are transforming their governing idea, from bureaucratic organization to service-oriented civil organization for citizenship community.

Our study makes contributions in two aspects. First, it sheds light on the few discussed role of government as "institutional entrepreneur". Considering the increasing concerns about transition economy, we make response to the initiative of Child (2007) to investigate the mechanisms of institutional change and the co-evolution between government (institutional change) and innovative regional development. Second, it contributes to our understanding to the mechanisms of path creation through a comparative study of two regions with similar natural endowments in China, pointing to institutional competition under political pressures, offering new perspectives and research directions to the study of path creation and institutional evolution.

Currently, a wave of making start-ups by returnee entrepreneurs is booming around China. That could be attributed to the change of institutional field in both domestic and abroad environment. In recent decade, especially after the breaking of dot com bubble and the latest financial crisis, lots of good educated talents with professional knowledge and tactic experiences in business, service industry and research institutes in oversea countries, such as U.S., U.K., Japan, Germany, etc., have returned back to China to pursue their dreams of being entrepreneur which they could not achieve in host countries. In this process, local government could play a significant role in attracting returnee entrepreneurs by renewing, setting, and innovating many favorable institutions to support the business and operation of those returnee entrepreneurs. By designing institutional arrangements that are uniquely attractive for a particular sector of the economy, a region can carve out a niche to attract returnee entrepreneurs and high-level professionals and talents from overseas to gain a superior competitive position. Thanks to governments' favorable and innovative institutional arrangements, currently many regions in China are experiencing large scale entrepreneur activities. Through designing and providing an especially attractive institutional environment, start-ups and new technologies and industries with participation of returnee entrepreneurs could be developed successfully within short time in a region. This has been proven in some regions in China, such as the Photovoltaic Solar Energy industry in Wuxi and Nano Biomedicine industry in Suzhou.

The relationship between interdisciplinary research and local knowledge: The case of Colombia¹

Diego Chavarro¹, Puay Tang¹, Ismael Rafols^{1,2}

¹*SPRU– Science and Technology Policy Research, University of Sussex, UK*

²*INGENIO (CSIC-UPV), Universitat Politècnica de València, Spain*

Abstract

Interdisciplinary research has been fostered globally by different policies and organisations. However, there is a debate about the benefits of interdisciplinarity in research and society. There is a widespread argument by policy makers and scholarly works that interdisciplinary research has the potential to generate new approaches to solving complex societal problems as well as promoting local science and technology capabilities. Yet, evaluations of research outputs continue to be made from points of view that favour mono-disciplinary research, e.g. by focusing on productivity and efficiency measures. As a result, in many research evaluations interdisciplinary research is perceived as subservient to disciplinary research.

Our results depict a positive relationship between interdisciplinary research and the production of publications of international visibility on local issues. Using the case of Colombia to analyse this relationship, the study shows that the outputs of interdisciplinary research can benefit a national ST&I system whose research has the potential to create social and economic impacts.

Introduction

It is believed that the complexity of a range of research issues and problems, including those that afflict society, demands interdisciplinary research because they defy disciplinary categorization and solutions (Lowe and Phillipson, 2006). The recognition of the benefits of interdisciplinary research has stimulated a steadily growing interest in developing new knowledge through research that integrates the skills and perspectives of multiple disciplines. In other words, interdisciplinary research is perceived as a necessary contribution to solving an array of societal problems.

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The notion that interdisciplinarity is important for socially relevant research has become one of regular (rhetorical) components in the formulation of Science, Technology and Innovation (ST&I) policies, as reflected in a number of policy documents. Examples of such documents are those by, among others, the OECD, UNESCO, the UK Royal Society, research funding agencies, such as the U.S. National Science Foundation, National Institute of Health and the UK Economic and Social Research Council, universities (Brint, 2005) and the Canadian Academy of Health Sciences interdisciplinary health research agenda and the Networks of Centres of Excellence program of the Canadian Government.

Stated differently, there needs to be research on local issues to strengthen national S&T capabilities. For example, in terms of policy, "local researchers combining the knowledge of local conditions – including knowledge of local political and social structures – ...provide the best prospects for deriving policies that both engender broad-based support and are effective..." (Stiglitz, p. 24 in Stone, 2000).²

This article examines the relationship between interdisciplinary research and the production of local knowledge, that is, knowledge on local issues. We will investigate this using Colombia as the case study. This will be discussed in relation to Colombian policies that promote interdisciplinary research.

Providing empirical evidence of the relationship between interdisciplinary research and the production of local knowledge can serve to test the assumptions underlying Colombian ST&I policies on interdisciplinarity. We test this assumption in two steps: First, we examine the relationship between interdisciplinary research and the production of locally oriented publications; then we analyse the effect of each of three properties of interdisciplinarity: variety, balance and disparity (more on these below). The first approach provides a general overview, while the second gives a detailed description of three different properties of interdisciplinarity that can be used to gain more insights into the inner workings of interdisciplinarity.

In summary, we aim to 1) analyse interdisciplinary research in connection with the production of knowledge on local issues; and 2) discuss whether the results support the rationales of Colombian policies on interdisciplinarity.

² See also Gahi, R. (2004) Use of local knowledge in impact assessment: Evidence from rural India, *Economic and Political Weekly*, 39(40): 2-8, and Bone, C., L. Alessa, M. Alta-week, A. Kliskey and R. Lammers (2011). Assessing the Impacts of Local Knowledge and Technology on Climate Change Vulnerability in Remote Communities, *International Journal of Environmental Research and Public Health*, 8:733-761, for the role of local knowledge in the design and implementation of public policies.

Dataset

In addition to an extensive review of Colombian policy documents related to the promotion of research in Colombia, the dataset is comprised of articles, reviews and proceedings papers extracted from the ISI Web of Science. These publications are authored by at least one researcher who was affiliated to a Colombian institution at the time of publication. We included records since 1991, one year after the official foundation of the Colombian System of Science and Technology and the designation of Colciencias as the institution in charge of ST&I policy in the country. We took into account only records with more than 9 bibliographic references successfully categorised, that had information on the countries of the participating co-authors. After these filters, the number of records is 14,402.

Method

Our method consisted in reviewing policy documents for the promotion of research in Colombia, combined with a test of the assumption that interdisciplinary research is beneficial for the production of knowledge on local issues.

The review consisted in gathering the programmes from public organisations in charge of policy-making in the country. Besides this, we also studied two of the most prominent universities in the country to see their approach to the promotion of interdisciplinary research, namely the Universidad Nacional de Colombia (public) and the Universidad de los Andes (private). This review was used to grasp the assumptions on interdisciplinarity and actions taken in Colombia for its support.

We also used bibliometric indicators to gauge interdisciplinarity and a multivariate test to find whether there is a significant relationship between degree of interdisciplinarity in a publication and the production of publications on local issues. The statistical method chosen for this is logistic regression, which allows one to find the probability that an event (publication of an article on local issues) occurs given the presence of a predictor (degree of interdisciplinarity and other variables). As our case study focuses on Colombia, we present data to show the relationship between the country's interdisciplinary research and the production of locally oriented research.

The dependent variable is whether an article is local or not. This is assessed by the presence or absence of the word "colomb" in the titles. The predictor we aim to test is interdisciplinarity, firstly as a synthetic variable (IDR) and secondly as represented by

its characteristics (variety, disparity and balance³). These variables are constructed by extracting the references of each paper in the sample, classifying them into subject categories and making calculations to obtain the following measures:

Variety = v = Number of Disciplines

Normalized variety = nv = ———

—————

—————, sum only for those categories in the reference set.

Where ——— = variety of the article with greater number of disciplines identified within the dataset, p_i = proportion of elements in category i , d_{ij} = distance between categories i and j , and d_{ij} = similarity between categories i and j (Rafols and Meyer, 2010: 267).

In order to account for the context in which interdisciplinary research takes place, we have explored the influence of two more variables on the orientation of research. The first is the type of collaboration, being national when an article is produced by only Colombian authors; international when it includes authors from other countries; and individual (no collaboration) when it is from one Colombian author. The second is macro-discipline, which is an aggregation of subject categories related by their citation practices. We also tested the models to assess their reliability.

We performed the logistic regression in four blocks: In the first we incorporate IDR, adding collaboration in the second and macro-discipline in the third. In the fourth, we replaced IDR by the set of separate characteristics balance, evenness and variety. The reduction in the -2 log likelihood (the variance) of each model is used as a criterion to

³ Variety corresponds to the number of categories in which observations can be classified, for instance, the number of species in an ecosystem, types of food in a region, etc. For example, if a researcher finds five different species of amphibians in an ecosystem, five is the value of variety. For the regression we take into account normalized variety, which gives a number between 0 and 1, as it will be shown below.

Balance differs from variety in that it takes into account the evenness of the distribution. A sample is completely balanced if all categories share the same number of observations.

Disparity is used to see the differences existing between observations. Given that classifications are a means to separate observations, disparity is a relational property resulting from the comparison of observations in terms of distance.

assess the improvement in each block. We use three Pseudo- R^2 measures to assess the adequacy of the models. The first measure is Hosmer and Lemeshow's R^2 , the second Cox and Snell's R^2 and the third Nagelkerke's R^2 . These measures try to calculate the variation that is explained by the model based in -2 LL and help to assess the goodness of fit of the model (Field, 2009: 269).

Main Results

After the review, it is possible to say that the presence of interdisciplinarity in strategic policy documents relating to interdisciplinary research is constant (República de Colombia – DNP, 2000: 15; República de Colombia - DNP, 2002: 130; see also República de Colombia, 2006; República de Colombia, 2009). The general assumption is that interdisciplinary research is a need to address local problems and enhance the National ST&I system. This suggests that at least in policy documents, interdisciplinarity is highly regarded as a means for development of local knowledge.

On the implementation part, policies for interdisciplinary research can be seen in public programmes driven by Colciencias –a public organisation in charge of policies for ST&I, such as:

- The promotion of research groups
- Calls for projects that are problem-oriented and require explicitly that the applicants demonstrate interdisciplinarity of the participants to apply;
- Centres of Excellence to create interdisciplinary networks of groups based on national strategic areas (Colciencias, 2004)
- Support to Centres for Technological Development, which are private Industrial Technology Research Institutes, centres for agricultural research and other centres in cross-cutting technologies; and scholarships for postgraduate studies.

In the same way as Colciencias, both universities examined consider interdisciplinary research groups as fundamental to their mission. According to its statutes, the Universidad Nacional has interdisciplinary institutes in which academics from different faculties share the same mission to "manage, coordinate and promote interdisciplinary research in a knowledge field" (Universidad Nacional, 2005). The Universidad de los Andes, on its part, every year calls for inter-faculty proposals with the aim to increase interactions between disciplines in the university and to approach research topics from different points of view. The calls can be seen in their web page at http://investigaciones.unianandes.edu.co/index.php?option=com_content&task=view&id=1616&Itemid=152). All the documents reviewed highlight the belief that interdisciplinary research is central to increasing the impact of research on national problems and priorities.

The results of the logistic regression show a positive relationship between interdisciplinary research and the production of knowledge on local issues. For every unit increase in interdisciplinarity, it is 1.7 times more likely that a paper addresses local issues. Furthermore, for every unit increase in disparity the odds increase in 3.0 times -- this means that when distant disciplines take part in a research it is more likely that the topic is local; evenness makes it 2.9 times more likely to happen, which means that the more balanced the contribution of disciplines, the more focused on local issues. However, variety has a slightly negative effect: for every unit increase in variety, the odds of an article mentioning Colombia decrease by 0.087 --this means that the more disciplines that participate in a research, the less likely that their focus is local.

Policy reflections

Policies for the promotion of research regard interdisciplinarity as beneficial for the development of knowledge on local issues, which can foster the advancement of locally relevant and pertinent research that is expected, among other things, from a national system of ST&I.

However, usually governments assess interdisciplinary research in the same way that they assess disciplinary fields. For example, assessments based on narrow indicators of excellence such as journal rankings may disadvantage interdisciplinary research and indirectly inhibit it (Rafols et. al., 2011). This practice, as reflected by our results and the examination of how Colombian policy makers have implemented their IDR policy, can have negative impacts on the development of local knowledge. Interdisciplinary research must be assessed in a different way and governments need to implement research evaluation systems that take into account diversity if they do not want to fall into contradictory policies that promote and at the same time suppress interdisciplinarity.

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Evolution of Regional Scientific Collaboration Networks¹: China-Europe Emerging Collaborations on Nano-science

Yantai Chen¹, Dimitris Assimakopoulos²

¹*Zhejiang University of Technology, China*

²*Linc LAB, Grenoble Ecole de Management, France*

1. Motivation

The global architecture of science is shifting towards two significant characteristics in the second decade of new millennium, i.e., one is that, although the traditional scientific superpowers such as Western Europe, the USA and Japan still lead the field, there are some emergence of new players and leaders, particularly with the rise of China and India (Royal Society, 2011); the other is, the scientific community is becoming increasingly interconnected, with the emerging cross-territorial regional ties which the physical distance impedes is decreasing over time (Hoekman et. al. 2010). Since 2010, China has emerged as the second largest nation both in terms of R&D input by PPP and scientific output performance based on Thomson Reuters' *Science Citation Index-Expanded (SCI)* paper, just behind the USA (Thomson Reuters, 2011). Traditionally the European Union (EU) is as competitive as the USA in terms of science and technology, and is one of the most important partners of China in international scientific and technological collaborations (Arnold et. al., 2009). In the past four decades, European Union is also the biggest knowledge transfer source of China (Shang, 2011). However, with the rising up of as a scientific power particularly in emerging technologies such as nanotechnology, China is changing the global landscape of innovation and the traditional role of partnership with EU and the USA (Zhao & Guan, 2011). The cross-borders of innovation collaborations between China and EU are of great significance to be explored in the emerging scientific research fields.

The present study aims to uncover the dynamic patterns of regional scientific research collaboration network between China, an emerging science polar, and EU, a traditional global science superpower by examining co-publication activities in nano-science field over time. Extant studies *either* explore the emerging global presence of China in nanoscience and general science (Zhou & Leydesdorff, 2005, 2006; Guan & Ma, 2007; Appelbaum & Parker, 2008; Huang & Wu, 2011; Tang, 2011), *or* scientific collaborations

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among other regions such as within traditional science superpowers (Wagner & Leydesdorff, 2003, 2005; Hoekman et al. 2010). Given the few studies combining the general pictures of China with leading countries in specific emerging science fields (Chen Yantai et al., 2011; Zhou & Guan, 2011), there are much room to be explored.

The contribution of the present paper lies in identifying the dynamic regional collaboration networks between China and EU in the past thirty years, especially since China's massive increase in R&D. This paper aims to shed light on the factors determining the dynamics behind two international science powers. Our analysis addresses three inter-related questions. First, how common is the China-EU regional research collaboration in nanoscience? Second, what are the driving forces behind these dynamics of bilateral collaborations on this emerging nanotechnology field? Third, what factors are either conducive to bilateral collaborations to regional science or detrimental to the scientists to engage in the innovation network?

2. Approaches

By conducting the bibliometric analysis of co-publications of nanoscience between China (together with 16 most prolific provinces which have high scientific paper output) and EU-15 Membership nations, this study focuses on the dynamics of cross-borders regional collaborations between a traditional scientific superpower and an emerging science polar, particularly in the context of transition from knowledge-transfer relationship to innovation-partnership relationship.

To explore the dynamics of regional scientific collaboration networks between China and European regions on the emerging nano-science field, the empirical data were extracted from the database of the *Web of Science (WoS)*, the bibliographical source covering most influential scientific journals in the world produced by *Thomson Reuters*, which is frequently accepted and used for bibliometric analysis of international scientific output collaborations (Leydesdorff & Cozzens, 1993; Wagner & Leydesdorff, 2005; Jensen et al. 2010). There is already a stream of studies on nano bibliometric search strategy in the past decades (Braun et al. 1997; Kostoff, 2004; Zhou & Leydesdorff, 2006; Guan & Ma, 2007; Heinze & Kuhlmann, 2008; Tang, 2011). We followed the strategy, and conducted the search on the global publications of nano-related research publications from 1990 to 2011 in the *Web of Science* database in January 2012.

In order to analyze the evolution of the China-EU regional scientific collaborations network, we utilize the social network analysis method, which is commonly adopted the network structure. The software of *Ucinet*, which can draw the visualized figures of social network interrelations (Borgatti et al., 2003), has been adopted in this research.

3. Results

This research shows that, in general the regional scientific collaborations between China and selected EU member nations are rising with an astonishing speed. Germany, England, France ranks top three in building collaboration networks with China. Sweden, the Netherlands and Belgium followed the active partners of China in the nano science collaborations in terms of co-publication records. However, in terms of collaboration intensity cross Europe-Asia continent, Sweden, Germany, Belgium and England rank top partners with China. Moreover, when examining the evolution of collaboration network in three specific nano sub-fields, the results are similar as the general picture of that in all fields. The differences include, during all three stages from 1990 to 2011, China and Europe worked closely in nano material field than nano biotechnology and nano medicine, and nano electronics & nano devices were comparatively scarce; the Germany-China collaboration intensity in nano electronics & nano devices seconds to England-China collaboration network; Italy and Poland have built collaboration networks in different fields with China in early stage, but the networks were less significant with time passed.

When exploring the scientific collaboration networks between China's provincial and European country level in different time period, there was only several participants involved in building regional network before 1996. While Germany dominated in the network building with China's different regions, France, Italy and Poland were comparatively active. Beijing, Shanghai, Jiangsu and Liaoning have built most preliminary collaboration networks with European partners in early stage. During the second time period, the China-Europe collaboration networks have become much intensively. In Europe, Germany had the most prolific regional networks with China. England, Sweden, Belgium, Switzerland have rose up in building networks with different China's regional cities. In China, the networks between Jilin, Anhui, Zhejiang and their European partners were increasing significantly. After 2005, the regional networks evolutes and became much intensively between any selected China's provinces and European countries. Some regional networks, such as Beijing-Germany, Beijing-England, Shanghai-France, Jilin-Italy and Zhejiang-Sweden are much significant than others.

4. Conclusion and/or Policy Implications of the Work.

The main theory contribution of this research lies in identifying the factors driving the evolution of regional scientific collaboration network between a rising scientific polar and a traditional superpower, are multiple and interrelated. The driving forces include the dynamic science capacity, formal scientific cooperation mechanism to promote bilateral collaborations, the improving geopolitical and diplomatic relationships between

two regions, the bilateral trade and economic linkages, and individual student or research staff mobility. In the early stage, China's scientific infrastructure was less advanced; there were less China-EU collaboration networks, despite of some diplomatic-friendly partners with better trade and economic linkages, such as Germany, France, Italy and Poland. Afterwards, the improving geopolitical relationship and increasingly trade linkage between two regions pave the basis for scientific collaborations. With the continuing improvement of scientific capability growth both in terms of R&D input and research staff in China, scientific cooperation mechanism both from EU level, member nation level and China has been built. The mobility of huge Chinese students and research staff to Europe, and the growing numbers of Chinese returnees contribute to the intensive collaboration network building. The uneven distribution of scientific capacity and infrastructure both in different China's provincial level and EU member nations can also explain the differences between the regional collaboration networks.

Policy implications for strengthening the bilateral scientific collaborations between China and EU include, for EU and its member nations, on one hand, they should maintain a stable geopolitical and diplomatic relationship with China and remove the obstacles hindering the implementation of bilateral collaborations mechanism. On the other hand, identifying the potential collaboration regions, organizations and targeted scientists in China's which are complementary to their specific scientific advantages. For China, it's important to attract both talented Chinese students and research staff staying in EU back to China, and more European scientists visiting China since there are much less European scientists in China than Chinese in EU. To reduce the regional imbalances in scientific infrastructure with China is also important both for the sustainable improvement of China's national scientific capability and international collaborations.

**New policy instruments
in regional innovation policy for clean-tech:
The case of Sustainable Business Hub in Skåne, Sweden**

Lars Coenen, Magnus Nilsson, Jerker Moodysson

Center for Innovation Research and Competence in the Learning Economy, Lund University, Sweden

Motivation

Regional innovation policy is considered to provide improved "on-the-ground" policy know-how about the specific conditions for innovation processes in firms and other organizations (Lundvall and Borras, 1999). Policy activities can therefore be formulated, implemented and monitored in a more targeted way. As Nauwelaers and Wintjes (2002, p. 205) argue: "The non-anonymous relations, the complementarity of activities and the historical setting are stressed in the regional context. [. . .] Further, in order to find out and articulate what a particular region or firm needs, or what is lacking concerning innovation, regional proximity and communicative interaction may be needed to address the tacit and latent aspects of such needs."

Instruments for regional innovation policy are traditionally characterized as either resource-oriented or behavior oriented (Asheim et al., 2003). The former aim at giving firms access to resources that they lack to carry out innovation projects, i.e. to increase the innovation capacity of firms by making the necessary resource inputs available, such as financial support for product development, help to contact relevant knowledge organizations or assistance in solving specific technological problems. The latter type of instruments have a focus on learning, with the aim to change behavioural aspects, such as the innovation strategy, management, mentality or the level of awareness in firms (Asheim et al., 2003).

This set of policy instruments has however a number of limitations when applied in the context of clean-tech due to the particular challenges that this industry is facing. Increasingly, clean-tech is considered as a new area for business development and concomitantly it is seen as an emerging new industry. While the sector remains difficult to define or to delineate, many clean-tech firms act as 'green' problem-solvers or solution-providers for other companies. In doing so, they develop and adapt various types of clean technology. As with most innovations, there are major uncertainties and barriers to the development and adoption of new clean technologies. First, there is the risk of technological spillover that may prevent the firm from capturing the full value of an innovation (Wustenhagen et al., 2008). Second, there is a fundamental uncertainty about new technology pathways, markets, user practices and regulatory frameworks provid-

ing an uneven playing field for clean-tech firms (Geels et al. 2008). Third, and unlike other kinds of technological innovations, there is often a lack of internalization of environmental cost benefits that accrue from greening firms' operations through eco-innovation (Rennings, 2000). The latter two are of particular significance for firms' possibilities to capitalize on their eco-innovations.

Given the specificities of the cleantech sector, it may therefore be argued that additional innovation policy instruments are needed. This paper's aim is to explore how procurement and marketing of sustainable solutions contribute to regional innovation policy aimed at strengthening an emergent cleantech sector in the Skåne region.

Case description

In the context of the clean-tech cluster in Skåne, Sweden, regional innovation policy is partly focusing on a different set of instruments, namely marketing and procurement. Sustainable Business Hub (SBH) is a cluster organization partly funded by the regional government with the aim to help companies active in the environmental and energy field to strengthen their competitiveness. At the heart of their work is the threefold task to (1) facilitate joint R&D and innovation activities between industry and research organizations in the region, (2) broker between firms and local users and consumers of clean technologies and (3) facilitate exports for its member companies. SBH has about 90 member organizations, falling within the broad definition of cleantech, i.e. organizations working on products and services that involve less environmental impact than comparable alternatives. The focus of SBH is primarily to foster the diffusion and adoption of cleantech solutions rather than to develop entirely new technologies. This is seen as key to strengthen the competitiveness of the industry and the region as a whole. Furthermore, the regional authorities in Skåne aim to be fossil-free by 2020, thus going further than the national goals set in this respect. Similarly, the urban planning initiative of Malmö, the region's largest city, "City of Tomorrow", includes many projects that utilize green procurement of infrastructure construction contracts to meet sustainability goals. This makes the public sector in the region a potentially important user of the region's cleantech firms' sustainable solutions. These observations raise important questions about the use of alternative instruments to foster innovation in relation to the specificities of cleantech industries.

Approach

Theoretically the paper draws on insights from industrial marketing and public procurement for innovation. In the industrial marketing or B2B marketing literature much emphasis is put on the relational character of business purchasing (Axelsson, 1992).

Business transactions are not viewed as single isolated events but as part of an often long-term interaction that in turn is part of a wider 'network of interdependencies' (Ford and Mouzas 2010; Gadde et al. 2003; Håkansson and Snehota 1989). Because of this, the importance of managing the level of uncertainty is typically greater. When each relationship is relatively more important to the involved actors the effects of failures are more severe and when there is a high degree of complexity in the transaction the need for managing uncertainty is great. A common way to view uncertainty in B2B relationships is along three dimensions suggested by Håkansson et al. (1977) [also Ford et al 2002 and 2007]: need uncertainty, market uncertainty, and transaction uncertainty.

Need uncertainty refers to the fact that the buyer often experience difficulties when it comes to understanding the exact nature of their needs. This is a combination of difficulties in interpreting and assessing the perceived needs of the buyer and the importance of the need (Håkansson et al. 1977). This is often the case in marketing eco-innovation since the solutions offered are often a mix of new products and technologies and support services. In many such cases the need concerns complex system solutions which add to the complexity of the need. Furthermore, in many cases it concerns a major investment in for example waste management, water purification, or energy supply which adds to the need uncertainty. *Market uncertainty* has to do with the supplier market for the product or service offering. The degree of market uncertainty depends on the heterogeneity of the supplier market (i.e. significant differences between suppliers) and supplier market dynamism (i.e. the potential/risk of changes in differences over time) (Cardozo 1980; Håkansson et al. 1977). When building a relationship with a given supplier, which is necessary in most B2B transactions, there is an opportunity cost that follows from not being able to readily change to other suppliers (ref). In young and rapidly developing sectors such as clean-tech that are characterized by technological development and innovation, both supplier market dynamism and heterogeneity is high, opportunity costs are large which arguably result in a high degree of market uncertainty. Lastly, *transaction uncertainty* refers to getting the product or service to the buyer. Håkansson et al. (1977) highlight three factors influencing this: (i) if the product needs to be coordinated with other events (e.g. just in time delivery); (ii) if there are significant differences between the buyer and seller (e.g. in terms of culture, language, technology, institutional context); and (iii) if the trading procedures are standardized (the less standardized procedures are the greater complexity of the negotiations). This means that when new business is initiated between actors in different countries with different cultures and institutional structures, and when it concerns unstandardized and highly comprehensive and complex system solutions currently not used by the buyer, transaction uncertainty is arguably high. Furthermore, if the total product offering is dependent on a high degree of coordination with other suppliers, transaction uncertainty is increased further. This may be the case when the buying situation con-

cerns bringing complex system solutions based partly on new green technologies to new international markets.

Public procurement is seen as a potentially highly effective demand-policy instrument in stimulating innovation (Aschhoff and Sofka 2009; Edler and Georghiou 2007; Rolfstam 2009; Rolfstam, Philips, and Bakker 2011). In justifying the use of public procurement to spur innovation, it is traditionally emphasized that it (1) creates new markets and demand pull for products and services that go beyond the state-of-the art, and (2) that it provides a testing-ground for innovative products (Lerner et al., 2010). Edler and Georghiou (2007) add that the purchase of innovative solutions can also improve public infrastructure and public services. Thus we are in need for considering the role public procurement can have in a broader context of public-private interaction and innovation policy (Aschhoff and Sofka, 2009).

While the literature on public procurement of innovation is gaining increasing momentum in the policy-making arena (Edler and Georghiou, 2007; Edquist et al., 2000; Hommen and Rolfstam, 2009), the debate has so far been somewhat limited to identifying different forms and typologies, distinguishing for example between general procurement practice versus strategic procurement, commercial versus pre-commercial procurement and direct versus catalytic public procurement. What is still missing is an investigation of the capabilities needed to coordinate and organize 'smart' public procurement of innovation across multiple levels and sectors. The public sector needs generative and absorptive capabilities in order to articulate its demands, but also coordination capabilities to organize the co-creation and procurement process of innovation. Here coordination is needed between the public sector and other stakeholders in the innovation system, but also coordination within the public sector across different levels and domains.

Expected outcomes

Based on a theoretical review of industrial marketing literature, public procurement of innovation and empirical analysis of Sustainable Business Hub, the paper intends to provide insights how marketing and procurement activities can contribute to the design and implementation of regional innovation support in the context of clean-tech industry. In doing so, the paper intends to contribute to ongoing debates in the field of 'greening of innovation systems'.

Managing uncertainty for radical products: Changing and creating market infrastructure to prepare future markets.

Aurelie Delemarle¹, Philippe Larédo²

¹*Université Paris-Est, LATTIS/IFRIS, ESIEE, France*

²*Université Paris-Est, LATTIS/IFRIS, ENPC, France and Manchester Business School, UK*

How can radical products be introduced on the market? How can actors develop strategies when both market and scientific uncertainties hinder their introduction on the market(s) (Abernathy and Clark, 1985; Courtney et al., 1997)? The motivation of the paper is to investigate these questions by focusing on strategies that can be deployed to prepare/anticipate the introduction on the markets of radical new products.

Economists do not consider that markets are/can be shaped; indeed markets are considered as naturally generated. This is clearly illustrated by this quote: "in the beginning there were markets" (Williamson, 1975:20). However, this view has been questioned notably by sociologists: markets are socially constructed and there is more to the notion of market than its spontaneous unfolding generated by the exchange activity between buyers and sellers: they are "institutional arrangements: (...) rules, roles and relationships (...) make market exchange possible" (Abolafia, 1996). Callon (1998) argues also for this idea of an organized market. Many studies have shown the political process that organizing a market is (Fligstein, 1996; Fligstein and Mara Drita, 1997) and the role of the State in its organization. But more recently, studies (Gond and Leca, 2004, MacKenzy, 2009) also pointed to the role of other agents (entrepreneurs or based on collective action) in doing so. What these actors, public or private ones, have in common is that they act towards creating or transforming frames of the markets. The concept of frame is derived from the sociological use of the economic concept of externalities. The concept of framing was originally developed by Erving Goffman (1971). Callon (1998, 1999) mobilizes it in his framework "framing and overflowing". He argues that frame defines what counts for the actors engaged in a collective action. Thus the action of framing consists in defining what is important and what should be the focus of actions. It results also in understanding the externalities (that are not taken into account because there are outside of the frame): for Callon, it is these externalities that lead to the overflowing: indeed the frame as it is does not allow new issues to be solved. An external arena needs to be set up to take into consideration these externalities. Once done (i.e. the creation of the new arena), a new frame is created and the externalities have been internalized into it.

However, this framework is difficult to operationalise. Therefore in our approach, we complement Callon's framework of "framing and overflowing" with the notion of market

infrastructure that we borrow from past studies on networks (railway, water, sewage, telecommunications) and finance. In this latter field, the EU commission even uses the plumbing metaphor to refer to the infrastructure: it is "vital, but unglamorous and forgotten until something goes wrong". Infrastructures have the characteristics, among other things, (Lee, 2010) to (1) provide the basic equipment that underlies some system or activity; (2) be critical to support the activity of the system; (3) provide a network; (4) require large investments; (5) provide public goods or services; (6) involve some form of government or public sector involvement. Infrastructures can be physical ones as it is often thought of but they also include public and social facilities. As studies in these fields show (Lee, 2010), creating an infrastructure is often related to creating institutions. Scott (1995) defines institutions as a set of rules, norms and values. We thus argue that market infrastructures are a sum of what we are allowed to do (rules), what we ought to do (norms) and what we want to do (values).

Combining the two approaches that we have shortly presented, we argue that overflowing offer the possibilities to create a new infrastructure for a market by modifying one or several of the existing frame constituents. Our hypothesis is that when frames are only modified to a small extend, products can find their way on the existing markets and when frames need to be heavily changed or created, that products will be introduced on specific markets i.e. niches. In the following, we will however adopt the term "market infrastructure" rather than frame because the notion of infrastructure implies the notion of long period, maintenance, and some kind of control and authority. These are important because a market is meant to last so its underlying infrastructure should also last.

We test these hypotheses with the nanoscience and technology case. The prefix "nano" just gives an indication of the size of the material you are dealing with. At the nanoscale, the matter is at 10^{-9} m (one billionth of a meter). A given substance at the nanoscale is said to exhibit different properties than the ones of the substance at a larger scale. At the nanoscale, properties can change: optical properties (e.g. color, transparency), electrical properties (e.g. conductivity), physical properties (e.g. hardness) or chemical properties (e.g. reactivity). Gold for example appears to us yellow but at the nanoscale, it appears red. Titanium dioxide, that has the property to block UV light, appears white to us, while it appears transparent at the nanoscale. Carbon at the macroscale is soft and malleable (like pencil lead) while at the nanoscale it is stronger than steel. It has been used as a selling argument in the past years because nanomaterials can offer new functionalities to existing products (e.g. nanostructured coatings on windows to keep them clean) or be used in the production process to improve some properties (e.g. lightness of bikes with carbon nanotubes). However, after the withdrawal of nanotechnology based products from the market – for example the Samsung washing machine using nano silver or L'Oreal nanozome face cream – firms have been

reluctant to put on the market new products using the properties of the matter at the nanoscale. We argue that markets are not yet framed for these new types of products and that markets need to be organised. One may argue that some products encapsulating nanomaterials are already on the market: the Wilson Woodrow Centre inventories in 2011 "1317 products, produced by 587 companies, located in 30 countries". However, we argue that these products do not question the frames of existing markets, to use Callon's terminology that we presented earlier: they do not largely challenge professionals or users practices and follow the existing requirements of the commercialization process. On the contrary, Samsung's and L'Oreal's products could not prove on the long term the non-toxicity of the nanomaterials on the environment or on human health.

The case of nanoscience and technologies is thus particularly interesting to test our hypothesis: because it points to at least two very different cases : (1) one in which the market infrastructure does not need to be changed (exemplified by cases of nano based products that are today on the market) and (2) one in which the market infrastructure needs to be adapted/changed. In this latter case, we propose to consider several cases: a) one in which the market infrastructure can be changed at the margin and b) one in which it need drastic changes. The richness of the cases come from the fact that nanoscience and technologies are general purpose technologies (Larédo et al., 2010) so they can be used in a very large number of industries for very different purposes. Nanosciences and technologies are also emblematic of an emerging field (Delemarle et al., 2010; Bonaccorsi and Thoma, 2007): thus conclusions could be also thought of for other emerging technologies.

Lessons will be drawn both for policy makers and for strategic actors for each of the 4 cases discussed earlier. For instance, the need to change drastically the existing market infrastructure will lead to the creation of a niche (Geels, 2002). The role of public policy in supporting the maturation of this niche will be highlighted. On the opposite, the need to change a few aspects of existing frames will imply generic and transversal strategies.

We will illustrate our arguments with various elements such as the work of the ISO TC 229 or the European Code of Conduct or the existing regulations that currently govern the various industrial sectors impacted by nanosciences and technologies. We will detail how actors, not only public ones, but also private ones, work at changing or creating market infrastructures on framing new rules, new norms or new values.

Trial and error in France's innovation policy: An activities-based approach of the restructuring of the French innovation system

Mafini Dosso

Centre d'Economie de la Sorbonne, University Paris, France

Since the last two decades, the term of (national) innovation systems (NIS) has been widely used in the formulation of national innovation policies and programs. However, the rapid diffusion of the concept in the political sphere has not yet led to the emergence of a clear and fully integrated IS approach in policy making decision process (Edquist 2011). In other words we are still missing a clear theoretical approach to address the role of national and local governments in the development and the diffusion of innovations. This, contrasts with the fundamental role granted to national policies in the literature on NISs. Taking stance from the traditional literature some empirical studies have underlined the relevance of an activities-based framework for the analysis of NISs (Liu and White 2001, Edquist and Hommen 2008). The activities are defined as the factors influencing the development and diffusion of innovations. They can be classified into four broad categories including the provision of knowledge inputs to the innovation processes, the demand side activities, the provision of constituents of the innovation systems and the support services to innovative firms. In this framework, institutions are seen as incentives or obstacles that influence these activities. According to Edquist (2011), "this is accounted for by including "creating and changing organizations" and "creating and changing institutions" in the list of activities" (p. 6). The activities-based approach goes from the principle that the activities are performed to different extent by public and/or private organizations so that, most activities have a policy element. In this perspective, the differences in national innovation policies are expressed in the different patterns of performance of public organizations within and across activities. Thus, compared to previous studies of NISs, this approach allows for systematic comparisons of NISs and, constitutes a useful point of entry into policy analysis. Besides its intrinsic heuristic dimension, this representation of NISs is consistent with the multidimensional and dynamic nature of the innovation processes and their determinants (Edquist and Chaminade 2006, Edquist 2011).

Following this latter approach, our study explores and discusses, with a normative stance, the recent evolutions in the division of labor between public and private organizations in the innovation-related activities in France during the last decade. More precisely it offers a critical review of the recent attempts to move from the traditional mission-oriented policies towards a more systemic approach with a greater focus on the exploitation of public research outcomes and SMEs in the design of innovation policies.

As pointed by Edquist (2005, 2011) a fundamental prerequisite is to identify through diagnostic analyses the policy or systemic problems of the NIS. Hence our paper starts from a quantitative account of the patterns of public organizations' performance of innovation related-activities. Then, we address the coherence and the relevance of the recent reforms in the innovation and research policy in France.

Our analysis mainly suggests that France's NIS is going through a transition phase characterized by a trial and error process. Current French innovation system is based on the coexistence of strong institutional foundations from the traditional mission-oriented model and an emerging model based on the introduction of more horizontal measures focusing on SMEs and the development of education and research poles of international dimension. Beyond the institutional inertia that affects the transition process, French policy makers have taken time to launch an official and coherent long run national innovation strategy. Indeed the bulk of reforms have been introduced before the design of the national innovation and research strategy in 2009.

Regarding the provision of knowledge inputs to the innovation processes the analysis shows that France's overall research effort has been decreasing since early nineties. The decrease in the percentage of gross expenditures of R&D performed by the Government sector has only been partially compensated by the business sector share which has been stable between mid-nineties and the end of 2000s. As compared to other major innovative countries as United-States, Germany, Japan, South Korea research intensity is still lower in France at the end of the 2000s. The sectoral structure of business enterprises R&D and patenting activities reveal a persisting high concentration around a narrow set of large firms and a narrow set of sectors. Besides the performance and direct funding, the French state has gradually extended its fiscal incentives notably through several modifications of the rates, the threshold, and eligible expenditures to the CIR (tax research credit) during the 2000s. Although most beneficiaries are SMEs this support has only led to a small increase in their research and innovation activities. The laws on innovation (1999) and on the organization of research (2006) to improve the exploitation of public research results and public-private partnerships have so far been limited to few fields. Regarding the evaluation of research, a systematic assessment procedure has been implemented through the creation of the AERES in 2007 (national agency for the evaluation of research and higher education). Since its creation the assessment criteria have gradually been modified to consider a broader set of indicators.

Over all expenditure on educational institutions as a percentage of GDP has been quite stable in France between 1995 and 2007 with more than 80% from public sources. The French education system has known major reforms including the *LRU law* (2008, the

law on the Liberties and Responsibilities of the Universities) and a convergence towards European standards under the Bologna Accords. Although the *LRU law* has paved the way for a greater autonomy of universities, the current outcomes are still far below the government's announcements. Several efforts are still necessary to improve the governance, the efficiency of expenditures and to achieve a better transfer of responsibility in the budget management. The early 2012 "Grand Emprunt" has brought massive investments in the university system with the creation of international higher education poles structured around eight large universities.

Although they performed an important share of the public procurement SMEs are still under-informed and trained to both national and international public procurements. In 2008 a major law, the LME (Law for the modernization of the economy) included several articles to favor the development of SMEs and notably their participation to the public procurement.

Concerning the provision of constituents for the NIS and the support to services to innovative firms major reforms have also been implemented. Created in 2005 from the merger of the three main former structures dedicated to the development of SMEs, OSEO agency has been since 2010, the central organization in charge of the support for innovation (funding, guaranty and technical assistance). During the 2000s, the French government has introduced new funding schemes and issued several measures for start-ups and small innovative firms including the establishment and/or promotion of dedicated investment, venture capital funds and incubators. The incubators system has been quite successful and tightly linked to public research. So far, the impact of networking policies as the competitiveness clusters and the *thematic networks* has been difficult to assess (Mayneris 2011).

In terms of scientific production the international publications and patents shares of France has been decreasing since the end of the nineties notably because of the entry of new international actors. However its relative performance as measured by the impact index has slightly improved (OST 2010). Although it has remained quite concentrated in few fields, the incentives for the exploitation of public research outcomes has led to a higher number of patents applications from the public sector organizations. The various initiatives for SMEs have led to limited developments beyond the very small firm size and to a low participation in international markets. Although important mission-oriented structures persist, France's NIS is undergoing an important restructuring process. This process has led to the multiplication of, sometimes overlapping, laws and policy tools, to an increasing participation of public local actors and to the formation of large research and higher education poles. The absence of a systematic *ex-ante* assessment of innovation policies and tools and especially, of the tax research credit and

the cluster policy, has sometimes led to the renunciation or continuous changes in the supporting tools and policies content. The efforts for a better coordination of the different public organizations involved in the innovation related-activities at the national, regional and local levels should be kept on track. It should facilitate the identification of overlapping and less appropriate incentives schemes. Also it will help to further enhance the visibility of small firms on the grey box of innovation support.

Understanding how mission-oriented research changes expert processes in foresight and how this reflects to governance

Mikko Dufva

VTT Technical Research Centre of Finland, Foresight and socio-technical change; Finland

1. Motivation

The Grand Challenges, such as climate change, ageing populations, food safety and security of energy supply are complex, interconnected and overall messy problems. They combine three aspects of complexity: the situation is unfamiliar and unpredictable, the causes and effects are far apart both temporally and spatially and people have different, even conflicting views on what the problem is and what should be done. In addressing these kinds of problems science and policy are faced with questions such as what should be included in the study, what is the appropriate timeframe, who should be involved and how does context influence the process and results. The Grand Challenges direct research towards mission-orientation and "mode 2" knowledge (Gibbons et al. 1997), which is produced within a context and in a diversity of sites, is trans-disciplinary and highly reflexive and calls for novel forms of quality control.

Some ways to address the Grand challenges have been to increase participation and stakeholder involvement both by workshops and virtual surveys, and to bring together experts from different disciplines. The rationale has been that this will result in holistic, robust and socially acceptable plans. But what does this holism, robustness and social acceptability actually mean? What are the processes that create them? How do the changes in the way knowledge is produced affect the nature of the knowledge produced?

In this paper I'm interested in what are the implications of this shift to mission-orientation on the micro-level of expert processes. I will focus on foresight, since it embodies the characteristics of mode 2 research (Miles et al. 2008), and is used in responding to the Grand Challenges (Popper et al. 2007). Foresight is a systematic approach to coping with interdependent and complex problems requiring long-term and policy-relevant solutions (Martin and Irvine 1989), and as such a good example of mission-oriented research.

In this paper I will study the character of expert processes in foresight. I will consider both how the changes in context affect the processes as well as what are the implications of the changes in micro-level processes for macro-level governance. I highlight three challenges for mission-oriented research:

1. Managing a diverse set of knowledge,
2. Building a sense of community in virtual settings,
3. Handling a plurality of truths while aiming for action.

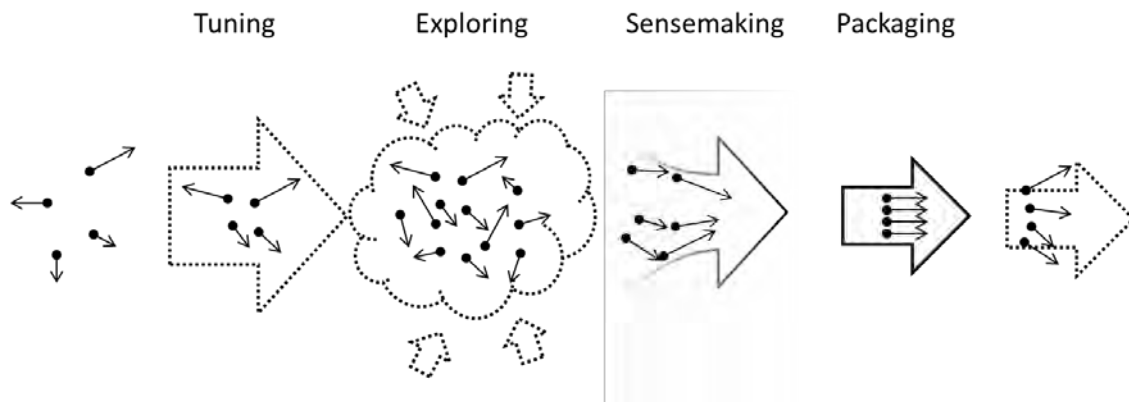
2. Approach

To understand expert processes in foresight I will describe a conceptual model. The purpose of the model is to act as a framework for understanding different aspects of the process, what affects it, how do the relations between experts evolve and how it relates to the context. I will use the model to study foresight workshops involving a diverse group of experts.

The conceptual model looks at the expert processes in foresight from four overlapping levels: thought processes, statements, group dynamics and context. By thought processes I mean gathering and making sense of data, using tacit knowledge and producing new knowledge. "Statements" means the evolution of initial utterances to "facts" about the future. Group dynamics means the relations and interactions between participants and context includes the theme, methods, place and framing. These three levels reflect the new aspects of mission-oriented research: transdisciplinarity, social construction of "facts", increased demand on participation and context dependence.

I distinguish four different modes of operating in the process: tuning, exploring, sense-making and packaging. The tuning mode usually takes place at the start of the process. It is about energising the participants and turning their focus toward the future. Exploring and making sense form the main cycle of foresight knowledge creation. Exploring is about finding new knowledge, having conversations with other experts as well as with available data and filtering the information. By sensemaking I mean reflecting on the information and interpreting it, simulating and thinking of the consequences and externalising generated tacit understanding to a communicable format. The process ends in the combining and packaging of explicit knowledge into a report, set of scenarios or other codified object to be disseminated.

Figure 1: Conceptual model of expert processes in foresight



The alignment of different views is illustrated in figure 1. In the tuning mode experts with different views are pushed together by the organisation and their viewpoints are stated. Exploring is initially largely based on expert's background and viewpoint. To open up the experts' imagination positive feelings are essential (Fredrickson 2001). As the experts discuss with each other while trying to make sense of all the knowledge, a common practice language (Collins 2011) starts to emerge. In the packaging mode the experts feel they speak the same language and their views seem to be aligned with regards to the outcome. However, this is only temporary and after the process is over, the views diverge as the experts interpret the outcome in different ways.

The conceptual model draws inspiration from many sources in addition to the ones mentioned above. The SECI-model (Nonaka & Takeuchi 1995) and its extension the "rye bread"-model (Uotila & Melkas 2008) explain knowledge management, while sociology of science (Latour 1987) looks at the evolution of statements. Systems thinking (Senge 2006, Jackson 2000) and systems intelligence (Hämäläinen and Saarinen 2008) provide good frameworks for understanding action within systems and how micro-behaviour affects the overall process.

3. Expected results

I will use two case studies for analysing the workshop processes and testing the conceptual model. The case studies will illustrate the model and its implications. Through the case studies I will also exemplify the effects of micro-level change in expert processes on macro-level governance.

The first case study is about enhancing innovation-driven and sustainable economic development of Antofagasta region in northern Chile. It is a joint project between CICITEM (Centro de Investigación Científico tecnológica para la minería) in Chile and VTT Technical Research Centre in Finland and includes building innovation and

knowledge management framework, foresight model and an evaluation and impact assessment framework. Because of the geographic distance the project will rely on virtual facilitation tools in addition to face-to-face workshops. I will study how the geographical distance and the use of virtual settings affect the expert processes and how to use virtual facilitation tools successfully.

The second case study is called VTT foresight network. It aims to gather the foresight capacity and experience inside VTT, provide a common toolset for foresight and build a network of foresight experts inside VTT. The context is strikingly different than in the first case study, as the culture is rather homogenous and the geographical distance is minimal. In this case study I am especially interested in how experts construct a future oriented mindset.

4. Conclusions

The conceptual model provides one description of how experts produce knowledge in foresight and how foresight processes work. It helps in understanding how the changes at the macro-level, i.e. the level of mission-oriented research as a whole, affect the micro-level, i.e. the expert processes in foresight, and vice versa. Recognizing the expert processes and how experts produce knowledge helps in understanding the macro-level policy processes. For example, as knowledge is produced in a participatory, future-oriented manner, using that knowledge may result in making the policy decisions more socially acceptable and anticipatory. Likewise, the embracing of plurality of truths at the level of knowledge production may guide governance from optimization to robustness.

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Innovative SMEs in Europe: An integrated analysis of European and national policies

Meral El-Zein

University of Strasbourg, BETA - Bureau d'Économie Théorique et Appliquée, France

Motivation

The Lisbon Strategy was introduced in 2000 with the specific objective for the European Union "to become the most dynamic and competitive knowledge-based economy in the world by 2010". As far as innovation is concerned, Lisbon Agenda set up a 3% EU GDP spending target for research and development, which includes public as well as private spending and recognises the role that innovative Small and Medium sized Enterprises (SME) can play in reaching the objective. Over the years and as it appeared that Lisbon targets will be difficult to reach, the European Union (EU) has revised its policies and introduced new measures: Lisbon Strategy was re-launched in 2005 taking into account the role of non-technological innovation; the introduction of the Competitiveness and Innovation Framework Programme in 2007, specifically dedicated to innovative SMEs; and the 2008 Small Business Act. However the 3% EU GDP spending target was not reached in 2010, consequently the EU has initiated a new process, the so-called Europe 2020 strategy which clearly sets innovation as an objective and reiterates the 3% EU GDP spending on R&D and innovation and obviously postpones its achievement to 2020. This might be interpreted as a difficulty of the EU to put in place accurate measures to help member States reach the targets. In fact the EU has witnessed major change in its composition over the last decade with 12 new Member States; today, more than ever, EU's member States represent a wide range of diversified patterns in terms of economic environment. The EU intends to fill the gap between the economies of its members thanks to its "umbrella" policy instruments: Countries which are lagging behind should benefit from additional funds tailored to their economic and social environment. This approach is also valid for fostering innovation in SMEs, accordingly member States are supposed to choose and implement EU policy measures that are best suited to their innovative SMEs' needs.

Entrepreneurship and innovation policies have become major research topics in recent years. Some authors have studied the link between entrepreneurship and economic growth¹, others have focused on the analysis of specific aspects of the policies such as

¹ For an overview of such papers see Carree and Thurik (2003) The impact of entrepreneurship on economic growth. Chapter 17 in Acs, Z. & D.B. Audretsch (eds) Handbook of Entrepreneurship Research. Kluwer. 437-472.

the creation of university spinoff firms². The last decade has witnessed calls for an integration of entrepreneurship and innovation policies³, research was undertaken on the determinants of entrepreneurship and innovation performance⁴. Lundstrom and Stevenson⁵ have shown that "innovative entrepreneurship" is becoming a priority area in policy formulation and together with Almerud⁶ they have carried out a comprehensive and systemic analysis of entrepreneurship and innovation policies in the EU, thus providing a one-of-a-kind analysis framework. However when having a closer look at the instruments available to innovative SMEs in a number of EU countries⁷, they do not observe any obvious correlation between the implemented policies and the economic environment of the countries in such a way that no specific policy model could emerge. Nevertheless there has not been any attempt to link this observation to the presence of EU policies: this approach is ignoring the high interference of the EU policy framework in national policies since a great number of domestic policy instruments are financed by EU funds and they are highly influenced by EU recommendations. A critical question was therefore left out of the analysis: How do EU policies impact the national policy instruments dedicated to innovative SMEs? More specifically, do countries pick up from the complete set of EU policy instruments, tools that are relevant to their specific economic environment and to their innovative SMEs' needs or do they simply try to implement a maximum number of instruments that are available under EU policies? This empirical paper will build on the analysis framework developed in Almerud, Lundstrom and Stevenson (2010) using a new combination of countries and will bring a new perspective to policy measures analysis in EU Member States and candidate countries by integrating the EU policy layer into the national scale instruments thus moving from a

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- 2 See for instance Mustar and Wright (2010) Convergence of path dependency in policies to foster the creation of university spin-off firms? A comparison of France and the United Kingdom. *Journal of Technology Transfer*, no. 35, 42-65.
 - 3 Golden, Higgins and Lee (2003). National innovation systems and entrepreneurship. Centre for Innovation & Structural Change (CISC) Working Paper No. 8. Galway, Ireland: National University of Ireland. Audretsch, Lehmann, Warning (2005). University spillovers and new firm location. *Research Policy* 34, 1113–1122.
 - 4 Verheul et al. (2001) An eclectic theory of entrepreneurship: policies, institutions and cultures. In *Entrepreneurship: Determinants and Policy in a European-US Comparison, Economics of Science, Technology and Innovation*, vol. 27, 11-81
 - 5 Lundstrom and Stevenson (2005) *Entrepreneurship Policy : Theory and Practice*. Springer Science.
 - 6 Almerud, Lundstrom and Stevenson (2010) *Entrepreneurship and Innovation Policies*, IPREG
 - 7 Belgium, Czech Republic, Denmark, Finland, Greece, Ireland, Norway, Poland, Spain, Sweden, United Kingdom.

classical examination of domestic policy tools to a holistic study of supranational influence on the selection of national policy instruments.

Approach

In order to see the way Lisbon Strategy – and EU policies that followed it – influenced the national policy instruments patterns dedicated to innovative SMEs in European countries, we will quantify and analyse the coverage of policies towards innovative SMEs before and after Lisbon Strategy was introduced. The method used to assess the coverage of policy measures dedicated to innovative SMEs is drawn from the 2010 IPREG project "Entrepreneurship and Innovation Policies". The steps to be followed are:

- Selection of five countries: Estonia, France, Luxembourg, United Kingdom and Turkey. This selection mirrors the variety of European countries with different economic environments, different sizes and diverse histories. This selection allows for a representativeness of differences in economic environments of EU countries.
- Brief historical reviews of industrial, entrepreneurship and innovation policies for each country which will allow for a description of circumstantial features that have shaped the countries' policy frameworks over the years.
- Having in mind the necessary integration of innovation and SMEs policies or the innovative entrepreneurship policy as Dahlstrand and Stevenson⁸ (2010) put it, a screening of innovation and entrepreneurship policy instruments that target innovative SMEs will be done. These instruments include measures dedicated to all SMEs regardless of them being innovative or not and measures that are available to SMEs solely because they are innovative. Measures will be grouped in policy categories such as finance, counselling, training and networking. Information on policy measures in place are drawn from official policy documents and official websites of implementing bodies. As to information on policy measures that were available before Lisbon Strategy entered into force, in addition to official documents, interviews will be conducted with implementing bodies' officials to determine the instruments that were in use.
- To establish whether EU entrepreneurship and innovation policy framework influenced the national choice of policy instruments targeted to innovative SMEs, the source of funding of such measures will be scrutinised before and after Lisbon Strategy was adopted. Measures that are financed by EU funds are assumed to be influenced by EU policy framework. The EU funds which will be taken into consideration are those that can be pooled into other national financial sources

⁸ Dahlstrand and Stevenson (2010) Innovative Entrepreneurship policy: linking innovation and entrepreneurship in a European Context, *Annals of Innovation and Entrepreneurship*

(e.g. the final beneficiary cannot directly apply to EU authorities to access the funds but have to turn to national or regional authorities).

- Using an ordinal scale, each country will be attributed a grade based on the score it gets in the general policy framework (general policy documents taking stock of innovative SMEs/Entrepreneurship) and in each policy category (such as financial instruments, training networking, counselling services etc.). This will constitute an innovative SMEs policy coverage index (the more policies cover categories the more comprehensive they are) and will allow for a comparison in time as well as between countries.

Expected results

The paper is expected to show whether EU policy framework has influenced the innovative SMEs policy coverage index. National policies of the selected five countries targeted to innovative SMEs are expected to have become more comprehensive after Lisbon Strategy was adopted (a higher coverage index) regardless the country thus pointing to a standardisation effect.

Conclusion

The EU has developed a set of policy instruments that can be used by its member States to reach Lisbon Goals. However European countries did not manage to achieve the 3% EU GDP spending target for research and development. This paper brings a part of the answer to this failure: Countries do not make any attempt to pick up the instruments best suited innovative SMEs policy measures but rather implement all available instruments, thus displaying a "try them all and see if things work better" attitude. The 3% EU GDP spending target for R&D and innovation was reiterated under the Europe 2020 strategy which introduced a new monitoring mechanism called the "European Semester". According to this mechanism based on recommendations of the European Commission, the European Council issues country-specific guidance on the way member States should reform their policy. This might indeed help European countries adapt their policies, including their measures towards innovative SMEs, to their specific economic environment.

Policies supporting technological dynamics: Why a narrow focus on R&D will not work

Jan Fagerberg¹, Maryann Feldman², Martin Srholec³

¹*IKE, Aalborg University, Denmark, TIK, University of Oslo, Norway and CIRCLE, Lund University, Sweden*

²*University of North Carolina, USA*

³*CERGE-EI, Charles University and Economics Institute of the Academy of Sciences of the Czech Republic, Czech Republic and CIRCLE, Lund University, Sweden*

When trying to explain, and possibly influence, long run economic growth, attention has increasingly turned to the social, institutional and economic factors that affect technology and productivity growth. Examples include Porter's four-factor diamond model in his *The Competitive Advantage of Nations* (1990); the literature on "systems of innovation" and notions such as social capital or social filter (Crescenzi et al. 2007). The policy implication is that to successfully generate technological capabilities and exploit these economically, a number of supporting social, institutional and economic factors need to be in place.

In contrast to this broad perspective on what matters for growth, the so-called "new growth theory" (Romer 1990) attributes cross-country differences in income and productivity to a single factor only – the ability to devote resources to R&D. The message that increasing R&D was the right direction for policy was received with enthusiasm by governments in Europe, who in the so-called 'Lisbon Strategy' – adopted by EU around the turn of the millennium – stated that R&D investment should increase to three per cent of GDP within a decade, with the purpose of making Europe "the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion." (Lisbon European Council 23-24.03.2000). The adoption of this goal was influenced by the observation that the United States, commonly seen as Europe's main global competitor, had a share of R&D to GDP far above the European level.

In our view, an important shortcoming of the prevailing analysis underlying the Lisbon Strategy and other policy discussions is a far too narrow focus on what shapes technological dynamics. The sole focus on R&D, while perhaps consistent with new growth theory, overlooks that R&D – while important – is only one among several factors influencing technological competitiveness (Fagerberg et al. 2004). Not all innovation results from or requires R&D, and a high level of R&D spending does not translate directly to innovation. To succeed in innovation, supporting resources and institutions are necessary, extending beyond the single firm to the wider environment in which the firm is embedded (Feldman and Kogler 2010). A proper analysis therefore requires a perspective that takes these wider aspects into account.

Another problem is that much of the prevailing analyses are based on comparisons between variable means for very large and heterogeneous geographical entities. Hence, the great variation within Europe and the US tends to be overlooked. Sweden, for example, invests nearly four percent of its GDP in R&D, which is about the same as California or Massachusetts. However, this investment is almost ten times that of several EU countries, such as Greece or Romania, or U.S. states, such as Wyoming or South Dakota. Moreover, the finding that some parts of Europe compare well with the most advanced regions of the US also holds when considering other social and economic data (King 2004). Thus, it seems pertinent to take such spatial heterogeneity into account when analyzing the technological dynamics and the scope for policy interventions. This paper, therefore, analyzes the technological dynamics in the two continents using the same indicators for European countries and US states.

The only prior attempt to tackle this issue, by Crescenzi et al. (2007), compares US cities to EU regions for the period of 1990-2002. To measure the outcome of the territorial dynamics of innovation, they use patent counts as their dependent variable. However, patents do not really measure innovation and is much more widely used in some technological fields (e.g., chemicals, biotechnology) than in others. Many inventions protected by patents never make it to the market, while many, if not most, innovations introduced to the market are not patented. Moreover, while Crescenzi et al. (2007) find that there are important differences in the technological and territorial dynamics between the two continents, their conclusions are based on separate analyses that do not always employ the same or comparable variables, which raises questions about the robustness of their findings.

The empirical analysis in the paper is based on a synthetic framework that takes into account key insights from innovation theory (Fagerberg et al. 2004), development studies (Adelman and Morris 1965, Kim 1997), economic history (Abramowitz 1986), and economic geography (Feldman and Kogler 2010). The literature suggests a broader notion of *technological capability* as the central variable and the inclusion of a set of *social capabilities* as conditioning variables for the development of technological capability. The empirical analysis, based on data for 75 geographical entities (48 states in the continental US and 27 countries in Europe) between 2000 and 2007, also takes into account territorial aspects, such as the possible effects of knowledge spillovers, agglomeration, urbanization and industrial specialization. Factor analysis is used to give a concise representation of how technological and social capabilities differ across US states and European countries.

Regarding technological capability, which includes not only R&D but also a number of other aspects related to exploration and exploitation of knowledge, the results suggest

that the worry expressed by many European policy makers over Europe lagging behind the US is to some extent misguided. In fact, the major difference between the two continents is not so much related to their top performers as to the fact that Europe includes a number of formerly Socialist countries in Eastern Europe, which understandably have not yet managed to generate technological capabilities comparable to those of Western Europe. As for social capabilities, the analysis suggests that while education is a strong point for Europe, the ability to engage the population in productive activities is not, at least when compared to the US. However, the biggest difference is to be found in what has been termed "social cohesion," which reflects norms, values, and institutions that facilitate economic activities, and for which US states tend to lag considerably behind Europe.

The results indicate that such differences matter for technological dynamics: Well developed social capabilities impact the degree to which countries and regions succeed in tapping into the global knowledge pool and exploiting it to their own advantage. Policy makers who do not take these lessons into account may fail to reach the desired results of the policies they pursue. Moreover, it has been common among policy makers, media and also scholars who study the difference in performance across the US and Europe to assume that the two systems work rather differently. However, the research presented here does not support this perspective but rather suggests that the underlying factors that influence technological dynamics in the two continents tend to be the same. But since both Europe and the US are quite heterogeneous entities, the observed dynamics – and the challenges for policy – may differ.

Due to its recent history, Europe has much larger internal differences in technological capability, and this has contributed to more vibrant internal dynamics, with several previously Socialist countries in the East catching up at rapid speed. The analysis in the paper suggests that a main challenge for European policy makers, in a time of crisis, will be to sustain this fortuitous trend by continuing to invest in education and preventing social conditions, for example unemployment, from deteriorating. In contrast to the European example, technological differences in the US are widening, in large part due to the combination of skill shortages and adverse social conditions in lagging regions. To reverse this trend, policies focusing narrowly on investments in R&D will not suffice. What is needed are comprehensive policies targeting the skills of the population and the broader social conditions that impact technological dynamics.

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The impact of the EU Structural Funds and the quality of local government in the European regions

Andrea Filippetti¹, Luigi Reggi²

¹*National Research Council of Italy – CNR Institute for the Study of Regionalism, Italy*

²*Ministry of Economic Development, Department for Development and Economic Cohesion, Italy*

Aim and background

This paper investigates the role of the quality of regional government for the impact of the European Structural Funds in 185 EU regions in the programming period 2000-2006. The EU strategy on policies for cohesion, innovation, and growth is experiencing a deep moment of rethinking in terms of strategies, instruments, and theoretical background. The Structural Funds represent not only a key source of funding for the current *Europe 2020* growth strategy and the flagship initiatives *Innovation Union* and *Digital Agenda*, but also a central mean to foster economic growth and cohesion by reducing disparities across the European regions.

The emphasis on the *contextual nature* of policy has led towards a differentiated territorial policy approach or *place-based policies* in EU regional policy (Toedtling 2010). In fact, regional policies are still far away from being place-based: they are often similar and based on policy imitation of 'best practices' sometimes conceived at EU or national level (Oecd 2011; Bonaccorsi 2009). Furthermore, their effectiveness has been questioned. Within the place-based framework the role of local institution has substantially raised in importance. In fact, regional governments often make a considerable contribution for cohesion policy in terms of programming, implementation, and evaluation (Barca 2009). In addition, in several countries a process of political decentralization has occurred (Batterbury and Fernando 2006). This paper addresses the following key question: what is the role of *local government* in making the Structural Funds effective?

Data

When it comes to government institutions, one of the main reasons for the lack of regional analysis is the lack of variables at the sub-national level. Recently, a comprehensive dataset of political institutions is that build by the Quality of Government Institute funded by the EU Commission's Regional Policy Department. It is based on a survey undertaken in 2009 covering 34,000 EU citizens at the region level in 18 countries. A composite indicator – the QoG Index – has been then developed. Extensive sensitivity tests and internal/external consistency checks have been performed (see Charron and Lapuente 2011 for the methodology).

Data on Structural Funds regional spending from 2006 to mid-2009 is based on the latest available dataset on commitments provided by the European Commission. The dataset includes the financial resources allocated to 245 Operational Programmes (OPs) within Objectives 1 and 2, as officially reported to the Commission by the Managing Authorities. The data takes into account all variations in the allocation of resources occurred by the end of 2007.

The OPs are co-financed by different sources, including the European Regional Development Fund (ERDF), the European Social Fund (ESF), The European Agricultural Guidance and Guarantee Fund (EAGGF), the Financial Instrument for Fisheries Guidance (FIFG), plus national and private funding.

Since almost 100% of committed resources have been spent at the end of the eligible period (European Commission, 2010), we assume that the total amount of public money actually spent is highly correlated with commitments. The same assumption was made in the Regional Expenditure study funded by the Commission (SWEKO, 2008) when representing ERDF data at the NUTS3 level.

The OPs are conceived with different territorial scope, namely national, multiregional and regional. The regional distribution is then calculated on the basis of the eligible regions' share of the population in the programme area. Information on eligible areas, which is crucial especially for those OPs impacting at the sub-regional level, is taken from the website of the Directorate General "Regional Policy" of the European Commission.

Methodology and expected results

In the table below we summarize the main variables of interest of the study.

Table 1: Variables

Dependent variable	Impact of the policy (variation of the real GDP per capita in the considered period)
Explanatory variables	Policy expenditure
	Quality of regional government
	Degree of political decentralization
	Objective 1 vs. non-objective 1 region
Control variables	Real GDP per capita at the beginning of the period
	Capital regions
	Country dummies
	Surface
	Population density

In terms of the methodology we plan to explore two possibilities. First, we would carry out a customary OLS regression model, also considering the effect of the interaction between policy expenditure with the quality of regional government as well as the degree of political decentralization. In a different attempt, we plan to employ the stochastic production frontier models, a methodology derived from the productive efficiency literature. This approach allows identifying the efficiency scores of each of the 185 regions in terms of impact of the policy. We would then employ OLS regression of the efficiency scores against our explanatory variables to explain the differences across the regions.

In the following table we summarize the working hypotheses along the two dimensions of analysis, i.d. quality of regional government and degree of political decentralization, and the expected results. These hypotheses will be tested both in the entire sample, as well as in the two subsample of objective 1 region and non-objective 1 regions.

Table 2: Working hypotheses and expected results

Degree of Political decentralization	Quality of regional government	
	Good	Bad
	Good	Negative impact
	Bad	Negative impact

Policy implications

In the new context of EU Cohesion Policy the importance of regional institutions has been largely emphasized. Yet, a systematic empirical research on this point is still lacking. This paper's findings point to a sharp policy implication: the Structural Funds' expenditures have been effective within a good local institutional environment, i.e. a good regional government. This supports the need of institution building at the local level. In addition, it raises a crucial point to be explored in future research. Is the place-based policy triggering a process of institutional learning at the local level? More implications for policy will be discussed in the light of the results concerning the role of political decentralization for the effectiveness of policy.

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Using evaluation research as a means for policy analysis in a 'new' mission-oriented policy context'

Ioanna Garefi², Effie Amanatidou¹, Paul Cunningham¹, Abdullah Gök¹

¹University of Manchester / Institute of Innovation Research, UK

²ATLANTIS Consulting S.A, Greece

Motivation

Evaluation exercises constitute a core part of the innovation process but there are still a lot of challenges that need to be met and confronted. There are basic underpinnings that need to be taken into account for sound evaluations to be conducted. Tailor made solutions need to be applied bearing in mind the identified needs of the different programmes.

At the same time, the so-called 'Grand Challenge' orientation that is put forward as the main policy rationale at the EU level brings new challenges in policy evaluation. Grand challenges are crossing several types of borders in relation to scientific disciplines, sectors of activities as well as policy – making levels, and policy areas. While a common understanding and definition is still to be developed everyone seems to agree that their impacts, if not effectively confronted, may be significant to all types of societies around the world (Cagnin, et. al., 2011). These features imply significant challenges for policy evaluation that has to accommodate multi-disciplinary, multi-level, multi-sector and multi-actor approaches in trying to tackle grand challenges and at the same time identify and attribute impacts in a specific policy.

A new approach to policy evaluation taking into consideration the above mentioned recent developments has yet to appear. Empirical evidence has shown that a core of methods is being applied and that specific approaches in "copy and paste" are being implemented across a range of innovation policy measures evaluations leading to one third of evaluations as being poor (Edler, Berger, Dinges and Gök, 2011). In their majority, evaluation exercises present serious quality problems not only in terms of their practical application but also in addressing the wider objectives which are set as part of an innovation programme, policy or project. Specific aspects of usefulness and behavioral additionality are also a point of discussion between policy makers and evaluators who recognise the need to measure, understand and interpret change in behaviour as well as to explore the ways in which evaluation is of use to them as a learning tool (Gök and Edler, 2011 and Cunningham and Gök, 2010).

At the same time, there are some cases that present common characteristics in terms of how evaluation is conducted and which are obliged to do so, given their abundance by

a wider regulatory framework. This is the case for the evaluations conducted for programmes receiving support from the Structural Funds whereby specific evaluation criteria need to be met. These evaluations usually follow specific guidelines and recommendations suggested by Structural Funds regulations.

On the one hand, this may lead to a certain degree of standardisation in the evaluation foci, methods and criteria applied. This comes in contrast with the specialised approach needed in evaluation, more so when policies are oriented to tackling specific challenges. On the other hand, the specific guidelines and recommendations aim at improving the quality of evaluations. However, it is doubtful whether it offers clear added value for programme evaluation beyond abiding by the SF requirements. In the meantime, this availability of guidance has been an important stimulus for the development of evaluation capacity (Tavistock Institute, et. al. 2003).

The motivation behind this paper lies mainly on the fact that there is a lot of potential in the different existing evaluation practices which could actually produce better policy making. However, they are not structured and designed in such a way allowing for tailor made approaches to be applied taking into consideration the special needs and aims of the programmes or policies at stake or following good practice guidelines promoted by institutions such as the Structural Funds. There is a need thus for rigorous and specialised evaluation approaches to be adapted based on the emergence of new trends in research and innovation policy oriented towards tackling grand challenges and taking advantage of possible standardisation in good practices to the degree possible.

Approach

The scope of this paper is **twofold**. On the one hand, it will examine conceptually and statistically the issues of behavioural additionality, quality and usefulness and other evaluation characteristics from the angle of Structural Funds related evaluations. This will be done based on relevant studies such as the INNO-APPRAISAL study (<http://www.proinno-europe.eu/appraisal>). This will then be examined within the scope of new challenges posed on policy and programme evaluation stemming from the orientation to certain missions in tackling 'Grand Challenges'.

On the other hand, a case study will examine the reasons why these attributes are as they are in the SF-related evaluations. The case study will start with the examination of the up-take of the specific requirements set under the SF regulation at specific national levels. In this regard, three countries – Greece (a Southern European country) and two new Member States, Poland and Malta – were chosen for detailed examination and for providing a concrete example of how SF evaluation related regulations and provisions

are implemented and affect evaluation practices in their specific contexts. The reason for choosing these countries was made because they presented diversity in their institutional contexts and level of experience in Structural Funds. The examination of the reasons why SF-related evaluations present high or low quality characteristics will be based on the following hypotheses:

- SF requirements may lead to specific characteristics in delivery and practice of evaluation;
- SF requirements may lead to higher quality evaluations;
- High quality SF evaluations may have greater impact;
- SF regulations demand high standards on structures and processes that inevitable need some institutional learning and structure building.

The first part will rest on a quantitative analysis, using regression analysis, of 171 evaluations' characteristics, backed by the relevant conceptual discussion, while the second part will be a qualitative case study. Then, this analysis will also be put in the wider context of the 'new' requirements for policy and programme evaluation based on the Grand Challenges agenda.

Expected results

Results are expected at three levels:

- Overall, results will indicate the usefulness of research and innovation programmes evaluations and the degree to which they lead to behavioural additionality;
- At the level of the SF-related evaluations, results will refer to whether and in what ways the specific guidelines set affect the evaluation practices, how much they lead to high quality and useful evaluations and whether the situation corresponds to the wider approach of evaluation policy;
- At the level of Grand Challenges requirements for evaluation; both the two previous types of results will be put under discussion within the wider framework of policy orientation towards tackling Grand Challenges and what the implications are for policy and programme evaluation.

Conclusion and/or (policy) implications of the work

Evidence about the usefulness and behavioural additionality of evaluations will be put under the framework of the new requirements for policy and programme evaluation emerging from this 'new' mission-oriented approach. In this regard, existing guidelines (like those under SF) and recommendations may be revised to meet the new requirements. Alternatively the basis can be set for new guidelines for good practice evalua-

tions taking into consideration the special features that policies dealing with GC should have (multi-disciplinary, multi-level, multi-sector, multi-actor).

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The transformation of the Greater Manchester waste system: A role for public procurement in system innovation

Sally Gee, Elvira Uyarra

Manchester Business School, The University of Manchester, UK

Abstract

Solving multifaceted environmental problems requires system-wide transformations rather than discrete solutions. It is widely agreed that market mechanisms alone are insufficient to motivate systemic eco-innovation or promote sustainable socio-economic practices and outcomes. Explanations for market and system failure include externality problems (e.g. Rennings, 2000) and socio-technical lock-in (e.g. Unruh, 2000). These structural constraints are compounded by the unprecedented scale and speed of change required to abate environmental degradation and have lead many commentators to conclude that the emergence of more ecologically sustainable systems is more policy-induced than market driven (van den Bergh et al, 2011). Indeed, transforming dominant socio-technical regimes into more sustainable configurations has become a major policy challenge (Berkhout, 2002).

This paper describes a case of radical system transformation in waste management. A body of literature has emerged around the governance of transformative change, questioning whether it is possible to stimulate or even coordinate systemic eco-innovation. The general message of the transitions management literature (e.g. Kemp et al, 2007) is that it is possible to guide or actively encourage system transformation through the policy process (Kemp and van Lente, 2011). Conversely, several authors question whether systems innovation can be managed and whether deliberative intervention is possible or effective (e.g. Shove and Walker, 2007). While these literatures focus on the potential for policy, particularly regulation and supply-side policy, to direct systemic change, the potential of public procurement to stimulate system innovation is relatively neglected.

A number of authors emphasise the role of public procurement for technology development and innovation (e.g. Edquist, 1996; Edler and Georghiou, 2007; Rolfstam, 2009). Indeed, the ability of the state to stimulate *discrete* non-eco technological innovations through procurement is well documented in a variety of sectors, including defence (e.g. Ruttan, 2006) and health (e.g. Phillips et al, 2007), with some discussion of *discrete* eco-innovations more generally. However, relatively little attention has been paid to the potential for public organisations to effectively orchestrate the emergence of

new more sustainable *systems* through procurement¹. This paper addresses that gap, drawing from the literature on sustainability transitions, transitions management and public procurement to explore the potential for major public buyers to stimulate and direct systemic innovation.

To do this, the paper deals with the transformation of a city-region municipal (i.e. household) waste management system between 2000 and 2012. More specifically, the paper describes how Greater Manchester (UK) underwent a transformation from a relatively simple landfill model to a highly complex, multi-technology waste solution based on intensive recycling and composting, and sustainable energy usage. In 2000/2001 only 3% of Greater Manchester's municipal waste was recycled (Melvine and Munch, 2005). By 2012 recycling and composting rates rose to over 50% and over 75% of municipal waste was diverted from landfill. The case is particularly relevant because the UK has long been an environmental laggard when it comes to sustainable waste practices. Indeed, the widespread availability of landfill sites meant that landfill was a cheap option for waste disposal – and a convenient way of 'filling holes in the ground' – compared with recycling and recovery. However changes in national and EU regulation aimed at reducing landfilling in the early 2000s prompted "a frenzy of activity" in the sector. After an initial sense of urgency to increase waste diversion and move practices up the waste hierarchy, many English local authorities opted for the relatively simpler chemical-upgrading route of building incinerators in order to avoid hefty penalties (Melville and Muncke, 2005). The national shift from landfill to incineration maintained the dominant industrial trajectory, representing a more "business-friendly" and centrally organised solution (Murray, 1999).

In what has become the largest private finance initiative project in Europe and critical to the national waste agenda, Greater Manchester bucked the national trend and opted instead for a solution that was deemed more innovative and sustainable, but which involved formidable technological, political and financial risks. The case shows how a clear strategy and strong political vision facilitated the procurement, and ultimately transformation, process, and describes the role of the public procurer in orchestrating this transformation.

The case illustrates how a public body developed the required interdependencies between technologies, institutions and practices to orchestrate change. This required the

¹ Although there are empirical examples of cases where demand management and demand side policies have played a role, for example the Swedish market transformation or the American energy management programmes, there is little academic literature on these types of intervention.

public body generating and drawing on multiple internal competencies to engage in a diverse range of activities to mobilise and connect many heterogeneous actors and system elements. For example, ensuring that household waste practices were consistent with Local Authority collection practices, that were in turn consistent with the new technological infrastructure, and co-creating markets to take the new outputs of the system. Significant resources were also directed at aligning the relevant local and national policies, and overcoming resistance from multiple stakeholders, including local planners. Generating cohesion between these different elements involved a coordinated yet iterative process of learning and joint problem solving, informed by a strong and consistent political vision by the public body. The paper challenges some ideas about how system innovation can be orchestrated. It also suggests that through the procurement process policy makers have an additional, often neglected, tool for stimulating and managing systemic change.

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Are arts and humanities researchers liminal in the current policy environment?

Magnus Gulbrandsen, Siri Aanstad

Nordic institute for studies in innovation, research and education (NIFU), Norway

1. Motivation

Arts and humanities researchers seem to be struggling in many countries, experiencing budget cuts as well as new and challenging demands and mechanisms of governance. Disillusioned researchers participate in dystopic discussions about the future of the arts and humanities, frequently blaming a perceived difficult situation on a policy environment that is oriented towards new indicator-based funding systems and tangible benefits from research in the form of university-industry relations and innovation (e.g. Kehm 2009). Even in Norway, a country shielded from the financial crisis and cuts in research budgets, the debate surrounding the humanities plays out along similar lines. "Do the humanities have a future in Norway?" newspaper articles have repeatedly asked over the last years. As such, the Norwegian case may be particularly useful in elaborating on the status of researchers within arts and humanities. Issues of self-image, value and identity can be explored in a setting where there have been no dramatic budget cuts or downsizing of research units, but where the main policy drivers and ideals are the same as in most other countries. We ask whether researchers in these disciplines are increasingly becoming *liminal*, finding themselves in an ambiguous no-man's-land between a traditional taken-for-granted identity and a new policy-infused and unwanted ideal?

2. Approach

Liminality is a term from anthropology dating back to the early 20th century writer Arnold van Gennep and later revitalized by other authors. The term refers to the condition of being on a boundary, often in an unstable transition state between memberships in more stable groups, like (in some cultures) teenagers in between the more stable communities of adults and children. It is a concept about the "complexities that affect those whose role in society cannot easily be defined" (Zabuskey & Barley 1997:370). Liminal people do not have a separate status that is institutionalized and codified, they inhabit a state which may imply marginalization, stress and other problematic aspects related to behaviour, values and self-image. Some positive features of liminality can also be envisaged, such as increased opportunities for flexibility and individuality. The term has been fruitfully applied to understanding academic entrepreneurs (Gulbrandsen 2005) and industrial scientists (Zabuskey & Barley 1997).

In this paper we will expand this strand of literature and discuss the proposition that arts and humanities researchers are increasingly becoming liminal under the ideals and goals in contemporary science and innovation policy.

The goals of public science continue to be fairly instrumental: universities and other public research organisations should contribute to innovation, economic growth and competitiveness, and, increasingly, to solving "grand challenges" facing societies across the world. Public-private partnerships, commercialisation and technology transfer offices and other intermediary organisations set up to transform research results into something useful are mechanisms for achieving these goals. Long-term basic research is still supported, but ever more in the form of concentration of resources in various excellence initiatives at group, department and institutional levels, where large teams of researchers concentrate on writing scientific papers, striving to be recognised as internationally leading places of science.

It can be hypothesised that arts and humanities researchers may feel somewhat out of place, in-between – or liminal – in this situation. Their research results seldom have direct economic benefits, maybe not even indirect ones; their channels to society are to a limited degree patents, licenses and collaborations with private firms, and goals of increased competitiveness and economic growth may be far from goals researchers within these disciplines identify with. The rhetoric and practice of research excellence may not be very well suited to arts and humanities researchers either, with their often more individualistic mode of work, patterns of output (many other things than scientific articles, from books to artistic products and performance) and frequent local and national orientation and language.

This is not to say that liminality applies to everyone. Most likely some arts and humanities researchers see centres of excellence and other large-scale or mission-oriented funding mechanisms as well-suited to their goals and ambitions. Others may feel comfortable with the goals of innovation, for example researchers within design, architecture and disciplines with links to the cultural industries. But the proposition is that a fair – and increasing – share of arts and humanities researchers finds itself in an in-between or outsider position, for which we will use the term liminality in the paper.

The data consists of written contributions to the policy debate surrounding the humanities in Norway, national policy documents including the strategic plan for humanities research and the latest science policy white paper, as well as interviews with twenty-something researchers, policy-makers and external stakeholders. The topic of liminality will be elaborated on through analyses of interviewees' perceptions of scientific work and identity, the external value of arts and humanities research, and more.

3. Results

A preliminary analysis of the policy debate indicates that there is a clear dividing line within the arts and humanities research community itself. Somewhat simplified, one group consists of researchers who are offensive on behalf of their disciplines. They accept or have even adopted new policy concepts (like grand challenges and innovation), highlight that their disciplines have many commonalities with other sciences, and are willing to develop their work in cross-disciplinary relationships. The contrasting group is more pessimistic and generally represents the view of exceptionalism: that arts and humanities differ so much from other disciplines that they need to be protected by specific funding instruments and other means.

The optimists can perhaps be characterised as a liminal group without a (yet) stable identity, exploring new funding mechanisms and the boundaries to other disciplines. It might be argued that they exploit the flexibility of their liminal status to accept untraditional funding and to develop new practices and outputs which may constitute the foundation for future stable communities. This implies a rather positive interpretation of the status of liminality.

A first impression from the interviews (the analysis of this material is still ongoing and will be finished at the end of February 2012) implies that there are some nuances to the picture. It seems that interviewees within arts and humanities research are fairly sensitive to the actual words that are used to describe their disciplines' relation to society. Some terms are easily accepted, like societal relevance and to some extent innovation. Utility value has different connotations, however, and is by many perceived as something instrumental and threatening. There seem to be rather large variations between different arts and humanities disciplines as well in the terms that are used and the identities and practices involved. Several interviewees nevertheless aim to find terms that unite the arts and humanities as a strong force in the research system and policy debates, and none of the interviewees are willing to part with the notion of intrinsic value of arts and humanities research (although a few found this value through interaction with other fields). It is furthermore clear that the turn towards mission-oriented research may provide opportunities for the humanities. The terrorist attacks in Oslo July 2011 clearly demonstrated that there are major societal challenges which require very different expertise than the ones most often linked to technological innovation and economic utility value.

4. Conclusion and policy implications

In other words, the swing towards more mission-oriented research may not necessarily be a threat to the arts and humanities, especially when the "grand challenges" are seen

to include non-economic and non-technological aspects of society. Contributing in a rather instrumental way may still be somewhat alien to many researchers in these disciplines, but the liminal status may yield some freedom of action to experiment with new approaches. Liminality is partly a choice through renouncing the "old ideals" or the "traditionalists" in the academic community (the optimists dislike the arguments of the pessimists), and partly an involuntary process through exclusion of the most innovation-oriented humanists from some academic communities (the traditionalists perceive the optimists as "weathercocks"). On the other hand, these researchers may be welcomed as part of a larger scientific world, finding allies and a stable community together with natural, social and life scientists.

Understanding these processes may be important in developing good mechanisms for including the arts and humanities in current goals of solving grand challenges. The most important message is probably that there is a high degree of heterogeneity within arts and humanities that needs to be reflected in policies targeting these disciplines. Another clear message is that stakeholders do not distinguish clearly between arts and humanities research and the broader competences that research contributes to. Policies that focus exclusively on research may therefore be somewhat limited.

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Can markets function as learning arenas? Feed-in tariffs, technological innovation systems and energy transition

Jens Hanson

Centre for technology, innovation and culture, University of Oslo, Norway

Given the challenges of climate change, fossil fuel dependence and need for energy security, governments are concerned with how to stimulate increase of renewable energy and technological change. It is common to distinguish between demand and supply side instruments for doing so, the former often being argued to be more efficient because one avoids "picking winners". This paper illustrates how Feed-in tariffs (FITs), the most widespread demand side deployment instrument for renewable energy, are as much a supply side instrument, heavily reliant on inducing technological change.

As a deployment tool, providing investors with substantial tariffs well above electricity market prices, FITs have lead to surges in investments in new renewable energy technologies (RET), raising their share in electricity generation in Germany from 4,7% in 1998 to 16% in 2009 (BMU 2010). FITs have received widespread attention in economic literature with regards to setting of accurate tariff levels (Butler & Neuhoﬀ 2008, Couture & Gagnon 2010) as well as with regards to cost and competitiveness (Menanteau et al 2003, Helm 2005, Frondel et al 2010). The relation between FITs and innovation is an issue which, although at the core of FIT policy, has received less attention.

The paper argues that a prerequisite for FITs to be a *viable* long-term deployment tool is that learning takes place in production of low-carbon technologies. Technologies need to be available at lower prices to accommodate for reductions of tariffs over time. The paper argues FITs to be heavily inspired by learning curve models. This goes both for the idea that market stimulation affects learning and the prescription of learning rates in policy design. Applying learning curve models in policy implies assuming technological development trajectories *ex ante*.

Such processes are however highly uncertain and development trajectories are not intrinsically knowable. In fact, the large technological transitions that are sought to be policy induced are complex processes where policy is but one part of broader technological and social transformations (Geels 2002, Kemp et al 2007). If we understand innovation as systemic processes of continuous and cumulative improvements in which diffusion and feed-back mechanisms are intrinsic, understanding the role of FITs within a framework of emerging technological innovation systems (Jacobsson 2008, Bergek et al 2008) provides new insight into their potential as learning tools (particularly when it comes to identifying bottlenecks and systemic strengths and weaknesses). The

second leg of the paper uses a technological innovation systems approach to look at the dynamics within the system for solar photovoltaics (PV).

Literature review: technological change, competitiveness and policy

The fundamental challenge with regards to increase in the share of RET is that new technologies seldom compete well at early stages of development (Rosenberg 1972, Mowery & Rosenberg 1998, Smith 2009). The literature on technological regimes (Freeman 1994, Kemp et al 1998) and paradigms (Dosi 1982) describes how barriers to entry of new and often alien technologies (into the market and energy systems) is due to incumbent technologies, industries and systems.

Regimes hence provide conditional factors, which hamper diffusion processes for new RETs beyond niche areas. The fact that new technologies diffuse slowly has been recognized repeatedly. Rosenberg (1972) pointed out that both overall slowness and wide variation in the rate of acceptance of new technologies are characteristic of diffusion processes.

Diffusion however is an inherent part of innovation processes (Rosenberg 1972). The fact that new technologies seldom compete well in part has to do with lack of learning processes associated with broader markets and user bases. Georghiou et al (1986) discuss such learning processes of post-innovation improvements, arguing that once an innovation has reached the market there usually is a long period of time where learning affects the performance of the technology.

Whilst the concept of technological regimes provides explanatory power as to why new technologies do not compete well from a contextual point of departure, the problem of diffusion and competitiveness is one which also has intra-systemic origins. A technology may not compete well because of lack of embeddedness within a system.

The paper applies recent contributions on technological innovation systems (TIS) (Bergek et al 2008, Jacobsson 2008, Hekkert et al 2007), to the analysis of FITs and associated systemic dynamics.

Learning curves, competitiveness and energy policy

A related approach to learning and how technologies evolve from a cost competitiveness perspective is the concept of learning curves. It is used to understand how costs decline over the long term as a function of increased production. Learning curves state that production costs fall at a fixed percentage for each doubling of cumulative output (Yelle 1979, Liebermann 1987).

The attempt to apply learning curves in policy design is an attempt at using ex post data to model ex ante trajectories. As a result the core selling point of learning curves in policy design is that immature technologies still have a long way to travel along the learning curve (IEA 2000).

There are several problems associated with using learning curves in policy design. First the obvious fact that we do not know what the learning curve for a given technology might look like beforehand. Modeling learning trajectories includes high uncertainty levels because it relies on innovation processes which in themselves are uncertain, and do in themselves create uncertainty. Second a learning curve does not tell us anything about which factors that influence learning. In other words, applying such a learning model, does not reveal any factors that may make technologies more competitive.

Key findings

The paper argues both the underlying rationale as well as the practical design of FITs to be heavily inspired by learning curves. The latter becomes evident when looking at tariff design. Under the tariff scheme an installation receives a fixed rate over 20 years. Yearly degression of rates applies only to newly installed projects. Hence, despite being a user oriented tool, FITs do in effect target learning in industry and in production of capital goods.

This, and the fact that FITs target immature technologies, resonates with the underlying thinking of learning curves, namely that markets constitute new learning arenas.

Policy as endogenous to systems

The analysis shows how FITs are designed to let industry do the "innovation effort" and public authorities prescribe the "learning pace". What is thought of being a demand side instrument hence in fact is one heavily reliant on supply side dynamics. These dynamics are however little understood using learning curve analysis. Using the design of a learning curve in a policy tool that formally is aimed at *users* of technology but in reality rests on the ability of *producers* of technology to reduce costs and price may prove to become the main challenge for FIT in the future. We therefore can identify strong but little coordinated interdependencies between policy and industry as policy in reality rests on the ability of industry to reduce costs and prices and in that the industry relies on the FIT system to grow. In this loosely coupled principal-agent relationship there however exists little coordination of what industry is supposed to be doing other than reduce costs.

Looking at the dynamics within the system for solar PV it becomes obvious that FITs have played a key role with regards to forming markets, and emergence of a range of extended effects. Understanding the development of competitiveness for new renewable energy technologies as a process of system building implies policy and diffusion being parts of broader and complex dynamics. These hence are endogenous to a broader set of processes which are not coordinated and not well understood. In conclusion we may argue from a systemic perspective that FITs stimulate one central function of TISs – market formation. Diffusion hence is stimulated by user incentives. However, other central systemic functions may be argued to be stimulated loosely and not directly by FITs, but by its extended effects. What the paper intends to show is that market deployment has stimulated various processes, such as the emergence of a range of producers of capital goods, specialised suppliers, a wide range of research activities and broad networks. There are however critical blocks that still constitute bottlenecks for further growth, such as raw-material supply for solar PV. This key component to cost reduction has nevertheless been little coordinated. This may be argued to be linked to system functions not being in place, such as reduction of uncertainties for entrepreneurial experimentation.

An initial conclusion is that markets in themselves do not function as learning arenas. Markets may however provide firms and organisations with learning opportunities. Whether or not these embark on "learning ventures" to the extent that is prescribed in FIT policy is however uncertain. It depends on the structure and functions of the system where market creation is one amongst many processes that need to be in place in order for a system to grow.

Governance of Offshore Wind innovation in Western Europe

**Marko P. Hekkert, Anna Wieczorek, Robert Harmsen,
Gaston Heimeriks, Simona Negro**

Utrecht University; Copernicus Institute, the Netherlands

Introduction

The development and diffusion of offshore wind energy technology is important for European and Dutch energy policy. First, the potential is large and therefore offshore wind may become an important pillar of the future European energy system, contributing to policy objectives on climate change and energy security. Second, the technology is in the early stages of technological development and therefore many business opportunities can be reaped in this emerging sector.

However, a large potential does not automatically lead to a large share in future energy systems and neither does an emergent stage of technological development automatically lead to success for firms and related economic growth and growth in employment. Innovation and technological change are by definition very uncertain processes. The outcomes are strongly determined by processes of chance and by external events that are impossible to influence. Nevertheless, the scientific community that studies innovation has shown that a conscious and intelligent management of innovation processes strongly increases the success chances of innovation.

The most important insight that has dominated the field of innovation studies in the recent decades is the fact that innovation is a collective activity and takes place within the context of a an 'innovation system'. The success chances of innovations are to a large extent determined by how the innovation system is built up and how it functions. Many innovation systems are characterized by flaws that hamper the development and diffusion of innovations. These flaws are often labeled as system failures or system problems. Intelligent innovation policy therefore evaluates how innovation systems are functioning, tries to create insight in the system weaknesses and develops policies accordingly.

Due to the complexity of innovation system analyses, very often analyses are restricted to a single country. There are good reasons for this since the institutional structures that support and hamper a technology differ strongly per country. However, technological innovation systems are global systems and the success or failure of a national TIS is also strongly dependent on the functioning of the TIS outside the focal country.

In this paper we therefore study the emerging TIS for offshore wind energy for 4 different countries (Netherlands, Germany, United Kingdom and Denmark) and analyze the interdependencies between the four different innovation systems. So we start by analyzing country specific system weaknesses but then also analyze how these weaknesses are balanced or enlarged by system strengths and weaknesses in other countries.

This paper therefore contributes to insights on how the National governments should improve their policies to support off shore wind, but also how the off shore wind innovation system in their country interacts with other innovation systems and how this affects national policies.

Theory

All innovation systems can be characterized by the same basic building blocks or components. These are actors, institutions, networks and technology. Examples of actors are organizations responsible for education, R&D, industrial activities, and consumers. Examples of institutions are supportive legislation and technology standards. Examples of networks are the linkages between organizations in research projects and advocacy coalitions. Technology is part of the innovation system as it enables and constrains the activities of actors in the innovation system.

Though different innovation systems may have similar components, they may function in a completely different way. Therefore, measuring how innovation systems are functioning is considered as the big breakthrough in innovation systems research. In a number of scientific articles lists of evaluation criteria are presented to evaluate how innovation systems are functioning. These assessment criteria are labeled in the literature 'functions of innovation systems'.

In Hekkert et al. (2007) the following functions of innovation systems are put central.

1. entrepreneurial activities,
2. knowledge development,
3. knowledge exchange,
4. guidance of the search,
5. formation of markets,
6. mobilization of resources,
7. counteracting resistance to change.

The important difference with the structure of the innovation system is that these system functions are much more evaluative in character. Focusing on functions allows us to address the performance of an innovation system. In other words: the structure presents insight in who is active in the system, the system functions present insight in what they are doing and whether this is sufficient to develop successful innovations.

Method

For each country we analyze the structure of the innovation system. This implies an analysis of the most important actors involved, the institutional setting in each country, the networks that are present in each country and between the countries and finally the infrastructure of the innovation system (knowledge and resources). The next step is to analyze how the four national innovations systems are functioning and how they interact. The functioning of the innovation systems is based on 24 interviews and an event analysis for each country for the years 2010 and 2011. A quantitative representation of the functioning of each innovation system is presented by plotting the average scores per system function on a 1-5 scale. Finally, we assess the system weaknesses and starting points for intervention policies based on the structural and functional analyses.

Results

So far we have only analyzed the Dutch offshore wind innovation system. Below we will present some figures to illustrate the type of data that we collected. In the final paper these type of data will be collected for all four countries and a thorough analysis of the data will be done. At the moment, we are not in this stage yet.

Figure 1 shows the supply chain for the Netherlands off shore wind industry. It makes a distinction between national and international projects in which the Dutch actors are involved.

Finally Figure 3 shows how the Dutch offshore wind TIS is evaluated by the interviewees.

Figure 3: Snapshot of system functioning of Dutch offshore wind TIS in 2011



The figure shows that the interviewees clearly evaluate the guidance of the search function and the market formation function as very problematic. Recently, the Dutch government stopped investing in offshore wind, which explains their problematic scores. Entrepreneurial experimentation is still seen as sufficient. This is mainly due to the very good business opportunities for Dutch actors in neighboring countries. Here we clearly see the international nature of the offshore wind industry and the interaction between different national innovation systems. Market formation in the UK and Germany seems to compensate for poor market formation policies in the Netherlands. Also in terms of knowledge networks, we observe that Dutch knowledge exchange is far less organized than international knowledge exchange. Following these types of observations we intend to analyze the interaction between different national innovation systems and the implications for national and European policies.

Overcoming critical gaps in the innovation value chain: The nano-to-macro approach

Peter Heydebreck¹, Andreas Gerdes²

¹*inno AG, Germany*

²*Institute of Functional Interfaces (IFG), Karlsruhe Institute of Technology (KIT), Germany*

Motivation

Europe has undertaken substantial efforts in increasing private and public investments into knowledge generation and prides itself with being a top performer in research. During the past two decades a consensus has grown amongst policy makers that research is a powerful instrument to generate innovation success, i.e. research creates results that can be employed to boost core values like welfare, social cohesion, and environmental sustainability. It is decreasingly looked upon as a value in its own right.

There is a conference room consensus on the importance of generating a return on tax payers' money in the form of e.g. increased tax income, increased number of jobs and improved environmental conditions. The expectations differ substantially and are typically rather vague. Also, a bundle of factors counteract the development of effective and efficient innovation value chains. Amongst the most important ones which result in a fragmentation of the process into isolated working packages is a lack of key stakeholders' motivation to strive for ultimate innovation success. This holds true both for researchers' intrinsic and extrinsic motivation to open their minds more towards valorisation:

1. *Intrinsic motivation.* Most researchers become researchers because they want to do research and because they appreciate that research tends to be a field less strictly ruled by hierarchical governance structures than most other fields. In order to boost intrinsic motivation, one would need to re-think e.g. the selection criteria for recruiting and offer the researchers higher degrees of freedom in their valorisation activities.
2. Neither individuals nor institutions can be assumed to behave fully rationally. However, their *extrinsic motivation* and their respective behaviour will be heavily influenced by the relevant incentive framework conditions in place. Currently, these incentives do not encourage a holistic view on innovation but encourage optimization of specific stages in the innovation process. For instance, individual researchers and research institutions are ranked and promoted/rewarded according to goal achievement in their respective stage. The career (both in terms of reputation and income) of a researcher is dependent on peers who tend to judge a researcher by the measurable final outcome of his research – a citation index – and not on the impact his research has on the achievement of societal objectives.

Even during their research activities the researchers' success is measured according to this factor along with the amount of third party funding acquired. The intervals in between scientific evaluations on which the future of a researcher and their team depends are getting shorter and shorter. The pressure to publicize resulting from this makes it increasingly difficult to implement topics such as technology transfer and innovation into the researcher's team.

3. The public as well as fellow researchers distinguish quite clearly when it comes to judging the importance of basic research and that of applied research. This is true for different research areas such as sciences focused on basic research (e.g. chemistry) and more applied research in engineering (e.g. civil engineering), it is also true for different types of universities, be they applied or not. The limited cooperation resulting from this increases the problem and widens the "Valley of Death" for innovation. Thus ideas with a high potential for technology transfer are not recognized early enough or the effort necessary for developing a product based on results from basic research up until its marketability is underestimated.
4. Thus a development program was aimed at purposefully connecting basic and applied research in order to noticeably accelerate technology transfer. The result of these works – the so-called "Nano-to Macro-Approach – will be introduced and discussed briefly in the following.

Approach

The paper draws upon the authors' practical experiences in creating and valorising research results. The background from their daily work is complemented by insights from an ongoing research project financed by the German BMBF in which the University of Münster, the University of Applied Sciences Karlsruhe and the innovation consultancy inno AG analyse good practice in overcoming gaps in innovation value chains in general and in the construction chemistry in particular. Within the project both qualitative data is collected in the form of in-depth case studies as well as quantitative data via standardised questionnaires.

The field of construction chemistry has been selected due to the following specificities:

- High pressure to innovate due to traditional factors (like increasing competition from Asia) but also due to rapidly changing demands from users due to global megatrends like climate change, globalisation and increasing limitation of natural resources.
- Complex interweavement of dependencies in the construction industry with a multitude of standards, norms and regulations which protract innovation processes.
- The importance of the construction industry for the economy in general to which construction chemistry contributes as a key driver of innovation in terms of realising new characteristics of materials.

Expected results

Germany has a strong tradition in attempting to overcome gaps between different stages in a research process, prominent examples can be found in the set up of e.g. the Fraunhofer Institutes which serve specific needs of society and business drawing upon and adding value to basic research performed at e.g. universities. Access to (even tacit) University knowledge is secured by e.g. interlocking directorates which ease interaction between "us and them". In respect to commercial employment of strategies and concepts, a lot remains to be done though. Users' demands need to be addressed pro-actively early-on in innovation processes instead of following the outdated linear technology transfer model attempting to sell whatever comes out of research. A recent example of a strong dedication to exploitation of research results is the launch of the Innovation Union by the European Union which is to "turn ideas into jobs, green growth and social progress".

The authors can show that the provision of arenas for intensive interaction between basic research, applied research and professional valorisation partners can substantially boost the motivation and competence of systems to achieve ultimate innovation success. More specifically, they constitute a powerful means of providing research with early signals on market needs and preferences as well as of speeding up innovation processes.

Conclusions

In contrast to common research strategies which "for the sake of simplicity" strictly separate basic research from applied research from valorisation, the authors recommend a policy which favours the development of borderless approaches to speed up innovation processes from research to employment of technologies. A highly promising example is the recently launched "ForschungsCampus" programme by the German BMBF.

The integration of competences and demands of all key actors in a specific field allows for drastically shortening the increasingly decisive time-to-market; in the case of construction chemistry from material design at molecular level (nano) via user-oriented further development of systems (micro) to the realisation of commercial technologies in the form of products and services (macro).

Priority setting for international STI collaborations to address global challenges

Florian Holzinger, Wolfgang Polt

Joanneum Research, Policies: Centre for Economic and Innovation Research, Austria

1. Motivation

In the context of global challenges international STI collaborations are promoted by policy makers and are becoming more common as these challenges cannot be *"tackled by one country alone thus increasing scope and scale by working together and by creating large research infrastructures enhances the potential impact of this research"* (Boekholt et al. 2009, p. 15). Analysts as well as policy makers are anticipating that the urgency of global challenges will lead to an increasingly collaborative international STI landscape in the near future. This will have an impact on the national and transnational governance of science: national modes of STI governance will have to adapt to newly arising challenges and opportunities of internationalization; and also the modes and structures of governance on the international level will have to change and new structures and institutions will have to develop (see European Commission 2008, p. 78).

One key dimension of (national and) international STI governance is priority setting which is an instrument to steer STI as it defines and selects areas, topics and activities of public intervention and allocation of scarce public resources. Especially in an international context which is characterized by high levels of fragmentation and strong vested interests defining and agreeing on objectives and means of cooperation is a well-known challenge. Priority setting for international STI collaborations to address global challenges has to be understood as a deliberative decision-making process in an international environment which is not only focused on the identification of "right" priorities but it also has to deal with obstacles and challenges of negotiations and decision-making in a global governance context. Although priority setting is a key governance dimension the OECD concludes in a recent publication on priority setting for public research that no standard approach and only a few principles have yet been established (OECD 2010, p. 9).

2. Approach

Therefore the aim of this paper is not to identify the 'right' priorities for international STI collaborations to address global challenges but rather ***to discuss key issues of priority setting processes in global governance contexts***. It asks how already existing forms of international STI collaborations are dealing with priority setting issues and

analyses what challenges and obstacles they are facing. It therefore leads to a better understanding of priority setting processes as well as of respective mechanisms and institutional set ups of these processes.

The Paper builds on research conducted in the context of an OECD project which analysed modes of governance for international STI co-operation to address global challenges. Within this project several case studies of international STI collaboration – like GEO, CGIAR, FACCE JPI, IAEA, IEA etc. were conducted to explore their governance frameworks. These case studies are based on interviews with experts working for these organizations/institutions/networks and on an analysis of relevant documents. They form the empirical foundation of this research which was complemented by an extensive literature review. To analyse these case studies five different governance dimensions were distinguished of which priority setting was one. The main research questions focused on the identification of challenges and pitfalls of priority setting processes in an international environment, on the main mechanisms to define priorities in international STI collaborations and on the assessment of their strengths and weaknesses. This analysis was contrasted with the results from the literature review. This paper condenses the findings of this research project.

Global challenges share common features and challenges of global public goods as they have non-excludable properties that can potentially affect everyone's lives. They are global insofar as they cannot *"be provided adequately through domestic policy action alone but require international cooperation to be available locally"* (Kaul et al. 2003, p. 12). Kaul et al. (1999; 2003) define global public goods therefore as the sum of national public goods plus international cooperation. The governance of these policy actions will have to be based on global, multilayered issue communities which would be best suited to develop concrete ideas and suggestions on how to advance the provision of their specific global public good. This, of course, has important implications for negotiations and decision making processes in respect to issues of inclusion, fairness and democracy (Held and McGrew 2003). To better understand issues of priority setting in international STI collaborations to address global challenges we will embed our analysis of case studies in the framework of the concept of 'global public goods'.

3. Expected results

The analysis of the case studies reveals that priority setting although quite differently organized and institutionalized faces common challenges. Priority setting can involve a broad set of diverse actors like in the case of CGIAR or can be confined to a limited number of specific actors and experts like in the case of FACCE JPI or IAI. Both approaches have their advantages and limitations. Within a limited number of actors de-

fining and selecting priorities is in most cases much more efficient compared to broad involvement. But processes which are involving only a small number of actors are very vulnerable to capture which means that they are very likely not to act in the common interest but generally serve the interests of a rather small and powerful group. On the other hand broad participation enhances the equity and the legitimacy of decisions.

Another important issue is the question of the granularity of selected priorities. In international S&T collaborations like GEO priorities are defined very broadly which means that a wide set of different needs and interests were taken into account. A broad definition offers the advantage that all actors will be able to recognize their own specific interests. This leads to a high legitimacy of these priorities as most or all actors can give their consent. On the other hand there are significant disadvantages to a very general definition. The foremost problem can be seen in the translation or transformation of general priorities into specific programs or actions and in the allocation of resources for these diverse priorities. Instead of providing a focus for resource allocation this results in diffusion.

International STI collaborations like GEO, CGIAR, IEA etc. are involving actors with different STI capacities and resources. These differences are hardly taken into account by these governance structures. The case of GEO shows that the selection and implementation of priorities is often guided by the availability of resources. Powerful GEO members which are equipped with sufficient resources and capacities are influence priority setting process by providing resources and capacities for implementing priorities which are in line with their own specific interests.

4. Conclusions and potential policy implications

Our analyses of priority setting processes and of the available literature shows clearly that different modes of governance do not take into account the different capacities and resources of involved actors and stakeholders. This is especially important for international STI collaboration to address global challenges. It is therefore important that mechanisms will be established to facilitate broad participation by different actors and stakeholders. This helps to avoid the risk of capture and of possible bias in the selection of priorities. Moreover, a combination of different approaches like top-down or bottom up, supply-led and demand-informed can lead to more balanced outcomes of priority setting exercises. Due process mechanisms and formal regulations of processes and procedures are a prerequisite for broad participation and inclusion of stakeholders and also counter unequal distribution of power and resources between stakeholders.

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Strategic Policy Making and innovation systems theory: Beyond systemic instruments

Miriam Hufnagl, Stephanie Daimer, Philine Warnke

Fraunhofer Institute for Systems and Innovation Research ISI, Germany

The **motivation** for our paper mainly derives from the desire to provide a conceptual contribution of how the reference to the grand challenges of our time changes our understanding of innovation policy and innovation, and affects innovation systems (IS). Following the established approach of IS, innovation takes place in non-hierarchical processes and normative orientation is not foreseen in the first place. The main target of (systemic) policy instruments used to be the enhancement of the system's innovation capability without any normative orientation on the nature of the innovation. Accordingly, we may talk about an "orientation failure" of innovation systems. In order to address this failure, we argue that strategic refinement is required. Systemic and strategic policy making and instruments would need to be aligned. Regardless of a qualitative assessment of the new "grand challenge" orientation, we observe that a transformation, or more modestly, a refinement of theoretical IS models and practical systemic innovation policy making would be needed in order to make this new mission-orientation successfully applicable. We give several empirical examples in this paper which underline the fact that this transformation can already be witnessed, where strategic policy making is aligned with systemic instruments. Likewise, our considerations and examples show that grand challenges risk remaining merely rhetorical if this new strategic orientation is being realized using top-down processes disregarding the systemic approach.

We **approach** the topic following several steps: First, we discuss how the notion of grand challenges changes our understanding of innovation policy and innovation, and how this actually does or probably should lead to a transformed concept of innovation systems and systemic policy instruments.

Sequentially we illustrate empirical examples in order to reflect about practical consequences of our conceptual ideas. We discuss these consequences at two levels. First, we try to answer the questions how the concept of innovation systems would need to be refined and how this new challenge orientation would need to be embedded in the system in order to make it alive and work. Secondly, we consider how systemic instruments in particular would need further refinement in order to realize the strategy of challenge orientation. Thirdly we would like to propose an applicable definition of strategic policy making.

Our **expectation** is to contribute to the conceptual advancement of innovation systems theory in times of the new challenge orientation (or "normative turn") of innovation policy.

Innovation policy has gone through several paradigms shifts. Early attempts in the 60ties tried to balance "market failures" through funding of certain basic research activities. This was followed by various forms of "mission oriented schemes" that aimed at specific targets such as the Apollo 1 program; lately the innovation systems school is addressing "system failure" through enhancing systems' learning capability, by trying to improve the management of interfaces as well as the capacity building of different actors of the system.

Each paradigm emphasised different innovation policy instruments such as direct funding of R&D, setting up of specific research projects and systemic instruments as well as demand side instruments (e.g. public procurement, establishment of lead markets. Since the 1980s the combination of instruments in a well-balanced policy mix was emphasized. Still, with all these different approaches there was a common rationale behind system oriented innovation policy. Fuelled by early innovation studies, which had shown that some countries were developing faster than others in spite of similar economic circumstances due to different characteristics of their innovation systems, the idea was to optimise "innovation ecosystems" in order to enhance innovation capability and thereby foster economic growth and competitiveness.

In recent years this rationale has been complemented. Next to competitiveness and innovation capability several innovation policy strategies aim to foster innovation that addresses the "Grand Challenges of our times" such as health, sustainability, mobility and security and thus contribute to better living conditions worldwide. Prominent examples are the US "Strategy for American Innovation", the EC's Europe2020 strategy and the German "Hightech Strategy".

This "normative turn" implies more than just different topics to be financed through RTI funding programs. Findings from innovation studies indicate that addressing the Grand Challenges requires a different type of research and innovation projects all-together. In particular the following characteristics of challenge driven innovation activities have been brought forward:

- Socio-technical,
- Systemic,
- Transition oriented,
- International,

- Transdisciplinary,
- Experimental,
- Participatory.

Fred Stewart (2008) has suggested the term "transformative innovation" for this type of innovation in a NESTA working paper. Other studies have emphasised that this kind of challenge driven innovation also implies different types of research. In a recent memorandum the scientific council of the German chancellor proposes a shift towards "transformative research" in order to address climate change (WBGU 2011).

From the point of view of innovation policy it seems obvious, that this type of innovation requires different types of supporting instruments. However, it is still little understood whether and how this type of innovation can be fostered by innovation policy. Early instruments such as transition management and strategic niche management have been applied mainly in the Netherlands and for a narrow range of topics. Several current challenge-driven innovation strategies embrace measures to address some of the characteristics of "transformative innovation". Nevertheless, there is no established definition of the concept and the principle of coordinative operation of innovation policy strategies.

To shed light on the issues of *transformative innovation and strategy*, we will consider how challenge-orientation "fits" into the concept of innovation systems. How can this general principle be integrated in order to lead to transformative innovation? Innovation systems are non-hierarchical structures, where different groups of actors are mutually dependent on each other. Imposing grand challenges as a major rationale of policy and hence a major goal of R&D by a top-down organized process will most likely not lead to any real transformative innovation, but will rather – among other potential side effects – lead to subsuming previous research under the new headlines like putting "old wine in new skins".

Is there a way to avoid this? In our view, the policy rationale of responding to grand challenges must be introduced into innovation systems by way of systemic thinking. The different actors and stakeholders need to be engaged in identifying the challenges and defining possible response measures; there is need for reflexive governance involving a number of discursive processes such as Foresight and transition management.

Systemic thinking and systemic policy instruments are not new. However, the main target used to be the enhancement of the system's innovation capability without any normative orientation on the nature of the innovation. Accordingly, in order to suit demand oriented policy strategies and address "orientation failure", strategic refinement is required (systemic **and** strategic policy making).

We would like to illustrate our considerations using empirical evidence along some of the functions of systemic instruments as formulated by Smits/Kuhlmann (2004, 11ff):

Providing an infrastructure for strategic intelligence: within the last decades Foresight processes have become a prominent instrument for defining priorities for research and innovation policy. Whereas the "first generation" of Foresight aimed at identifying "key technologies" for underpinning competitiveness through expert based processes, more recent approaches emphasised the relevance of the Foresight dialogue process for enhancing the innovation system's learning capability. With the advent of challenge oriented innovation policy however, the mere creation of learning platforms seems no longer sufficient. Foresight processes are increasingly requested to define "grand challenges" for certain innovation systems and to suggest "transformative priorities". Using recent examples such as the Netherlands Horizon Scan we will illustrate the consequences of addressing "orientation-" rather than system failure" for the notion of Foresight as innovation policy instrument.

Providing a platform for learning (by interacting): making more use of accompanying research/ evaluation of policy measures by a participatory approach. This implies going beyond mere stakeholder input by combining it with a systemic understanding (i.e. for the stakeholder's functions and context in the innovation system). Different forms of participation and interaction which allow stakeholders the access to new information, communication with other groups and feedback will be discussed that possibly offer opportunities for learning. The paper will elaborate on the example of the accompanying evaluation of the policy measure "Validation of the innovation potential of academic research" which is an ongoing project of one of the authors.

Stimulating demand articulation, strategy and vision development: new concepts of demand oriented research planning through customer inclusion in research processes. Briefly we will also address anticipatory demand oriented measures like the project "Discover Markets". Scientists deal with the demands of futures users at a very early stage of product development within this project. They also exchange with other relevant actors at an early stage to ensure market (demand) success.

With our contribution we would like to discuss the following core questions in order to draw **conclusions** and propose **policy implications**:

- How can a "grand challenge"-orientation fit to the concept of innovation systems?
- How does the concept of "grand challenges" need to be integrated in order to lead to transformative innovation?
- And how can innovation politics benefit from an alignment of strategic policies and systemic instruments?

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Does the Technology Life-cycle moderate the Innovation Impact of Demand-Pull Policies? – The Case of Wind Turbine Technology

Jörn Hünteler, Michael Peters, Malte Schneider, Volker H. Hoffmann

ETH Zurich, Department of Management, Technology, and Economics, Switzerland

1. Introduction

Maintaining economic growth amid major societal challenges of our time, such as climate change and resource depletion, inevitably calls for substantial technical change (UNEP, 2011). To support clean technologies, governments have made extensive use of 'demand-pull policies', which aim to spur demand by either addressing negative market externalities of current technologies or directly subsidizing clean alternatives (IEA, 2010). Besides diffusion, justifications for demand-pull policies include their benefits in the form of (i) incentives for firms to innovate, and (ii) experience gained in production, field tests, and prolonged use, which are expected to enhance the competitiveness of clean technologies. And indeed, many studies in the field of environmental economics have come to the conclusion that demand-pull policies 'induce' innovation (extensive reviews can be found in Jaffe et al., 2002 and Carraro et al., 2010). However, unresolved issues remain regarding the workings within the 'black-box' of policy-induced innovation (e.g., Del Río, 2009). In the quantitative literature in particular, contingency factors specific to emerging industries have received relatively little scrutiny (Kemp and Pontoglio, 2011).

2. Theoretical Framework and Hypothesis

In this paper, we aim at disentangling the effect of the technology life-cycle on the innovation impact of demand-pull policies. The emergence of new technologies usually initiates a period of high uncertainty and various technological approaches; in other words, firms adhering to different 'technological paradigms' compete in the market (Dosi, 1982). Typically, the subsequent selection process culminates in the acceptance of agreed upon 'standard' design approaches, also referred to as 'shared technological frames' or a 'dominant paradigms' (Abernathy and Utterback, 1978; Anderson and Tushman, 1990; Kaplan and Tripsas, 2008).

To conceptualize the impact of the life-cycle on the conditions for innovation, we reframe the life-cycle as dynamic pattern of diversity. We apply Stirling's (1997, 2007) heuristic and assume the attributes 'variety' (number of options), 'disparity' (difference between options), and 'balance' (evenness of options) as constituting properties of di-

versity. In this framework, innovation along trajectories does not really affect diversity – because significant disparity is only apparent between different paradigms. Major changes in system diversity occur only if paradigms appear/vanish (variety), change in relative importance (balance), or merge (disparity). The era of competing paradigms (one dominant paradigm) can thus be conceptualized as period of high (low) diversity.

Thus far the effect of the life-cycle on innovation has not been taken up by empirical scholars when analyzing demand-pull policies. From a heterodox innovation economics perspective, diversity provides, among others, the 'fuel' for recombinant innovation in the early phase of the technology life-cycle (Cohen and Malerba, 2001; van den Bergh and Vandenberg, 2008; Stirling, 2010). Therefore, if we understand demand-pull policies as regulatory means to raise the potential pay-off for innovation, we would, *ceteris paribus*, expect their impact on innovation to decrease over time, together with the moderating level of diversity. In existing quantitative studies, however, the innovation effect of demand-pull policies is assumed to be constant over time. We address this gap by investigating the question of how demand-pull policies impact innovation in different phases of the technology life-cycle. In particular, we test the hypothesis that *demand-pull policies will trigger more innovation in an era of competing paradigms than in an era of a dominant paradigm*.

3. Research Case

To test our hypothesis we present an econometric patent panel data analysis of the evolution of wind turbine technology. The wind case appears well-suited for testing the above hypothesis since its technological development was intimately tied to demand-pull policies. Worldwide installed capacity for wind power has been growing rapidly, subsidized by allocated public funds in the order of billions of USD. Furthermore, patenting activity, as an important indicator of innovation, has been dynamic over several decades; and even though the technology is still not competitive with fossil energy, costs and reliability of wind power utilization have been greatly improved in recent decades (e.g., Schilling and Esmundo, 2009).

The third reason for selecting the wind case is that after the emergence of different paradigms by the mid-1970s, the technology went through two distinct periods of development, one with several competing paradigms until about 1990 and one with a widespread, dominant paradigm thereafter (Bergek and Jacobsson, 2003). We identify four main paradigms how to design wind turbines that emerged after the first oil crisis. They differ in terms of turbine size (small vs. large) and in terms of knowledge base and the degree of scientific sophistication – what scholars called the firms' 'technological styles' (Heymann, 1998), 'paths' (Garud and Karnøe, 2003), or 'design

philosophies' (Stoddard, 1986). In the late 1980s, the 'small Danish' turbines outperformed all other, much more sophisticated designs and emerged as the dominant paradigm.

4. Data and Methodology

This work uses a panel regression analysis with patent counts for 15 OECD countries, between 1978 and 2002, as a proxy for innovation in wind energy. A combination of keywords and IPC classes was chosen so as to reduce potential errors in the patent search to a minimum. To address the skewed nature of patent value, we counted only patents that received at least one forward citation within five years after application.

As a proxy for the main independent variable, demand-pull policies, we use annual and cumulative capacity additions in MW. Thereby we explicitly abstract from the policy instrument choice and only consider the effect of policies (Walz, 2008; Peters et al., n.d.). To model the moderating impact of the life-cycle, we included a life-cycle dummy – 1 until 1989 and 0 thereafter – and constructed interaction terms from the dummy and the demand-pull policy variables. These interaction terms allow us to estimate the difference in slope of the effect of policy on patent counts in the two life-cycle stages. The signs of the interaction terms indicate whether the effect of policy was stronger in the era of competing paradigms (positive sign) or in the era of a dominant paradigm (negative sign). A variety of other exogenous factors was controlled for. Unobserved heterogeneity between countries is controlled for by using a model with country-fixed effects. Time-specific effects are addressed by a time trend variable.

5. Results

Our main regression results are summarized in the following. Proxies for both marginal and cumulative demand-pull policies show significantly positive effects on innovation. With regard to the life-cycle stage-specific influence of demand-pull policies, the coefficients of the interaction terms are significantly negative in all models. That means that we indeed find a moderating effect of the life-cycle on the effects of demand-pull policies. The negative sign implies that the slope of the innovation effect of the demand-pull policy variables was smaller before 1990; i.e., unexpectedly, we find indications that the positive innovation effect of demand-pull policies is *weaker* in the era of competing paradigms. Hence, we do not find support for our hypothesis. Our results appear consistent with regard to the 'pure' effect of diversity, however: the coefficient of the life-cycle stage dummy itself exhibits a significantly positive sign across all models, confirming that high diversity appeared to have had, *ceteris paribus*, a positive effect on innovation.

Since the calculations with interaction terms do not provide insights on the *absolute* innovation effect of demand-pull policies in specific life-cycle stages, we further analyzed the policy effects by dividing the observations into two separate subsamples. Intriguingly, the analyses of the subsamples yield a *negative* impact of demand-pull policies on innovation in the era of competing paradigms.

6. Discussion 240

Our contribution lies in showing that the innovation effect of demand-pull was positive, but weaker in the early phase and in some models even negative. The negative sign in the early years in particular raises important questions regarding the underlying mechanisms. Qualitative accounts of the case of wind power indicate that the emergence of the 'Small Danish' paradigm and the contraction of the others were, at least partly, due to increasing returns such as learning by doing and using. When the small Danish firms emerged as the preferred suppliers, it was less due to a clearly superior design but more due to field experience in the home market that their turbines were more reliable – indicating policy-induced increasing returns. This advantage may have been irreversible, since competing designs were obviously not able to catch up as Danish manufacturers scaled up production and gained experience further increased the competitiveness of their small-scale designs. That is, demand-pull policies might have increasingly exerted 'selective' pressure on the competing paradigms, thereby reducing diversity. This effect could explain the negative effect of demand-pull policies on innovation in the era of competing paradigms. More significantly, however, it implies that diversity is an endogenous factor in our model.

From a normative policy perspective, our results show that demand-pull policies are no silver bullet to achieve innovation policy objectives. In particular, the preliminary findings regarding possible selection effects highlight the risk of lock-ins in inferior paradigms caused by demand-pull policies (Sandén and Azar, 2005). This calls for the cautious use of demand-pull policies, as well as the integration of demand-pull policies (exerting selection pressure) with research funding directed at diversity preservation/creation.

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Defense Procurement and Innovation Dynamics: Changing Patterns and Policy Responses

Andrew D. James¹, Jordi Molas-Gallart², Rikard Stankiewicz²

¹Manchester Institute of Innovation Research, Manchester Business School, University of Manchester, UK

²INGENIO (CSIC-UP)V, Spain

³University of Lund, Sweden

1. Motivation

Defence procurement is an archetypical case of Public Procurement for Innovation (PPI). Most industrialised countries have developed complex defence procurement systems to acquire defence systems with higher performance levels than their predecessors. During the Cold War the technologies developed through defence funding were at the forefront of technological development and are at the root of the technological systems that define our modern societies. Beyond the often contested rationale supporting the development of new defence systems in terms of their contribution to national security, the high investments in defence procurement have also been justified for their alleged contributions to development of new industrial capabilities in high technology sectors. Thus, specific procurement policies targeting the development and production of a new weapons system are linked to very broad strategic objectives addressing military, security and economic challenges.

Despite their scale and central role in the development of PPI, defence procurement policies have seldom been analyzed by innovation scholars. Their study has become the concern of a specialised group of analysts focusing on defence technologies, their development, and on the interaction between private and public agents in their development. This paper aims to provide a bridge between innovation scholars and defence procurement specialists by applying theoretical constructs derived from the analysis of innovation to the study of the role of defence procurement. It assesses how defence procurement is adapting to a transition between modes of technological accumulation, and the implications of these changes for future procurement policy.

2. Approach

The paper uses concepts developed in the broader field of innovation studies to analyse the role and evolution of defence procurement as a form of PPI. The paper argues that the structure and modes of functioning of innovation systems reflect the processes of creation, accumulation and use of knowledge. As the nature of these processes

changes, the institutional and organizational approaches to innovation have to be re-evaluated.

We distinguish two different modes of technological accumulation (specific and generic), and shows how the defence procurement policies in the Cold War period responded to a model of specific accumulation. It then discusses the challenges that the transition to a dominant mode of generic accumulation poses to defence procurement policies and analyzes procurement reform in terms of the need for public policy to adapt to an emerging mode of "generic technological accumulation".

3. Expected results

The paper will show how the balance between *specific* and *general* modes of technological accumulation has affected the approaches to defence procurement. During the Cold War years technological accumulation occurred along the developmental paths of particular artefacts (such as aircraft¹). The selection, codification and organisation of knowledge were therefore guided by particular needs and were highly specific.² In defence procurement this situation translated into a complex organisational structure oriented to the development of new defence systems; the defence research and technology system was vertically integrated with the development of component technologies being funded by defence customers to support specific systems. Defence firms were highly specialised, and customers could influence the characteristics of the technologies they required down to component level.

The paper will show how this mode of technological accumulation has transitioned during recent decades to a new system characterised by a rapid expansion of generic capabilities that create technological commonalities across seemingly unrelated innovation domains. We will argue that recent transformations in the defence sector may be ascribed more to the pressures operating in all high-technology industries than to the end of the Cold War per se: the mode of *general* accumulation occurs *across* diverse domains and is creating the stock of knowledge and capabilities common to a wide range of applications. It is this form of accumulation that gives rise to an open '*design space*'.³ Its enlargement and evolution account for the growth of generic capabilities:

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- 1 Vincenti, Walter (1990) What Engineers Know and How They Know It: Analytical Studies from Aeronautical History. Johns Hopkins University Press.
 - 2 Utterback, James M. (1994) Mastering the Dynamics of Innovation. Harvard University Business School Press.
 - 3 Stankiewicz, Rikard (2000) The concept of design space. In Ziman, J., ed., Technological Innovation as an Evolutionary Process, Cambridge University Press, 2000.

technologies that in the past evolved independently of one another share today increasingly similar knowledge bases. Technical elements with the greatest generic potential will diffuse and evolve more rapidly than the highly specific or idiosyncratic ones. We will argue that these processes are greatly enhanced by the ubiquitous presence of information technologies.

Defence procurement, and therefore the use of Public Procurement for Innovation has had to adapt to these changes. As ICT gained ground as a horizontal technology, contributing to *general* technological accumulation, the high volume and the diversity of ICT applications became key drivers of the new technology dynamic. Defence applications and systems were no longer driving this technological dynamic. Procurement practices have had to adapt to allow for a loosening vertical ties among defence suppliers: suppliers of basic capabilities (tools, materials, components, R&D services, etc.) escape their captive status within vertically integrated firms and industries to form new industries responding to diverse markets. The integrator firms shed the weight of basic technology development, which is inherently risky and difficult to exploit commercially, and this development is taken over by entrepreneurial start-ups and other commercially nimble specialist firms. This development does require, however a profound change in procurement policy.

4. Policy implications

As the importance of lateral linkages increases, the defence research system becomes, at least potentially, co-extensive with the entire innovation system. The relationships between defence customers and their suppliers change and adopt a new configuration. This change is particularly daunting for Europe. The blurring of the civil-security-defence boundary appears to be breaking up formerly closed defence R&D policy networks. Yet, the institutional setup that grew during the Cold War within a model of specific accumulation can only change slowly. The paper will argue that while there will be growing commonalities between defence and civilian sectors at the technological and functional level, important institutional divisions will persist posing intricate policy problems. The paper will review four sets of emerging policy responses to the changing knowledge dynamics and the challenges they generate:

1. Defence technology strategies are being develop to seek *access and influence civil origin technologies* and technological capabilities, and to exploit in different environments the results of the investments made in defence R&D.
2. In an environment in which the knowledge that is required is diverse and its sources widespread, "dynamic capabilities" including monitoring, absorption, and integrative capacity are of key importance. An answer is the development of *policies to improve connectivity with broader systems of innovation*, opening up, for

instance, defence research establishments to new markets and activities. The specific measures vary across countries but typically seek to increase managerial flexibility through the promotion of commercial practices. The result is increased diversity in the client and activity portfolio of these establishments, opening possibilities for the exploitation of their capacities in civilian markets, and increasing their ability to absorb and integrate technologies developed elsewhere.

3. Some countries are seeking to *promote synergies between defence and security research*.
4. The generic character of many security and defence related technologies, the diversity of locations in the innovation systems at which knowledge critical to the development of these technologies is created, and the new security environment have had significant consequences for the governance of technology. New approaches to *regulate "dangerous knowledge"* are being implemented. In the US, for instance, new laws such as the USA PATRIOT Act and tougher enforcement of existing regulations have generated a new regulatory environment effecting scientific research and higher education.⁴

4 A. Teich, 'Impact of Post-September 11 Security Policies on US Science', In A.D. James (ed), *Science and Technology Policies for the Anti-Terrorism Era NATO Science Series* (Amsterdam: IOS Press, 2006).

Shaping social reality: Foresight as catalyst for institutional change?

Katharina Jarmai

*AIT – Austrian Institute of Technology GmbH, Foresight & Policy Development Department,
Austria*

Interaction in research and innovation systems is characterized by complexity, limited knowledge about stakeholders' rationales, views and intentions, and uncertainty regarding the future. Grand societal challenges such as climate change, demographic change or the depletion of natural resources add to this complexity: These challenges are, by their nature, not confined to national borders and require interdisciplinary research as well as cooperation between research and governance. In addition, the time frame of dealing with grand challenges is larger than many policy instruments are suited for. In light of these challenges, foresight and other systemic instruments are increasingly applied to support systemic functions of research and innovation systems; such as the management of interfaces between different sub-systems, providing a platform for learning and experimenting, and stimulating vision development.

Foresight is expected to help reduce system imperfections by facilitating alignment between stakeholders, re-framing stakeholders' perspectives and the joint production of consensus¹. While expectations regarding such impact of foresight are considerably high, there is still little empirical evidence to support them. Can foresight exercises be actual "*catalysts for system disruption*"²? Can they trigger creative destruction, in terms of Schumpeter? How can foresight be useful in achieving policy transition and system innovation? Connecting a foresight activity to subsequent change in the system is one of the main challenges in assessing impact of foresight. This paper presents an analytical framework for assessing impact of participative foresight activities on the individual stakeholders and their home organizations, and applies it to discuss the results of a recent case study.

¹ Smits and Kuhlmann (2004); they also list "poorly articulated demand", "local search processes which miss opportunities elsewhere" and "flaws in the capital market" (2004: 8)

² European Commission (2005)

Motivation

While so-called process output in form of learning and networking has become inherent to many rationales of foresight³, learning processes themselves remain underexplored in the literature⁴. Analytical concepts for studying the effects of knowledge generation and learning in foresight are rare⁵. This study wants to contribute to the existing literature by investigating how participatory, policy-oriented foresight processes can instigate learning and networking among participants, and how new knowledge and new relationships affect stakeholders and their home organizations. Impact of foresight will thus be measured in terms of its ability to change values and behaviors of actors⁶. The research objective is two-fold: First, investigate if participating stakeholders learn⁷ in a foresight exercise; and second, if this new knowledge subsequently translates into observable change in behavior.

Approach

This study applies a constructivist perspective to learning and thus understands learning as social process of creating meaning in interaction. In this framing, learning does not refer to mere reflection of presented information, but a self-referential construction of reality which enables successful action⁸. From a constructivist perspective, knowledge is actively and subjectively constructed by the individual; a process which takes place in a social context and is heavily influenced by the individual's previous knowledge. In their interactions, members of a community define the properties of their common reality. From a social constructivist perspective, a foresight process can thus be viewed as venue for construction of social reality of present and future of a certain

³ Cagnin et al. (2011), Van Mierlo et al. (2010), Fuller and Loogma (2009), Smits and Kuhlmann (2004)

⁴ A recent search for the term "learning" in title/abstract/keywords of in *Foresight, Futures, International Journal of Foresight and Innovation Policy, Technological Forecasting and Social Change* only produced a hand-full of articles that discussed the connection between foresight and learning on any theoretical basis.

⁵ with the exception of Van Mierlo et al. (2010), who present an analytical framework to study how systemic instruments may enhance social learning processes (as defined by Röling, 2002)

⁶ Georghiou and Keenan (2006)

⁷ *Learning* includes: definition of present and future challenges, development of options for action or visions, reflection on own role and perspective, gaining insight into other stakeholders' goals and perspectives

⁸ Siebert (1998): 37

topic. Application of Berger and Luckmann's⁹ terminology makes it possible to explore the following assumption: In foresight, methods encouraging formal and informal interaction and communication are applied to produce an environment in which participants are encouraged to "*fantasize freely and at ease*"¹⁰, and construct intersubjectively shared meaning regarding the present and future of phenomena. They do this by concretizing challenges, insecurities, problems, and potential solutions. In addition, interaction between stakeholders enables reciprocal typification of action and reflection on own role in the system and that of others. Generation of intersubjectively shared meaning and reciprocal typification of action are the first steps towards institutionalization, and thus towards objectivation: the transformation process of subjectively shared knowledge into social reality.

Consequently, the empirical investigation focuses on the individual stakeholder, as he/she functions as transmitter between the temporary foresight system, (where knowledge is created and links are formed) and the stakeholder's home organizations. Open questions in semi-structured stakeholder interviews address three levels of impact ensures the establishment of cause and effect relationships, and makes it possible to explore three levels of impact:

- Individual stakeholder: Change in perception
- Home organization: Dissemination of new knowledge, influence on strategic behavior
- Foresight network: Follow-up interaction (projects, communication)

Results

Results from the case study support the hypothesis that foresight processes can increase mutual understanding between actors from different stakeholder groups, regions or sectors. Participants learned in moderated and informal discussion and were thus able to develop a more complete picture about the past and present state, as well as regarding potential future developments. In addition, stakeholders benefitted from insights into other stakeholders' rationales and behavior. The case study also produced evidence of knowledge diffusion in participants' home organizations, while impact on actor behavior and strategic decisions could only be detected in isolated cases.

⁹ Berger and Luckmann (1966)

¹⁰ Jungk and Müllert (1989): 81

Conclusions

The social constructivist perspective provides the means to analyze how moderated and informal communication and interaction processes taking place in the course of a foresight process support the definition of present and future challenges, development of visions and options for action, and reflection of own role and that of other stakeholders. The study supports the notion that foresight can be applied as systemic instrument in research and innovation systems. It emphasizes the potential of foresight as platform for learning and networking. At the same time, expectations regarding the impact of foresight on participants' home organizations may need to be scaled down: Translation of new knowledge and links into observable change depends on stakeholders' motivation for participation, their level of interest during the foresight activity, and their potential influence upon returning to their home organization (including potential "allies"). Participants add knowledge to the periphery, not the core of their expertise. In most cases, a foresight process will thus be but one potential influence on subsequent strategic decisions and stakeholder action. If conducted successfully and adequately, foresight is likely to create resonance, but no impact in terms of profound change in actor behavior. In practice, foresight should build on its potential for stakeholder learning and networking, but scale down expectations of inducing radical institutional change.

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Governance and coordination of mission-oriented innovation policy: A critical analysis of partnership approaches

Erkki Karo, Rainer Kattel

Tallinn University of Technology, Department of Public Administration, Estonia

Motivation

The emergence of mission-oriented innovation policy paradigm has so far been in most countries a rhetorical change rather than a substantive transformation of policy systems. Yet, it has initiated a search for 'better' innovation policies and governance systems. While the search for 'better policies' or how to best solve the grand challenges seems to be in its infancy, there is a much stronger consensus on 'better governance'. The consensus seems to be that mission-oriented innovation policy is best built on governance systems that center on public-private-partnerships or some sorts of networks as tools for priority setting (definition of grand challenges) policy design, delivery, coordination etc.¹

This partnership approach is probably the best legitimization tool for any policy initiative as it moves beyond politically, ideologically, theoretically contentious state-market dichotomy. It admits that governments tend to lack the capacity to design and implement complex policies through purely hierarchical systems. It also provides for the policy stakeholders a more central role in policy systems and thus re-creates the (more limited) legitimacy of policy interventions. But at the same time, it makes strong presumptions about the capabilities of stakeholders to participate in policy processes and about the capabilities of governments to understand and adapt to the ideas emerging from partnership based policy models. It seems quite logical that these capabilities and its' division between policy actors and stakeholders are in fact extremely diverse across economies and this diversity should be taken as the basis for search for 'better governance' models.

The goal of this paper is to discuss the implications of the diversity of public and private policy-related capabilities on innovation policy governance. We show that this diversity firstly, turns the search for universal model of 'good governance' into a futile activity as good governance is always contextual; and secondly, turns the concept of public-private-partnership into an oxymoron as most known innovation policy governance systems from 'developmental state' to 'industrial policy' to 'innovation systems' etc. represent some partnership or network characteristics. The diversity and division of policy-related public and private capabilities determines the orientation of the model, or closeness to hierarchy- or market-like settings.

¹ See also the call for the current conference.

Approach

In this paper we interpret policy governance systems as 'feedback systems' – or systems of information exchange and coordination between public and private sector actors in search for better definition of policy problems and solutions. In policy studies research feedback is seen in a linear manner and taking place only, or mostly, at the end of the policy cycle – that is, policy design and delivery is followed by evaluation, learning and eventual feedback. Most of innovation policy discussions implicitly or explicitly adhere to this approach.² In our approach we look at feedback from a more systemic perspective arguing that feedbacks take place and impact policy in every step of the policy cycle. In other words, policy design is always a compromise between different interests (political, bureaucratic and others) and policy implementation changes the contents and meaning of policy (bureaucrats re-interpret compromises, implementation process is based on negotiations between bureaucracy and private sector etc.).³

Based on this approach we describe three ideal-types feedback or coordination models – *hierarchy*, *network*, *market* – and show how in these ideal-type systems coordination and information exchange takes place at each step of the policy cycle.⁴ We show that in each of these models there is a certain division of roles and tasks and expectations on public and private capabilities that lead to different types of feedback models. In short, *in hierarchy* the bureaucracy is the central feedback collector and translator; *in market models* there is no central feedback coordination and the market signals (e.g., which companies win the 'competitions' for government research grants) act as automatic feedback for bureaucracy; *in network models* there are different institutions (associations, councils etc.) where different stakeholders debate over and translate the meaning of feedback for the bureaucracy.

Thus, in different politico-economic contexts the effectiveness of feedback or governance systems may vary as both political and economic variables determine the division of roles, tasks and levels of public and private capabilities. *On the policy side*, some of the relevant variables are the structure of policy system (e.g., centralized/hierarchical vs. decentralized), profile of civil service (e.g., recruitment patterns, motivation systems, career models), decision-making processes of governments (e.g., centralized vs. decentralized, corporatist vs. open) etc. These factors determine the

² See, e.g., Flanagan K, Uyarra E and Laranja M (2011) Reconceptualising the 'policy mix' for innovation, *Research Policy*, 40: 702-713.

³ In this interpretation we depart from the public administration perspective as opposed to policy studies perspective, see, e.g. Painter M and Pierre J (2005) *Challenges to State Policy Capacity: Global Trends and Comparative Perspectives*, Palgrave Macmillan, Basingstoke.

⁴ Based on Bouckaert G, Peters GB, Verhoest K (2010) *The Coordination of Public Sector Organizations: Shifting Patterns of Public Management*, Routledge, London & New York.

mode of interactions between bureaucracy and the stakeholders and also capabilities of the bureaucracy. *On the side of economic actors*, the relevant characteristics are the structure of the economic system as a whole (e.g., skill and production capability levels, export orientation) and of specific sectors (e.g., consolidation vs. fragmentation, the level of state intervention), structure of the science system (e.g., levels of public and private R&D, the status of public science), interest group dynamics (e.g., strength, formation etc.) etc. These factors determine the interests, capabilities and activity dynamics of the stakeholders.

Expected results

Based on the elaborated approach we argue that an effective governance or feedback system has, by definition, the best possible fit between the above-listed policy and economy side factors. Yet, as some of these factors are more structural or cultural than others, a shift of policy paradigm or emergence of new policy goals will hardly change these factors. Our key argument is thus that the contextual suitability of different policy governance systems is dependent precisely on the level and division of public and private sector capabilities within an economy and the change of governance systems can only be co-evolutionary. Thus, a shift of policy paradigm – i.e., move towards mission oriented innovation policy and attention to grand challenges – does not automatically lead to or convergence towards a common governance system.

Our second argument is that none of the ideal-types of feedback systems exist in reality and in fact most empirical governance systems have some partnership or network elements and are either closer to hierarchy-based models (i.e., the government coordinates the networks) or market-based models (i.e., the networks are 'self-organizing' or led by other stakeholder interests). The relative success or failure of these models does not depend mostly on policy goals, but more importantly on the politico-economic context where it is found. We explain and illustrate this argument with stylized analyses of the US, EU and East Asian innovation policy governance systems by looking at them as feedback systems and explaining its' evolution and reasons for comparative differences in its' effectiveness.⁵

⁵ For the analysis we rely on and interpret sources such as also Block F (2008) *Swimming Against the Current: The Rise of a Hidden Developmental State in the United States*, *Politics & Society*, 36(2): 169-206; Block F and Keller MR (eds) (2011) *State of Innovation: The U.S. Government's Role in Technology Development*, Paradigm, Boulder & London; Borrás S (2009) *The Widening and Deepening of Innovation Policy: What Conditions Provide for Effective Governance?*, *CIRCLE Electronic Working Paper Series* 2009/02; Breznitz D (2007) *Innovation and the State: Political Choice and Strategies for Growth in Israel, Taiwan and Ireland*, Yale University Press, New Haven & London; Edquist C and Hommen L (eds) (2008a) *Small Country Innovation Systems*, Edward Elgar, Cheltenham; etc.

Conclusions and policy implications

Our paper claims that the effectiveness of innovation policy governance systems is always dependent on the contextual variables and the apparent change towards mission-oriented innovation policy does not change this premise much. Our paper interprets policy governance system as a feedback system and distinguishes certain characteristics (both from the side of policy and economy) that define the institutional underpinnings of these feedback systems.

Given our interpretation, we argue that governance systems as feedback systems are always partnerships or network-like settings, but the currently dominating fashion-like interpretation of partnerships and networks may be too simplistic and idealistic for policy-making purposes. Based on our analysis we offer some lessons for policy-making on how to manage a compromise between, on the one hand, the common rhetorical move towards mission-oriented innovation policy, which implicitly may lead towards convergence and de-contextualization of governance systems, and on the other hand, the maintenance and development of context-relevant policy analysis practices.

Using the multi-level perspective on socio-technical transitions to assess innovation policy¹

Florian Kern

SPRU- Science and Technology Policy Research, University of Sussex, UK

This paper contributes to the debate about whether new methods are required to evaluate mission-driven innovation policy by developing one such new approach in the context of sustainability. Sustainability and sustainable development has been heralded as one of the key societal challenges to be addressed via innovation policy. For example, technological change and wider changes in the form of socio-technical transitions are believed to be key to tackle climate change. In recent years a growing literature on socio-technical transitions towards sustainability has emerged. Scholars have explored ways through which configurations of technologies, infrastructures, social practices, institutions and markets can change to fulfill their functions in a more sustainable way. A multi-level perspective (MLP) has been developed to describe and analyse these complex, long-term processes (Geels 2002; Geels 2010). It has also been used to help design policy for example in the Netherlands (Kern and Smith 2008).

Motivation

Building on an improved understanding of socio-technical change processes, there is a growing interest in how policy initiatives can support transitions towards sustainability. Most scholars agree that governments have a key role to play in bringing about transitions. What is less clear is *how* policy makers can support these processes and which policy instruments seem to be promising. In this paper the MLP is therefore used in a novel way: as a heuristic to ex ante assess policies to stimulate socio-technical transitions. The MLP is usually used for historic case studies of socio-technical change and not to explain or to predict ex ante developments in specific socio-technical arenas. Genus and Coles argue that scholars have generally sought "to explain processes of radical development of novel technology whose diffusion pattern produces a new set of socio-technical relations, which largely replace the existing general social practice" (Genus and Coles 2008: 1437-1438). The interesting question from a policy perspective is whether the MLP can also be used fruitfully to analyse and evaluate current policies aimed at stimulating transitions? Rather than using it as a framework to inform policy, it is suggested that the MLP can also be used for the analysis of policy. The

¹ This paper will be published in *Technological Forecasting and Social Change* in Feb 2012, doi:10.1016/j.techfore.2011.07.004.

conceptual contribution of this paper is to attempt to operationalize the MLP for policy analysis and show its utility by applying it to a case study.

Approach

The conceptualisation of the MLP used in this paper is following Geels and Schot (2007), Shackley and Green (2007) and Verbong and Geels (2007). These publications have been systematically reviewed to distil important processes which could be supported by innovation policy in order to foster a transition. Firstly, according to the MLP for a transition to happen niche innovations need to build up internal momentum through learning processes, price-performance improvements, the support from powerful groups and through establishing market niches (Geels and Schot 2007). It is important to emphasize that niches do not only encompass the innovation itself (e.g. a technology) but also socio-economic and political opportunities for early deployment (Shackley and Green 2007). Secondly, it is the regime which provides the stability in incremental socio-technical developments and only the destabilization of the regime creates windows of opportunity for radical niche innovations to break through, compete with the existing regime and eventually create a new, more sustainable regime (Geels and Schot 2007). These processes can be analyzed in terms of changes in rules, technologies and social networks (Verbong and Geels 2007). Thirdly, the MLP assumes that a transition only comes about if there is pressure from the landscape level on the regime which destabilises current practices and creates opportunities for niches to break through. Important factors on the landscape level are macro-economic and socio-economic trends, macro-political developments as well as deep cultural patterns (Geels and Schot 2007; Shackley and Green 2007). These concepts were used as a framework against which to evaluate a specific policy initiative – the Carbon Trust in the UK which was set up in 2001 to 'accelerate the transition to a low carbon economy'. The empirical analysis of the case study is based on 26 semi-structured interviews with employees of the Carbon Trust and key stakeholders from government, research, business and environmental groups which were informed by and complemented with a systematic literature and documentary review. The Carbon Trust has been selected as an appropriate case study because it is one of the main innovation policy instruments in the UK to achieve the desired transition towards a low carbon economy. Despite its importance it has not yet been systematically analysed in the academic literature.

Results

The analysis finds that the activities of the Carbon Trust consist of a variety of well targeted ways to stimulate the development of socio-technical niches as well as to change regime practices directly. Pursuing a combination of both strategies is seen as very helpful to support a transition to a low carbon economy. Niche developments are sup-

ported through grant support for applied R&D but also through direct equity investment in promising niche companies, by setting up new low carbon businesses and by providing targeted engineering and consulting support for niche players. Through these activities the Carbon Trust contributes to learning processes, helps to establish niche markets and enrolls support from powerful groups to some extent. It is unclear to what degree the work of the Carbon Trust has been successful to contribute to price-performance improvements of low carbon technologies as this would require a detailed technology-specific analysis which is beyond the scope of this paper. At the regime level the Carbon Trust contributes to rising awareness of climate change and carbon emissions by companies and public organisations and offers help to cut emissions by management advice as well as providing loans or tax breaks for energy efficient equipment. Through these activities the Carbon Trust contributes to changes in cognitive, normative and regulative rules and incremental technological change as well as limited changes in social networks. The landscape level shows mixed developments in macro-economic, socio-economic and macro-political as well as cultural trends which might not necessarily be supportive of a low carbon transition

Conclusions

This paper makes two contributions to the discussion about how to evaluate mission-driven innovation policy.

Conceptually, this paper has demonstrated the usefulness of the socio-technical multi-level perspective to analyse innovation policies and ex ante assess their likely impact against the background of theorising about how large scale, socio-technical change happens. Light has been shed on how policy influences specific processes at niche and regime level which are commonly claimed to be key for enabling transitions and on how the Carbon Trust's activities are influenced by landscape level developments. Even ex post analysis of policy outcomes is tricky and analysis instead often focuses on policy outputs. It is even more ambitious to "know the precise consequences of a policy measure perfectly in advance" (Smith, Voß et al. 2010: 445). Of course predicting policy outcomes is notoriously difficult but this paper argues that MLP-inspired analyses can foster policy learning about how well existing policy instruments contribute to processes which might enable transitions. It is argued that compared to classic cost effectiveness type of policy evaluations (e.g. in terms of costs per tonne of reduced carbon emissions), this kind of analysis produces more instructive and sophisticated policy assessments. There are a number of lessons which can be learned from such an MLP analysis of policy initiatives. The analysis can identify which of the necessary processes of niche-regime developments are well supported by policy and for which there is a lack of engagement. This helps to identify the need for complementary

policy action. The analysis also helps to identify which landscape level processes are helpful/not helping the initiative to be successful.

Empirically, this paper has analysed the Carbon Trust in the UK as an innovative policy initiative to accelerate the transition to a low carbon economy. The analysis showed that the Carbon Trust has developed a variety of novel funding mechanisms which seem sensible and useful for contributing to transitions by supporting niche actors and by trying to influence the regime through increasing awareness for the need to move to a low carbon economy and providing advice to businesses and policy makers. However, the mindset with which it operates is too narrowly focused on business opportunities and less so on the wider social processes underlying innovation (for example, public acceptance, skills or network building).

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Struggling for space: solar photovoltaic niche developments in the Netherlands and the UK

Florian Kern¹, Adrian Smith¹, Rob Raven², Bram Verhees²

¹SPRU, University of Sussex, UK

²Eindhoven Technical University, the Netherlands

Introduction

One of the key areas of mission-oriented innovation policy is sustainability in general and climate change in particular. In response to this challenge many countries around the world are trying to develop and deploy renewable energy technologies to reduce carbon dioxide emissions. One approach to studying emerging alternative technologies and the build up of their respective socio-technical systems is the literature on sustainable niches (Lovell 2007; Smith 2007; Schot and Geels 2008; Verbong, Geels et al. 2008). The niche literature emerged with a concern for innovations for sustainability, where market contexts in particular are generally non-conducive to system building, and so niche spaces are required. A defining characteristic of these niches is that they afford temporary '*protective space*' for the configuration and development of innovations (Schot, Hoogma et al. 1994). Initial protection is deemed essential, because path-breaking innovations fail to successfully compete within selection environments of incumbent 'socio-technical regimes' (Schot and Geels 2008). Hence, the protective space is needed to shield the innovation against (some of) the prevailing selection pressures. Within this protective space, niche actors can nurture the path-breaking innovation so it becomes more robust through performance improvements and expansions in supportive socio-technical networks. As the innovation enters broader and more diverse markets, so the need for protection falls away progressively, and the innovation becomes competitive and influential in shaping wider contexts.

Motivation

That, at least, is the argument in the literature on sustainability transitions. It is therefore surprising that the concept of '*protective space*', so foundational to transition studies, has received little systematic attention. Even responses to criticism from Hommels *et al.* (2007; see Geels and Schot 2007), about the undesirability of protection in innovation, have not prompted serious reflection on what protection is, where protection comes from, who is involved in shaping protection, and how protection is transformed and removed as transitions towards more sustainable socio-technical systems come about. This paper is aimed at analysing the protective space dynamics around a

particular technology (PV) by comparing and contrasting national experiences in two countries (UK and the Netherlands).

Approach

Our approach builds on Smith and Raven (forthcoming) who argue that effective protective spaces includes three important processes. First, they shield against prevailing selection pressures, and thereby create the space required for alternative innovations to develop. The processes by which shielding operates can involve both the exploitation of relatively 'passive', pre-existing situations – such as the opportunities afforded for PV by remote locations requiring off-grid electricity – or the more pro-active construction of shields through deliberate policies that counter selection environments. Protective spaces operate as shields by countering selection pressures and furnishing different search heuristics, knowledge, specialist markets, institutional voids, helpful infrastructures, a concentration of lead-users, a sympathetic cultural milieu, or establishing political and policy significance. Second, shields also contribute to the nurturing of protective space. Development of the niche 'socio-technical configuration' (i.e. the niche innovation) operates from project ('experiment') to project through which important nurturing processes (articulating and sharing promising expectations, social learning processes that improve the innovation, the creation of resourceful networks) build up. Third, even though 'protective spaces' are recognised as necessary, there remains little exploration of how they are constructed and operate. Analysis needs to better understand how niche innovations become sufficiently empowered that they no longer require protective spaces. Smith and Raven hypothesise two distinct forms of niche empowerment. The first form of empowerment involves the niche becoming competitive under the prevailing regime: the niche innovation is able to fit and conform. Any legitimate need for protection falls away. The second form of empowerment involves the niche modifying the prevailing selection environment: the niche innovation is able to stretch and transform. Features that once constituted niche protective space become institutionalised into a new socio-technical regime.

Seeing protective space as something functional to the imperatives of niche development, and that ought to shield, nurture and empower in certain ways for sustainability transitions, appears reasonable from a managerial or outsider perspective (Smith and Stirling 2007). However, empirical research demonstrates how challenging it is to develop these functions in practice: ideas for how protective space *ought* to operate soon encounter confounding and conflicted realities (Lovell, 2007; Voss *et al.*, 2009). Moreover, such a perspective also has to be politically informed, because, ultimately, niche agency results from advocates within different institutional positions and unequal access to resources influencing powerful actors more usually associated with incum-

bent regimes, and thereby creating space for niche innovations. Niche protection is about power and antagonisms, and it is this that makes it political (Mouffe, 1996). Smith and Raven propose a framework based on networks and narratives to understand the politics at work in different niche spaces (forthcoming).

The paper applies this analytical framework (processes of *shielding*, *nurturing*, *empowering*) to the analysis of the development of PV in the UK and the Netherlands between the 1970s and 2011. The analysis is based on more than 25 semi-structured interviews with actors involved in the development of PV and PV policy in the Netherlands and the UK as well as secondary literature, documentary evidence, quantitative data on deployment, R&D funding, etc.

Preliminary Results

The analysis shows that in both countries niche advocates have struggled to develop a coherent and powerful PV niche able to challenge dominant regimes in the electricity and housing sectors. In both cases deployment has so far been limited. Policy support has also been quite limited and has often changed course which provides an unreliable context for niche actors trying to develop networks, enter into protected niche markets and generally undermines faith in the feasibility of the technology. In terms of *shielding*, the analysis showed that early niche markets for PV (satellites, telecommunication installations, cathodic pipeline protection) provided space for learning and the development of networks of actors interested in PV. These niche spaces however remained small. Our analysis, however, reveals that a variety of niche advocates over the course of time have been able to shape and mobilize many different active and passive spaces, including R&D labs, off-grid locations, building-integrated PV, consumer-driven initiatives and spaces for production (both PV cells and the machines to produce PV cells), each with their own 'logic'. There are some striking similarities between developments in terms of *nurturing* in both countries. For example, academics in both countries pursued research on PV and attracted funding for their research by framing their work as materials research rather than PV as PV in itself was not a funding priority. Lobbying for direct PV funding had limited success and only provided modest R&D funding. However, in recent years there have been some increases in funding for advanced, next generation PV cells in both countries. Actor networks involved in PV have widened over time (from academics, some oil and electronics companies and green NGOs to a wider network including building contractors, installers, housing associations, farmers, Members of Parliament) and have tried to align PV with a variety of policy goals including climate change, energy security and fuel poverty. The analysis highlighted two different patterns of *empowerment*: 'fit-and-conform' and 'stretch-and-transform'. The fit-and-conform strategy is to make PV competitive with other electricity

generation options by bringing costs down (grid parity) and leaving the selection environment unchanged. Another pattern of empowerment is aiming at completely transforming an existing regime changing the selection environment (stretch-and-transform). An example for this is the zero carbon housing ambitions for new developments in the UK which provide a regulatory driver for PV deployment.

Preliminary Conclusions

The analysis highlights how, despite long term, dedicated efforts by niche advocates in both countries, PV technologies in the UK and the Netherlands have struggled to break through and diffuse more widely. Complementing economic arguments about the high cost of the technology, our analysis has highlighted the political nature of constructing 'protective space' for this niche innovation. In contrast with expectations about the emergence of a coherent and strategic niche space over time, as assumed in both the strategic niche management and the technological innovation systems literatures, the analysis of niche developments in the UK and the Netherlands over the last four decades revealed that a number of distinctive institutional spaces emerged at different points in time with different networks of actors involved, with different applications for the technology in mind, different learning processes and development of shared expectations. These niche spaces follow different logics and often were opportunistic responses to changing contexts which entailed surprising re-interpretations of the socio-technical configurations of PV. The multitude of niche spaces partly explains why niche developments have not been more successful (lack of accumulation, dominant design, etc.) but also explains why PV developments have persisted for such a long time in spite of limited success and often unfavorable political contexts. Advocates have been successful in mobilizing and creating very different niche spaces through time, with quite distinctive shielding, nurturing and empowerment dynamics. We therefore argue that the framework of 'protective spaces' is a useful heuristic device for the analysis of mission-oriented innovation policy aimed at promoting alternative, sustainable niches by shedding light on the political dynamics around the support and development of sustainable alternatives.

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Science policy approaches and responses to grand societal challenges: A comparative analysis of research systems in Norway, Denmark, Germany and the United Kingdom

Antje Klitkou, Lisa Scordato, Dorothy Olsen

Nordic Institute for Studies in Innovation, Research and Education NIFU, Norway

(1) The motivation

Few studies have investigated the way countries organise research policy and activities to respond to grand societal challenges. This paper tries to contribute to the global challenges debate, by analysing what role science policymakers in four European countries attribute to research in finding solutions to global challenges. The article thus explores how four European countries (Denmark, Norway, German and UK), with their specific institutional set-up, develop research policy priorities in a time characterised by intensifying social and environmental challenges. The article explores how countries with different science and innovation policy approaches have responded to the need to solve global challenges. We identify priority setting processes and institutional implementation in research and innovation policy targeting challenges related to climate change/environment, renewable energy and welfare.

We want to answer following research questions:

- How do countries develop priorities for research and innovation in response to Grand challenges?
- How do Scandinavian countries – Norway and Denmark – differ from central European countries, such as Germany and the United Kingdom in their response to Grand Challenges?
- What kind of balance between central steering and aggregation is optimal for addressing Grand Challenges?

(2) Approach

We make use of the literature on *agenda and priority setting and on technological and institutional "lock in" in science and technology policy*.

Agenda and priority setting are key issues in science and technology policy. Within an OECD framework priority setting is defined as "the selection of certain activities at the expense of others with an impact on the allocation of public resources. In short, it is the decision on who and what and how much research to fund and for how long" (OECD 2010). Agenda setting is understood as defining more general objectives and rationales

than priority setting. Agenda setting focuses on public societal discourses which raise awareness for specific problems and challenges and put them "on the agenda". Agenda setting is therefore preliminary to priority setting. The latter is a negotiation process where heterogeneous actors and stakeholders have to agree on common goals, objectives and actions.

Since the Second World War there have been at least four paradigms of priority setting in science, technology and innovation policy: 1) A traditional mission-led approach which focused on key military technologies and which was dominant during the late 1940s and 1950s. 2) During the 1960s this traditional mission-led approach was broadened towards key technologies for civilian industrial purposes and use. 3) The rise of the national system of innovation framework in the 1980s led to a systems-oriented approach which emphasized functional and generic aspects. 4) With the latest shift in paradigms a new mission-led approach evolved which is oriented around the development of technologies for coping with new societal challenges like demographic change, ageing society, (global) health care concerns, security, environmental and sustainability issues etc. These paradigms have not replaced each other but coexist (Gassler, Polt et al. 2008). In their work on *shifting priority paradigms in technology policy* Gassler, Polt and Rammer characterise the new mission-led approach along the following principles:

- combining societal needs and technological inputs to generate solutions for these needs and challenges,
- decentralized process of identifying and selecting priorities,
- involvement of multiple actors,
- quick and broad diffusion of research results,
- acknowledgement of the importance of incremental innovations rather than of radical innovations.

Priority setting pre-determines the subsequent phases of implementing policies. The degree of involvement into the priority setting phase also can have a strong impact on the (financial) commitment of participants in this process. The interdependence between priority setting and resource allocation (funding) is especially strong (Stewart 1995).

The notion of *path dependencies* of dominant energy systems is central in understanding the process of developing sustainable energies (Shackley S. and Green K. 2007; Knudsen 2008). Foxon (2002) has examined the role of *technological and institutional "lock-in"* as a barrier to more sustainable innovation, and the implications of this for

determining appropriate policy responses. Foxon identifies following implications for policy (Foxon 2002):

- Existing technological systems have benefited from long periods with increasing returns because of scale economies, learning effects, adaptive expectations and network effects. This has been reinforced by institutional developments which also benefited from increasing returns.
- These processes created a "techno-institutional complex" which can lock out the deployment and up-scaling of new and more sustainable technological solutions, which still have a niche status and too high costs.
- Policies can promote the development and deployment of more sustainable technologies and contribute to a rapid take up of such solutions.

In our analysis of the empirical material we distinguish between *steering* and *aggregation* as two different systemic aspects of research systems. According to Rip and Van der Meulen (1996) steering refers to the institutional infrastructure and competence to align scientists to the objective and the aims of the principal, in our case the state. "It refers to institutional infrastructure and competence, not to actors' behaviour as such". They define aggregation as the institutional infrastructure for processes of socially distributed agenda building. The second dimension is aggregation and "refers to institutional processes of agenda building and the infrastructure for such processes. Bottom up processes in research councils and other scientific organisations which lead to *de facto* priorities in research are one example" (Rip, 1996).

Rip and van der Meulen (1996) argue that science policies in Scandinavia and the Netherlands are more willing to support aggregation processes and the institutional structures tone down tendencies for steering. Science policy in the Scandinavian countries is characterised by a high density of intermediary organisations that mediate the relations between government, society and science. Science policy is often the outcome of consensus-seeking processes. In science policy, processes like priority setting, programming, budget allocations, evaluations, etc. multiple actors are involved. Germany and the UK are regarded as countries more prone towards steering.

As the empirical basis of our analysis we use the latest analytical reports produced by the ERAWATCH Network, TrendChart country reports and the ERAWATCH Research Inventory. In addition relevant policy documents have been analysed. The article presents an analysis of the empirical data, paying particular attention to a) the policy processes resulting in research priorities and strategies for tackling grand challenges, and b) ways of implementing strategies through programmes and other measures.

(3) Expected results

Here just a summary of first results from the analysis of the two Scandinavian countries. The analysis of Germany and the UK is in progress and will follow a similar line. The analysis so far has shown that there are differences also between the two Scandinavian countries, not just between Scandinavia and Germany and UK.

For Denmark we have identified political agreements on research priorities in the field of sustainable energy and environment. These political agreements are based on advice from many stakeholder groups and from research organisations. Research councils, the Technology Board and others contribute to the priority setting processes. The government has a high policy focus on technological solutions for energy, environment and welfare (Klitkou, 2011). Institutional development for the implementation of these technologies has been on the political agenda: several policy instruments for promoting research and innovation in these fields have been established over the last years. The results of bottom-up processes for defining strategic research priorities (FORSK2015 and now FORSK2020) are used by the programme commissions in the Strategic Research Council to define their calls for projects.

For Norway we also identified a political agreement for sustainable energy solutions and climate which was informed by a broad process involving stakeholder organisations. In the field of energy this has led to a research strategy (Energi21) which has been implemented in the research policy, but not that much in the deployment of new technological solutions. In the field of climate the implementation of the strategy (Klima21) has halted despite of a broad consensus from stakeholders and bottom-up processes involving many research organisations. Welfare has been targeted in several research policy measures, but not that much in the deployment of these technologies.

(4) Conclusion and/or (policy) implications of the work

So far we have come to following conclusions:

- There is a need for strategic steering which is grounded in processes of aggregation.
- Research systems which are characterized by a high level of political steering may have problems with motivating changes in the research community.
- Research systems which focus on a high degree of aggregation and bottom-up processes may favor the existing networks and directions of technology development.

- There is a tendency to favor the low hanging fruits which is positive for achieving rapid deployment of existing technological solutions, but policy incentives are necessary to develop also more far reaching solutions.

There is a need for policy instruments to promote innovation in the public sector. This is especially important for welfare solutions.

What constitutes a good research design when evaluating research and innovation policy?

Mark Knell, Inge Ramberg

Nordic Institute for Studies in Innovation, Research and Education NIFU, Norway

Do public R&D subsidies complement or substitute private R&D spending? The literature related to this question does not provide a clear conclusion regarding the sign and magnitude of the effect. It is a question, however, that is highly related to the study of the impact of public policy. A *good* research design for impact evaluation should have a clear understanding of causation and be able to address any threats to its "internal validity", or whether the analysis contains any bias and its "external validity", or whether it relates to the real world. The central question this paper addresses is what should be a *good* research design, or methodology to evaluate research and innovation policy. We answer this question by considering the recent academic debates over alternative approaches to policy evaluation and by critically reviewing recent impact evaluation studies of research and innovation policy as to whether they follow good practices.

Impact evaluation is a broad term that is both challenging to define as well as to carry out. They identify both the probable and the factual causal effect of a public policy intervention, which appears as the difference between ex-ante and ex-post impact evaluations. Ex-ante evaluations are carried out before the policy measure is implemented, and ex-post evaluations are carried out after the implementation of the measure. They insure that there is a stringent relationship between the policy problems realized, the defined objectives, the resources, activities and implementation of the program in relation to the results as well as shorter and longer-term outcomes (or "effect") of the policy initiative. Impact policy evaluation studies cut across several disciplinary boundaries and appear in three groups: (1) structural econometric models using non-experimental data; (2) statistical models based on field experiments; and (3) experimental and quasi-experimental research designs based on Campbell and Stanley (1966), and later applied to the social sciences and policy studies. The philosophical foundations of causation and counterfactual thinking provide the common thread across these groups.

What constitutes a good research design for impact evaluation is highly controversial. There has been considerable debate among academics over whether an "experimental" approach, based on random assignment of those receiving assistance (treatment group) and those that do not (control group), or the "non-experimental" approach that compares the outcomes of those receiving a subsidy with those that do not, is better. Randomization-based inference is essential to experimental design and in survey sampling, yet the experimental approach may not be the best research design to evaluate

research and innovation policy. The point was strongly made by James Heckman in several different papers when assessing the case for social experiments.

Causality including counterfactual thinking lies at the heart of a *good* research design. This was the starting point of Trygve Haavelmo's (1944) "probability approach to econometrics". Counterfactual thinking describes the condition that would have occurred if a policy instrument had not been adopted, and is necessary for both experimental and non-experimental designs. The counterfactual condition is used to assess the impact of an intervention by comparing outcomes for groups that have participated in the program with similar outcomes for groups that have not participated. Comparative analysis applying the counterfactual state is a central precondition for making valid assessments of impacts of public policy interventions *ex-post*. Economists following Jan Tinbergen used this approach to study various policy alternatives.

Heckman focused his research on the development of non-experimental designs where the treatments are neither fully randomized nor autonomous. He recognized that decisions of economic agents are usually discrete, but the outcome is generally continuous, which meant that behavioural relationships are generally captured in non-randomly selected samples, which create a specification error or sampling bias (Heckman, 1979). Sampling bias is common in non-experimental designs when a policy intervention, or treatments effect, is related to an unmeasured characteristic that is also related to the policy being evaluated. It occurs because of the inherent difficulty in obtaining a truly representative sample of a complex population. Sampling bias becomes an econometric problem as well as a problem for evaluating research and innovation policy because treated agents differ from the non-treated agents, which often leads to a misleading and often an incorrect estimation of the policy interventions.

In a survey of the literature on the complementarity of R&D subsidies to private R&D investment, David, Hall and Tool (2000) argue that previous studies largely ignored a possible selection bias in the empirical investigations. Several studies have been carried out since then that take into account the problem of selection bias, and other limitations of non-experimental data, but few explore a few of the ways to deal with internal and external validity that have been explored in the wider literature. Reflection and discussion about the cause and effect, counterfactual condition, treatment group, comparison group, the relevance of the evaluation design and the validity, are important factors to strengthen the methodology used in the impact evaluation.

Three preconditions are required for an impact evaluation of policy interventions: 1) a theory that identifies the logical chain- between the intervention and the intended outcome; 2) whether the policy is ready for evaluation; and 3) the relevant methodological design – according to the theory, the program objectives and the given constraints of the policy being considered. This requires a counterfactual approach to compare out-

comes of the treatment group (exposed to the program) and the comparison group. While there is no overall single best or optimal design, there can be several *good* designs each of which might provide a different perspective on the policy being evaluated. It is best to use the most appropriate design relating to the specific policy evaluation and that considers the various threats to internal and external validity.

The delicate issue of external validity is a major precondition for impact evaluation. Experimental designs are frequently considered to be strong on external validity. Randomized control trials are often recognized as a golden standard partly from this. They are most often applied in clinical trials testing the effects of new drugs are however often impossible or irrelevant to apply in public policy impact evaluations for several reasons. Randomization of the treatment (experimental) group and the (control) comparison group may simply not be accessible either due to policy design or ethical concerns. Also, experimental designs can cause severe threats to the validity, if implemented in laboratory like conditions isolating the program in question from its real context. Moreover, the selection problem described by Heckman is present in both experimental and non-experimental research designs and the former can experience an additional randomization bias when participants in the evaluation design differs from the participants the program as it normally operates. Non-experimental designs often provide better policy evaluations regarding the extent to which research findings can be generalized to larger populations.

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New Directions in Modelling Innovation: Applying agent-based methods and complex systems analysis to socio-technological transitions

Jonathan Köhler, Michaela Gigli, Antje Bierwisch, Arne Lüllmann

*Fraunhofer Institute for Systems and Innovation Research ISI, Sustainability and Infrastructure
Systems, Germany*

Abstract

The objective of this paper is to propose some directions for research into the simulation modelling of structural change in socio-technical systems. As the other contributions in this reader show, there is a rich literature in the study of technological change using the ideas of systems of innovation. Most of this literature takes the underlying social and technological structures as given. However, there are some innovations that arise from entirely new technologies (e.g. digital computers) that offer new products or services and give rise to new social and economic structures. There are also social and political issues, of which global warming is a clear example, where there is a scientific consensus that far-reaching technological changes are necessary (e.g. the transition away from the fossil fuel motor car and a transition to housing that actually generates energy). Such drastic changes in technology also involve changes in culture, markets, institutions and in behaviour (Freeman and Louca, 2001; Grin et al., 2010).

There are two literatures that address these radical changes: Kondratiev waves (or Long waves) and transitions studies. Both of these address the dynamic processes of change and use the idea of co-evolution of sub-systems of society as a framework for analysis (Köhler, EIST forthcoming). The concepts of innovation systems and in particular the technological innovation systems (TIS) framework have also been used to consider new technologies for sustainability. Markard and Truffer (2008) compare the two frameworks and propose an overarching conceptualisation. They see the TIS as concentrating on niche(s) of new technology, while transition studies concentrates on how niches grow and transform the socio-technological structure.

Formal modelling has some particular advantages over other research methodologies in this context of radical changes. It can accurately address complexity of system dynamics and transitions, which are the result of multiple interactive mechanisms, dynamics, feedback and synergy. This is important for counterfactual policy analysis and forward looking studies, notably when these involve radical, structural changes. Theoretical model analysis can generate testable hypotheses or 'confront' theoretical explanations of historical phenomena with historical data, to examine whether the theory indi-

cates relevant variables and processes. Looking into the future, models can simulate implications of social structures and environments, to generate scenarios of possible future developments for use in policy guidance. Combinations of instruments and their interactions through the social system can be tested for their effectiveness in terms of improving the likelihood of desirable transition patterns. Likewise, the combined effect of different transition policy instruments in different phases can be examined using formal models.

The Kondratiev wave literature has a long history of quantitative analysis (Freeman and Louca 2001), which however only considers the methodologies of economics. Freeman and Louca (2001) show that the methods applied have severe limitations and argue for a qualitative approach based on 'reasoned history'. Köhler (2003) proposed a model structure for the analysis of Kondratiev waves, but this also only uses economic variables and does not explain changes in the structure of demand. The transitions literature has relatively little modelling analysis; Safarzynska et al. (2011) has a survey. An important direction is the use of evolutionary economics, but these models do not address the complex social structures proposed by the theories. They also do not address how the behaviour of people as consumers and firms as producers change their behaviour in response to radically different technologies or pressures from the general environment such as climate change. Therefore, models which can simulate the development of such structures might provide new insights.

The paper introduces the theoretical structure proposed by transitions theory, the 'Multi-level perspective' (MLP). A discussion of the limitations of the current literature leads to the consideration of the research questions to be addressed by modelling developments. Köhler et al. (2008) is one of the few attempts to try and represent the social structure proposed by transitions theory in a numerical model. The model uses an agent-based modelling (ABM) approach, combined with a systems representation of the MLP. This structure is introduced and used as a starting point for the discussion of possible modelling developments.

An important feature of agent based models is that they are structured to enable a wide range of behaviours to be represented. These behaviours can range from simple heuristics such as 'buy the car that your neighbour bought' (keeping up with the Jones') through homo economicus (maximising utility over the alternatives subject to a budget constraint) to empirical observations in choice experiments and economic psychology. Since the modelling of behaviours is limited in the current literatures, the possible application in models of psychological understanding of consumer choice and sustainable consumption is considered.

A further set of issues when modelling transitions is that of definition of entities. The two central concepts in transition theory are the niche and the regime. These are not single agents, but are variously defined by different authors as sets of institutions – rules, standards, regulations, norms or as societal sub-systems with actor networks – firms, consumers, political actors. A question then arises as to whether niches and regimes should be modelled as agents explicitly, or whether they should be allowed to emerge from a complex system of agents that form the elements of social systems e.g. firms and consumers.

The conventional approach in an ABM is to model the elements. A criticism of ABM is then that because each individual agent is separately represented, there are too many parameters to enable a parameterisation to be realistically calibrated against empirical data. This problem can be addressed by considering the 'inverse' solution problem. The conventional simulation approach of developing a model, estimating the parameters as well as the data permits and simulating forward through time produces scenarios as results, which vary according to the parameterisation and the structure of the model. In the inverse problem, the overall phenomenon is identified – in the present example data about a transition that has already occurred such as the transition from steam power to internal combustion engines in transport or the adoption of the internet for communications. Then, plausible parameter ranges for all the parameters in the model are identified. From an initial set of parameter values, the model is run many times to identify the set of parameter values that optimises the performance of the model, by minimising the discrepancy from the empirical data set for the overall transition phenomenon.

If the approach of modelling the niches and regime directly is taken, then there is question of how to represent the structure of a niche or regime. One possibility is to consider these as networks. Then, the mathematics of network theory and graph theory can be used to provide indicators to characterise the niche and regime entities. If they are treated as social systems, then the system structure of a niche and regime can be addressed directly. The sectoral system of innovation approach provides a possible structure here. A further possibility is to treat the regime and niches as neural nets, with decision nodes and a structure that enables a learning process. This would enable the niches to be set goals and then simulate their learning behaviour in response to a socio-economic environment.

The application of these ideas in the context of examples in transportation and IT is discussed. The paper concludes by indicating possible directions for the modelling of sustainability transitions into the future.

Investing in research and innovation for grand challenges

Johanna Kohl¹, Jos Leijten², Maurits Butter²

¹*VTT Technical Research Centre of Finland, Finland*

²*TNO (Industrial Innovation Policy), the Netherlands*

The starting point for this study is that the European Research Area Board (ERAB) feels a need to strengthen the European "grand challenges" approach in research, development and innovation. Although a grand challenges approach is now widely accepted in European policy making and is going to be one of the principles guiding Horizon 2020, there is uncertainty about how it is really taken up in practice across Europe. This needs also to be seen in the light of the high ambitions ERAB has set for the European grand challenges approach: in its second annual report ERAB proposes that Europe should take a leading role in addressing the global challenges.

Against this background ERAB would like to know in how far there is evidence for a shift towards a challenge driven research and innovation approach in Europe¹, and about the nature and dynamics of this shift. The European Commission supported this by commissioning a project to the Joint Institute for Innovation Policy (a collaborative initiative of TNO, VTT, Joanneum Research and Tecnalia). The core of the project is a comparison of grand challenges initiatives in a number of countries around the world in order to find indications for what could be considered as good or strong approaches. On this basis a number of policy conclusions and/or recommendations has been made.

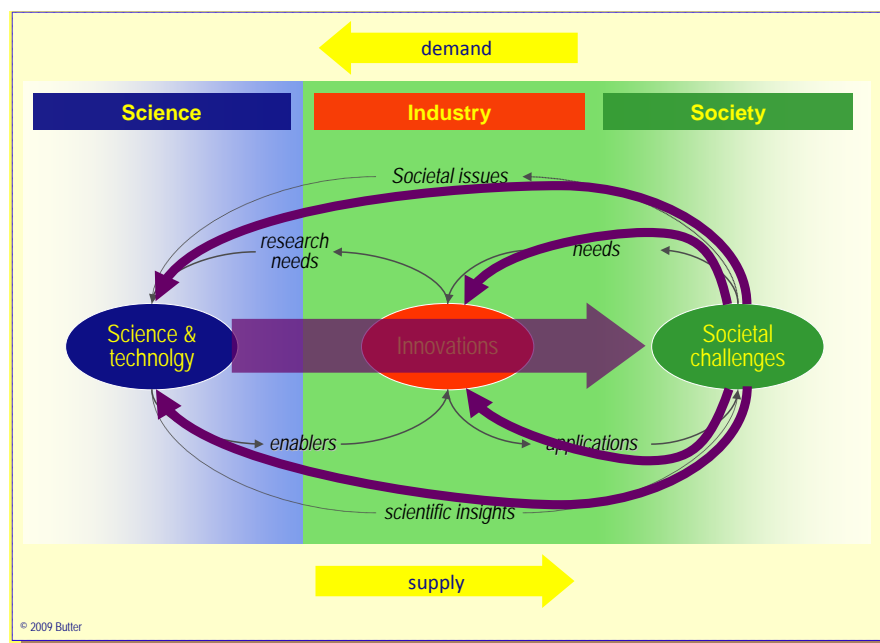
Grand challenges involve a combination of major public and private interests, are seen as key for realising future economic growth, and are concerned with important social and/or environmental problems. Grand challenges are not to be defined, assessed or solved by any single scientific or technological discipline or within one specific sectoral policy framework. Societies are facing complex, interlinked, global and local challenges. For challenges like healthy aging and climate change it is evident that we need new policies, new governance models, new innovation solutions and strategies, and new investment models. But the necessary holistic or generic approach also includes the need for highly specialised knowledge and highly specific technological and organizational solutions. Grand challenges involve many different stakeholders, are multidimensional, transdisciplinary, systemic and they require new ways of thinking which go beyond traditional frameworks and disciplines. And they lead to a need to re-think research and innovation policy.

¹ As one of the participants in a web-based group discussion organized by the authors says: "Evidence of success would likely be that the GCs selected were both Grand and Challenges, thereby suggesting that current approaches may be focusing on non-grand non-challenges".

It is expected that the way politics, business and society handle the grand challenges will strongly affect economy and society in the coming decades, both in Europe and worldwide. But the broad societal risks and problems represented by the challenges are at the same time also providing opportunities for new activities, goods and services and for moving towards a smart, sustainable and inclusive economy.

But this broad understanding of grand challenges and grand challenges approaches leaves a key question unsolved. Is the grand challenges approach a specific way of targeting strategic research and innovation programmes, or is it mainly broad conceptual and contextual thinking which gives direction to stakeholders' research and innovation activities?

In order to include both possibilities in our analysis we use a conceptual framework which distinguishes between three domains: the public or societal sphere in which the challenges need to be defined, a sphere which is more industrial (broadly conceived) in which innovations take shape and a sphere of research and technology where fundamental understanding and directions for scientific and technological solutions are being developed.



With this framework in mind we searched and compared grand challenges initiatives or approaches in 13 countries and also looked at a couple of private initiatives. The focus of the search was on climate change and energy challenges and on healthy ageing challenges approaches. Looking at the two challenges it immediately becomes appar-

ent that a challenge has a life cycle. The climate change and energy challenge has reached political agenda's much earlier than the healthy ageing challenge. Its global character is recognised in many policy initiatives and we could by now speak of a broad global community of scientists working on understanding the fundamental complexities of the challenge. Healthy ageing is less well articulated at the level of public and political discussions, less internationalised and the development of (multidisciplinary) communities of scientists working on the challenge is still in very early stages.

For the climate change/ energy challenge it is evident that the more impacts are already felt in a country, the more concrete are the steps towards challenge driven interdisciplinary research and technology programmes, re-thinking funding systems and framework conditions (e.g. China, Japan). And in the same countries this also seems to become true for the healthy ageing challenge.

Generally the challenges are of a highly complex systemic nature crossing a range of different policy areas like energy, environment, natural resources, and others in relation to climate change/energy and health, social affairs, employment and housing in relation to healthy ageing. A challenge therefore almost always faces fragmentation of policy making. Overcoming these problems at national and international levels requires deep and often difficult changes in governance.

Typically – and this may very well be seen as the most important finding of this study – in both challenge fields the middle sphere of innovation is less well articulated in policy-making terms and in targeted innovation initiatives. This is particularly true for the international arena, but also at national levels we find generally a stronger focus on broad framework conditions (e.g. pension and insurance systems in relation to healthy ageing and taxation schemes trying to shift the balance between energy sources). However, at regional and local levels we find many innovation oriented initiatives in both challenges fields: pilots, living labs, demonstration projects, etc. But very often their reach seems limited and only very few initiatives succeed in reaching a wider visibility.

Based on the comparative analysis of country initiatives around the world we find three main different approaches currently in use to address the grand challenges from a viewpoint of research, development and innovation. For reasons of discussion they are presented here in a somewhat stylized way, whereas the reality is usually more complex and multifaceted.

1. *Policy mainstreaming*: trying to build the grand challenge into regular policy making and implementation is a tendency which can be found almost everywhere.
2. *Jumping to science and/or technology*: where in Europe the challenge is translated into a jump to (fundamental) scientific challenges, we find in the USA a

stronger focus on jumping to technologies and creating longer term industrial opportunities.

3. *Comprehensive transition approach*: building on a strong tradition of national priority setting several Asian countries succeed in taking a comprehensive approach in which scientific research, technology development, industrial innovation and social organisation are being aligned for a systemic transition towards green growth, green industry and green employment.

The main recommendations of the study are the following:

1. Take advantage of the current situation in which more and more member states seem to be willing to accept guidance from Europe in the fields of grand challenges. Going through the policy documents of Member States there is a relatively strong consensus about the nature of the challenges backed by ample reference to European Commission and Union documents. In our view this provides *a basis for stronger guidance and/or process management by the Commission*, even when many of the challenges are part of policy domains which largely fall under the member States' responsibilities. On this basis it should be tried to reinforce and speed up the Joint Programming Initiatives, make them more ambitious and call for larger coordinated investment from the side of the Member States. Additional EU-funding should be used explicitly to leverage this kind of investment (in a similar vain as the Gates Foundation manages to do quite well).
2. *Do not focus the European grand challenges approach on research only*, but start from the demand for solutions that a challenge may generate. The wealth of regional and local initiatives in the two challenges studied points to a strong interest at the level of innovation and diffusion of innovations in market and society. Fostering and "upscaling" initiatives at this level may prove to be very beneficial for the goals of research excellence and industrial growth and leadership as well. It may turn a challenge field into a highly dynamic and demanding market which triggers the development of new institutions, organisational innovations, new technologies and fundamental research questions. The field of healthy ageing provides many good examples for this.
3. *As the sphere of Innovation is very different from the sphere of Science and Technology it is not advised to seek a strong integration and/or alignment of the two*. In some Asian countries where stronger integration is part of the challenges approach (in what we have called the "comprehensive model") building industrial strengths seems to be the major driver. Apart from the risks of making wrong choices in a highly dynamic social and technological environment it requires political legitimisation which in Europe most likely will not work. Europe's scientific world does not have to solve all the issues relevant for a challenge, but it can build a strong position when it effectively responds to a better articulation of challenge driven research and technology needs in the sphere of innovation.

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4. When implementing GC-focused programmes in Europe, *the setting up of arm's length agencies should be part of the plan*:
 - Examples from the agencies in the US and the private sector initiatives show us that a degree of political and organisational independence from changing governments and administrations usually leads to more effective programmes.
 - The agencies should not so much be seen as (research and innovation) funding bodies, but rather try to be "change agents" building upon the relatively strong and stable political consensus with regard to the specific challenge.
 - It is important that such agencies are audited in a longer-term horizon with a clear focus on their mission: contributing to solving GC.
 - As different challenges may – given their characteristics – need different approaches it is advised to set up multiple agencies.
 5. Each agency requires a platform/mechanism where the different stakeholders can engage in real constructive dialogue.
 - Explore how European Innovation Partnerships can fulfil this role by bringing stakeholders' representations together in a framework for constructive engagement along the lines of Triple Helix thinking.
 - The dialogue should take advantage of the long historical, democratically and politically stable roots of the European research community. "Learning by doing" across the borders of disciplines and nations could be a strength of EU.

Transition towards replacing animal tests in safety assessment of cosmetics and chemicals: a combined TIS-MLP framework

**Marlous Kooijman¹, Peter J.K. van Meer², Ellen H.M. Moors¹,
Huub Schellekens^{1,2}, Marko P. Hekkert¹**

¹ *Copernicus Institute of Sustainable Development, Innovation studies, Utrecht University,
the Netherlands*

² *Utrecht Institute of Pharmaceutical Sciences, Department of pharmaceuticals, Utrecht
University, the Netherlands*

The urgency of the transition to replace animal tests in safety assessment of chemicals and cosmetics was triggered by societal resistance to animal testing (Rowan, 2007) and the scientific dispute concerning the value of animal testing (Olson et al., 2000). Since the 1980s the European Union (EU) has been developing policies to reduce animal studies. However, these policies have not been very successful, since only a few regulatory safety assessments in animals (among which the Draize eye test, skin sensitisation test, pyrogenicity test and batch potency test tetanus vaccine) have been (partly) replaced by innovative methods. These few 'successful' replacement processes were laborious and took decades.

It is unclear why transitions towards the replacement of animal tests by innovative methods in safety assessment of cosmetics and chemicals take so much time. The aim of this study is to elucidate the mechanisms that complicate these transitions. In order to understand this transition it is crucial to take the micro level actions of actors into account, while relating these actions to the larger socio-technological context. To that end, this study follows the suggestion by Markard and Truffer (2008) to combine Technological Innovation System (TIS) and Multi Level Perspective (MLP) to capture multiple aspects of transitions.

Understanding societal transitions has emerged as an important topic of (Olson et al., 2000) research during the last decade. Several perspectives have been developed to contribute to the understanding of how these transitions work. Two frameworks have become dominant: 1) The TIS approach focusing on the emergence of a particular technology and 2) the MLP approach that aims to study the broader transition process. Both TIS and MLP approaches are subject to criticism. The TIS approach is praised for its analytical power but is regarded as myopic concerning the explanation of technological transitions. The strength of the MLP approach is that its conceptual repertoire links innovation activities in niches with transformations in regimes of current practices; however the analysis of the regime level is often underexposed as MLP studies are largely confined to the niche level.

Studying all transitions in the broad field of safety assessment of chemicals and cosmetics in animals is too extensive. This study therefore focuses on the successful transition to innovative methods for eye irritation testing. Eye irritation testing can be considered a pioneer in the development and validation¹ of innovative methods to replace animal tests (Eskes 2010). Several innovative methods have been developed since the early 1970s. Major multi-laboratory research efforts to validate the innovative methods were undertaken as early as in the 1990s, resulting in around 30 innovative test methods. It took until 2004 before a thorough review was carried out to advance the validation of innovative methods, and the most promising methods to replace the animal test were identified. Finally, two tests have been approved to partially replace the Draize test in 2009: the Bovine Corneal Opacity and Permeability assay (BCOP) and the Isolated Chicked Eye (ICE) test method (OECD, 2009). Both tests were already published in 1985, well over 20 years before regulatory acceptance. For this reason, this transition to innovative methods for eye irritation testing of chemicals and cosmetics turned out to be very challenging. This study elucidates why this transition was so challenging.

To enhance insight in transitions Markard and Truffer (2008) suggested exploiting the complementary strengths of the TIS and MLP approaches. We use this combined framework to assess whether this actually works out in practice. To reinforce the regime analysis insights in cultural and structural inertia to change are used to explore regime mechanisms that inhibit the transition.

The TIS-MLP framework has been successfully used to identify technological and organizational development options within a specific innovation field (Markard et al., 2009). Since the purpose of this study is different, explicating the transition process towards animal-free regulatory medicine testing, we designed a different method. We use a three step approach; (i) regime analysis using, (ii) a TIS analysis and (iii) an integrated analysis. The data is gathered making use of a process analysis approach using scientific literature complemented with semi-structures interviews with stakeholders and experts.

The TIS-MLP analysis showed that moderate landscape pressure in the form of the effective anti-Draize campaign happened at a moment when the emerging technologies in the TIS had not been sufficiently developed to substitute the Draize test. However, the campaign disrupted the safety assessment regime enough for regime actors,

¹ (Technological) development and regulatory validation are considered to be synonymous with 'replacement', because once a method for safety testing has been validated by regulatory authorities, it is more or less automatically adopted by companies and research units.

industry and public authorities in particular, to become involved in the development of innovative methods in the TIS. Regime actors contributed by modifying the innovation activities that were needed to get the ICE and BCOP test validated for use in formal regulatory safety assessment. From the moment that the first validation studies took place, the ICE and BCOP test have coexisted in symbiotic way next to the Draize test. Inertia in the regime, due to the success and incorporation in formal regulation, required cumulative adjustments and reorientations in the safety assessment regime to validate the ICE and BCOP test: legislation was created that forced the development of innovative methods; industry in collaboration with public authorities and public research support actors started extensive validation programs, which have improved considerably through learning, by including prediction models, protocols and a tiered testing strategy. Under the landscape pressure of globalization, EU and US authorities increased their collaboration and undertook a retrospective validation study, which paved the way for US federal endorsement and OECD by the acceptance of the ICE and BCOP test. ICE and BCOP did not fully replace the Draize test. Mild to moderate irritants still have to be assessed using the Draize test.

Based on the combined TIS-MLP analysis it can be concluded that the most problematic system weaknesses were lack of entrepreneurial activities and guidance of the search with respect to the validation process. Government interference by stimulating the development of innovative methods and banning the use of animal tests for cosmetics was key in solving the deadlock in entrepreneurial activities. Without the pressure that the EU put on manufacturers, there was a lack of incentives to activate manufacturers to invest in innovative methods. In a later stage inertia in the regime impeded the validation of innovative methods by setting unrealistic validation endpoints. Years of successful use of the Draize test induced cultural inertia. Therefore, the Draize test was the golden standard in the validation studies and the performance of the innovative methods was judged in relation to the Draize test not taking into account the flaws of that test. Due to the variability of the Draize test, results of innovative methods insufficiently correlated with results of the Draize test leading to failure of the multi-laboratory validation studies. Again government interference, a ban on cosmetics tested in animals in the EU, was necessary to start the review of the validation studies which convinced the OECD to accept the ICE and the BCOP.

The advantage of the combined TIS-MLP approach is that it makes it possible to study the development of different emerging methods in relation to changes in the regime and landscape with the analytical power of the TIS approach. Using only the TIS approach would have provided insight in the processes that inhibited and influenced the change towards an innovative method. However, it would not have enabled us to explain how the regime and landscape development influence the TIS and decelerate the tran-

sition. Using only the MLP framework would have enabled us to study how the development of animal-free methods interacts with the regime and the landscape. However, the framework does not provide much analytical power with respect to identify the mechanisms that inhibit and influence the transition. Combining TIS and MLP made it possible to analyze how the development of innovative methods interacts with the regime and the landscape with the analytical power of the TIS approach. The use of the concepts cultural and structural inertia increased the understanding of the mechanisms that induce regime resistance to change.

The combined TIS-MLP framework proved to be valuable to identify the issues that inhibit the transition to innovative methods for eye irritation testing. Whether the conclusion of this study with regard to the mechanisms that complicate the transition are generalizable and whether this approach is equally valuable to study different empirical cases or prospective cases require further research.

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Agriculture and innovation – A neglected sector in innovation research and innovation policy

Knut Koschatzky, Thomas Stahlecker

Fraunhofer Institute for Systems and Innovation Research ISI, Germany

Motivation

In an era in which not only the global population is still growing and the demand for food is increasing, but also the global climate change strongly affects agricultural production in many parts of the world by floods, drought and desertification, innovative and sustainable agricultural production systems are essential to human survival. Agriculture can contribute to a reduction of hunger and poverty by the production of food and by offering employment and income. Agriculture can also contribute to sustainable land use and thus to environmental protection in cases when the agricultural production system is well adjusted to its natural and social environment.

In developing countries agriculture is regarded as an important sector for economic growth, especially when productivity is increased in smallholder farming (Worldbank 2007, 1). In so-called agriculture-based countries, mainly located in the Sub-Saharan area, agriculture accounts on average for 32% of GDP growth. Due to the sectoral change during economic development, this share reduces to 5% on average in so-called urbanized countries (Worldbank 2007, 4). Nevertheless, also in these countries the agricultural sector plays a prominent role (McIntyre et al. 2009). Although its share in employment and gross value added is much smaller than most other industrial sectors, the production and processing of food and the safeguarding of a sufficient supply of healthy and affordable crops, fruits and food products is a necessary requirement for socio-economic welfare and stability.

The role of agriculture in developed countries differs from the role it has in developing countries, especially regarding its role in reducing poverty and food insecurity. On the other hand, also in developed countries agriculture has a great potential in securing natural resources, in environmental protection and sustainable development. The agricultural sector is a core element in the whole food chain, ranging from the production of primary products (and the creation of conditions to produce these products) to the technical and industrial processing of food and its distribution. This is a systemic process in which different processing stages, supplying sectors, users and consumers interact in different value added chains. Although agriculture is characterized by this systemic interaction and despite the fact that the whole population of a country depends on the (domestic) agricultural production, the role of this sector in innovation as user or

producer of new products, processes and organizational concepts is not analysed in great detail so far (cf. Menrad 2003 for the food sector).

It is thus the objective of this paper to shed some light into the black box of innovation in the agricultural sector and to discuss the policy implications of these findings. Looking at the different production chains in agriculture (e.g. animal breeding, plant breeding, horticulture, food processing) and the different sectors which are closely related to agricultural production (e.g. chemical and pharmaceutical industry, biotech industry, agricultural machinery) the thesis is put forward in this paper that agriculture cannot be regarded as a coherent innovation system but as a fragmented set of sub-systems in which innovative activity plays different roles. It is therefore assumed that innovation policy varies in its importance and has to be coordinated with agricultural policy and the regulatory framework in the agricultural production system.¹

Approach

Due to its fragmented character, it will not be possible to analyse the amount and structure of innovative activity in agriculture in a cross-country perspective. The approach chosen in this paper is to focus on the German agricultural system, based on the understanding of agriculture as a sectoral innovation system (Malerba 2002). The paper presents findings about the major characteristics of innovative activity in German agriculture and draws some conclusions about the necessity of a specific set of innovation policy measures which have to be adapted to the specific socio-economic situation of this sector. R&D statistics as well as publication statistics, enriched by other data and information are used for the description and explanation of innovative activity. It is an exploratory study, because there is not much research so far about agricultural innovation in a systemic perspective in Germany, at least at the national level.

Results

Innovation in agriculture cannot be explained by looking at the agricultural sector alone. Taking the R&D activities as one – certainly not sufficient – indicator for innovation input, agriculture is characterized by a low R&D intensity. The share of investments in R&D amount to 0.32% of all German industrial R&D expenditures. This is lower than the shares of agriculture in employment (2.7%) of all German employees work in this

¹ The work presented in this paper is based on a contribution by the authors to the sectoral study "Analysis of the innovation system of German agriculture" ("Untersuchung des Innovationssystems der deutschen Landwirtschaft"), commissioned by the Bundesanstalt für Landwirtschaft und Ernährung, Bonn, and carried out by the Humboldt-University, Department of Agricultural Economics together with other partners.

sector) and in gross value added (0.9%). Growth rates of patent applications are slightly lower than the increase of all German patent applications, while the share of agricultural patents decreased from 3.1% in 1991 to 1.6% in 2008. This can both be attributed to a decreasing patenting activity in the core sector and to a shift of patenting activities to sectors which supply technologies to agricultural production but which do not focus on agricultural use alone (e.g. satellite navigation in precision farming). It is therefore necessary to open up the view to upstream and downstream sectors like plant protection, fertilizer industry, plant breeding, agricultural machinery, food industry, and wholesale trade in order to a better understand the generation of invention and innovation and the use of agricultural-oriented innovations in the agricultural sector. Looking especially at the food industry, this sector shows a quite low R&D intensity. As a result, a strong innovative impetus cannot be expected from this sector. Agricultural production is therefore strongly dependent on new products and processes which are developed and brought to the market by the different upstream sectors like pharmaceuticals or agricultural machinery. As a matter of fact, the competence in handling these new products or processes is not well developed, nor are the products in all cases well adjusted to the needs of farmers. This results in reservations regarding the adoption of innovations coming from other sectors and, in a kind of a vicious circle, in quite low own innovative activities.

As a matter of fact, the agricultural sector itself is fragmented with regard to different patterns and routines in innovation, depending on farm sizes and the interactions with predominantly upstream industries, but also the whole agricultural production system including upstream and downstream activities shows different levels of innovative activity and institutional structures affecting its innovative output.

Policy implications

It can be concluded from this analysis that a "one size fits all" innovation policy is not appropriate for stimulating innovation in agriculture. On the first hand, the whole agricultural policy and regulatory framework has to be taken into account. Innovation cannot neglect safety regulations, safety values, agricultural subsidies etc. which sometime trigger innovations or limit their use to certain applications. Innovation policy must therefore be coordinated with agricultural policy in a way that the objectives of agricultural policy interventions are integral part of innovation policy measures. Innovation policy can also contribute to changes in agricultural production processes and the use of specific technologies which, on the other hand might influence agricultural policy. Only through this 'fertilization' process and the incorporation of agricultural innovation routines in a greater political framework the agricultural sector by itself will be enabled

to develop solutions which provide answers to challenges related to climate change and the turn in energy production.

Within innovation policy, our analysis shows that it has to take the specificities of the sector into account, namely the traditional behaviour of farmers and their reservation in using unknown technologies, machinery or products. Innovation policy in agriculture has to be different from the 'general' innovation policy, because it should be in most cases a 'first step' or 'opening-up' policy. This is related to the creation of a knowledge base which enables farmers to better assess the advantages and risks of new technologies, but also to a much closer interaction with innovators originating from the sector ('lead innovators') so that also endogenous innovative activity is stimulated.

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Breaking down the innovation policy and system debate towards an effective toolbox of instruments

Martina Kovac, Carsten Dreher

Freie Universität Berlin, Institute of Management, Germany

Abstract

Today's innovation policy debate is grounded on a variety of changing discourses. Particularly evolutionary ideas on technological innovation and, within this framework, the rise of systems of innovation caused important shifts in the innovation policy debate. These shifts led to a different use of innovation policy instruments and changes in policy rationales. Innovation is seen as a dynamic process, which is affected by a complex and dynamic system under conditions of uncertainty. This development established a more realistic approach about determining factors of innovation, while at the same time is accompanied by a higher importance of orientation possibilities for policy decision makers. In order to support policymakers in setting funding priorities and to design features of possible policy measures, the level of complexity and uncertainty needs to be reduced. As a first step, the paper illustrates the historical development of innovation policy debates to revisit relevant funding and allocation criteria.

Historical development:

Traditionally, policies for economic growth were dominated by assumptions of neo-classical economics introduced by Solow in the 1950s. The clarity of market failure justification, which was based on the idea of static equilibrium and rational actors, provided the grounds for the potential need for policy intervention. However, it gave no indications about the use or arrangement of policy instruments. Furthermore science policy followed the idea of the so called "**science-push model**" in organizing basic research. It was assumed that basic research knowledge would simply trickle down into technological inventions. The innovation policy debate broadened with the rise of "**demand-pull arguments**" (Schmookler, 1966). Mostly based on the results of empirical studies the discussion emerged, whether the rate and direction of technological change was more influenced by changes in market demand or by advances in science and technology (Mowery and Rosenberg, 1979).

Radical shifts in the debate were triggered by the introduction of the systemic perspective on innovation (Freeman, 1987; Lundvall, 1992). The innovation system approach introduced the idea of an interactive character of knowledge production and diffusion. It emphasizes the complexity of knowledge production by a variety of different actors and institutions within the system. Analysis now focused on the interdepen-

dences between economic, technical and social actors, which each in their own way influenced the system. Following this idea the role of governance was seen as "connector" of the system that must also consider whether educational or legal frameworks were conducive with respect to the particular technology.

The innovation system can be understood as an analytical instrument to better understand system performance and dynamics. In the past, innovation system analysis was conducted in a more static way. The literature focused on system failures resulting from weaknesses in the structural composition of a system. Above all, the analysis of a technological innovation system using processes or "functions" provides improvements in order to capture the dynamics of a certain system (see e.g. Bergek et al., 2008; Hekkert et al., 2007). The technological innovation system analysis focuses on the development, diffusion and use of a particular technology in a socio-technical system (Carlsson and Stankiewicz, 1991) and enables moreover to identify system and technology bottlenecks inside the system. Today, old pattern of policy intervention like market failure justification is rejected because of changing assumptions related to fundamental ideas on how innovation is generated and diffused. Especially as systemic thinking in innovation policy has been adopted as mainstream approach, a stronger differentiation between policy instruments and measures is required.

Actual challenges:

Innovation policies can involve a wide range of instruments and require highly specialized knowledge of the particular technology. In this paper it is assumed that policy will be more effective in supporting the development and diffusion of a technology when there is a match between **the characteristics of the context conditions** and the **pre-requisites of the respective policy instruments**. Consequently, a mismatch leads to non-efficient promotion results (Dreher, 1997).

For this purpose, the context conditions like the *level of technology/diffusion* or the (*future*) *demand conditions* need to be analyzed. In reference to the systemic perspective this means that the timing of certain states of technological innovation system needs to take into account the future demand. At this point the technology cycle provides first orientation possibilities for policy practitioners (Meyer-Krahmer and Dreher, 2004). Building upon a range of different indicators it defines the position of a specific technology in the technology cycle. An ideal-type of six phases for a successful technology is identified, assuming that different phases require different policy measures to be effective in supporting the development and diffusion of a technology. Especially the combination of the two methodological approaches introduced by Dreher and Edler et al. (2006) bases policy decisions on systematically generated data and information. By

interlinking the technological innovation system approach with the technology cycle, an ideal-type technology and policy matrix can be devised. This combination thus captures both, the dynamic and the time dimension. In addition, when analyzing context conditions *relevant stakeholder* and the *respective political goal* should be considered. It is furthermore argued that innovation system approaches are in many cases too much oriented towards technologies. This scope is broadening through the fact that *non-technological innovations* (and problem solving through product-related services) are becoming increasingly important in specific technologies, e.g. information and communication technologies.

With respect to the dynamic efficiency of the innovation system, the paper focuses on the systemic and temporal dimension of existing instruments and policy measures. The use of innovation policy instruments is necessarily not stable over time or across space. To be effective, prerequisites like *a broad impact of the instruments, the administrative effort or the budget* should be closely aligned with the respective context. For this, a clear definition of *target groups* (e.g. small and medium-sized enterprises) and *their role inside the system* is needed. While addressing different types of challenges requires different instruments, their *impact on innovation* should be a central criteria. Furthermore, from a functional perspective, policy instruments also vary in their design depending on the *innovation-oriented R&D function* they need to fulfill (Grupp, 1997). Taking into account different research stages, beginning with the basic-oriented research up to the industrial application, a varying set of instruments exist already in the policy agenda-setting. This set of instruments should be considered, when it comes to the integration of the research, technology and innovation policy.

Based on the need for a more dynamic view of policy formulation the paper provides **orientation-possibilities in terms of a "toolbox of instruments"**. This contains an aggregation of the relevant characteristics and criteria derived from the innovation policy literature. Secondary analysis will be used to establish and systematize relevant criteria and therefore integrate aspects of the historical development of the innovation policy debate, like relevant aspects of the technology push vs. demand pull discussion as well as aspects of the recent development of dynamic-oriented innovation system analysis. Evaluations of previous policy interventions will be analyzed in order to integrate former experiences with the results of the scientific discussions. Ultimately, it will be shown by examples what policy implications may arrive, if results from literature are treated seriously. It is expected that the integration will provide systematic information to support policy decision makers and thus include respective aspects of the context conditions and instrument characteristics.

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Science, technology and innovation for economic competitiveness: Bridging academic to policy practice in the case of Bulgaria

Sorin Krammer¹, Gabriel J. Goddard²

¹*University of Groningen, Faculty of Economics and Business, Department of Global Economics and Management, the Netherlands*

²*The World Bank, Private and Financial Sector Development group of the Europe and Central Asia Region, USA*

"It is not the strongest of the species that survive, nor the most intelligent, but the ones most responsive to change." – Charles Darwin

It is already a cliché to invoke innovation and new technologies as drivers of economic growth and competitiveness, given the impressive amount of attention devoted to this topic (Cameron, 1996; Hall and Jones, 1999; Freeman, 2002; Rosenberg, 2004; Wang et al., 2007; Gibson and Naquin, 2011). Furthermore, the current global crisis has exposed significant weaknesses of anchoring growth to non-tradables (e.g. financial sector, real estate, and construction) emphasizing research and technological innovation as a sustainable alternative for the future. As a result, both science and technology are now more integrated in the economic rationale, and national innovation systems (NIS) arguments dominate the policy arena. However, despite strong consensus on pursuing innovation both through public and private vehicles, the practical implementation proves always difficult and very much case-specific (Mowery and Oxley, 1995; Gu, 1999; Hadjimanolisa and Dickson, 2001; Wang, 2007). Beyond the well-known economic failure of free-markets to yield optimum streams of innovation (Nelson, 1959; Arrow, 1962), such allocation conundrums are particularly salient for latecomer countries (Furman et al., 2002; Hu and Matthews, 2005; Dogson, 2009; Krammer, 2009) where private firms lack resources to innovate and rely heavily on public and foreign sources of knowledge. In these cases, the supporting infrastructure and policies, conceptualized within the systemic NIS (Lundvall, 1992; Nelson, 1993) or STIG – science, technology, innovation and growth – frameworks (Aghion et al., 2009) become critical for long-term competitiveness and economic success.

The approach undertaken by the present study is to analyze in depth the components of these systems and provide alternative avenues for future development, based on their inter linkages and interactions with a strong policy emphasis. These aspects will be captured at the country level using a wide range of proxies from primary and secondary data. Our assessment of international competitiveness is anchored in the recent literature on industrial production, exports and economic growth (Feenstra and Rose, 1997; Imbs and Wacziarg 2003; Klinger and Lederman, 2004). According to this view,

countries climb over time the ladder of export sophistication and competitiveness by first diversifying, and later specializing in upper echelons of products with high value added (Cadot et al., 2007). This process is fueled both by *internal* (in-house R&D and scientific production, existing human capital) and *external* sources of innovation (licensing, foreign direct investment, technological alliances, learning by exporting, spillovers) that contribute jointly to the development and success of new products for new markets.

This study provides a detailed and systemic analysis of economic competitiveness and STI systems in the case of Bulgaria, a laggard both in economic and innovation terms within the enlarged European Union. A survivor of a lengthy transition that still bears the scars from centralized planning era, Bulgaria faces now multiple challenges from rekindling its economic growth in this global recession. The first part of this study assesses the Bulgarian competitiveness using detailed (4-digit) export data, and identifies possible niches for future export-led development (Hausmann and Klinger, 2008). Second, this work provides a comprehensive analysis of both "new-to-the-market" and "new-to-the-world" innovative output using international and domestic patent data (Acs et al., 2002; Grupp and Mogege, 2004). This analysis is complemented with microeconomic insights on firm innovation from two enterprise surveys, namely the Business Environment and Enterprise Performance Survey (BEEPS) and the Administrative and Regulatory Costs (ARC)¹. Third, we close the circle by analyzing the current scientific system in Bulgaria using bibliometric data (Weingart, 2005), and identify opportunities for future capability development (D'Este and Patel, 2007) as well as linkages with its industrial and technological systems.

The second half of this paper develops concrete policy recommendations aimed at enhancing Bulgaria's competitive advantage through a more efficient utilization of its STI assets. This part addresses structural weaknesses that impede productivity and export-oriented growth. Furthermore, it promotes actions to bring "science, higher education, and business closer together" as a governmental priority both to achieve the targets of Lisbon agenda and spur economic recovery. This type of analysis may serve as a policy blueprint for analyzing the fit between STI systems and competitiveness of other countries.

Overall, it is imperative for Bulgaria to support innovation in potential export-champion sectors through national funding instruments. Better incentives and finance for these activities need to be developed in order to stimulate domestic knowledge creation. In

¹ The BEEPS survey used was conducted in 2008 and includes 288 firms from manufacturing and services, while ARC surveys more than 320 firms from manufacturing and IT.

terms of science and innovation, international collaboration remains crucial for laggards such Bulgaria in terms of achieving a critical mass and absorbing new knowledge from the global frontier. Another priority involves strengthening the links between academia and business through new policies in tertiary education and R&D legislation that will involve also the restructuring of the Bulgarian Academy of Science (BAS). Finally, as one of the new EU members, Bulgaria needs to take advantage of the existing European opportunities by accessing structural funds, eliminate bottlenecks in absorption of such resources, and redesigning instruments to promote commercialization of public-sector research.

The PBF as an instrument for fair funding? The Performance Based Funding in German University Medicine

René Krempkow, Uta Landrock

IFQ Institut für Forschungsinformation und Qualitätssicherung, Germany

1. Motivation:

In recent years, performance based funding (PBF) has taken a central role among competitive elements in German universities. Links between performance evaluation and mechanisms of financial distribution are now in place not only at national level, but also at faculty levels.

The main ideas of the New Public Management framework, as well as New Governance literature, to some extent, are based on the assumption that output orientated governance is the most efficient form of governance. As of yet, however, little is known about the impact of PBF as a means of governance. Also, recent empirical findings do not offer clear answers about whether such a method of governance actually leads to increased performance, and to what extent unintended effects occur.

Partly this may arise from the need of differentiation between – at minimum – two levels of governance and their more or less inadequate (vertical) coordination with governance instruments. We will focus our conceptual discussion and later our empirical analyses firstly on the macro-level (germanwide: the governance and performance of university medicine in all 36 faculties) and secondly on the micro-level (here: Scientists inside the faculties).

On one hand – on the macro-level of the faculties – so-called "Matthew effects" ("to all who have, more will be given") are seen as unintended outcomes of governance based on third party funding (for example, see Jansen et al. 2007, Zechlin 2008, Münch 2008). And – in the micro-level – scientists reportedly think that competition pressure negatively affects the quality and validity of research. This is also seen as an unintended effect.

On the other hand – in the macro-level – the increased volume of third party funding of institutions is cited as proof of successful governance (for example, see Jäger 2008, Auspurg et al. 2008, Hilzenbecher 2010). And – on the micro-level – more just and fair financing of Science and a higher motivation of scientists are seen as an intended effect and as evidence of successful governance via PBF.

Despite the current research, comparative effects of governance and the impact of Matthew effects on third party funding are rarely investigated empirically (Butler 2010, Hicks 2012).

An analysis of German university medicine suits this question well, given that it has been over a decade since the first PBF models were implemented nationwide in medical faculties, and the performance based funding budgets of medical faculties are not small – in contrary to other faculties in German universities.

The Institute for Research Information and Quality Assurance (iFQ) in Bonn therefore investigates this problem through a project about the desired effects and perception of performance based funding. Our investigation is sponsored by the German Federal Ministry of Education and Research.

2. Approach:

In a first step the proposed presentation will show selected results – on the macro-level – of a multivariate analysis of both intended and unintended effects of PBF in relation to the volume of third party funding of medical faculties. It builds on the framework of our iFQ project that conducted document analyses of PBF models, analyses of statistical data from university medicine, a survey of faculties, and Internet research.

We will begin by considering characteristics of PBF models (i.e. performance criteria and their weighting) and the implementation of PBF (when they were initiated, evaluated, and revised) along side the structural characteristics of the faculties, intensity of publications, and initial financial conditions. Additionally, we will review the relationships between other structural characteristics of the faculties, such as the deans' scope of decision-making or the presence of vice deans of research.

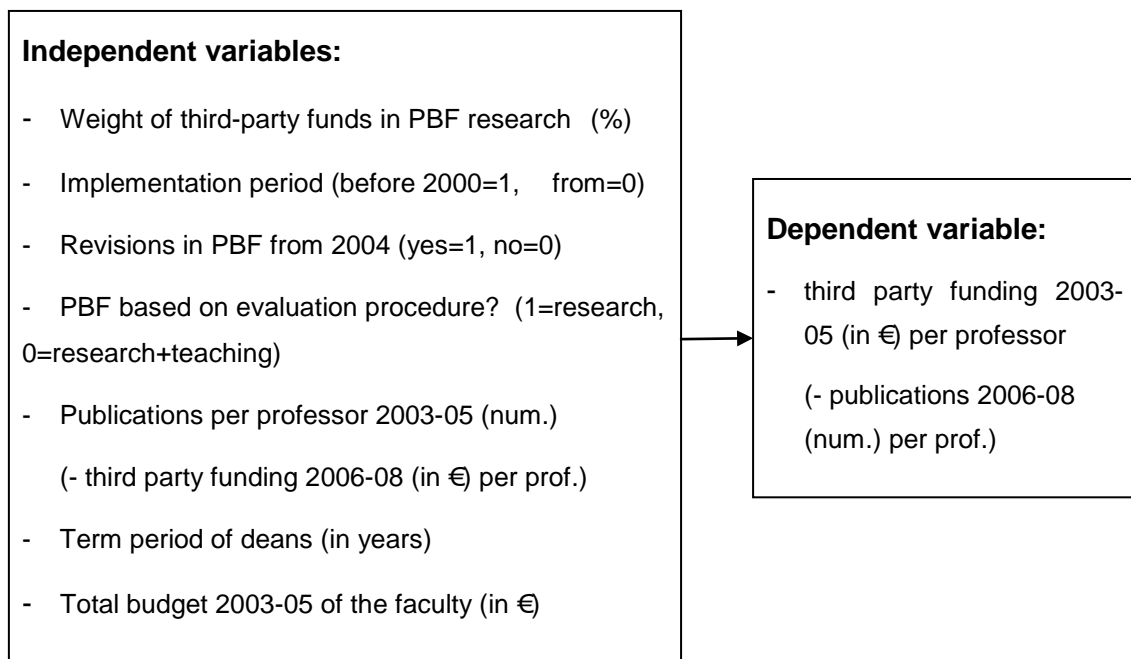
Subsequently we present hypotheses for correlations between PBF model characteristics, the interaction with another dimension of performance, structural characteristics of the faculties and initial conditions to the volume of third-party funding:

1. Model characteristics of internal faculty PBF: A higher weight of PBF criteria (e.g. third-party funding) correlates positively with later performance in this area (here: third-party funding).
2. PBF systems that are based on evaluations that have been introduced earlier than others (and therefore probably are more strongly established), and that have been altered (and therefore probably further developed) accompany higher performance.
3. Interaction with other dimensions of performance: A high performance of publication correlates positively with performance of third-party funding (and vice versa).

4. Structural characteristics of the faculties: Longer term periods of deans (as proxy indicators of the establishment and esteem of this function) are accompanied by a higher performance of the concerned faculties.
5. Input/initial conditions: Higher investments and federal allocation of sums (LZB) to the concerned faculties are useful for research performance (here: third-party funding).

Our analysis model for the performance of faculties/macro level with variables (Here the Publications per professor are an independent variable; in another model it is a dependent variable. For an explanation of this modelling see Krempkow/Landrock 2011):

Performance of faculties (macro level):



In a second step we will analyze data from a cross sectional online survey of scientists – that means on the micro-level, following the same principle (with different dependent and independent variables):

Target achievement and performance of Researchers (micro level):

Independent variables (survey items):

- participation by PBF development
- PBF is an adequate mirror of performance
- Justness of PBF distribution
- Justness of PBF procedure
- working motivation through PBF
- What do the colleagues think about PBF
- relevance of high salary
- relevance sum of Third Party Funding for reputation
- relevance PBF-success for reputation
- access to information about their PBF system
- Discussion of PBF-results
- PBF supports cooperations
- PBF supports a better working climate
- PBF supports mainstream-research
- age groups
- chief physician position
- line function

Dependent variables:

target achievement in research:

- transparency of research performance
- efficiency of research performance
- quality of research

target achievement generally:

- competition intensity

publications:

- sum of peer-review-article publications
- sum of other publications (e.g. book chapters, books)

For the survey we created (according to our hypotheses) an online questionnaire in which all of the medical professors of the 36 medical faculties in Germany were invited to participate. 644 professors participated in this survey (response rate 25%). We also checked the percentages of professors in subjects and the percentages of women in both our sample and also in the database of the federal statistic office. We are confident from our analyses, that our sample is unbiased for the testable sample characteristics.

The proposed presentation will show selected results of a multivariate analysis of both intended and unintended effects of PBF in relation to the perceived success of PBF from the perspective of scientists. Despite it is being a subjective view, it is very important for the daily practice of research, done by these scientists.

Furthermore our results on both analysed levels (macro and micro level) show, that our data have some potential for Multi Level Analyses, for example with the software packages "Mplus" or "HLM" (Hierarchical Linear Models). We plan to do this kind of analyses in the next months and we plan to include their results in our presentation.

3. (Expected) Results:

Contrary to the expectations, and also to the statements from PBF actors in ministries (see, for example, Hilzenbecher 2010), the results of our multivariate analysis on the macro-level established that the researched characteristics of PBF models and the actual volume of third party funding per professor are *not* directly related. However, a comprehensive evaluation process, the size of financial resources, and intensity of faculty publications are related to third party funding. Also significant is the connection between the volume of third party funding and deans with long tenure, although this is not as strong as the aforementioned relationships.

This shows that the investigated characteristics of internal PBF models do not accompany the expected effects, at least as they relate to German university medicine. Overall, however, our observations of faculty governance (also independent from concrete properties of the PBF models) have indeed found intended effects. Then again, in addition to such effects of governance, as well as the expected impact of publication intensity and effects of initial financial conditions, there is also evidence of Matthew effects, which is an outcome that some skeptics of PBF had expected to see. However, these Matthew effects are not contrary to the predictions, but only stand "in moderation" (Hornbostel/Heise 2006) to the volume of third party funding.

Furthermore we will show results of a multivariate data analysis of our Scientist Survey of medical faculties in Germany on the micro-level. We found, that not only the characteristics of the PBF systems, but also scientists' perception of them related to the success of PBF (this means transparency, efficiency and quality of research). One of the strongest related aspects to the reported target achievement is: How just are the PBF-systems?

4. Conclusion and/or (policy) implications:

The PBF is a relevant topic in the discussion about Performance Measurement and the outcomes of Higher Education and has practical relevance for the ministries and the higher education institution (faculty) management. We found intended and unintended effects of governance. Our aim is to find out which possibilities ensure that PBF models manifest the least possible undesirable unintended consequences in the future – and which models from other countries could be adapted to realize this step by step in a better way.

Also – a little bit more related to theoretical concepts of governance – with our results, we hope to answer some of the questions about the relation between the characteristics of governance and the performance of faculties and scientists inside the faculties.

The experiences with PBF, both positive and negative, could also be interesting for (medical and other) faculties outside of Germany.

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Policies for research excellence: A comparative study of centres of excellence schemes

**Liv Langfeldt¹, Egil Kallerud¹, Siri Brorstad Borlaug^{1,2}, Mats Benner³,
Hanne Foss Hansen⁴, Antti Pelkonen⁵, Ernst Kristiansen⁶,
Dag Aksnes¹, Gunnar Sivertsen¹**

¹*NIFU – Nordic Institute for Studies in Innovation, Research and Education, Norway*

²*University of Oslo, NIFU– Nordic Institute for Studies in Innovation, Research and Education, Norway*

³*Lund University, Sweden; ⁴University of Copenhagen, Denmark;*

⁵*VTT Technical Research Centre of Finland, Finland; ⁶SINTEF, Norway*

1. Background/motivation

Policies for research excellence have been developed and implemented in a large number of countries in the form of some novel instruments and schemes categorized as "research excellence initiatives" (REIs). These are seen as a relatively recent part of broader changes in structures of funding of public research and research institutions. "Centres of excellence" (CoEs) often form a key part of these policies (Orr et al. 2011). A central institutional aspect of the initiatives is the "overarching central objective of restructuring the research landscape" (op.cit., p. 6). More specifically, systemic changes are sought in terms of enhancing the international competitiveness of domestic research, i.e., enhancing the international visibility and attractiveness of the best national research institutions and/or research groups. Thus, research excellence initiatives often require up-scaling of research efforts and extended networking between institutions, disciplines and actors (Heinze et al 2009). Through shifting resources to the best and strongest performers, efforts are made to create conditions of critical mass, international visibility and enhanced scientific and economic competitiveness. These policies are most often explicitly phrased in terms of adapting research and innovation to the dynamics of competitiveness, specialization and division of work inherent in globalization. Such centres are expected to become highly visible poles of attraction both to volatile investment capital searching for high-tech and R&D-intensive investment opportunities, and to the best talents of an increasingly mobile and high-competent workforce looking for outstanding work conditions and creative work environments.

2. Approach

These observations form the background for the PEAC project, the objective of which is to better understand the context and dynamics of policies for excellence in general, and the formation of CoEs and their effect on the research community in particular (Aksnes et al. 2012). The research questions include how CoE schemes affect the (re)distribution of resources at the universities and how centres benefit from and exploit

the accumulative advantages that their status and conditions provide, i.e., in terms of access to additional national and international funding. This paper presents the results from the first stage of the project – a comparative study of excellence policy and instruments in Denmark, Finland, Norway and Sweden.

The study builds on three different approaches. Firstly, we trace the origin of policies for research excellence in each of the four Nordic countries. Based on policy documents, we describe how main national policies and instruments have emerged and developed and how they differ in terms of objectives and emphases. We map the allocation of resources to CoEs and estimated the relative importance of the schemes in terms of overall national research funding.

The second approach is a detailed mapping of the centres selected for support by the 11 CoE schemes identified in the four countries (in total 287 centres). The types and scope of the centres, their locations/host institutions and the research areas that benefit from these excellence schemes are identified.

Thirdly, we measure the relative competitiveness of the research institutions that host CoEs (CoEs of the 11 schemes mapped), on the basis of available comparative statistics (bibliometrics, EU funding), in order to provide a basis for assessing to what extent the centres are allocated to groups within the leading/strongest research institutions in the relevant research fields. In this way we also illuminate to what extent the institutions that are branded as excellent in a national setting also have high performance in an international context.

3. Results

Policy context and objectives: The four countries have followed different paths to the introduction of CoE schemes. The policy contexts and arguments vary between entrepreneurial processes succeeding because of the – coincidental – availability of funds, to being part of overall national policy decisions. Whereas the paths to excellence centres schemes differ, there is much similarity in policy objectives. All four countries have schemes aimed at enhancing the country's international scientific competitiveness, as well as schemes also aimed at innovation and economic growth and/or broader social objectives, including grand challenges. The main objectives for the scientific communities include international visibility and competitiveness, resource concentration, researcher recruitment and restructuring the research system.

Size and impact: The amount of money allocated is an important indication of the potential impact of a research policy scheme. The average annual funding per centre varies between €0.5 million for the Finnish CoEs and €1.4 million for the Norwegian CoEs.

These are the figures for excellence schemes aimed at scientific objectives, and include the scheme funding only. In addition comes co-funding from host institution and in some cases large amounts of other funding. The schemes aimed at innovation and economic objectives in most cases provide higher average funding per centres (up to € 16.5 million), and these centres also have more other funding – including funding from business partners. In total the annual funding for the excellence schemes as share of the total national government expenditure on R&D varies between 2.5 and 6.1 per cent in the four countries. Biomedicine/Health Sciences, and Engineering/ICT/Materials Sciences dominate CoE activities in all four countries. These fields encompass close to 60 per cent of the 287 mapped centres.

Host institutions score high on competitiveness criteria: In all countries, most CoEs are concentrated on a few host institutions and there are one or two universities that host a large number of centres. The large majority (89 per cent) of the centres included in the analysis are in fields where the host universities obtained a citation index above world average. Moreover, the CoE host institutions dominate the ERC grants; only 6 out of 189 ERC grants to these countries are traced to an institution without an excellence centre. Moreover, there is high correlation between number of approved ERC grants and the number of centres at the host institutions.

4. Implications

Overall, the excellence schemes account for a low percentage of the national public funding for R&D, but may still – due to co-funding and cumulative effects – have extensive impacts in terms of redirecting research resources and the organisation of research, especially since it is one of the few schemes that offer long-term and substantial funding. When it comes to impacts on the organisation of research, policy documents and evaluations of CoE schemes report an increased focus on academic leadership; increased facilitated recruitment of both junior and senior researchers, as well as researchers from abroad; and increased research responsibilities for postdocs.

The data indicate, not surprisingly, that the CoEs are hosted by institutions which are among the leading/strongest in the relevant fields, and that they are part of interrelated processes of cumulative advantages. CoE schemes allocating large amounts of long-term funding may accelerate cumulative advantages in various ways. The obvious ways are increased status and resources that make the groups more attractive to eminent scholars and talented students as they expect affiliations with renowned groups and institutions will be beneficial for their research as well as their career. In addition the centre schemes may have general visibility effects. By introducing competitive funding schemes selecting centres to be generously funded and given a formal status

as "excellent", the importance of, attention to and transparency of review decisions are intentionally increased – in order to promote the international competitiveness of the selected groups. These effects may, however, vary both between different types of excellence schemes and research fields. The schemes have different objectives and status, and research fields have different needs and different possibilities for acquiring additional funding. Hence, the excellence schemes are likely to have different kinds of importance and impact in different research fields, which is studied in the next phase of the PEAC project.

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The use of indicators and evidence in governance and policy development of Science, Technology and Innovation

Manuel Laranja¹, Nuno Boavida²

¹*Instituto Superior de Economia e Gestão, Universidade Técnica de Lisboa, Portugal*

²*Universidade Nova de Lisboa – Faculdade de Ciências e Tecnologia, Portugal*

The relatively poor performance of Europe in turning research into innovative new businesses, generating growth and employment, (EC, 2001; Kok, 2004; Aho, 2006) is probably fuelling a need for better informed policy makers (Veugelers, 2006) and, more generally, a new "utilitarian" view of European STI – *Science, Technology and Innovation* policy.

Evidence-based policy i.e. what works, rather than rationale informed by systemic models of innovation and from economic theories of knowledge and technical change, seems to be a watchword for STI policies in many European countries. The increasing large sums of public funding to R&D at European and National levels combined with the easiness of access to computer-based data collection are, according to some authors, the main determinants of this renewed interest in using evidence and indicators as inputs for policy development (Freeman and Soete, 2009; Grupp and Mogege, 2004; Godin, 2008).

According to Freeman and Soete (2009 p. 11) "having broadened STI indicators from R&D to the "blue sky of innovation", we seem to have come even closer to the measurement of economic dynamics". For more than a decade now, the EC publishes the EIS – *European Innovation Scoreboard*, (recently renamed *Innovation Union Scoreboard*), with a view to gather evidence that can be used for systematic comparison of innovation performance across countries/regions, promoting international policy benchmarking (Grupp and Mogege, 2004; Grupp and Shubert, 2010). Both PRO INNO Europe and ERAWatch systematically collect and diffuse data and evidence on European, National and Regional research and innovation, as well as on which policies and programmes are implemented across Europe.

Moreover, contributing to this new interest on evidence and indicators, we also have a growing demand from private business, a industry of consultants and policy advisors (Mytelka and Smith, 2002; Godin, 2008) and numerous reports on technology assessment that indicate the need to enhance the evidence upon which to base forecasts on the impacts of future technology developments (Grunwald, 2007; STOA, 2004).

However, while there is an increasing interest in the use of evidence, there is also a growing academic discussion and controversy on the purpose and methodologies used to gather data and build STI indicators (Godin, 2008; OECD, 2008; Grupp and Mogege,

2004; Barré, 2004). Authors such as Grupp and Schubert (2010) sustain the idea that some aggregate/composite indicators were not subject to extensive research, and may present confidence, comparability and overlapping problems. Additionally, indicators used to benchmark countries and regions are often subject to decontextualized interpretation, simplification by the media and political appropriation (Feller-Länzlinger et al. 2010). Because of their inherent pragmatism, indicator sets (scoreboards) and composite indicators or indexes are often preferred by policy-makers as they may function as strategic instruments to influence policy change.

Although we agree that STI indicators are in need of more extensive scientific research (Feller-Länzlinger et al, 2010), we do not wish to discuss here their technical and methodological limitations in design, embodied concepts, completeness, etc. In our view it is equally important to understand the articulation between "indicators" and their use as input for policy decision making.

An interesting approach, proposed by Perry 6 (2002), suggests that the situations in which policy makers find themselves, will shape which information from the complex set available is used and, most importantly, which information is rejected or at least downplayed. Perry 6 (2002, p.7) argues that policy-making "always makes use of some evidence, but that there is a plurality – a limited plurality, indeed – of things that count as evidence, and what counts depends on where policy makers are situated".

In this paper we take up the challenge to reflect upon how policy-makers look for, interpret and use evidence for reflection and policy development. We propose an exploratory framework that sets out two of the elements necessary to a conceptualization of what may explain the way in which evidence and indicators are used in STI policy development. By making interviews to decision makers involved in STI policies, in Portugal and Germany we hope to gather information on how are indicators (and other evidences) being used for policy development.

From pure evaluative to mixed or combined approaches

Our first conjecture is that the use of evidence and indicators by STI policy-makers is a combination of a pure evaluative approach – within the technical constraints and limitations of indicators' construction – with ideas, conciliation of interests and considerations of popular support and acceptability of key constituencies. By a pure evaluative approach we mean an approach that values technical evidence e.g. ex-ante cost-effectiveness, overlooking other kinds of evidences.

The first direction of research is therefore the extent to which the use of evidence varies between a pure evaluative approach based on technically sound metrics and a combined approach, and what might be associated to this variation.

Policy makers' use of composite indicators for impressionistic propaganda (and over simplification) is an example of a combined approach where evidence is used (or rejected/downplayed) to suit political intent. The relevance of composite indicators to policy is perhaps best captured by the idea of indicators that become "policy-resonant" (Hezri and Dovers, 2006) *i.e.* an indicator that "strikes a chord" with its intended target audience, hence easier to communicate and often appropriated by policy-makers and by the media. Policy makers' claims that some indicators are difficult to interpret and/or peripheral to the issues that generate political concern (Nardo et al, 2005) may be, on the other hand, taken as examples of how evidence is rejected because it may not suit policy ideas.

On the other extreme, the use of evidence by independent policy evaluators may be closer to a pure evaluative approach *i.e.* with the objective of building technically coherent measurement sets upon which to surmount technically sound advice.

The use of evidence and governance

Second, another possible direction for research is whether the use of evidence and indicators is associated to styles of governance. In STI policy, decision processes appear to be broadening away, from "simple" hierarchical mechanisms, towards collective multi-actor multi-level participative consensus building and other less formal arrangements (Edler *et al*, 2003; OECD, 2005; Borrás, 2009). While this clearly brings new issues of accountability and efficiency, it also demands for a "different" use of evidence in policy development.

The more rigid hierarchical forms of governance, though perhaps recognising limitations in the use of statistical evidence and quantified information, tend to assume that indicators inform decisions in a somewhat linear and mechanistic manner. The assumption is that more precise and higher quality indicators will always positively influence policy decision-makers.

In the centralised forms of governance indicators are perhaps used to diagnose and justify or to build upon a given rationale. By contrast in the new multi-actor, network forms of governance, indicators must serve the 'steering' of a complex system of interactions requiring multiple information flows directed to different user segments, each with its own political agenda. It also requires different communication strategies of the indicators and indicator systems used. Network forms of governance may therefore lead to a better set of consensual indicators compared with that obtain through centralised governance forms.

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Evaluation and policy learning: toward a new approach to the evaluation of social impacts of public research activities.

Philippe Larédo¹, Laurence Collinet², Pierre Benoit Joly²

¹*Université Paris-Est; France and The University of Manchester, UK*

²*INRA Institut National de la Recherche Agronomique, France*

In 2007, Nightingale and Scott, argued that 'research impact' is becoming a more and more explicit dimension of the social contract between research and society. This was reflected in EC documents, such as the 2008 report by a high level group discussing the rationales for EU intervention (Georghiou et al.) highlighting the importance of 'grand (societal) challenges.

The issue of measuring impacts from public research is not new. In the 1970s the studies on space programmes, NASA and ESA, have represented important landmarks, if only by their different approaches, BETA for ESA having developed an approach centred on indirect effects. The question was raised for EC 'precompetitive' programmes as early as 1984 (for a review see Bobe and Violla, and Massimo in Callon et al., 1997), with, in particular issues associated with effects of collaborative research and networks. Similarly the 1990s were marked by the development by the US ATP programme of micro-level approaches associated with individual or clusters of projects (for a review, Feller and Ruegg 2004).

Two 'recent developments' have put this issue again on the research agenda.

The first one is associated with a shift of emphasis. Most of these efforts have focused on public programmes. New developments in the UK (with the REF including impact as a key evaluation component, and assessment units becoming more and more entire schools rather than individual research groups) or in France (especially through the requirements set by the new evaluation agency, AERES) shift the focus on organisations.

The second one follows on the wake of work like Bozeman on how to consider the public values that public research serves, or the discussion of the social impacts of public research (e.g. the EC funded SIAMPI project, see Spaapen or Mollas Gallart and Tang in the 2011 special issue of Research Evaluation on impact assessment). These argue for a broader scope of impacts: being not only economic, but also social, environmental, political and cultural. These questioning have paved the way to a first generation of multi-criteria approaches such as the payback framework developed for health research (see Donovan 2011 for a synthetic presentation). Such an enlargement has however its counterparts: (i) some dimensions are difficult to translate into financial benefits and render thus difficult the construction of a synthetic financial measure

(around a notion of rate of return to the Dollar or the Euro invested). (ii) synthetic financial measures do not enable to map the potentially very different 'vector of effects', which are often important components when discussing lessons and when learning for future policy making, the core reason why evaluations are made. (iii) Policy analysts have highlighted numerous times (in particular in debates at the AAAS) the very poor mobilisation of the results from sophisticated approaches, the political debate remaining focused on simple quantitative data (where are the beneficiaries for instance) and driven by anecdotal evidence (the 'exemplary cases' mobilised enabling to give flesh and provide images to an otherwise rather 'technocratic' discussion, even more so when they are controversies on the models used and the parameters they mobilise).

This triggered the will of INRA, when asked by AERES to develop the analysis of its impacts in society, to initiate a review (Collinet 2010) and from it initiate a research project with the ambition to develop an approach that (i) takes a broad view of effects, (ii) has the ambition of becoming a 'standard' within agronomic research, and (iii) combines quantitative and qualitative methods. The ASIRPA projects gathers 7 researchers and is organised in two phases, the first one (2011-12) being dedicated to a first conceptual elaboration and initial testing.

Four considerations organise the deployment of the approach we are experimenting:

The first consideration derives from repeated results observed in impact studies. Like publications, there is an asymmetric distribution of effects between the individual components of the programme or organisation observed, and, even if it does not follow a Lotka law, the core of effects observed from a portfolio of research projects /activities is concentrated on a limited number of such projects/activities. For instance, an evaluation of CGIAR (that gather the international agronomic research centres) demonstrated that one innovation (Cassava mealybug) represented 80% of total impact measured in sub Sahara African and that economic benefits derived exceeded total CGIAR investment in Africa since 1971.

This consideration has important consequences. It means that the core effects of an organisation at a given time are borne by a limited number of its activities. The sentence 'at a given time' is critical. Such impact analysis observes effects that have taken place, thus derived from past activities. There may be more recent activities that may bear important potential effects, so that, five years later after the first analysis, a new analysis of the effects of the organisation may be borne by a different set of individual activities. What is stable over time is the asymmetric distribution. Focusing impact analyses on these activities is thus enough to identify the core effects. It opens the road thus to work from a "reasonable" number of cases (the flesh needed) and to mobilise micro approaches for impact measurement.

It requires however that an organisation is able to identify such cases, and also that the cases provide an adequate image of the variety of activities undertaken by the organisation (otherwise impact becomes the remit of a specific division of the organisation while the others remain in other paradigms). In the case of INRA there is a database of 'faits marquants' (key results), may these be articles in Nature, a new patent, a new breeding technique or new agronomic methods. Developing a characterisation (though a complex codification process) has enabled us to define a limited number of impact configurations and their corresponding 'vectors of output' and also have a view of their distribution. This has fed into an interactive process with the 14 heads of departments to define with them the critical activities (in term of 'quantity/quality of impact'), but also discuss other 'productive situations' that, though generating 'less' impact are exemplary of the type of impacts research done in the department generates.

The second consideration is linked with the fact that impact observed is the results of the involvement of an heterogeneous set of actors over a long period of time during which actors appear and disappear, they deploy different activities (they change role). These networks of actors associated with the effect generated render difficult any robust analysis of causality. This is why we share the approach proposed by Spaapen (2011) to replace attribution by contribution. This however requires that the approach is able to describe the mechanisms through which this contribution is made. To do so, we propose to adopt the approach of CGIAR (2008) about the impact pathway which enables to look at conditions through which: (a) the research outputs were produced, (b) these results were circulated (taking on board the critical importance of intermediaries and mediators, and of the productive interactions in which researchers have been engaged, cf SIAMPI project), (c) the direct effects generated (often called outcomes), and (d) the broader, often indirect, effects that derived (called impact in the CGIAR method). We have witnessed in our interactions with policymakers the misunderstandings generated by the use of outcomes and impacts. This is why we use the notions that remain more open of first level and second level impacts. These impact pathways are important since they enable to identify the role that early engagements can play in the later trajectory of innovations.

The third consideration is linked with the fact that most impact assessments are linked with well delimited sets of projects, linked to the funding allocated by an external body to the researchers. There have been multiple works to discuss the 'project fallacy', meaning that funded projects are often simply slices in a broader set of activities. There has been discussions about the importance of downstream phases and of investments associated to generating the impact. When looking at an organisation and its activities, it may not be enough to look at the individual project that generates the productive interactions and the impact analysed. Account must also be taken of the accumulated knowledge. Where to go and where to stop, has no 'one size fits all' answer. This ex-

plains why the approach requires to complement the impact pathway by a characterisation of the productive configuration and its dynamics. For this two tools have been developed which establish a chronology and enable a standard description of productive situations.

We have thus developed a 'standardised method' for presenting and analysing the cases selected. This was done on six initial cases which helped us stabilise the method, which is now tested on another round of 10 cases. These cases play a triple role: they feed into the overall impact analysis, as such they can be mobilised to render the ways in which INRA generates impact more visible, they also are intended to develop reflexive capabilities by actors themselves as a source for learning on the relevance and limitations of given mechanisms, but also on substance, the effective pathway taken for a given innovation.

The fourth consideration deals with the observed vector of impacts. Multicriteria analysis drives to put on the forefront a vector of impacts. And de facto in our initial cases we have observed this variety of impacts (this has enabled us to build a characterisation grid that complements the standardised case). But we have also observed that the distribution is often very unbalanced, one type of impacts dominating. Our experimental approach for the time being is to work on one or more physical indicators that enable to capture this impact, with the assumption (verified up to now) that such indicators already exist and can be mobilised (like the treatment frequency index for an new apple resistant to scabbie). These indicators remain specific and rooted in the cases. If we wish to arrive at a more general measure of impacts, they need to be translated in a wider level indicator or index of the type of impacts it corresponds to (as done by Larédo et al when characterising the different engagements of research labs, see the research compass card, 2000 and 2001). This is still work in progress, but our on-going effort is not to jump to financial translations, but remain at the level of physical indicators, leaving to a later stage potential second-order translations into monetary units.

At the conference we will be able to present our first tested results and thus open the discussion with the audience about this type of approach that mix a global analysis of the impacts of an organisation with the in-depth understanding of the activities and processes that generated it.

Innovation as a Nonlinear Process and the Bibliometric Perspective

Loet Leydesdorff¹, Daniele Rotolo², Ismael Rafols³

¹*Amsterdam School of Communication Research (ASCoR), University of Amsterdam,
the Netherlands*

²*SPRU Science and Technology Policy Research, University of Sussex, UK*

³*INGENIO/CSIC-UPV, Universitat Politècnica de València, Spain.*

(1) Motivation

Among the Flagship programs of the EU in preparation, FuturICT calls specifically for transformative governance "by developing new scientific approaches and combining these with the best established methods in areas like multi-scale computer modeling, social supercomputing, large-scale data mining and participatory platforms" (at <http://www.futurict.eu/>). Helbing and Baliatti (2011) further elaborated the program in terms of an "innovation accelerator."

A bibliometric perspective on innovations is difficult to obtain because innovations by definition occur across scientific, technological, and economic domains that have been archived using different databases and classifications, and from different perspectives. Whereas bibliometrics has focused on output indicators of the science and technology system such as publications and patents, economists consider patents and other knowledge carriers as input to "total factor productivity" (TFP). As Griliches (1994: p. 14) noted "our current statistical structure is badly split, there is no central directions, and the funding is heavily politicized."

Furthermore, given the non-linear nature of innovation processes feedback loops between different stages can be expected to prevail (Kline & Rosenberg, 1986; Nelson & Winter, 1982). For the study of knowledge-based innovations, one would need to be able to move from representations of contexts of discovery to contexts of application, and vice versa (Gibbons *et al.*, 1994), and map path-dependencies, yet without losing control about how the interacting systems are further developed, both recursively and in relation to one another.

(2) The approach

The Medline/Pubmed database is indexed from sixteen different perspectives. Among these (virtually orthogonal) branches, three are most relevant for the process of medical innovation: (i) "Diseases" (category C), (ii) "Drugs & Chemicals" (category D), and (iii) "Techniques and Equipment" (category E). Agarwal & Searls (2009) proposed data-

mining using "Diseases" as an operationalization of "demand" (or "need"), and "Drugs and Chemicals" as indicators of "supply." Different from this linear model, the mapping in terms of perspectives on the data enables us to visualize interactions (e.g., in animations). Building on previous mapping efforts (Leydesdorff & Bornmann, in press; Rafols *et al.*, 2010), we aim to develop and test software for a potential upscale at the same time of developing the project empirically and theoretically.

Because the different domains operate upon one another as selection environments – and since selection is deterministic – one can expect specific trajectories of innovative ideas to consist of relatively fixed sets of steps and phases (De Nooy & Leydesdorff, in preparation). In the case of RNA Interference (RNAi), for example, Leydesdorff & Rafols (2011) distinguished between a first stage of preferential attachment to inventors which they associated with Schumpeter Mark I or mode-1 research, and after standardization an oligopolistic dynamic between centers of excellence in metropolitan areas ("creative accumulation"; Gay, 2010; Soete & Ter Weel, 1999).

Can sets or patterns of interactions be distinguished as innovation trajectories? In this study we develop the tools for exploring this question in terms of relevant visualization techniques and apply these to the single trajectory of RNAi that we previously studied in terms of patents in the USPTO database (Leydesdorff & Bornmann, in press), and publications in the *Science Citation Index* (Leydesdorff & Rafols, 2011).

(3) Expected results

The full Medline/PubMed database 2010 was used for generating a baseline map. These approximately one million records are attributed with of the order of ten million Medical Subject Headings (MeSH). After an exploration of using a single of the branches ("Diseases") and all 16 of them, we focused on the three branches mentioned above, and developed an overlay technique for the 822 MeSH at the second level of the index which form a largest component in and among these three domains. Base maps were constructed for visualization using Pajek and VOSviewer. These two network visualization programs are based on graph-analysis and multidimensional scaling, respectively.

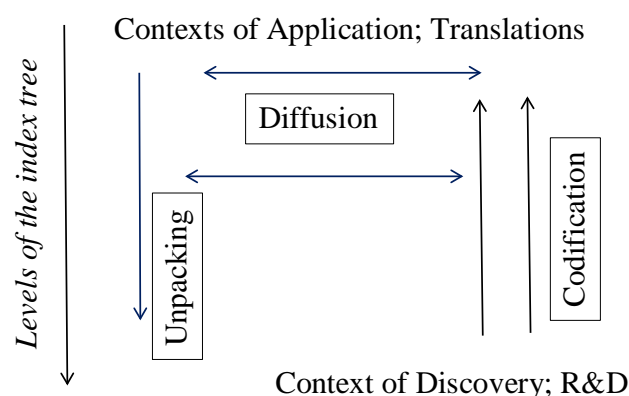
Software is made available at <http://www.leydesdorff.net/pubmed> which enables users to make overlays to the map of these three domains in terms of different colors and labels. As an example, we downloaded all papers in the PubMed database using an informed search string about RNAi for each consecutive year. The animations for the period 1998-2010 can be retrieved at www.leydesdorff.net/pubmed/rnai_vos.pps and www.leydesdorff.net/pubmed/rnai_paj.pps using VOSViewer (MDS) and Pajek (Kamada-Kawai), respectively.

RNAi was first (1998-2002) developed at levels of the database more specific (and deeper) than the second level and thus not visible for this "radar." The MeSH terms "Nucleotides" and "Proteins" appear in the semantic domain of the second-level index categories as early as 2000. After the turn to a diffusion dynamics in 2002-2003 (Leydesdorff & Rafols, 2011), the indication at the second level shifted from the chemical composition ("Nucleotides") to functionalities such as "Genetic Techniques", and thereafter also to "Diseases". As of 2005, the focus on "Prognosis" became more dominant in this representation than "Genetic Techniques."

In a further extension, we decided to develop a similar routine in which all lower-level index terms are collapsed at the second level of the index and thus mapped into the same projections. This enriched the visualization, but did not significantly change the (eigen-)structure of the network. In the case of RNAi, 486 MeSH categories occurring 515 times in the set of 112 documents with publication year 2000 were collapsed into 25 MeSH categories at the second level. In 2003, however, 1,197 (that is, ten times as many) documents show a structure that can be compared with this earlier structure in 2000.

In other words, the relevant environments were already visible in an earlier year, but the finer-grained distinctions in the scholarly literature reach the higher levels in the tree structure of the index only in a later year. These dynamics are reminiscent of the dynamics between "restricted" and "elaborate" discourses, which change over time. Latour's (1987: 226f.) "mutable immobiles" also indicate this alteration in innovation processes (Figure 1).

Figure 1: Two stages of permeation into the database in terms of levels of the *Index Medicus*



(4) Conclusions and policy implications

Patterns can serve as signatures of innovation trajectories and their starting parts allow for the identification of emerging and developing innovation trajectories, which are prime candidates for targeted support (early warning indicators). Bibliometric and semantic analysis can extract the networks from large databases of publications, patents, and so on. Efficient algorithms for the detection of signatures as small subnetworks in large sparse network are available. They can be further developed to handle the temporal dimension of signatures and the multi-relational character (cooperation, citation, co-citation, co-affiliation, concordance, alliances, and so on) of the networks (De Nooy & Leydesdorff, in preparation).

In a further extension of the empirical work, we first envision integration of PubMed data with patent and citation data. Geographical spread of innovations by projection upon Google Maps can enrich the institutional perspective. The base maps and different overlays in this and other studies thus provide us with an agenda and heuristics of how one would be able to study the dynamics of emerging technologies from a bibliometric perspective.

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Demand-side Innovation Policies in Promoting Mission-oriented Innovation – the case of New Energy Vehicles in China

Yanchao Li

*Manchester Institute of Innovation Research (MIOIR), Manchester Business School,
The University of Manchester, UK*

Mission orientation is required for innovation policy nowadays to face the challenges of climate change, energy shortage and sustainable development. Although policy tools such as R&D support and tax reduction can effectively motivate suppliers, diffusion is normally difficult under pure market conditions as private consumers tend to be unwilling to pay for innovative solutions due to their high costs and uncertain performances. Hence individual policy instruments are insufficient to support mission-oriented innovation along the value chain. A transition towards systemic usage of mixed policy tools from various aspects is in great need, which makes the policy making, implementation and evaluation processes much more challenging. Demand-side innovation policies (hereafter DSIPs), defined as 'public measures to increase demand for innovations, to improve conditions for the uptake of innovations or to improve the articulation of demand in order to spur innovations and allow their diffusion', include regulations, standardization, innovation-oriented public procurement (hereafter IOPP) and consumer policies. They have been gaining ground in both academia and political arena in recent years, and recognized as complementary elements with supply-side policies and other measures which aim at improving framework conditions. In particular, IOPP is considered most efficient and powerful in terms of stimulating the commercialization of innovative solutions since in this approach the state can play directly as lead users as well as indirectly as coordinators to create lead markets.

In practice, many countries have started to utilize DSIPs to stimulate innovation especially in mission-oriented areas such as green technologies and SME development. Examples from OECD countries include the Australian 'Climate Ready' program, the EU 'Lead Market Initiative', the US 'SBIR' program and the Japanese efforts to promote international standardization. This trend has been actively echoed by China. The Chinese *Guidelines on National Medium- and Long-term Program for Science and Technology Development (2006-2020)* explicitly emphasizes the necessity of systemic usage of public procurement and standardization together with fiscal and financing measures to stimulate 'indigenous innovation', especially in strategic areas related to sustainable development, e.g. energy saving and new energy technologies. Despite the increasing interests of policy makers, the implementation process and impacts of DSIPs are yet to be evaluated.

This paper aims to investigate this phenomenon in the context of the 'energy saving and new energy vehicles sector' (hereafter NEV sector) in China. Considering that the nature of the research objective is explanatory as well as exploratory, case study is selected as the research strategy. Primary data used in this paper include elite interviews with 12 respondents (4 NEV suppliers, 6 government officers, 1 manager from a public transport company and 1 private consumer who meanwhile works in a well-known NEV manufacturing company). Secondary data were collected from policy reports, government and firm documentation and mass media. The analytical framework is based on two approaches. The first is policy analysis with a focus on rationale justification in comparison with NEV promoting policies adopted in the EU context. The second is micro-level analysis, i.e. two sub-case studies that include concrete IOPP processes. The first sub-case is the procurement of hybrid & electricity buses for Universiade Shenzhen in 2011, and the second sub-case is the procurement of hybrid & electricity buses and taxis in the city of Jinan. Both cities were selected as NEV demonstration cities in the first batch in 2009.

There are preliminary results at this stage. Comparison of policies adopted in China and in EU is conducted with similarities and differences identified. The starting point in the Chinese case is more complex and the feature of mission-orientation is more obvious – besides social needs and common challenges of sustainable development, the 'indigenous innovation' scheme has been the main driving force and the Chinese government aims to develop domestic NEV technologies to overcome the drawback of traditional auto industry. We can see clear catching up intention in China's NEV policy mix. Meanwhile the challenges facing China are more complicated due to this scheme. Favouring domestic/local products on one hand led to imperfect competition conditions on the other, which can be a barrier for IOPP to function well. In EU, major DSIP tools adopted include regulations, standardization (about emission limits and core technologies etc.), demonstrating program (mainly public transport) and consumer subsidies for purchasing NEVs. China covered all of these instruments, and some other measures in addition. For example, China also produces lists of approved NEV models, which is a signalling approach to bridge the communication between suppliers and users. In many localities, private consumers enjoy subsidies not only when purchasing cars, but also when paying for toll and parking fees. In big cities such as Beijing, there are featured stimulating measures, e.g. for NEVs the 'lottery for plates' is not required, and NEVs can go on to the road seven days per week instead of six for traditional cars. Another measure is that China selected demonstration cities to create lead markets for promoting NEVs. The central government allocates 3-year targets and considerable funding for participant cities and leave space for them to tailor their own NEV policy mix and implementation mode. Particularly it is identified that between 2009-2011 the main fo-

cus of most participants was on development of public transport e.g. buses, taxis and logistics vans. Since late 2011 there are emerging public procurement cases in which local government organs purchase hybrid & electricity cars for everyday use. This shift can be more stimulating for private customers. The 'demonstration cities' approach is efficient in terms of articulating demand, but there are risks associated e.g. regional protectionism in favour of local NEV suppliers, which also leads to duplicate production and a waste of resources.

Downstream impacts and practical issues are investigated through the two IOPP examples. Positive impacts include (to a limited extent) improving product quality, raising awareness, accelerating the building of charging facilities and lowering costs. However, a list of challenges can be drawn according to feedbacks from stakeholders, including uncertainty of technological roadmap (hybrid or pure electric), technological bottlenecks, difficulty to mobilize private consumers and a lack of facilities that requires better coordination with other policy tools. While the first two challenges are specific for China, the latter two are common challenges now facing the EU as well.

To better utilize DSIPs to promote NEVs in the context of China, the building of framework conditions seems to be most relevant, e.g. reforming the institutional setup to prevent departmental conflicts, rebuilding a more international public procurement system to protect competition, improving capacity for both procurers/users and firms. In the context of EU, further diversification of DSIP tools to support private consumers is needed to better articulate demand.

Local leadership transforming governance to support locality eco-systems for innovation

Su Maddock

Manchester Institute for Innovation Research, The University of Manchester and University of the West of England, UK

Motivation

In the current environment, political commentators draw attention to the need for new social institutions and governance that will both, socialise business and its growth, as well as add value in the public domain and create more innovative public services. Public innovation is currently hampered by institutional practice, poor public procurement and too little financial investment. The economy and communities are suffering from too little emphasis on systemic, governance support for locality innovation strategies that stimulate innovation in both business and the public service.

In spite of twenty years of public sector reform and five years of public innovation policy in the UK that endorses local engagement in service innovations, central government continues to assume responsibility for driving change and for determining the framework for innovation in public services and business, in spite of the Coalition government's *Localism* Policy. Innovation theory is also dominated by a focus on top-down, structural change and business models, rather than on the significance of local determination and leadership capacities.

Approach

The hegemony of government led innovation strategies has resulted in too little research on locality leadership and/or locality eco-systems for innovation or that tracks the emergence of new governance frameworks or the agents driving them. To counter this the author will present examples of cities in the UK where locality leadership is collaborative and seeking to support business growth, innovation and local resilience, and in doing so also transforming the local public governance architecture. The tracking the role of locality leadership and new innovation ecosystems, can provide the evidence for policy-makers of how to better support transformative governance where it is occurring – in addition, this type of research methodology can better inform policy-makers of the underpinning relationship between social agency/participation/leadership (capabilities) and policy objectives. Innovation policy has ignored the dynamic role of social agents in governance and innovation which in turn has led to poor intelligence in central government and a lack of confidence in alternative social systems at the local level.

Findings

Austerity measures and a renewed political energy for localism, locally and nationally is motivating local leaders to find better ways of working across sectors, being more strategic as place-based leaders; as opposed to their continuing to be either public leaders or business leaders. After ten years of pursuing a single track approach to public service innovation, local leaders are now developing more integrated and place –based approaches to stimulating innovation. In the UK, those places, where business and the public sector partnerships are strong, political, business and community leaders are beginning to recognize the need for a locality based perspective and seek to stimulate both business growth and local people's resilience and well-being.

Evidence is presented from cities in the UK – Bristol, Manchester, York and Plymouth. Local leadership in university cities is becoming much more inclusive of business, particularly of the creative and corporate industries; they are also becoming less ideological and politically tribal, and in so doing developing whole-system, integrated and systemic approaches to the local economy and to intransigent problems, such as inequalities, unemployment, housing, waste, health-care and a skills deficit.

Impact

This presentation will show how some innovative local leaders are forging new locality eco-systems and transforming governance arrangements in their cities- evidence which is much needed in the UK. The question for policy-makers is how to stimulate systemic innovation to the support the above and develop the leadership capabilities capable of transforming governance. Early findings show that locality innovation platforms are necessary to support the connectivity that innovation uptake and flow demands; the implications for central government being that their role is to direct less and develop the intelligence and capabilities to support locality governance frameworks, more .

Understanding Evaluation of Science and Technology Policy in a multi-level Governance Context

Edurne Magro

Basque Institute of Competitiveness and Deusto Business School, Spain

Motivation of the paper

Regions constitute a complex policy space due to the interaction of policies administered at different levels. Multi-level governance of STI policy has become an important issue in the literature, increasing the importance and definition of regional policies as a consequence of the systemic view of innovation and the application of the regional innovation systems concept into policy-making. Therefore regions have become policy spaces in which policies at different administrative levels are being felt (Uyarra and Flanagan, 2009).

Multi-level governance, together with the broader conception of innovation, affords more complexity to the STI policy-making process – especially in regions – from definition through to policy evaluation. Policy evaluation is an important stage of the policy-making process due both to the need for analysing the real effects of the policy, which is related to accountability purposes, and the need for improving the understanding of policies themselves, thus linking evaluation to policy learning purposes.

Policy evaluation is related to the concept of additionality, which tries to capture the additional effect of policy. It means that policy intervention is only justified if it generates an additional effect that would not have occurred in the absence of the policy. In the literature different types of additionality can be identified: input, output and behavioural additionality (Georghiou, 1994; Bach & Matt, 2002; David et al. 2000; Heijs, 2001; Herrera & Heijs, 2003, 2007; Georghiou & Clarysse, 2006; Autio et al., 2008; Clarysse et al., 2009; among others). The first two additionalities (input and output) are associated with the neoclassical approach (Metcalf and Georghiou, 1998), whereas behavioural additionality responds to an evolutionary-systemic approach (Georghiou, 2002, 2004). Nevertheless, behavioural additionality should be understood as a complementary effect of input and output additionality more than a substitutive effect (Clarysse et al. 2009).

Input and output additionality have traditionally been measured following quantitative approaches, whereas behavioural additionality is normally measured by qualitative approaches due to the fact that it is difficult to capture behavioural effects through quantitative analysis. Moreover, additionalities are commonly analysed in a separate way and do not take into consideration interactions among different policy additionalities.

ties. Indeed, STI policy evaluation has not evolved at the same speed as policy, and it is difficult to find empirical evidence of evaluations carried out following a systemic and multi-level perspective.

Therefore regions or any other policy space might be defining STI policies without taking into account potential effects derived from interactions among rationales, domains and instruments from different administrative levels. This fact is important for the understanding of current STI policies and in order to improve the whole innovation system and optimise the resources assigned to it. Such concerns are heightened bearing in mind the current financial crisis, in which context it is not only important to assess the effectiveness of public resources, but also to understand interactions among policies that are produced and what effects these have. Assessing these effects will enable better design and implementation of such policies, thus maximising their impacts. Therefore, evaluation of STI policies constitutes an important tool for contributing to policy learning, taking into account policy complexity and budget restrictions.

The main aim of this paper is to improve the understanding of S&T Policy by analysing the differences in effects of STI policies from one isolated level of governance to a multi-governance level, leading to complex interactions among different policies in a certain territory. Therefore, this paper considers the innovation policy system as a whole and evaluates the impacts of the different policies at different levels, instead of considering only the impacts of these policies separately.

Approach

This paper uses a specific case study for its analysis. This case study is focused on a concrete S&T policy from the regional innovation system of the Basque Country, Spain. More concretely, we will base our analyses on the main R&D programme of the region (the INTEK programme).

The Basque Region is an Autonomous Community composed of three "historical territories" which enjoy important competences, including tax collection. In fact, there is no region in the EU that enjoys more political autonomy than the Basque Region does (Cooke and Morgan, 1998). This is one of the reasons that motivated the choice of the Basque Region for the case study, as it provides a valid framework for analysing a regional policy, which is part of a complex policy setting that overlaps sub-regional, regional, national and international policy arenas.

The focus of this research will be on the measurement of different additionalities (input, output and behavioural) on firms located in the Basque region by differentiating the

effects of a regional programme in isolation (the INTEK programme) or the whole funding system administered and implemented at different levels.

This paper explores a triangulation methodology for evaluating S&T policy. It proposes an approach that combines a quasi-experiment, concretely a matching protocol, (quantitative technique) with semi-structured interviews (qualitative technique), therefore giving a holistic view of policy impacts from different administrative levels.

Results

Results obtained from this research show differences in additionalities, taking into account the level of the programme implementation.

Specifically, in this research we find that some additionalities, such as input additionality, that are more dependent on resources are not achieved by the regional policy in isolation but by the combination of policies at different levels. On the other hand, effects such as those with regards to behavioural additionality or collaborative and interactive patterns seem to be effectively achieved by a regional policy as it involves mobilizing regional agents and creating social capital that is more easily reached in lower territorial levels due to proximity effects.

Summarizing, in this paper we demonstrate that policy effects on firms vary depending on the level of the implementation of the policy and that complementary effects might occurred as a consequence of the combination of multiple policies administered at different levels.

Conclusion and Policy Implications

Policy has evolved from a linear conception to a more complex view in which different policies interact at different levels following an evolutionary perspective. In regional policy these interactions are even higher than with respect to national policy. Regions can be considered as policy spaces in which different policies impact; they are overlapping spaces in which different policies from various level of implementation interact (Uyarra and Flanagan, 2010). This policy complexity should be followed by a new approach for capturing these effects in regions. That is to say, a new evaluation approach should be defined in order to cope with these challenges.

In this research we provide an evaluation framework that takes multi-level considerations into account. Through this approach we find different effects depending on whether an individual or systemic evaluation approach is adopted. Indeed, some crowding-out effects are avoided when considering the whole policy system. This im-

plies that there is a risk of implementing policy decisions following the results of individual evaluations rather than a systemic one. This latter type of evaluation could demonstrate complementary policy effects that would not have been achieved considering each policy in isolation.

Furthermore, a multi-level evaluation provides an integral view of the suitability of some instruments at different policy levels. Therefore, as Koschatzky and Kroll (2007) argue, there are some policies that should be better implemented at national level as major effects can be produced with this scale and scope. On the contrary, there are some policies more appropriate for regional level due their characteristics. These are programmes aiming at fostering cooperation among regional agents and firms, for example, rather than those mainly based on resources such as the establishment of a physical infrastructure for Science and Technology, for example. Nevertheless, in any case regions should develop regional governance capacities to effectively implement S&T policies at regional level. According to Walendowski et al. (2011), regional governance capacities are those referring not only to sufficient autonomy and resources, but also to sufficient human resources and competences to effectively implement policies.

Summarizing, there are policy measures more suitable for implementation at regional level and others that should be implemented only at other administrative levels or at least at various levels at the same time, looking for complementary effects. The success of this implementation will depend on the governance capacities regions have developed. It is therefore important to know the different effects of policies implemented at different levels and evaluating these effects from a holistic point of view in order to better design and implement S&T Policies with impact in a certain territory.

Transformation of European Governance via Integrated Policy Approaches – Challenges and Opportunities

Nina Maier

Bremen International Graduate School of Marine Sciences GLOMAR, University of Applied Sciences Bremen, Germany

Motivation

The European Union is constantly on the move. For a long time, most EU policies have been characterized by their strong sectoral focus. This approach has not always led to optimal policy outcomes, as measures within the same field sometimes had contradictory or even conflicting goals. More recently, it seems that the Union is reconsidering this practice and increasingly promoting more encompassing policy concepts. One example is the Lund Declaration, which postulates a "move away from current thematic approaches".¹ In other policy fields, this new framing of policies has already advanced from a mere declaration to actually adopted EU legislation. In the Union's water policy, two examples of so-called integrated policies can be found. The aim of the Water Framework Directive from 2000² was not only to merge formerly piecemeal regulation into one coherent framework, but also to introduce an ecosystematic approach. This includes that waterways as a whole are addressed, requiring riparian Member States downstream to cooperate. The Marine Strategy Framework Directive (MSFD)³, adopted in 2008, follows a similar strategy: a number of different sectoral approaches to marine environmental policy shall be replaced by one coherent, so-called integrated framework (Markus et al: 2011; Long: 2011). The anticipated goal of the MSFD is to overcome the experienced failure of governance (Crowder et al: 2006), which led to the degradation of the European seas. Marine regions thereby set the ground for coordinative action between riparian Member States.

Whereas coordinating formerly separate measures in highly fluctuating ecosystems seems plausible, the example of the MSFD also clearly reveals the significant challenges these new encompassing approaches entail (Koivurova: 2009; Juda: 2007). As the structure and the capacities of the Commission by no means allow to adequately set out detailed provisions and requirements of such complex Directives, and just as

¹ 2009 Lund Declaration, p. 2.

² Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for community action in the field of water policy.

³ Directive 2008/56/EC of the European Parliament and of the Council establishing a framework for community action in the field of marine environmental policy.

little to monitor their implementation, an adjustment of the roles of the involved actors is needed. This holds true for the horizontal dimension, thus the supranational level, as formerly separated Directorate Generals need to cooperate more closely. But also the vertical dimension partly experiences redefinitions. Whereas the Member States' competences to actively design policies have been increased, the Commission's role increasingly shifts into becoming a manager of EU policies.

Approach

Central questions of this project include:

- How can the EU face the challenge of promoting innovative encompassing policies within the limits of a given institutional framework?
- By which means can the EU support broad policy objectives while at the same time preventing deficient implementation?
- Does the constellation of actors involved experience adjustments? Do new (regional) actors experience the possibility to access the European arena?
- Is the MSFD evidence of a general paradigm shift in EU regulatory policies? Which effects can be expected for other policy fields?

A process oriented analysis of EU policy making lies at the core of this research. It includes the analysis of the horizontal, thus European level, as well as the vertical level, focusing on changing modes of interaction between the EU and its Member States. For the European level, mainly the concept of path dependency can provide useful insights on the scope of possible cooperative action among the different Directorate Generals. This holds true for the horizontal dimension as well, but in this case, also the concept of multi-level governance can set the analytical framework for the changing roles of Member States and European institutions as well as the emerging intermediate regional levels.

Results

For the EU's marine environmental policy, the analysis provides evidence that the European Commission is proactively promoting regional approaches as a means to on the one hand promote broad policy objectives, and on the other hand to avoid deficient implementation by creating binding effects at subordinate levels. This proceeding seems to be a necessity for the Commission as it does not have the capacities to transpose increasingly complex regulations. Moreover, achieving consensus among a rising number of Member States on increasingly complex and ambitious policies is likely to fail. Therefore, it seems that the Commission introduces regional cooperative arrangements in order to transfer the decision-making problem to subnational levels. It is

assumed that Member States' interests are similar within one region, which would facilitate decision-making procedures as well as be beneficial for the implementation process.

In the course of this process, the roles and assignments of the involved actors undergo transformations. The European Commission, traditionally the initiator of new policies and concerned with monitoring their implementation, more and more develops into a manager of policies, transferring certain competences to the Member States. They, in turn, remain the addressees of the EU Directives. However, the requirement of regional coordination with other Member States limits their sovereignty in achieving encompassing policy goals. Yet, this limitation is partly balanced by the possibility to define action plans as well as particularly the final status the subject of regulation, namely the marine environment, shall achieve within a marine region.

Conclusion

The EU's aim to overcome sectoral approaches to regulation by promoting overarching policy objectives seems reasonable. Some of the expected benefits include the possibility to address interactions between formerly separated sectors, enabling developing coherent approaches and the possibility for overall better policy outcomes.

However, in light of rising numbers of Member States, broad frameworks entail a number of risks, inter alia of deadlock in the decision-making process, as consensus among actors with greatly varying interests can often hardly be reached. New concepts of governance are therefore sought. The example of the MSFD indeed shows that the new focus on integrated policy approaches entails adjustments in the modes of EU governance. These alterations provide the possibility for regional actors and stakeholders to play active roles in the policy making process as well as at the implementation stage.

So far, similar arrangements can only be found in the EU's environmental policy. It seems that the ecosystematic focus facilitates building trust as the basis for cooperation and finally also for the successful implementation of integrated policies. In order for other policy fields to make use of this approach as well, a systematic connection and similar interests can operate as useful links for establishing cooperative arrangements.

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Tracking synergies between energy security of supply and the development of the wind energy industry in Spain: An approach from a multilevel policy analysis

Cristian Matti, Rodrigo Martinez Novo, Mayte Lopez Ferrer

Institute of Knowledge and Innovation Management Institute INGENIO (CSIC-UPV), Spain

1. Introduction – Motivation

Renewable energy has been a staple of the international policy agenda since the second oil crisis (1979). In its origins the source for alternative energy sources emerged as a result of scarcity of natural resources combined with the high risks involved by dependence on external energy supply. More recently, the issue of renewable energy has become even more urgent due to increasing societal demand and the pressure to counter, or at least mitigate, the effects of climate change. This has given way to a wide ranging spectrum of policy experiments aimed at promoting alternative energy sources and the associated actions for industry promotion.

The objective of this paper is to review critically the strategies for pursuing energy security of supply and for supporting renewables industry in Spain. We focus on a particular subset of strategies aimed at supporting the wind energy industry by focusing on government and industry response to the current multilevel framework on energy and environment (Corfee-Morlot et al., 2009, Bulkeley, 2005, Hooghe and Marks, 2003). To this end we analyze government activity at the point of delivery (Hogwood et al., 1984) by considering the dynamics of need emergence and policy response underpinning the build-up of a new market.

Our key objective is the identification of two key dimensions of policy-building. First the set of priorities, strategies and goals, perspectives and the activities stemming from them; second, the mechanisms that facilitate interaction across agents (e.g.: regulations, availability of resources and economic instruments such as subsidies and technical support). The study seeks to make sense of the multi-level policy portfolio (EU, central and regional Spanish governments) by considering studies on the impact of EU measures in the Spanish context (de Alegría Mancisidor et al., 2009; Montes et al., 2007), institutional barriers and drivers for the introduction of new technologies (del Rio and Unruh, 2007) as well as the stability and flexibility of policy instruments (Perez and Ramos-Real, 2009). In so doing this analysis seeks to advance understanding of policies reformulations toward further alignments between public goals, private motivation and a competitive environment.

The paper will frame the debate on rationales for government intervention not only by considering the promotion and supporting of new markets (Salmenkaita and Salo, 2002, Mazzucato, 2011, Manseau and Campagnac, 2005) but also the intuitional capacity (Künneke, 2008) and governance structures (Bodas Freitas and Von Tunzelmann, 2008, Busch et al., 2005, Jordan et al., 2003) (Morata and Font, 1998). At the same time, specific issues in the energy industry will be highlighted by focusing on structural characteristics such as stability, creation of specific capabilities and competitive energy market conditions (Enzensberger et al., 2002; Moselle, 2011; Lewis and Wiser, 2007).

In order to address the changes in policy intervention and industrial response we apply techniques for document review, document content analysis and discourse analysis to a variety of official texts and business documents. This will facilitate the identification of "patterns of relationships" such as "expressions regarding favourable position to different decisions and actions" as well as linkages across different action points.

2. Summary of the case

Spain has been extremely successful in promoting the production of wind energy. Early individual initiatives on wind turbine in the 1980s were financed by dedicated energy agencies and investment subsidies based on government purchases. In the 1990s new laws heralded a new era of mandated contractual purchases of electricity by companies and a more competitive market structure (see Fig. 1). Additionally a new regulatory framework has been introduced, including a tariff scheme that reduces private risk and guarantees the profitability of Spanish companies. Finally, in 1999 a long-term strategy was introduced through the Plan to Promote Renewal energy, establishing a set of rules, incentives and objectives for 2010 (Perez and Ramos-Real, 2009).

As a result of the described policy and the correspondent business response, Spain has become the Europe's second and the world's third largest wind energy market. The growth of wind power in 2007 has been the second in the world market behind the USA and twice as big as Germany – a country that, however, remains leader in the ranking of installed power (GWEC, 2009). Between 2000 and 2008 installed capacity in Spain has increased 7.5 times (compared to 4 times in the case of Germany). Therefore, the Spanish wind energy sector was well-positioned to meet the government target of wind energy capacity by the end of 2010 – and the Spanish Wind Energy Association (AEE) estimates that overall installed capacity can be doubled by getting operational new technologies in onshore and offshore wind farms by 2020. The national wind energy industry started to export wind generators to China, India Latin-America and some African countries (Montes et al, 2007).

Beginning 2008 the economic crisis forced a revision of the foretold strategy. Several measures aimed at reducing the tariff deficit consisted in lowering the subsidies received by wind energy facilities (RD 1614/2010). Furthermore, the most recent reformulation of the subsidies regime (RDL 1/2012) suspended any further action on the new and some of existence wind energy facilities which highlights potential increase in market risk and reduces expectation on the long term strategy for the expansion of the renewals industry.

3. Methodology – Expected results

This paper follows a qualitative approach by applying techniques on "textual content analysis" (Stone, 1997). This will be applied to a variety of official texts and business documents regarding the development of wind energy in Spain¹. The empirical study will be framed by the application of two techniques: semantic analysis and discourse analysis. At first semantic analysis will be applied to identify relationships between the topics searched in the text. Then those topics will be taken as input to follow discourse analysis on the variety of argument representing different positions and perspectives.

More specifically, semantic analysis will facilitate the identification of common topics around the two key dimensions of policy-building described before. Atlas.ti software will be applied to systematize and assess content by means of qualitative techniques ((Mayring, 2000) rooted in Ground Theory. To approach those common topics, the development of a thesaurus² will help to cluster and coordinate the variety of terms founded.

At last, from the inputs developed in the previous step, discourse analysis can be applied to find and represent "patterns of relationships" such as "expressions regarding favorable position to different decisions and actions" as well as linkages across different action points. Those relations will be critical to develop a framework to analyze influence of the policies under study (Hajer and Wagenaar, 2003; Forester, 1993).

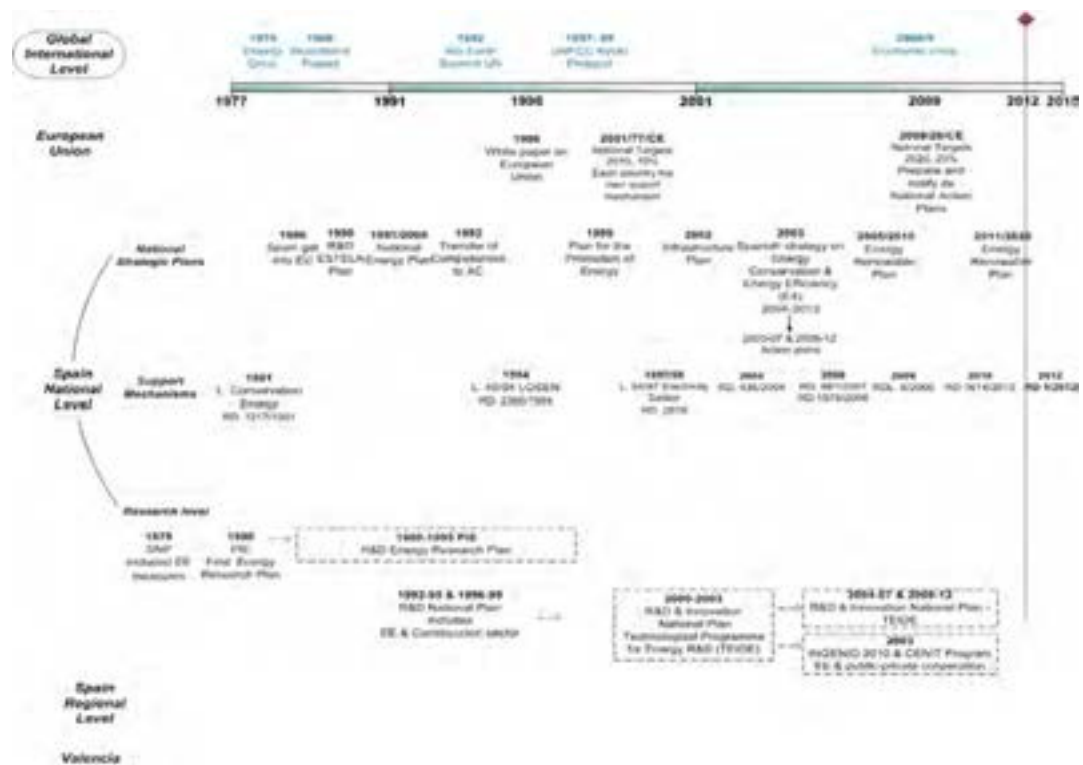
1 The documents include: European policies and initiatives (includes EU directives, and R&D specific programs), National plans on energy sector, Official documents on regulatory mechanisms (laws and royal decrees), Business reports and annual memories of business associations and, Industrial publications

2 Thesauruses are built up by documental technique in order to reduce the volume of vocabulary. They are post-coordinated languages in which the terms represent the themes contained in the document allows. They include a variety of relation between terms (i.e. equivalency, hierarchical and associative) that represent and frame the ideas contained in the document (Lancaster and Graduate School of Library Science (Urbana-Champaign), 1991, Langridge and Langridge, 1992, Maniez et al., 1993)(SLYPE, 1982)

4. Conclusions – Policy implications – expected contribution

The Spanish success in the development of world-leading technologies and the formation of knowledge-intensive networks in the emerging wind-energy industry, provide an excellent backdrop to investigate the interplay between public intervention and the articulation of systemic dynamics of a new market. The last reformulation of the policy instruments challenge the wind national industry to reveal competences acquired during the protected period to operate under competitive conditions. In that sense, the proposed research seeks to highlight chronologically the developmental feedback effects -associated to the set of multilevel policy portfolio- incorporated within the long term sector strategy. By doing so, the study will contribute to a broader reflection on the policy challenges associated to the emergence of a new sector, and particularly to the emergence of industries that respond to pressing societal needs.

Figure 1: Key events and policies on Renewals energy in Spain. European, national and Regional level (1979-2011)



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Using Governmentality as a new approach to innovation policy analysis

Peter Mayr

Centre for Social Innovation, Austria

Structure of the abstract

(1) Introduction, (2) the motivation and research question, (3) theoretical framework, (4) (expected) results, and (5) conclusion and/or (policy) implications of the work

(1) Introduction:

The European Research Area (ERA) occupies a central position in the 'European Innovation Union', one of the seven flagship initiatives the EU has identified to boost growth and jobs over the coming decade (European Commission Communication on Europe 2020). Since 2002, the Commission has funded more than 100 trans-governmental networking initiatives officially aimed at consolidating the ERA by coordinating national research funding programmes and policies with a view to strengthening 'Europe's position in the new global landscape of knowledge creation and innovation' (European Commission website, ERA-NET testimonials). These initiatives are run by national research funding bodies and ministries and include Joint Programming coordination instruments such as the ERA-NET projects or Article 185 initiatives (European Commission Communication on Joint Programming).

(2) Motivation and research question:

Generally speaking, but especially in financial terms, many of these trans-governmental networking initiatives do not seem to have been particularly effective. Compared to the money spent on launching and maintaining them, they have had relatively little impact as far as creating new funding opportunities for multilateral science projects is concerned (FP6 ERA-NET impact evaluation; FP7 Interim assessment; Netwatch website of the European Commission). I therefore argue that the contribution of such coordination endeavours to ensuring Europe's place at the forefront of cutting-edge research is debatable. Instead it seems that network partners tend to take advantage of the trans-governmental networking process to follow their own (national) agendas, facilitated by the flexible character of the projects under discussion. Neither peer pressure nor a sense of shared European identity seems sufficient to overcome this unilateral exploitation. By reflecting on the projects' organisational details and delegates' attitudes and behav-

our, I aim to question existing governance practices and suggest a new approach to analysing processes of policy innovation.

My paper focuses on two projects as case studies¹:

1. ERA.Net RUS – a project that targets the coordination of national funding programmes aimed at supporting research cooperation with Russia.
2. ERA-NET Pathogenomics – a project that seeks to coordinate existing national programmes for funding genome research on pathogenic microorganisms.

I seek to establish whether neo-liberal power games take place within these two networking projects, and then compare and contrast the effects of these with the projects' official objectives, tasks and results. In particular, I investigate the commonly held view that Northern-dominated institutions dictate counts of good governance while non-Northern states are forced to take responsibility for implementing these policies. The analytical framework used is that of the notion of ownership. Who considers themselves to have ownership of an ERA-NET project? Does the engagement of national authorities together with dedicated groups of experts create enough peer-pressure in the European coordination process to overcome fragmentation of national and regional research programmes and policies?

I am not expecting to be able to establish absolute causality in my analysis as to why and how such projects continue to come about and continue to be funded, but rather, focusing on political rationality, to explore the complex circumstances and conditions under which different actors choose to support this particular kind of intergovernmental discourse.

(3) Theoretical framework:

'Governmentality' (Foucault 2004) can be understood as a tool to study networked governance where power is exercised not just nationally or by official supra-national

¹ Both networks have a lot in common. They have ministries and science funding agencies as project partners, develop joint funding and policy scenarios and implement joint calls for proposals for the funding of multi-lateral science projects. These two were chosen out of a group of more than 100 inter-governmental networking projects as both are considered to be particularly successful projects and to be typical of their kind. However, they have also been selected because of their differences: they each represent one of the main types of ERA-NET projects: horizontal/geographic and thematic. ERA-Net RUS is a horizontal or geographic project aimed in the first instance at identifying common ground and objectives with Russia before then turning to particular scientific disciplines to fund. The pathogenomics ERA-NET has a thematic focus from the very beginning. The latter specific difference will provide us with a sample of the full spectrum as regards the coordination of national programmes.

institutions, but also shared by a complex network of institutions, practices, procedures and techniques which act to regulate social conduct. 'Among its essential features is a further questioning of the limits of state power and a focus on the market through the introduction of rules of competition and the construction of an entrepreneurial model of conduct.' (Joseph 2009, p.426)

The aim of the ERA is, officially at least, to encourage competition and a 'free market' in trans-national research funding. I contend however that trans-national research programme networking initiatives such as the ERA-NETs follow complex, nationally-driven agendas which contradict or at least work to undermine the European Union's own strategies outlined e.g. in Europe 2020 or a joint statement of 400 scientists in the Lund Declaration who called for 'a new deal among European institutions and Member States, in which European and national instruments are well aligned and cooperation builds on transparency and trust' (Lund Declaration, 2009).

This paper will use governmentality as its theoretical frame, focusing on power conduct and practices inside and outside of the networks and the interdependence of these two spheres. I will thus seek to deconstruct official political rationalities and the public actions and documents that propagate them. My particular focus will be on the way in which the different actors involved communicate, their social power, expert knowledge and its instrumentalisation (compare Merlingen 2010). Why do single authorities decide to participate and stay in these networks if the outcomes are not those predicted? Why do they contribute resources including time and money? What are their 'real' driving arguments for interconnecting with other European member states' research programme owning (political) and managing of stakeholders?

(4) (expected) results

The European Commission claims that ERA-NET projects will eventually lead to Joint Programming initiatives (of research and innovation funding programmes) which are intended to become key instruments in strengthening Europe's global position as a research and innovation powerhouse, thus helping to combat the 'Grand Challenges' of our time. This paper will critically examine this claim by comparing and contrasting the official pronouncements of the EC, the networks' own publications, comments from secondary literature, statements by experts and interviews with network participants in the above mentioned cases. I will reflect in which respects these two projects could in fact 'turn into sustainable solutions in areas such as global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics or security.' (Lund declaration, 2009)

This attempt at critical reflection will contribute to the general discussion on how European research governance could strengthen Europe's position in the world. I try to prove that post-structuralist approaches such as governmentality could be applied to multi-lateral innovation policy evaluation. In practical terms, my results could eventually lead to a rethinking of the way in which RTD policy is implemented, helping national and European stakeholders understand better what they are doing and why.

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Public-private partnership research cooperation

Dirk Meissner

*Institute for Statistical Studies and Economics of Knowledge, National Research University -
Higher School of Economics, Russia*

1 Motivation

Public Private Partnerships (PPP) are becoming increasingly important in many places. Particularly in the areas of infrastructure and public services, cooperation between public and private actors is frequently seen as an alternative – in some countries even as a panacea – to privatisation and state control. In addition to the current PPPs, especially in building and the transport infrastructure, in recent years PPPs in research and development (R&D) have been formed which aim at improving cooperation between private and public players.

It is increasingly being assumed in scientific and political discussions that investments in applied research cooperation – especially by means of PPP research cooperation – increase the effectiveness and efficiency of the national innovation system and the national innovation policy and focus on new scientific, corporate, economic and social challenges. These investments are consequently important in strengthening, using and sustaining a site's innovation potential and competitiveness in a scientific and industrial context.

There are, however, hardly any systematic concepts or definitions for PPP research cooperation's even though these become increasingly common in OECD and ERA countries. Therefore, it is the aim of this analysis to embed the concept of PPP research cooperation in the context of innovation policy in order to provide definitional principles and to highlight the expected advantages and disadvantages as well as the effects and potential impacts. Furthermore, politics, science and industry will be presented with the arguments for and against PPP research cooperation in order to contribute to the further sustainable strengthening of the national innovation system. The study provides an overview which:

- answers basic questions on the application of this instrument,
- analyses PPP research cooperation already established in OECD and ERA countries with regard to the methods applied, the procedure and experiences and
- provides an analysis of the advantages and disadvantages based on theoretical considerations and practical experience.

The study answers the following core questions:

1. Which objects are suitable for PPP research cooperation?
2. Which models for PPP research cooperation can be used for this?
3. Which countries are already using PPP research cooperation?
4. Which success factors and approaches with regard to PPP research cooperation can be identified in other countries?

2 Methodology/approach

The role and significance of applied R&D is discussed against the background of the changing nature of the innovation processes. Innovation processes are increasingly organised in the form of open innovation and emphasise the significance of cooperation along the value chain. This is the basis for requirements for innovation policy instruments. In the current context of innovation and globalisation, these must, on the one hand, strengthen the connection between basic research and applied research and, on the other, promote networking and cooperative initiatives. These theoretical considerations are in line with the general trend of increasingly moving from unilateral, isolated promotional instruments to the general furthering of cooperation. There is currently a wide range of research cooperation which can be divided into

- information-based,
- action-based and
- resource-based cooperation.

These forms are characterised according to three dimensions: formalisation level, form of interaction and timescale. Based on this detailed classification, the advantages and disadvantages of various forms are illustrated. Arguments for PPP research cooperation are prepared on the basis of theoretical considerations and international experience, and their potential role in the strengthening of applied research is clarified.

The significance of applied research and the modified general conditions for innovation is examined in detail in order to indicate the central elements of current innovation instruments. Research cooperation in various forms is then considered in detail and its potential benefit illustrated. Following on the public private partnership are introduced as an innovation policy instrument.

In accordance with these basic statements, the forms of PPP research cooperation are analysed in selected countries – especially in Ireland, Sweden and Germany – and embedded in the appropriate innovation policy. The combination of theoretical consid-

erations and empirical analyses will be used to establish arguments and principles for PPP research cooperation.

Using these examples, statements on general conditions, the subject and organisation of PPP research cooperation are made. Finally, success factors are identified and the effect of PPP research cooperation is estimated.

3 Results

It is demonstrated that, irrespective of context, long-term PPP research cooperation based on confidence building and the optimised coordination of cooperation is best suited to the sustained improvement and strengthening of an innovation system. National scientific and research systems cannot stand in the way of globalisation. This considerably increases competition between the individual national scientific, research and innovation sites at a global level. In such an innovation context marked by feedback mechanisms and increased competitive pressure, resource-oriented, long-term and legally established forms of cooperation present a possible efficient and effective response to global challenges. In so doing, network forms of research cooperation and in particular virtual, distributed networks are not taken into account. It has been demonstrated in various studies and according to generally accepted expert opinions that such networks can have a supportive effect but that the main innovations come from direct interaction on a personal level. Against this background, PPP research cooperation is therefore defined as:

infrastructure-based partnerships between public and private players aimed at increasing and applying knowledge in the mid to long term in contractually agreed institutional set-ups which take into account the original interests of each party, notice and share risks and opportunities and serve the long-term common good.

Based on this definition, a distinction can be made between three types of PPP:

- ad-hoc PPP with short to mid-term focus;
- test PPP with a pooling of resources and mid-term or project-related focus, and finally
- sustainable PPP marked by long-term cooperation with an institutional basis.

On the basis on further considerations which throw light on the benefit and potential effect of the three types of PPP on national innovation systems, the form of sustainable PPP research cooperation is examined in depth as a very effective innovation policy instrument. The high level of commitment associated with long-term focus as well as the establishment of national and international networks are important in doing this. In

addition, a sustainable skills base, promotion of interdisciplinary research and synergy effects are expected by means of the institutional components, which will accelerate the innovation process.

The study shows that PPP research cooperation has been established in various forms in many OECD and ERA countries. It is particularly demonstrated that the majority of states use PPP development programmes which support innovative research project partnerships. Although sustainable PPP research cooperation is theoretically thought to have the greatest benefit, these are mainly in the form of ad-hoc or network cooperation without a common institutional basis.

The identified, sustainable PPPs are active in the most varied of areas. Whereas technological research fields dominate, some sustainable PPPs with a social focus have also arisen. In accordance with the states' support criteria, predominantly promising areas of research are approached using PPPs. These are identified in some countries using foresight studies.

The organisational models are just as varied as the areas of research so no single success model can be distinguished. Centrally, there is an interdisciplinary management committee consisting of both academic and industrial representatives and which is responsible for the comparison of interests. In addition, the following success factors determined on the basis of theoretical and empirical analysis are important and can be summarised into six central components:

1. *Carefully developed strategy and a well thought-out contract*: in addition to the responsibilities, the dispute settlement mechanisms also have to be clearly regulated in a contract.
2. *Communication with stakeholders*: information, communication and decision processes are adapted to suit the partners and their objectives. In addition, importance also has to be placed on personal interaction.
3. *Careful selection of partners*: common interests, values and objectives are a basic condition for successful cooperation. Partners have often already been in contact with each other beforehand through a network.
4. *Involving the public sector*: the public sector should be involved from the start by means of a control mechanism established in the contract. There should also be an awareness of innovations and the associated risks and activities.
5. *Securing long-term income*: with gains via multiple sources.
6. *Political leadership*: the political leadership must support sustainable PPPs both in public statements and statutory regulations.

4 Conclusions

In the course of globalisation, site considerations are becoming increasingly important for R&D and innovation related investment decisions. Therefore, in addition to statutory regulations – human resources, scientific excellence and infrastructure are important for an innovation site with PPP potential.

Eventually it must be noted that two different research cultures meet in sustainable PPPs: synergies have to be found between basic academic research and applied industrial research and have to be used for mutual added value. Before preparing sustainable PPPs, particular attention must be paid to so-called competing values. These must be regulated in a contract and transparent control and sanction mechanisms must be introduced. In so doing, the mistrust associated with divergent interests (for example in relation to intellectual property rights) can be effectively prevented from the outset.

Although the effect of sustainable PPPs is often difficult to evaluate and most foreign sustainable PPPs have only been set up recently, positive effects can be seen which encourage further intensive initiatives in this direction. A central component in this is the strengthening of knowledge and technology transfer (KTT), which is often promoted via various KTT offices but would nevertheless be given further impetus, especially as PPP research cooperation has a direct influence on KTT and uses sustainable synergies. As sustainable PPPs are also connected with the strengthening of applied research and networking, they would be suited to taking direct action on the frequently identified shortcomings in national innovation systems. At the same time, it should be ensured that the promotion of basic research will continue and existing (private) initiatives will not be eliminated.

Joint Programming Initiatives: Balancing National Dynamics and European Interests in research cooperation

Susanne Meyer, Florian Holzinger, Wolfgang Polt

Joanneum Research, Policies: Centre for Economic and Innovation Research, Austria

1. Motivation

Europe as a whole is one of the global Research, Development, and Innovation (RDI) hubs. An estimated 27% of the global R&D expenditure is spent by European countries (2007). Yet, within the European Union (EU), some 85% of all public Research and Development (R&D) is still programmed, financed, monitored and evaluated at the national level. This makes aligning national R&D undertakings an especially important task, complementary to the effort to strengthen joint R&D directly carried out at the level of the EU (Kaiser and Prange 2004, Edler 2008).

To this end, 'Joint Programming Initiatives' (JPIs) are currently being established in order to introduce a new process into European research cooperation (European Commission 2008). Other than policy actions at the level of the EU's institutions, JPIs aim at aligning national RDI policies and programmes on a self-organised basis. Beyond this, they are even supposed to create new, trans-national programmes, which can play a complementary role to existing programmes at EU-level. Joint Programming is a process that allows the establishment of research initiatives that are thematically related to the grand societal challenges (e.g. climate change, urban development, food scarcity, etc.) (European Commission 2010). JPIs are created by all or a subset of EU Member States on a voluntary basis that show interests to align national research funding along a commonly agreed theme and structure. The organisation and governance is overtaken by Member States, the European Commission provides support for coordination of JPIs. In beginning of 2012 ten JPIs have started.

JPIs are an explicit response to the repeated calls for more and better research cooperation that have emanated from the European Council and the European Parliament over the past years (European Parliament 2000). These calls are raised against the background of perceived limitations (e.g. lack of collaboration and coordination between national public R&D programmes) of existing policy instruments. As JPIs are still in the start-up phase this paper is motivated by providing policy implications based on a critical review of the JPI process to even better shape this instrument to make significant progress in reaching a defragmented and efficient European Research Area.

2. Approach

The paper follows the *intervention logic approach*. In the first part the position of the JPI in the existing European research landscape is analysed according to rationale and objectives of the JPI. Overlaps, differences and distinct characteristics are pointed out in comparison to e.g. ERA-NET scheme, Actions under Article 185, Framework Programme activities like European Technology Platforms, Joint Technology Initiatives, and other collaborative research projects. This part of the paper is based on a document analysis.

The second part introduces the genesis and main activities of the JPI process. As this instrument is still very young, particular attention is paid to the first steps of developing a JPI: setting up thematic priorities, developing of a strategic research agenda, creating a governance structure, agreeing on framework conditions for specific research instruments, involving of stakeholders or installing a pilot phase (High Level Group for Joint Programming 2010). The process on European as well as on national level is shed light on. Data and information for this part are collected (1) by coordination and support actions of the authors during the development phase of the JPI Urban Europe for the Austrian government and (2) by the authors' participation in the OECD CSTP project: Governance of International Co-Operation Science, Technology and Innovation for Global Challenges (STIG), where a case study was conducted on the JPI Agriculture, Food Security and Climate Change (FACCE).

In the last part pitfalls and tensions of JPIs are focused on. The JPI process is critically assessed with focus on expected results and impact. The guiding question is whether JPIs eventually contribute to defragmentation and efficiency of the European Research Area. Although the JPI process has just started, some lessons for international governance of research, development and innovation can already be drawn. Early lessons learned provide the potential for policy makers and scientific consultants to still shape the on-going JPI process.

3. (Expected) Results

Lessons drawn from the JPI process are based on the authors' assessment. The number of JPIs is expected to be limited, as they are focussing on major societal challenges. Individual countries are hardly in the position to find solutions for broad societal problems. JPIs have been considered as a process having high potential to more effectively interlink national and European research. Compared to other instruments like ERA-nets JPIs are larger and long-term in nature. But JPIs are exploiting experiences made within ERA-net collaborations. JPIs are following a voluntary, bottom-up approach with strategic guidance from the European level. Therefore they should be

driven by high political commitment of Member States. The main underlying governance principle is that of variable geometry which means that not all Member States need to be involved in JPIs. This offers considerable flexibility but can also raises questions of equity, inclusion and fairness.

While the general policy rationale behind JPI seems to be well grounded, some major challenges arise with respect to the sound and appropriate way of implementation. The organisation and action plan of JPIs reveals a high heterogeneity. Instruments to organise research on a common base vary from joint calls, tender, research alliances, knowledge platform. Framework conditions like budget collection and distribution, application and review organisation and monitoring procedures are individual for each JPI, but have no common structure. There is a lack of coherence in the modes of governance and in the framework conditions of the various JPIs which might lead to even more instead to less complexity of existing policy tools.

The analysis of the two specific JPIs shows that although they have been established only recently they have made significant progress in setting up governance structures and priorities for joint activities. The challenges and tensions they are currently facing are very much related to international (RDI) politics. This concerns decision making processes between diverse actors, coordination between international and national activities, involvement of stakeholders from different institutional backgrounds and levels as well as the intensity and strength of coordination between activities of different countries.

4. Conclusions and policy implications

Lessons learned – especially in this very early phase of the JPI process – can be turned into adjustments as the JPI process is still on-going. E.g. governance structures and framework conditions are under permanent revision. Policy makers have still the chance to react to potential threats. The European Commission has already started to react to some of the threads, e.g. coordination of governance and framework conditions, by giving common recommendations. From our research on JPIs and from our involvement into JPI processes we draw the following conclusions:

- Decision making bodies of research programmes on transnational level need to have a clear profile. In the case of JPI the respective body on EU level (High Level Group for Joint Programming - GPC) is very much driven by specific national interests making independent decision making on most potential research projects and fields difficult.
- Priority setting for particular themes covered in JPIs needs some sort of strategic policy intelligence in order to be sufficiently evidence-based.

- Processes of linking national to international priority setting should be given high attention at the national policy level and should be carefully crafted not to 'leave behind' the national stakeholders (including the private sector).
- Incentive mechanisms for participation of countries should be designed in a way as to avoid free-riding and moral hazard.
- On the other hand, small and medium-sized countries – especially from Eastern Europe – should not be left behind due to limited resources and capacities.
- Platforms for mutual learning from other transnational STI governance programmes are highly recommended. Within JPIs this is only partially developed.

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Innovation policy, human capabilities and democracy

Reijo Miettinen

*Institute of Behavioural Sciences, Center for Research on Activity, Development, and Learning,
University of Helsinki, Finland*

The European innovation policy has been strongly framed by the necessity of succeeding in the global economic competition. Its connections to discourses of welfare and especially of democracy have been coincidental. In this paper I argue that the interconnection between innovativeness and economic growth, enabling welfare politics and democracy is essential in a knowledge-based economy. I will use an analysis of the innovation and education policies of Finland as a case to uncover the importance of this connection.

It has been argued that the Finnish innovation policy contributed to rapid economic development of Finland in the 1990s and to the emergence of the Finnish ICT sector. A more credible explanation is the combination of liberalization of financial market in the late 1980s, well-timed decision made by Nokia cooperate management to focus exclusively on digital technology and mobile phones as well as the educational and university system that ensured the sudden recruitment of 15 thousand Finnish engineers by Nokia in the 1990s (Häikiö 2002).

The Finnish innovation policy inspired by the national innovation system approach developed the idea of "strategic intelligence" that based on foresight activities and evaluation (Hämäläinen & Heiskala, 2006). The various foresight exercises in the early 2000s were, however, made by a small elite composed of representatives of few ministers, of R&D funding organizations, representatives of major business companies and selected researchers from universities and research institutes. The professional and civil society associations as well as unions were excluded from these exercises. At the same time the participation of stakeholders to the preparation of important reforms declined when the committee institution was gradually replaced by liquidators nominated by a minister. This is paradoxical since the Finnish innovation policy at the same time started to underline the importance of user involvement in innovative activity.

The innovation research has underlined the significance and human capital and interactive learning to the extent that it started to speak about learning society (Archibugi & Lundvall 2001). The welfare state research, on the other hand, has shown that the significance of education for the participation to society and working life has been increased (Esping-Andersen 2009). Consequently, a shift from distributive to enabling welfare state, that is, into welfare policy that focuses on production of capability creating services has been suggested (Sabel & al. 2011, Kristensen & Lilja 2011). The Fin-

nish comprehensive school is a good case for studying the conditions of providing the enabling services. It is well known that the Finnish 15-year-old old students have been at the top in reading, math and natural science knowledge in the four PISA studies instituted by the OECD. In addition the share of low achievers is exceptionally low (8% compared to the OECD average of 19% in 2006) and the differences between the schools are lowest among the OECD countries. Among the reasons suggested three are essential (e.g. Aho & al. 2006): 1) The high status and university-based education of the teachers, 2) a decentralized system of school governance based on trust on multiprofessional school communities supported by universities, regular in-service education, and learning from the solutions developed by other schools, 3) special education system based on the early recognition of learning difficulties and immediate measures taken to overcome them in the first grades of the comprehensive school (Sabel & al. 2011).

The paradox of the PISA results is that a country that has most stubbornly resisted the internationally dominating neoliberal educational policy is at the top in the achievement comparisons. Finland has continued to develop its public unitary school system that was inspired by ideal the educational equality. No one of the main features of the new education policy, privatization, creation of educational markets or the establishing a governance system based on the results of high-stakes national testing has thus far realized in Finland. No national tests are run except the student matriculation in the age of 18. The responsibility of student evaluation is given to school communities, because they are thought to be most able to help the students and take the necessary developmental measures. The centralized evaluation is sample-based and the authorities prevent the publication of the comparisons of the student achievements between schools (Aho & al. 2006). Coordination primarily takes place by a frame-law, national curriculum that defines the general goals and contents of education, by in-service education and experimental projects, and by extensive collaboration and institutional learning that take place across horizontal and vertical boundaries between the organizations in the organizational field.

The development of Finnish comprehensive school system clarifies the relationship between the politics of enabling services, welfare, innovation and democracy. Public education and other capability and creativity enhancing services – such as kindergartens, libraries, museums, cultural activities, study circles in adult education centres – not only prevent exclusion and contribute to the capability of the citizens to participate to working life and civil society. Strategic language skills and the capacity to follow the development of a knowledge field constitute the individual foundation for the absorptive capacities of firms and other organizations. The universal school system contributes to the formation of social capital and trust that stimulates network collaboration between

different actors with complementary knowledge. The high-quality education creates preconditions for the rapid redirection of education to emerging fields of technology and production as exemplified by the development of the Finnish ICT sector.

An essential part of the establishment of welfare state services in the 1970s by the state in Finland was the establishment of the professional education and research related to the new services. As a result, today communities of highly educated professionals provide the services. Two thirds of an age cohort in Finland today has a tertiary education. A huge potential of theoretical and practical knowledge is embedded all domains of society. The expertise and creativity of these well-educated professionals and practitioners need to be mobilized to the development of new solutions and practices. The extended participation to experimentation and problem solving in the local level and learning and dialogue across hierarchical levels may be an important step in extending democracy in society through "democratization" of innovation (v. Hippel 2005)

This idea corresponds the ideas of associative democracy (Wright, 1995,) and pragmatist democracy outlined by John Dewey (1926/1988). According to Dewey, the positive rights of individuals to develop their capabilities depend on how work, community life and the state are organized. The self-development of an individual is realized through her contribution via the division of labor to the common good of a community. The 'procedure' of democracy is collaborative experimental solving of social problems by communities of inquiry. These communities are 'prepolitical' collaborative associations. They constitute the foundation for the successful functioning of state institutions. As a model of participatory democracy, it seems to supply answers to the problems caused by managerialism, hierarchical governance and the top-down policy making. It has also been seen as an epistemologically realistic alternative to evidence-based policy making (Sanderson, 2009).

The concept of democracy and distributed innovation contradicts the "command and control" regulatory strategies based on strict goals and control by constant auditing of results by using indicators (e.g. Pierson 2006). While this procedure without doubt increases the efficiency of present forms of activity, it rather hinders than stimulates innovativeness. The development of decentralized forms of government is needed that supports local experimentation and the distribution of its results, as well as enhances dialogue and learning across boundaries and levels of governance.

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Managing urgent innovations

Exploring restrictive and broad strategic niche management

Ellen H.M. Moors¹, Wouter P.C. Boon², Albert J. Meijer³

¹*Copernicus Institute of Sustainable Development, Utrecht University, the Netherlands*

²*Rathenau Institute, the Netherlands*

³*Utrecht School of Governance, Utrecht University, the Netherlands*

Today, society is facing some extraordinary challenges. Environmental pressures and resource scarcity question the sustainability of our current consumption pattern, and longer life expectancy and chronic diseases are putting a strain on the capability of health systems to meet the needs of the (ageing) population. A broader, mission-oriented innovation policy is increasingly seen as being critical for effectively meeting these grand challenges.

Innovation, however, always has a dual character in the sense that innovation might simultaneously spur positive and negative effects. New technologies hold promises for economic growth, improving health or decreasing environmental problems, but also fears for economic decline, health damages or pollution. The duality of potential benefits and negative consequences is poignant when a wide range of actors need the innovation with such urgency that fast market introduction is required. Urgent innovation is challenging since fast introduction may endanger thorough investigation of potential risks.

This paper delves deeper into the challenge of managing such innovations with a high degree of urgency. As case-in-point we focus on innovative pharmaceutical products intended to meet unmet medical need. For these products EU and US government instated specific regulatory pathways that ensure shortening of the clinical testing and regulatory decision phases, but at the same time require stricter commitments about monitoring the drugs while they are on the market. Examples of disease areas to which these regulations are applicable because of their related unmet medical needs are HIV, cancer, pandemic influenza and orphan diseases (Boon et al., 2011).

The introduction of novel pharmaceutical products is heavily regulated and procedures are to a large extent standardised. Accelerated procedures enable fast introduction by bypassing some of these procedures and, therefore, they call for flexible solutions to monitor the effects of these drugs. Uncertainties about these effects, including beneficial impacts (efficacy) and risks (safety issues), might be higher than with normal drug approvals. Accordingly, this paper deals with the challenge of managing innovations with a high degree of urgency while minimising the safety risks of these innovations.

It is assumed that besides new scientific and technological developments, more demand-oriented innovation policies, such as flexibilisation of market approval of drugs, combined with a more thorough post-marketing surveillance of drugs for unmet medical needs, are necessary to achieve transformative changes in dealing with urgent innovations.

Strategic regulatory niche management – defined as creating and managing a space that is protected from the harsh regulatory selection environment – is presented as an approach to this more demand-oriented management challenge. The (temporary) space allows for the marketisation of innovations under the condition of strict monitoring of their effects. Restrictive and broad approaches to the strategic management of regulatory niches are discerned and theoretical advantages and disadvantages of these two approaches are formulated. The advantages and disadvantages of these two approaches to strategic management of regulatory niches are further explored in two case studies: 1) the development of treatments for HIV and 2) the development of a vaccination against the pandemic influenza. Based on strategic niche management, we propose a conceptualisation of the dynamics of creation and maintenance of 'regulatory niches'. The first step in this process is the creation of a shared agenda about the necessity of niche protection through special regulation. This leads to the formation of a regulatory niche in which the innovation can be implemented and monitored. The niche and its demarcating boundaries are then fleshed out by network building and learning. These dynamics inside the niche, but also concerning the actors outside the niche, define and redefine the niche boundaries.

We found that in the HIV case, there was plenty of room for bottom-up, informal user initiatives, and only after a few years some post-marketing studies and monitoring organisations were formalised. A relatively open community network existed, in which users played a major part. The excluded actors were mostly powerless or included strategically along the way. Accordingly, the HIV case answered to a *broad strategic niche management* approach.

In contrast, in the influenza case there was a high degree of top-down steering. A formal, close-knitted network of regular users was in place that was adjusted to the pandemic and augmented by new initiatives set-up by the Netherlands Pharmacovigilance Center. Informal interactions and rules were placed in a more formal context. 'Critical' groups of non-users remained outside this regulatory niche network. The pandemic influenza case answered to a *restrictive strategic niche management* approach.

The two cases focused on post-marketing surveillance in the Netherlands. The politico-economic tradition and governance culture in the Netherlands can be characterised as

democratic, deliberative, and supportive to discourse-based decision-making. This is further expressed in the large variety of intermediary organisations engaging in the political arena in a corporatist/participatory rather than a confrontational/activist way. The two cases show on the one hand a situation that leans more towards corporatism (HIV) as compared to, for example the US in the 1980s. On the other hand a situation leaning towards confrontation (pandemic influenza), which is more or less comparable to other countries.

Furthermore, the cases can be regarded as exceptional, even singular, e.g. because of a high sense of emergency and media attention. However, the context of these cases is not unique. In the pharmaceutical field, the lessons are relevant because the European Medicines Agency Road Map 2015 provide openings for a more flexible approach to drug approval. One consequence can be that several approval and post-marketing practices co-exist inside and protected from the more general drug regulation niche, i.e. the EMA standard drug approval procedure. Furthermore, also scientific and technological developments, such as the advent of personalised medicine and pharmacogenomics, might make the use of drugs more fragmented, leading to a growing number of small disease niches. In this respect it is hypothesised that personalised medicine will increasingly resemble orphan disease fields (Boon and Moors, 2008).

The exploration of the two cases provided support for the theoretical advantages and disadvantages of the proposed two approaches to regulatory niche management, i.e. restrictive and broad strategic niche management. The homogeneous network in the restrictive approach is able to learn faster but offers less second-order learning than the (more) heterogeneous network in the broader approach to regulatory niche management. In line with our expectations, the restrictive approach was more contested.

This paper increases our understanding of the management of urgent innovations in the context of 'regulatory niches'. The focus on these niches provided knowledge about how the specific post-marketing practices in these regulatory niches are maintained, not necessarily through the protection provided by the regulation alone, but also because the protection spurs network and learning. The research highlights the advantages and disadvantages of restrictive and broad approach to strategic management of regulatory niches. The advantage of a restrictive approach is that it enables fast first-order learning and the disadvantage is that this may come at the risk of a decline in legitimacy. The advantage of a broad approach is that it enables more reflection and second-order learning which result in more legitimacy. At the same time, this may result in less ability to move fast and, interestingly, a heterogeneous niche may become too comfortable to break down. We conclude that strategic management of regulatory niches requires a balancing act between fast but superficial learning processes and

slower but more reflective ones. This balance determines the ability to react fast to the need for urgent innovations but also the long-term legitimacy of these innovations. Restrictive and broad strategic niche management could then be deployed as policy instruments to deal with the grand challenge of unmet medical needs and to govern transitions towards more sustainable healthcare.

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The Coordination of Stakeholders in Japanese Science, Technology and Innovation Policy at the Cabinet Level

Noriyuki Morichika, Lee Richard Woolgar

School of Engineering, The University of Tokyo, Japan

This paper analyses the role of different stakeholders and coordination mechanisms for the governance of science, technology and innovation (STI) in Japan. Japanese policy makers have recently shifted to an STI policy emphasizing societal challenges and innovation. Using a case study of the Japan's Council for Science and Technology Policy, this paper draws on publicly available minutes to quantitatively assess the role of different stakeholders in setting policy changes. The development of Japan's multi-annual 4th Science and Technology Basic Plan is used as the benchmark. The paper finds that policy making for STI succeeds in maintaining a difficult balance between coordination with other strategically important policies. Although there are imbalances in the commitment levels of STI stakeholders, coordination is achieved owing to individual skills of the Chairman.

In 2011 the Japanese government introduced the 4th Science and Technology Basic Plan. This will determine Japanese policies for science and technology until the end of fiscal year 2015. Unlike previous plans, there is a stronger focus on innovation and addressing societal challenges in the form of life and green innovation fields, and a clearer connection with growth initiatives and strategies. This new trends mark a significant departure on the previous sectoral orientation of the Basic Plans.

The plan was developed by the Council for Science and Technology Policy (CSTP), which plays a fundamentally important role in the Japanese innovation system through planning the five year Science and Technology Basic Plan, prioritizing resource allocations, and evaluating national research projects. As an advisory council under the control of the Prime Minister's Office, and above other ministries and agencies, members comprise the Prime Minister, the Minister for Science and Technology Policy, and other related ministers as well as members from academia and industry. The membership of diverse stakeholders is intended to add greater comprehensiveness to the functioning of the council. The role of the CSTP with regard to leadership and the role and usage of strategic intelligence is therefore of key importance.

As the coordination of STI policies has come to be recognized at political and governmental levels, the need to overcome institutional fragmentation and enhance horizontal coordination has become more important (Braun 2008). There are seen to be a range of mechanisms through which policy coordination can be enhanced. These include external or internal coordination mechanisms, coordination at the agency level, provi-

sion of leadership from the cabinet level, or strategic intelligence (Braun 2008). Until now, most studies of how such mechanisms are operationalised have only concerned European countries (Griessen and Braun 2008; Pelkonen 2008).

In order to clarify the policy making process inside the CSTP and the role of different stakeholders within Japan's STI policy setting process, this paper undertakes a detailed examination of the process of developing the 4th Science and Technology Basic Plan, developed between June 2009 and December 2010. The plan was developed by the Expert Panel on Basic Policy within the CSTP and all documentation was made publicly available. Until the finalization of the complete version of the Plan, 12 meetings of the Expert Panel occurred. At each meeting, government officials provided basic documentation to support discussion, and then revised the documents reflecting the discussion in preparation for the next meeting. It is therefore possible to track the evolution of the plan through each discussion over the course of the 12 meetings. Based on their current affiliation, CSTP members were categorized into six types: 1). University; 2). Industry; 3). Public Research Organisations (PROs); 4). Government officials; 5). Politicians; 6). Others. These stakeholders reflect different communities and may possess differing objectives towards STI policy.

The evaluation of the proceedings was performed through three different approaches:

- Firstly, counts regarding participation, number of statements and number of Chinese characters in the conference note were made to clarify the commitments of the six types of stakeholders.
- Secondly, using word analysis software the word frequency, main characteristics of opinions, and differences between the six different stakeholders were assessed.
- Thirdly, by comparing their opinions against the conference notes and the documents used for discussion, an assessment was made of how opinions from different stakeholders were reflected in the development process.

Regarding participation in meetings, it was found that the commitment from university derived members is the highest while that from the other five stakeholders is more modest. Of the members involved in policy setting for the 4th Basic Plan there were a total of 50 persons involved over a period of twelve meetings. The shares for each stakeholder were 40% university members, 22% industry members, 12% government officials, 10% from PROs, 10% as politicians, and 6% from other. From the record of attendance for the twelve meetings, it is also apparent that members from universities tend to attend more meetings than the five other stakeholders. Counting the number of statements by each stakeholder shows that university members state their opinions the most, with industry second.

Secondly, to assess the word count data by stakeholder¹, at each meeting, a *Government official* gives an overview of the distributed documents which tends to be highly descriptive, leading to a high count of characters. In general, politicians tend to attend fewer meetings and speak only a few times, but they tend to speak for longer durations. The Chairman leads the meetings by steering the order of the contributions from different stakeholders. So the number of statements is naturally large, but the number of characters per statement is small because he only leads the discussion. From external stakeholders, university members are the longest speakers per statement, industry and others are second, and PRO members are the shortest.

By counting word frequencies by each stakeholder group, it was possible to clarify the main characteristics of the stakeholders. For example, industry has considerable interest in the relationship with universities. They use the phrase 'Academic-industrial alliance' much more frequently than the five other stakeholders, and words such as 'Patent' and 'Venture' are also highly used. On the other hand, university members have less interest in this topic. They focus more on the diversity of research staff and use words such as 'Woman', 'Junior', and 'Foreigner' many times. University members are also interested in 'System reform', which is frequently used in the discussion of measures for reform of the research system. PRO members have more interest in 'Education' than other stakeholders. Politicians use only primary words such as 'Science' or 'Technology' and do not use more specific words. However, the analysis found that politicians regularly used the word 'Communication', and this implies they think that science and technology communication is important. *Others* also used this word many times, and they also used words such as 'Environment', 'Green', or 'Solution-Based'. Government officials speak descriptively, so from this analysis it is difficult to observe the major characteristics of Governmental contributions.

For analysing the development process through comparing the conference notes and the distributed documents for discussion, it was found that there were three different development phases over the course of the 12 meetings. At each meeting a revised version of the document reflecting the previous meeting was distributed. During the first phase attendees undertook a free discussion about topics presented by government officials and the Chairman. After collecting these opinions, government officials presented the first outline of the 4th Basic Plan at the 5th meeting. In the second phase they used this document to discuss the outline. Between the second and third phases,

¹ There is less reliability in this data as in some cases where long statements have been made, some long statements have been cut. This nonetheless shows the speaking characteristics of each stakeholder.

movement was made towards the final outline. The third phase saw the emergence of the final document with minor amendments on the completed version.

At the juncture between each of the latter phases (the 5th and 10th meetings) there were intense debates regarding the structure of the new document. For instance, between the first and second phase, new concepts such as 'Green Innovation' and 'Life Innovation' were presented for the first time, but are derived from the economic growth strategy which is a separate document to the Basic Plan. However, the fact that the CSTP is under the Cabinet Office which also exercises jurisdiction over other important strategic units permitted this introduction. Most CSTP attendees opposed these new concepts because they were afraid that it would lead to undue concentration on these two areas of 'innovation' and less to other areas. During the third phase, they complained again about the high frequency of the word 'innovation' in the final version of the plan. But from the 6th meeting, only small amendments were made. In the third phase they were persuaded by the Chairman and government officials, so their complaints were not reflected in the final document. In this defense process, the Chairman and government officials performed key roles. Positively speaking this suggests a good balance between top-down decision making and bottom-up opinion collecting.

Conclusion

At a time when increased interest is directed towards the governance of STI policy and coordination mechanisms, this study of Japan suggests that the CSTP accomplishes a difficult balance between coordination with STI stakeholders and coordination with other national strategic policies. The success of this depends to some extent on the institutional design of the CSTP and other strategic institutions, but also on the individual skills such as the leadership of the chairman, who plays a key role in directing discussion and forging consensus. This occurred in the shift towards emphasizing innovation and new growth strategies in the 4th Basic Plan. As shown in this research, for example, university members make a larger contribution to Japanese STI policy making process relative to other stakeholders. However, this imbalance is presently moderated by individual skills, so contributions from other stakeholders should be increased by various means such as increasing other stakeholder membership. The Science and Technology Policy Council (STPC) in Finland which takes the same role as the CSTP in Japan also succeeded to bridge science and technology policies and other policy sectors such as economic policies or higher education policies because of the contribution of its secretariat and consensus-oriented operation between various stakeholders (Pelkonen 2008). This indicates that strengthening the role of government officials may also lead to a more successful position of the CSTP.

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Policy-making practices and governance models of transformative change

Marja-Liisa Niinikoski

Aalto University, School of Economics, Finland

1 Introduction

Currently the scope of innovation policy has expanded in many countries (see eg. Niinikoski, 2011; Kuhlmann et al., 2010, 4-5; Borrás, 2009). The concepts of horizontal innovation policy (OECD 2005), broad-based innovation policy (Edquist et al., 2009), and strategic innovation policy (Teubal and Zlotnick 2011), inter alia, have been introduced to describe the changing and expanding nature of the policy field.

At the same time new policy-makers have entered the policy-making field. They represent, amongst others, various policy sectors, new business fields, and new disciplines. It can be claimed that the boundaries of the innovation policy field have expanded in society (Niinikoski, 2011). There are new conditions under which the policy is designed and executed.

However, at the same time observations about difficulties to 'implement' broadened innovation policy have been increased (see eg. Edquist et al., 2009), either policy formulation is unclear, policy problems are insufficiently identified, or there is a lack of suitable policy instruments. Much less has been discussed the questions in the field of science, technology and innovation (STI) policy studies how this expansion of innovation policy has also increased the political nature of the policy, since it covers wider areas in society and in the economy, and whether the 'traditional' policy-making practices are sufficient in this new policy era to govern a transformative change.

One of the key elements, when trying to understand 'effective' governance of transformative change, is practices by and through which the policy is made. It sheds light on the issues who are allowed to participate in policy-making, whose claims are taken seriously having truth-value in policy-making, how the rules defining the policy discourse are set.

The key question, which is discussed and which theoretical foundations are developed in this paper, concerns the interconnection between policy-making practices and public governance models. The basic assumption lies at heart of the interconnection between policy-making, and public governance of transformative change. If policy-making practices significantly differ from the means and practices how collective interest is pursued

in order to enable transformative change, significant inefficiencies in public governance can be identified.

This paper is based on an ongoing study, and it further elaborates the notion of policy-making practices, which has been defined and used in a previous study (Niinikoski 2011), and integrates the concept of policy-making practices with the theoretical understanding of public governance models. This paper aims to contribute to STI policy research by highlighting the political aspects of innovation policy.

2 Theoretical underpinnings of the study

The political nature of innovation policy is a question which is quite often nowadays passed over in STI policy studies (Morlachhi and Martin 2009). The instrumental function of policy analysis has dominated the research field since the 1980s. The assumption of apolitical strategic aspects of innovation policy formulation (see eg. Teubal and Zlotnick, 2011, 5) strengthens the understanding of policy-making as a rational process, and thus public governance of transformative change as a rational matter. This paper wants to make explicit how actual policy-making practices open, restrict, or legitimize broadening innovation policy, and thus creates conditions for governance of transformative change.

In order to understand the political nature of policy-making the concept of policy has to be theorized. Quite often in the empirically motivated and empirically oriented STI policy research has not theorized the policy itself (Morlachhi and Martin 2009). Empirical observations of problems to carry out horizontal or broad-based innovation policy tell not just about the lack of efficient co-ordination structures and mechanisms but also about a struggle over the ultimate aims of the policy (see also Niinikoski 2011). Thus, by setting aside the political nature of innovation policy also the political nature of public governance is not understood. This, in turn, leads to an oversimplified picture of 'efficient' governance of transformative change.

2.1 Theoretical understanding of policy as a discourse

Discursive approaches in policy analysis have gained strength since the 1990s. However, these approaches do not constitute any consistent theoretical or methodological approach. One of the main dividing lines in policy analysis, using discursive approaches, has been between Habermasian and Foucauldian oriented studies. The Habermasian approach is a normative one speaking about what should be done (Flyvbjerg 1998, 210). When one really wants to know and understand, how actual policy processes evolve, then the Foucauldian approach might help to understand them. Like

Flyvbjerg (1998, 210) argues Foucault is interested in the real, this means what is actually done.

The theoretical understanding of discourse in Habermasian oriented studies, rooted in the ideal theory of communicative actions, emphasizes the argumentative nature of communication. Fischer's (2003) theorization of discourse and his discursive approach to policy analysis derives from the Habermasian theoretical foundations. The Habermasian approach leads to understanding of rational political will formation (Flyvbjerg 1998, 214). Experiences gained in policy-making processes rarely impress 'rational'. Some policy initiatives are more easily accepted than others, and some policy-makers are taken more seriously than others. There can be always identified some (dominant) rules which organize policy-making in the field (Niinikoski 2011, 28-34). If we accept that humans are infinitely more complex than Habermas' *homo democraticus*, then we assume that social processes, such as policy-making, are more complex (Flyvbjerg 1998, 217), and normative approaches cannot explain why certain innovation policy paradigms, or elements of them, are more easily accepted and implemented than other ones.

Although sharing the theoretical understanding of policy with Fischer (2003) as socially constructed in discourse this paper turns the analytical focus on actual policy processes. In this respect Foucault's conceptualizations of discourse through knowledge and discursive practices can offer a rich and fruitful theoretical framework for policy analysis. According to Flyvbjerg (1998, 220) Foucault's strength is in his sophisticated understanding of *Realpolitik*, actual policy processes.

Based on Foucauldian understanding of discourse I have earlier developed a conceptual framework of discourse specifically for policy analysis. By using his archaeological understanding of discourse (Foucault 1972) I define a policy as a discourse, representing a specific discursive field, and being constructed from two intertwined elements, namely policy knowledge and policy-making practices (Niinikoski 2011, 163-164). I define policy knowledge to mean temporally and spatially constituted ways of thinking concerning the contents of policy. This kind of policy knowledge is produced by discursive and non-discursive practices of policy-making. The distinction between these practices applies to ways in which these different practices affect policy knowledge, and thus, the very policy, its formulation and implementation. Discursive practices leave explicit verbal traces, for instance, in policy documentation. Non-discursive practices also have a role in policy-making, affecting the boundaries of policy knowledge, but they do it without any literal verbal traces. These practices are the 'hidden' parts of policy-making process. This type of practices can concern how a 'representative' group of parties is defined, whether people show them up in meetings

etc. This means that non-discursive practices can also be traced but usually they cannot be captured in policy documentation but other type of research material is required in empirical analysis.

In the ongoing study the empirical analysis of policy-making practices will be theoretically integrated with the notion and theoretical understanding of public governance, reflecting various types of governance models.

2.2 Public governance of transformative change

The governance perspective has gained more relevance in the field of innovation policy and in STI policy studies with the increasing inter- and transnationalization, as well as regionalization, of innovation and innovation policy initiatives (Kuhlmann et al., 2010, 11).

As a general term, governance refers to all patterns of rule (Anttiroiko et al., 2011, 2). The concept of transformative change tries to describe a 'radical' change, meaning a change from one form into another¹. From the point of view of the discursive approach applied in this study a transformation is a new discursive configuration, where the essential elements, relations, rules, and interdiscursive configurations are established in a new way. In the field of STI policy studies, with the notion of broadened innovation policy, the question is how transformative change is governed, and how innovation policy-making practices reflect the breadth and the depth of the aspired change.

Sometimes concepts of both old and new governance are used in public policy studies in order to point out radically different eras of governance. Old governance refers to bureaucratic and hierarchic state government which is used to be very powerful and self-sufficient (Bevir, 2009, 3, 22). Nowadays the central tenet of the governance approach is that state-society relations are changing and becoming more complex and interrelated (Pierre and Peters 2000). New public governance is used as a concept to describe this new era (Osborne 2006; Pierre and Peters 2000). It refers to steering, coordination and the use of institutional arrangements in the policy-making and implementation processes in a polycentric multisectoral stakeholder context to pursue the collective interest (Anttiroiko et al., 2011, 3). Anttiroiko et al. (2011, 3) claim that exact definitions of new public governance are difficult to formulate because forms and regimes of new public governance differ from one context to other.

In this paper models of public governance are approached from the point of view of policy-making practices. The question of innovation policy governance in Europe has

¹ Oxford English Dictionary.

been earlier tackled by Kuhlmann (2001) theoretically as the co-evolution of "political systems" and "innovation systems". In this paper the question of actual policy-making practices is discussed in relation to the theoretical understanding of different governance models. They are used as an analytical framework to discuss how empirically identified policy-making practices enable or restrict 'effective' governance of transformative change. Theoretically speaking four fundamentally different approaches to public governance can be separated (Anttiroiko et al., 2011, 9-16). The market efficiency, performance efficiency, stakeholder relations, people's influence approaches will be used in the analysis of policy-making practices. Shortly speaking the market efficiency approach emphasizes a minimal state paradigm. The performance efficiency approaches forces through a top-down structuring and neglects the bottom-up and lateral components of public governance. The stakeholder relations approach pays attention to democratic process of deliberation and public engagement prioritizing other considerations before cost and efficiency. The people's influence approach to public governance is a citizen-centric approach, which relies more on direct citizen power.

3 Analysis of policy-making practices and governance models

The empirical case study has been carried out in a national context, recognizing the regional, and the transnational nature of innovation policy. The focus of empirical analysis is in the period of the broadening phase of innovation policy, and the empirical material has been gathered in Finland covering the period of time from the mid-2000s until 2010.

Results of the analysis of these practices will be described in the full paper. Moreover, the policy-making practices will be elaborated in relation to theoretical understanding of governance models. The analysis aims to highlight how understanding of applied and actual policy-making practices can lead to better understanding of conditions how and why certain governance models enable or restrict a transformative change in society and in the economy.

4 Conclusions

Drawing on the results of empirical analysis of actual policy-making practices, reflecting with and through the theoretical considerations of various governance models more general conclusions will be made especially from the point of view of public governance of transformative societal and economic changes.

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Challenge-driven priorities in European research and innovation policy

Dorothy Olsen, Egil Kallerud

Nordic Institute for Studies in Innovation, Research and Education (NIFU), Norway

1. Motivation

During the last 3-4 years the concept and/or terms *grand and global challenges*, often with the added epithet "social", have gained widespread use in international research and innovation policy discourse. One notable and highly influential example is the increasing centrality and extended use of these terms in current EU policy debate and developments. Its dissemination and impact extend, however, by far its use in emergent European policy. Similarly, the need to address *global challenges* through research and innovation has been taken up in OECD science, technology and innovation (STI) policy discourse, as seen in OECD's recently published "Innovation Strategy" (OECD, 2010), and a soon to be finalized OECD project to develop new models of governance in international STI co-operation to address global challenges (OECD, 2012). In a similar vein, a major report by the Royal Society's (2011) emphasised the need to step up efforts for international STI co-operation to address global challenges. The term also figures prominently in some regional research and innovation policy, e.g., in Nordic STI policy (NordForsk, 2011), and there are indications, as seen in recent ERAWATCH reports, that it is being taken up in national policies as well.

Some see in these developments signs of an emerging new *paradigm* in research and innovation policy, i.e., "a new mission-led approach" (Gassler et al, 2008), exhibiting major differences compared to, e.g., the "systems of innovation" approach which may be seen to have been dominant during the latest 10-15 years. At this early stage, the nature and extent of these changes, is still open; the terms themselves are vague and used with multiple meanings by different actors and in different contexts, and it is far from certain whether the discursive changes are a simple relabeling of existing priorities and instruments or if they will have a substantive, transformative effect on policies.

2. Approach

The paper will present the results of a discourse analysis on the emergence, development and uses of the *grand challenges* concept in major EU policy documents from 2008 until the present. Its notable strong impact and quick uptake in EU research and innovation policy discourse may be seen to respond to perceived need for reorientation and change in EU policy; at the time, its success within EU policy discourse discursive

has added to its wider impact in policy discourse both at the national and the wider international levels.

Within the EU context, the grand challenges term was introduced in the so-called "rationale report" published in 2008 (EUC, 2008). It has since been incorporated in official EU policy discourse. An important step in this process was the Lund declaration (July 2009) during the Swedish presidency, and the term has since been taken up in virtually every major EU research and innovation policy document. The importance of a challenge-driven research and innovation policy approach has, *inter alia*, been strongly emphasized in ERAB reports, and has become integral to the new EU policy framework of the Innovation Union (EU, 2010) and Horizon 2020 (EU, 2011). The notion has gained wide currency and is used extensively to structure overall policy, e.g., as seen in the tripartite structure of Horizon 2020. At the operational level, the notion is used as a framework for establishing Joint Programming Initiatives (JPI). While 10 JPIs have been selected, only one (Alzheimer) is at the time of writing actually being implemented.

We will map this use and spread of the term in major EU policy documents, retracing the steps from its introduction within a general rationale debate to its nascent use to justify and design allegedly new types of policy priorities and policy instruments. In analysing and mapping these developments we will draw on several different analytical/theoretical frameworks including discourse analysis, as applied in studies of STI policy by Miettinen (2002); theories of STI policy paradigms (Gassler et al, 2008; Kallerud, 2011); and STI policy priorities (OECD, 1971; OECD, 1991; Gassler, 2008).

3. Expected results

We expect to be able to identify a multitude of meanings and uses of the grand challenges term, – meanings and uses that may diverge and appear to be mutually incompatible, but also uses and meanings that may be seen to converge to form an emergent novel, conceptual framework. As weakly defined terms that are used in multiple meanings and for different purposes, they lend themselves to uses by actors who frame problems such that *their* contribution is perceived as key to their resolution. In some cases they may be used as a mere re-labelling of policy objectives, priorities and instruments that remain largely unchanged, while in other cases they may reflect a genuine search for policy innovation and learning.

We will trace the use of the grand challenges notion by the way it has developed in major policy documents: e.g., being *grand* they tend to be addressed at a supra-national level, and do not lend themselves to a "rigid, thematic" approach, as *societal* challenges they differ from, but also in some ways and degree overlap with, economic

and technological priorities; challenges are also essentially *opportunities*, for research and business, etc. The challenge/opportunities conceptual pair invites a closer analysis of the issue of the way in which a "grand challenge" approach to priority-setting might differ from the "systems of innovation" approach and be a candidate for an alternative paradigm. This may require a closer analysis of how the relationship between challenge-driven and demand-driven STI policies is articulated, and on how the relationship between social challenges and business opportunities is framed in emergent notions of challenge-driven policies. It is also not evident that challenge-driven research and innovation policies should simply be categorized as a case of mission-orientated policy; the possibility should be kept open that research themes grouped around challenges might be different from traditional mission oriented research programs and that the themes related to challenges might be more easily linked to public concerns and policy.

The polysemic character and multiple uses of the grand challenges notion is not necessarily an indication of flaws and weaknesses; it may also be seen as a precondition for major players to identify a place and role for themselves within a consensual, all-inclusive policy framework. To fulfil this constructive function, the challenges discourse will, we expect, be poor on analytical acuity, so as not to highlight potential differences, opposites and contradictions and force making choices between incompatible, alternative meanings and options.

4. Conclusion and/or (policy) implications

The notion that research and innovation need to address and help resolve "challenges" has been developed in vague and malleable terms, which may hence make them function as "boundary object" (Star/Griesemer), i.e., objects which have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, enabling to work as a means of translation and coordination. Its polysemy and plasticity may be seen to have underpinned its success as a term around which key players in the policy-making process within the EU have been able to both align interests. At the same time, a change in the terms by which (a major part of) EU research and innovation *has* taken place, and closer analysis of these terms may contribute to the identification and promotion of changes that *may*, at least according to many players, be required for EU research and innovation policy to make progress.

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Science, Technology and Innovation Policy in Developing Countries: Rationales and Relevance

Gonzalo Ordóñez-Matamoros, Stefan Kuhlmann, Britta Rennkamp

University of Twente, the Netherlands

In a historical UN conference held in 2000, the leaders of 189 countries agreed upon a set of eight major ambitious development goals to be attained by 2015 to reduce extreme poverty, hunger, illiteracy and disease¹. It became apparent that S&T progress was among the main policy areas for action in order to attain such goals given its potential to contribute to increase productivity, facilitate the innovations necessary to create markets, protect jobs, help reduce the consequences of extreme poverty, provide conditions necessary for the prevention and treatment of diseases such as HIV/AIDS and malaria, and help contain and reverse the continuing loss of environmental resources among other problems currently facing developing countries.

Recently, the WB-IMF 2011 Global Monitoring Report concluded that the targets set for hunger and primary education completion will probably not be met by 2015, and that the targets on most health-related issues such as child and maternal mortality and access to sanitation will certainly not be met by then. Furthermore, according to the report, at the present economic trends the number of people living in developing countries on less than \$1.25 will be over 800 million by 2015². This means that if labor demand does not grow enough to meet the increasing supply in these countries, this additional labor force will have to be absorbed at a falling relative wage therefore reducing the rate at which growth decreases poverty. Moreover, the financial crisis that burst out in 2008 and is currently affecting most developed countries will likely affect developing countries in the med-term, risking of deteriorating further the living conditions of the most poor and escalate inequality in those countries.

In this scenario, S&T Capabilities, defined broadly as the set of human, physical, technical, institutional and intellectual resources available in a country to acquire scientific and technological knowledge and skills for addressing with creativity and competence local, national and international needs, are understood to be the basis of economic development and social wellbeing (UNDP 2001; IAC 2004; TWAS 2004; UNDP-S&T 2005; UNIDO 2005). However, as is well known, one of the defining characteristics of

1 See the set of goals and sub-goals as well as the strategies designed to meet them at <http://www.un.org/millenniumgoals/>

2 See full report at <http://siteresources.worldbank.org/INTGLOMONREP2011/Resources/7856131-1302708588094/GMR2011-CompleteReport.pdf>

the so-called developing countries is that they lack such capabilities, a condition that not only affects the countries directly concerned but also the entire world as a result of the 'global' status some of these problems have reached, such as those related with public health, security and environmental quality (Wishart and Davies 1998; Juma, Fang et al. 2001; Weatherall 2003; Harris 2004). For these reasons, the consensus today is that developing countries need to raise the level of their local S&T capacity, and make this goal a priority of their development strategy (OECD 1996; World-Bank 1999; UNDP 2001; UNDP 2005; World-Bank 2005; UNDP 2011).

However, although knowledge of the physical, living, and/or social world has always played an important role in the development of societies in their material, institutional and cultural achievements, policy tools inspired on expectations and theoretical constructs about its promises for improving the standard of living are a rather recent phenomenon. In fact, it was in western industrialized countries where science and technology became first perceived as the critical factor in the process of long-term economic growth and development, whereby the idea of "progress" developed mainly with the Scientific Revolution in the seventeenth century, was reinforced later during the Enlightenment in the eighteenth century, then consolidated during the Industrial Revolution, and gain policy status and started to expand rapidly among developing countries during the current era of Globalization.

All these social and economic changes were fueled by public policies inspired on particular perceptions about "progress," both as an end and as a means. In this process, governments in developing countries have implemented policy tools with the expectation of contributing to better conditions for their society. However, for reasons still not fully understood, some of them have not succeeded at all, and in others the result is a mixed situation where rapid growth of innovative capacity takes place simultaneously with extreme poverty and increased social inequality. This is the case of countries that rely strongly on global markets (trade and investment), explicitly support local "winners," and modernize their local STI infrastructure, but social, economic and political exclusion of large parts of the population persists, where the majority does not benefit from the STI developed both locally and globally. This situation is arguably the result of the implementation of STI policies inspired on conceptual logic models (copied or "imposed" by multilateral lending organizations); on demands from local STI elites; and on institutional constraints that have all resulted in the neglect of local needs, capabilities and "realities."

This paper builds on previous research pointing to a better understanding of agenda-setting processes in developing countries and their socio-economic implications in the long run. In this sense, Rennkamp and Kuhlmann (2010) studied the implementation of

both endogenous as well as exogenous models for innovation policy in South Africa and Brazil, and investigated the international and domestic driving forces of the science and innovation policies that started in the 1990s. They focused on the role of ideas, interests and institutions to better understand the main rationales and trajectories for STI policy making and found that the global ideological and economic-financial environment strongly affects the policy choices in these countries and the frameworks for policy planning, which do not necessarily meet the domestic needs.

The question this paper addresses is *to what extent do these perceptions, expressed in the form of theories, models, concepts, paradigms and ultimately policy tools, are considered relevant and legitimate as source of inspiration for the design of public policies aiming at satisfactorily addressing the challenges developing countries face?* To answer to this question, we analyze the assumptions implied in the most prominent models governing STI policymaking scholarly, and assess their plausibility vis-a-vis the specificity of developing countries. In addition, we rely on the analysis of policy documents, budget allocation, and on interviews to STI policy designers and scholars in a group of developing countries. We analyze the resulting policy dilemmas that policy-makers face in terms of seeking competitiveness while dealing with social exclusion.

In fact, one of the main concerns and challenges for the governance of STI in these countries is that if local policies do not address current trends, public policy intervention in STI can lose its legitimacy and fail in advancing sustainable development in the long run. Therefore, STI policymaking needs to innovate and bring balance to the system by broadening its views, scope and role. To achieve this goal, local STI governance capabilities need to develop further. Of course, improvement of competitiveness and poverty reduction are not mutually excludable goals, but to sustain economic competitiveness, governments need to solve the poverty crisis, which paradoxically is not the main goal of STI policy in developing countries. In order to balance this situation, developing countries need to innovate in both, design and implementation of STI policies in the short run.

Political Commitment as a Critical Ingredient for and Driver of a workable STI Policy in Africa: The Experience from Nigeria

Ayobamia Oyewale, Omowumi Hassan, Wale Olaopa

National Centre for Technology Management, Obafemi Awolowo University, Nigeria

Introduction/Motivation

Interest in Research and Development (R&D) and Science, Technology and Innovation (STI) Policy as areas of academic research has perked up recently, even among the practitioners of mainstream politics. This probably reflects the perception that new technologies have had significant impacts on productivity, growth and governance process in recent years; and some countries have done better in exploiting these technological opportunities than others, partly because of efficient policy programmes that have effectively sequenced interventions through a well designed political engineering and calculus, and thus generated real additional effects. Nevertheless, the understanding of the politics of R&D and STI policy is still in its infancy among the developing countries of Africa. Very little has been done in the area of systematic inquiries into the understanding of 'what works'; 'how it works' and the quantification of effects of various political manipulations/instruments, given the nature and characteristics of African states. Thus, policy-makers and stakeholders continue to proceed only on the theoretical basis of policy formulation process and jettisoned the issue of politics explainable within the confine of the political (good) will and commitment of the leadership. This argument is premised on the past and current national experience on STI review in Nigeria by the authors, which confirmed that this singular factor/condition is germane to the sustainability of any Public Policy. Hence this forms the motivation for this paper.

Effective responses to STI policy and its coordination among respective stakeholders as can be discerned from its implementation and utilisation require the support and involvement of leaders from all levels and sectors of society. The creation of a supportive environment for STI policy and programs involves not only the formulation of appropriate policies and the allocation of resources but also the mobilization of a broad political consensus that such policy and programs are necessary for the well-being of society (USAID, 2000). Political support is defined broadly to include much more than just senior government leaders and civil servants. Political commitment implies the support of a broad range of civil and community leaders, at all levels of society. This includes the public sector, the private sector, nongovernmental organization (NGO) leaders, religious leaders, and other influential citizens at national and local levels. Leaders are the role models in society: it is not only their votes but also their personal actions and behaviors that send strong signals about what is important (USAID, 2000).

This underscores another need to embark on academic discourse that considers the issue of leadership's political commitment.

Governments have a unique and crucial role in the national response to the development of STI. In most industrialised countries like USA, Japan, and Europe countries and a few emerging countries in Asia, notably Malaysia, Korea, Singapore and China, governments have taken concrete action to address STI and development. In many other countries like Nigeria, something is clearly missing. Government failure, particularly in these countries worst-affected, has generated calls for greater 'political commitment', yet we do not have a common or clear understanding of what this elusive factor is or how it might be increased. This then brings the questions concerning 'What is political commitment and why is it so important? Is it possible to take conscious actions to build political commitment as a key step in formulating STI policy in Africa? Are there blueprints or approaches that have proven to be effective? This paper considers these questions and offers some discussion and guidelines for those determined to increase political commitment for effective STI policies and programs.

Aim

The principal aim of this paper is to

- a) Critically examine and explain the concept of 'political commitment and its importance;
- b) Examine the possibility of taking conscious actions to build political commitment as a key step in formulating STI policy in Africa; and
- c) Examine whether there are blueprints or approaches that have proven to be effective in building/measuring political commitment.

Approach/methodology

According to Welman et al (2005), research methodology considers and explains the logic behind research methods and techniques. This research method and techniques include the procedures and modalities adopted in the collection of data, determination and identification of the population, sample size, sampling procedures, validity and reliability of data collected during the study. Also the sources of data used and methods of analysing the data collected for the purpose of the study.

This paper explores and discusses all issues relating to its aim as regards political commitment in driving any development-led (STI inclusive) policy. To really capture information on these, the study employs largely the qualitative method which Liebscher (1998) describes as "methods that are appropriate when the phenomena under study

are complex, are social in nature, and do not lend themselves to quantification". The utility of the method has been put into perspectives by scholars. For instance, Payne and Payne (2004) argued that, the method captures the intricacies of social life and "treats actions as part of holistic social process and context, rather than as something that can be extracted and studied in isolation".

On the other hand, to really understand the critical influence of political commitment on the effectiveness of STI policy and properly diagnose same requires a retrospective analysis of various government efforts and profile on STI which is document-based. This documentary analysis of written records, as a supplement to interviews and questionnaires, was considered appropriate because it enhances the understanding of the political phenomena of our interest which, according to Johnson and Joslyn (1995) cannot be measured through personal interviews, with questionnaires, or by direct observation. Specifically, secondary data were obtained from relevant textbooks, journal articles, magazines, newspapers and official documents in Nigeria.

Expected result

This paper is written in order to stimulate discussion about political commitment in response to STI development. The paper would also enable individuals and organisations working in the field of STI and development, including researchers, policy makers, programme managers and activists to consider the issue of political commitment as a critical force in driving STI policy and public policy in general.

Conclusion

The paper concludes that the inadequacies that characterise the measurement of political commitment notwithstanding, a focus on political commitment would be more useful in driving any development-led (STI inclusive) policy than simple exhortations for adherence to theoretical stages of public policy making and implementation. In other words, the performance or effectiveness of any public policy is dependent on its formulation and implementation processes which are function of the complex networks of political bargaining, lobbying (recently and politely called 'Advocacy') and compromises amongst national and local political elites. Thus, for effective STI policy, building political commitment through broadening participation in the policy process is a critical factor. The more that interested actors from the government, the private sector, civil society, and the communities can be engaged in policy dialogue, planning, and evaluation, the greater the chances for an effective response to the utilisation and implementation of a policy.

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Consumption, Configurations and Innovation: Exploring New Patterns of User Dynamics

Alexander Peine², Ingo Rollwagen¹

¹Deutsche Bank Research, Macro Trends, Germany

*²Innovation Studies, Copernicus Institute of Sustainable Development, Utrecht University,
the Netherlands*

In this paper, we explore, both conceptually and empirically, the recent turn towards more hybrid technologies, usually referred to as technological configurations (Fleck, 1993; Peine, 2009; Voss et al., 2010). In particular, we address the policy implications of more differentiated patterns of consumption with more active and co-creating consumers that help create such configurations. Configurations are technological systems, yet their overall identity depends on local contingencies and on the (enacted) prescriptions of users. Configurations bring together technical components, software, standards, services and user practices in more or less unique ways, and they are thus dependent on specific contexts of applications. Recent examples are infrastructure technologies like Smart Grids, Tele (Health) Care, or e-mobility and consumer technologies like Smart Homes or learning technologies. Understanding the configurational nature of these emerging systems, we claim, is a key element towards devising adequate policy measures for their creation and diffusion thus fostering growth and social welfare by innovation policy.

This paper particularly discusses and explores the marked shifts in the role of consumers as drivers of distributed innovation processes around technological configurations. We build our analysis on Fleck's original studies of configurations, which have analyzed industrial technologies and highlighted shifting roles for the organizational routines of corporate users in technological development (Fleck, 1988 & 1994 & 2000). Our empirical domains as highlighted above, however, also heavily involve infrastructure and consumer technologies, and, therefore, consumers as well as the process of consumption. When such technologies become more hybrid and distributed, entangled with the everyday life consumers, these consumers move to the centre of innovation; their activities, instead of providing a tail-end to the activities of companies and researchers, start to define the very nature of configurations-in-use. In innovation processes of technological configurations, consumers more actively co-shape innovation processes as a focal point in the triangle of education, research and innovation, and thus give rise to new forms of collaborations.

Using a set of explorative case studies, we explore these seismic shifts in the meaning of consumers for innovation, and introduce the notion of "innosumer" to capture these shifts and spur discussions on future avenues of innovation policy:

We first explore new organizational models and product design approaches, which take into account or better empower users to take up more active roles. We show on the basis of case studies – in the field of smart grids, and a software company's social business initiatives in Southern Africa that develops and roles out new mobile-based enterprise resource planning/supply chain software solutions – that users are increasingly taken on board at an early stage of system design processes to reduce costs and failures of product development processes and creating markets for these technological solutions.

We discuss these cases in the light of the notion of technological configurations, and show that these shifting roles of consumers in the development process of hybrid technologies are undertheorized and still await a thorough conceptualization. To fill this gap we introduce our notion of the "innosumer" to capture how consumers are integrated in innovation processes of configurations in novel and fundamental ways with their knowledge creating activities ranging from the creation through to application down to marketization. This also asks for a reconceptualization of the understanding of (and the term) technology; innosumers contribute substantially to broadening and refining *technological knowledge*, which is the basis for the development of new applications.

We also show, that the emerging innosumer concept – especially in the field of smart grid technologies, in which industrial customers' feedback is used to improve smart grid solutions as well as in the field of do-it-yourself activities with suppliers of machinery integrating end-users' ideas – is distinct from other notions such as 'user innovators' (von Hippel, 1988) or 'prosumers' (Toffler, 1980; Humphreys and Grayson, 2008). Due to the neat integration in product development and marketing processes of configurational technologies, the innosumer contributes more actively and epistemologically more relevant to innovation processes.

Finally, our case studies in software development and learning technologies, in particular, show that both the broadening and the refinement of the knowledge bases ('what should work' and 'how it works') and the development and rolling out of technological systems-in-use ('what really works at which costs') is most valuable to be put under scrutiny. Departing from Stankiewicz' (1990) conceptualization of technologies, we thus argue that consumption in the emerging world of everyday life configurations is more knowledge-intensive: the users contribute with their own knowledge-intensive activities (like coding in improving moodle solutions in education technologies or mobile learning apps) or own experimentation ("tinkering"), when they create new technological configurations, for instance in the form of integrated student-life-cycle-management and higher education software management systems. In the case of end-users actively coding and co-creating new software solutions, or in the case of some corporate strategies

that take up the agency for the prescribed end-users (in the form of the use of advanced marketing techniques like 'lead-user approaches' or 'future acceleration' in the automotive or the aviation industry), today's consumers are more heavily integrated in designing hybrid, technology-based solutions.

Finally, we show that these profound changes to consumption in the emerging knowledge economy have important policy implications. Today most concepts of innovation processes see consumption and the role of consumers as rather passive. There is still a dearth of integrative policy-making models especially for developing/policing environmental, infrastructural and learning technologies. Today, with more differentiated consumption and the nature of technologies changing to more hybrid configurations, we posit that innosumers should be conceptualized as 'the' new balancing point in innovation models. More integrative technology policy models with more refined methods of integrating the interested and effected public (civic participation), new forms of knowledge and technology transfer, new rules in intellectual property (law) not restricting the use of knowledge but even encouraging it by smart standardization, general public licenses and patents are only few of the policy implications which will be discussed in more detail.

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The design of design: A systems approach to Integral Planning and spatial Design in the Dutch Southwest Delta

Bonno Pel, Jurian Edelenbos, Arwin van Buuren

*Erasmus University of Rotterdam, Governance of Complex Systems Research Group,
Department of Public Administration, the Netherlands*

The mission-oriented turn as proposed in the 2009 Lund declaration advocates 'research addressing the Grand Challenges of our time, moving beyond the current rigid thematic approaches'. This contribution exposes how such research is taken up in the Dutch 'Integral Planning and Design in the southwest Delta' (IPDD) project¹, specifying the challenges of spatial design in the context of societal complexity and sustainability transitions. To redefine societies' challenges is to redefine the task of spatial design, as well as its relations with governance and data management. One of the key questions raised in the project is therefore the following: *In what way do the composed nature and complex dynamics of the delta areas on the one hand and the anticipation to future transformations and transitions on the other hand put new demands on the form, function and role of spatial design in reaching synchronized/integrated/interconnected delta area development?*

The Dutch Southwest Delta is a densely populated delta area, roughly bounded by the North Sea, the ports of Rotterdam and Antwerp and the Brabant province. The area is widely considered to be a hallmark of the Dutch tradition in spatial planning and water management, and especially of its longstanding struggle to cope with and transcend its natural conditions. Yet however ingenious and successful in terms of flood protection, it is increasingly acknowledged that in the longer run, business-as-usual policies will fall short: Rising sea levels and increasing river discharges pose mounting pressure on the system, and the Delta works' ecological shadow sides have only become more prominent – revealing the unintended consequences of earlier engineered spatial solutions (IPDD, 2011). The distant but real possibility of future transitions and catastrophes has thus prompted a national Delta Program to meet future water challenges. Parallel to but independent from this policy initiative, the interdisciplinary IPDD project serves to inform current and future decision-making. The project especially seeks to sensitize stakeholders to the broader system dynamics these water challenges form part of: The delta's complex spatial system and equally layered and diverse societal system yield a variety of intertwined challenges, also involving issues of agriculture, industrial development, preservation of natural areas and restructuration of the energy sector (Meyer,

¹ <http://ipod.verdus.nl>

2005). This broad and long-term oriented view responds to the largely sector-based designs and strategies developed thus far (IPDD, 2011). The aim is to develop a methodic for design and planning in the Southwest delta and other densely populated delta areas, taking into account both the complexity of the challenges and the changing conditions under which solutions are to be devised. Considering the changing task and circumstances of spatial planning and design, IPDD's mission can therefore be characterized as the 'design of design'.

Deliberately intended to develop a complexity-sensitive form of spatial design and planning, IPDD has taken a systemic approach: Following recent theoretical advances in transition management (Rotmans, 2003, 2006, Loorbach, 2007, Grin et al., 2010) and social-ecological resilience (Folke, 2006, Scheffer, 2009), the delta area is conceptualized as a complex adaptive system of co-evolving subsystems, with constant interplay between the spatial layers of substrate, networks and occupation patterns (Sijmons, 1991). This conceptualization helps to break loose from reductionist and sector-based approaches that have marked earlier spatial design and water management in the Netherlands; non-linear system developments are taken into account. Moreover, this acknowledgement of complexity not only pertains to the physical-ecological properties of the area, but to its societal dimension as well: The delta is understood to involve a multitude of societal actors, dispersed over various sectors and scales. Under these conditions of dispersed control nobody is in charge, actors are frequently confronted by the unanticipated consequences of others' actions (Teisman et al., 2009), and the mismatch between 'governing system' and 'system to be governed' can be considered pervasive (Folke et al., 2005, Termeer et al., 2010). In line with Luhmann (1995), Nowotny (2005) and Ulrich (1983), an essential source of complexity is that actors diverge in their system understandings, and that systemic problems and solutions cannot be assumed obvious. This implies a radical break with social engineering and other approaches in which this complexity of meaning is bypassed: A crucial governance challenge is not so much the integration of interests and the forging of consensus, but rather the continuous task of attunement and 'synchronization' (Teisman & Edelenbos, 2011, Pel, 2012) between system understandings. Advances in geographical information systems and decision-support are promising precisely for the added capacity to articulate and inform these system understandings, and to facilitate *dynamic* system representations (Kooistra et al., 2009, Vervoor et al., 2010). Based on these considerations, the practice and content of spatial design is reconsidered. Beyond traditionally sequential order of survey-plan-governance, IPDD develops an interdisciplinary approach commensurate to the dynamic and multifaceted task: Understanding that survey-before-plan and command-and-control approaches no longer suffice, expertise on spatial design, governance, and data management is brought in constant interaction.

The methodic-in-development crucially hinges on integration within the design-governance-GI(D)S triangle, taking shape through interrelated activities in 1. Historical transitions analysis, 2. Scenario development, 3. Participative design of regional spatial concepts, 4. Urban design in focal areas, and 5. International comparison of delta areas. Through a cyclical build-up of the project, IPDD seeks to secure gradual refinement of its design-of-design.

As the 2-year project started in the fall of 2011, only early insights can be reported. On the basis of conceptual developments, results can be expected to be achieved in the following three respects. First of all, the project promises to generate insights into the governance of system innovations and transitions: However great the conceptual advances in this area, questions remain on the practical and political aspects of avoiding, stimulating and coping with future transitions (Smith & Stirling, 2010). A specific issue is how to build and maintain the requisite synchronization (Teisman & Edelenbos, 2011, Pel, 2012) between the diversity of actors involved with this transformation processes. Second, IPDD promises to further develop the possible role of spatial design in these processes: As yet, transitions research has been found to be lacking in geographical concreteness (Coenen et al., 2011), and IPDD's cross-pollination between the spatial layers approach and transitions research is one step in this direction. Third, the systems-theoretically informed interplay between governance, spatial design geographical information systems experts promises to reinvent spatial design. The challenge is to move beyond technocratic visioning, imaginatively empty compromises or merely instrumental spatial design (Zonneveld & Verwest, 2005). The methodic is to shape design practices that are particularly sensitive to the complexities of long-term-oriented governance, while fully capitalizing on the rapidly augmenting possibilities to gather, process and present spatial information to decision-makers, experts and stakeholders.

As mentioned, the IPDD methodic should inform decision-making and spatial design in delta areas, with the Dutch Southwest Delta as its 'laboratory'. While elaborating a methodic sufficiently generic to be applicable in other areas, the project team has also committed itself to regularly reflect on ongoing decision-making and visioning in the Delta Program. Focusing on complex dynamics and possible transitions, implications for policy will not be of an instrumental kind. IPDD aims to sensitize stakeholders to the complexity at hand, and to help them anticipate on future transitions. This also implies that the allure of the singular 'system leaps' will be counteracted, highlighting instead the manifold of smaller and greater systemic changes that manifest across sectors and scales.

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Tracing long term and multidimensional sequences of impact from academic R&D

Eugenia Perez Vico

Environmental Systems Analysis, Chalmers University of Technology, Sweden

Introduction

Addressing grand challenges is emerging as a new policy rationale for research funding. This broadens the types of impact expected from academic research beyond economic growth and competitiveness. Relying on conventional impact indicators, such as new firms, patents and products, is particularly insufficient for understanding the role of R&D in meeting such challenges.

A new approach to assessing the impact from R&D is called for. The technological innovation systems (TIS) framework has been used to study the emergence of innovations addressing grand challenges in energy supply, food production and transportation (Bergek et al. 2008). Being also the point of departure for a framework that captures and explains the impact of academic R&D (Jacobsson and Perez Vico, 2010), the TIS approach is promising for a study of the role of academic R&D in meeting grand challenges.

Indeed, studies applying this framework have shown that impacts from academic R&D are diverse, context dependent and often emerge after decades (e.g. Hellsmark and Jacobsson, 2009; Perez Vico and Jacobsson, 2011). In addition, some studies reveal substantial indirect impacts (adding to direct ones) where benefits are mediated through the behaviour of firms, students and policy actors in longer sequences. Although sequential impacts of direct and indirect kind have been sporadically accounted for, a systematic analysis of these is lacking. To gain a fuller understanding of the impact of academic R&D, more knowledge of such sequential effects is required.

The purpose of this study is, therefore, to illustrate sequences of direct and indirect impacts and systemically explain how these emerge. This paper will contribute to a more accurate understanding of the role of academic R&D in meeting grand challenges and to the development of a methodology for capturing and explaining sequences of impact.

Exploring sequences of impact necessitates an extensive empirical analysis and, therefore, a narrow point of departure. Professor Bengt Kasemo and the group that emerged around him at Chalmers University of Technology in Sweden, is chosen as a suitable study object. Professor Kasemo is long-established and well-recognized in the area of

surface science. His impact can be seen in two areas addressing grand challenges; catalysis that targets pollution-related challenges and biomaterials targeting health-related challenges. Additionally, sequences of impact emerged as Kasemo gained experience in how to organize and utilize research and diffused this to other research and policy actors.

Analytical framework and methodology

The TIS framework applies a holistic approach to studying the development and diffusion of innovations through key processes involving the four structural elements actors, networks, institutions and technology. Jacobsson and Perez Vico's (2010) development of the framework captures and explains the impact of one actor, namely academia, on these processes. A slightly modified set of seven key processes from the TIS scheme is used. These are *Legitimation*, *Influence on the direction of search*, *Knowledge development and diffusion*, *Resource mobilisation*, *Entrepreneurial experimentation*, *Market formation* and *Network development*. Sequences of impact are accounted for through the interdependence between the processes.

For example, an increased awareness of the threat of climate change *influences the direction of search* for solar cells, attracting more producers to enter the market. These new actors may *develop* political *networks* that *legitimate* solar cell technology which in turn may *mobilize new resources* as governments answer with funding schemes. New resources may enable *entrepreneurial experimentation*, which *develops and diffuses* new *knowledge* and in turn *form* new *markets*. Academics may impact on these processes directly, for instance through *developing and diffusing knowledge* through research, providing guidance which *influences the direction of search*, *mobilizing human resources* through education and creating new *networks*. In turn, these effects spread indirectly on to other processes and so sequences of impact unfold.

The data comes from 20 semi-structured interviews, 150 reports, research evaluations, news articles or books, patent and bibliometrical searches and mapping PhD students and key individuals.

Results

Kasemo's interest in catalysis sprung from a cooperation starting in 1974 with the car manufacturer Volvo. Together they *developed knowledge* and *influenced* each other's *direction of search*. Impact sequences evolved as *networks developed* when additional industrial partners were involved. In 1995, Kasemo initiated a R&D centre that integrated diverse research groups and industry. In addition to *developing and diffusing knowledge*, *influencing the direction of search* of involved companies and supporting

entrepreneurial experimentation and *network development*, resources were mobilized as a many students were trained and later employed by industry. Further sequences unfolded as some industrial partners became knowledgeable catalysis customers, *developing* the catalysis market.

Kasemo's biomaterials engagement sprung from contacts with Per-Ingvar Brånemark in 1979. Brånemark developed dental implants whose functionality was not fully understood. They explored the biocompatibility of materials in several research programs throughout the 80's and 90's, *developing knowledge*, *influencing the direction of search of the area* and *mobilizing resources* as students were trained. Sequences evolved as Kasemo became a highly recognized researcher and *legitimized* the development of the technology while Brånemark *experimented* and commercialized applications through the company Nobel Pharma. Researchers from Kasemo's group eventually started their own groups at two research institutes. These became important partners in *knowledge development* and *experimentation* for Nobel Pharma and the emerging regional biomedical industry, extending impact sequences. Further, *Networks developed* as well as *markets* as a radically new product was introduced.

As Kasemo gained experience and legitimacy as a researcher, he initiated sequences of impact in research policy. He *legitimated* integrating needs-driven and fundamental research as well as interdisciplinary research and underlined the importance of reaching critical mass within a research group – as an advocate and a successful example of the realization of these ideas. These ideas *diffused* through key research policy players, *influencing the direction of search* of research policy. Together with other factors this resulted in *experimentation* with new ways of organising research, further extending sequences. Similarly, Kasemo *diffused* ideas regarding the importance of a national nanotechnology strategy, ethics and risk issues as well as pointed to the opportunity of applying nanotechnology to various energy applications.

Patterns appear regarding how and when these sequences emerge. The early impact targets *knowledge development and diffusion* closely linked with *influence on the direction of search*. With a time lag of 10-15 years, substantial impact on *resource mobilisation*, *legitimation* and *network development* emerge. After another 10-15 years, significant impact is observed on *entrepreneurial experimentation* and *market formation*. Networks are vital in enabling sequences of impact since human interaction is central and impacts are deeply intertwined in the actions of others. Further, some important types of impact are very subtle, such as being an intelligent and creative discussion partner, mentor or inspirer.

Conclusions and policy implications

This study illustrates how sequences of impact emerge. *Knowledge development and diffusion* was continuous and often parallel with *influence on the direction of search*, *resource mobilisation* and *legitimation*. In these processes, the researcher was directly involved. Substantial indirect impacts mediated through other actors also emerged in these processes, but particularly in *market formation* and *entrepreneurial experimentation*. Networks were important for sequences to develop, as well as competent and involved partners. When in place, sequences of impact unfolded leading to materialisation (i.e. new products, processes) and industrial development within a time scale of several decades. The case, thus, reveals a multidimensional impact from academic R&D, deeply intertwined in its context.

Policy should recognise that impacts from academic R&D are diverse, subtle and materialise as sequences of impact over longer periods of time. These results clearly points out the limitation of conventional economic or competitiveness indicators such as patents, firm or product creation when capturing the full impact on addressing grand challenges, particularly when measured without a long time lag.

A central research task is to develop an approach reflecting the multidimensional impacts of academic R&D on grand challenges, where legitimation processes and influence on the direction of search are of particular importance to capture. Although indicators capturing the initiation of sequences of impact, such as the extent of knowledge development and interaction with other actors may be useful, methods accounting for causality and context interdependency are also needed.

Innovation and Infrastructure – the Case of Electric Vehicles in Germany

**Patrick Plötz, Elisabeth Dütschke, Till Gnnann,
Uta Schneider, Martin Wietschel**

Fraunhofer Institute for Systems and Innovation Research ISI, Germany

1 Motivation: Electric Vehicles and the Call for Infrastructure

Electric vehicles bear a high potential for making individual transport more sustainable, e.g. by reducing global CO₂-emissions and local traffic noise. Accordingly, this new propulsion technology has been identified by national governments as a promising option for future mobility and gained much attention and political as well as financial support. The same holds for Germany, where the federal government has set the goal of one million electric vehicles on the roads for 2020.

Against this background the question about public infrastructure for charging electric vehicles comes to the fore. On the one hand, battery electric vehicle have a very limited driving range compared to conventional vehicles which seems to point out, that charging infrastructure might be crucial. On the other hand, implementing a broad infrastructure is extremely costly and various stakeholders have demanded public subsidies. Thus, this issue warrants an in-depth analysis. Which kind of infrastructure is really needed to ensure individual mobility? And which kind of infrastructure is needed from a consumer's point of view? In the present work we want to shed light on these questions by combining technical and psychological perspectives, drawing on data collected in several e-mobility projects. Possible conclusions for political decision makers are also discussed. The case study gives insight into the complex process of providing information for political decision making in the context of new innovations and their required infrastructures and how this challenge can be solved by applying a multi-disciplinary perspective.

2 Methods and Data

Firstly, we analyze driving profiles to determine whether (or which part of) driving profiles are possible to be driven by a battery electric vehicle (BEV) or a plug-in hybrid electric vehicle (PHEV). These analyses are based on the Mobility Panel (MOP) for German driving behaviour which consists of some 12,000 households with travel data for one week [1]. Using this data set to simulate the battery capacity of electric vehicles we can establish which driving profiles could completely be managed by a BEV. Additionally, by simulating the state of charge for a PHEV, we determine the share of driv-

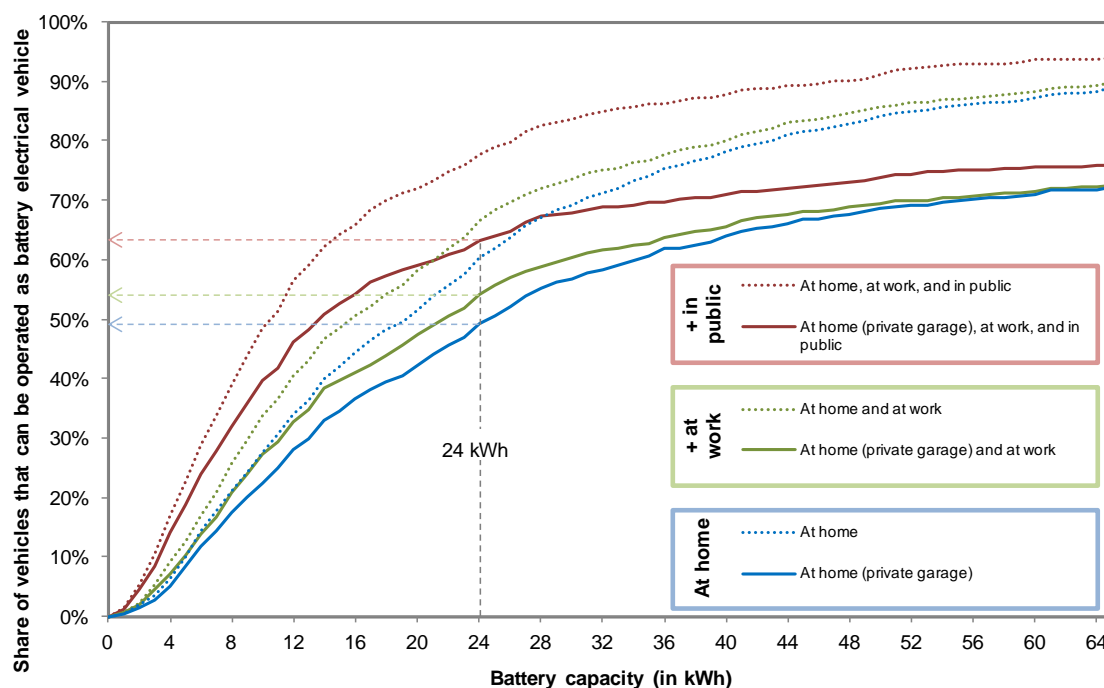
ing in electric mode. Since the battery profile is dependent on the charging infrastructure, we can evaluate its influence in a comparison of results in different infrastructure scenarios to receive the technical demand for infrastructure.

Secondly, a set of survey data of participants in field trials from the eight pilot regions for electric mobility in Germany will be analysed as well (N=2306). Participants – amongst other topics – were asked to rate their perceptions of and experience with the current infrastructure as well as their recommendations for the future development of electric mobility in Germany. A longitudinal survey design was applied, i.e. users were invited to take part (1) before starting to use the vehicle, (2) after a short usage period to report first impressions (between one week and up to three months) and (3) after a period of adaptation (after three months up to about a year). The survey includes individuals with private as well as commercial vehicle use; most vehicles were BEVs. The survey data is analyzed in combination with data on existing infrastructure in each pilot region.

3 Results

3.1 Results on driving behaviour: the need for infrastructure from a technological and economical user's perspective

In order to estimate the need for charging infrastructure from a technical perspective, one has to consider the actual driving behaviour of potential customers and the availability of existing charging options for them. Furthermore, the availability of charging options at home needs to be studied. Figure 1 shows the result of a simulation of over 10,000 German driving profiles. Displayed are the share of vehicles that could be operated as battery electric vehicles as a function of battery capacity (24 kWh resulting in a range of ca. 100 km). Even under the constraint that only drivers owning a garage (where charging options are available or could be easily installed) should be considered, we find that roughly 50% of the German drivers could technically use a battery electric vehicle for all their trips in the week of measurement. Furthermore, Figure 1 shows that additional semi-public and public charging options can increase the share of vehicles that can be operated as battery electric vehicles but only by roughly 15%. This is only a limited increase compared to the cost required for installation of ubiquitous public charging infrastructure [2].



In addition to battery electric vehicles, PHEV allow very long trips to be driven without any additional public or semi-public charging infrastructure. In fact, a detailed analysis shows that more than 90% of the drivers reach electric driving shares of 80% or higher when charging overnight [3]. Thus, charging at home is advisable in order to increase the electric driving share of PHEVs and to reduce the operational costs.

In summary, from a technical point of view, for market introduction of electric vehicles there is only little need for public charging infrastructure and its installation promises only limited gain compared to significant costs.

3.2 Results on user needs and user behaviour from a psychological perspective

Based on user surveys we find that the evaluation of the availability of public and semi-public infrastructure is critical – at the same time users complain about the restricted driving range. Moreover they report to not fully trust the indicated range, i.e. there is uncertainty in handling the limited range. Thus, electric vehicles are not yet able to fulfil users' expectations in this regard.

In line with this, users ask for developing the existing infrastructure especially with regard to providing charging options which can be used en route – 40% want more charging possibility in the inner city or at shopping points, 30% think it is most important to invest in infrastructure at employer sites. Only 2% regard the existing infrastructure as already good enough.

Analyses from fleet trials point to the direction that the available public infrastructure is hardly used. A possible explanation for the gap between user's demand for public and semi-public charging infrastructure and the actual usage could be a badly chosen position of the public and semi-public charging facilities.

4 Discussion and Possible Political Implications

For a market introduction of electric vehicles no public charging infrastructure is technically required since many potential users can charge at home easily. However, public charging infrastructure also has a psychological function: It reduces the well-known "range anxiety" of users of battery electric vehicles [5]. Moreover, some drivers might not be aware of their actual driving behaviour and might feel safer with public charging infrastructure widely available. Additionally, as it is not clear, if these charging stations will be profitable for their providers, at this point the market introduction of electric mobility may depend on financial support from the government or on the provision of some kind of incentive to the providers.

In summary, we find that a some public charging infrastructure at well chosen locations seems advisable in order to facilitate the user's decision for an electric vehicle and to reach the political targets for market shares of electric vehicles.

5 Conclusion

We have studied the technical and psychological factors for a possible need and potentially publicly supported charging infrastructure for electric vehicles as an example for the complex relations for the introduction of new technology, its infrastructure and policy goals. We find that a thorough and combined analysis of the technical requirements, the psychological user needs, and the costs are highly useful in guiding a decision for political action.

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Conceptualising and Measuring the European Research and Innovation System (ERIS)

Dimitrios Pontikakis¹, Luisa Henriques², Laura de Dominicis²

¹Newcastle Business School, Northumbria University, UK

²Institute for Prospective Technological Studies, Joint Research Centre, European Commission, Spain

Motivation

Research and innovation policy are gradually moving away from national level – with increasing importance attributed to the regional and European levels. And while there is a preponderance of analytical work to inform such policy at the regional level, we are still lacking comprehensive analyses of the European 'layer' or more generally, of the implications of the move towards a multi-level system of research and innovation governance. To be sure, a lot of excellent work has been done in this area, but the advances made so far are difficult to piece together into a 'big picture' without additional work that may 'bridge' insights from areas as diverse as the dynamics of research collaboration (e.g. Luukkonen et al., 2006; Tijssen, 2008; Hoekman et al., 2010), institutional change (e.g. Caracostas and Soete, 1997; Bonaccorsi, 2007;) and changes in the rationales and instruments of policy (e.g. Borrás & Jacobson, 2004; Lepori, 2011).

In this work we attempt to uncover the boundaries, magnitude and structure of the emerging *European Research and Innovation System (ERIS)*. In striving for a comprehensive conceptualization of ERIS, we extend upon the foundational work of Borrás (2004). Moreover, given our institutional background in the Commission, the concerns of European policy makers – and the interfaces between the ERIS and EU policy instruments such as the Framework Programme (FP) and the Structural Funds – are systematically accounted for. More specifically, we chart the historical evolution of ERIS in the context of broad strategic concerns for the EU such as international economic competitiveness, internal cohesion & societal challenges and their translation into specific *problématiques* for research & innovation policy, in the form of the debates on duplication vs. specialization, the efficiency of public R&D spending and the institutional changes put in place to support them.

Our two year research study was guided by two principal questions:

1. Following decades of cooperation and integration in the European research activity, infrastructures, and policies, is there something like a European Research and Innovation System (ERIS) in place?
2. What is the structural configuration of ERIS and what are the (policy) implications of such structure?

The first question seeks a politically meaningful, yet scientifically rigorous delineation of what a European 'system' may be. The second question is especially pertinent to the recent turn towards 'directional' research and innovation policy at the European level – which of course includes not only mission-oriented research, but also the recent emphasis on concentration as manifested in "smart specialization" policies (Chorafakis and Pontikakis, 2011).

We are mindful that a work of this scale and ambition cannot be fully documented in a short article; therefore the aim of the paper presentation is to give a broad overview and a selection of results so far, with interested scholars referred to our soon to be published working papers for further details and discussion.

Approach

Our overarching framework is inspired by literature on national innovation systems: It centres on the identification of boundaries, of important actors and relationships as well as background routines / institutions. In line with tradition in that literature much of our discourse is qualitative & historical in nature. However in seeking systematic ways to answer our questions over long periods of time, we complement the qualitative insights with quantitative analysis. The latter occupied the larger part of our work and included the introduction and calculation of custom-made S&T indicators (of integration, of connections/networks and of structural configurations/structural change), as well as a statistical evaluation of the impact of alternative structural configuration regimes on the innovative capacity of the EU over a two-decade period.

Results

- We put forward a working definition of ERIS. The emerging European Research and Innovation System (ERIS) is a system of research and innovation relationships between actors located inside the borders of the EU-27 at multiple levels – European, national or regional – to produce, diffuse and explore knowledge for new products, industrial processes and services to the benefit of European citizens. The ERIS is conceptually different from the European Research Area (ERA) because of its systemic nature and defined boundaries.
- We propose a methodology to quantitatively identify the boundaries of ERIS and consider four possible ideal-types of political configurations, distinguished primarily in terms of the ranks of the various levels of governance. In attempting to operationalise such a ranking framework we consider two, potentially measurable, systemic properties: *unity*, i.e. internal connectedness and cohesion and *distinctiveness*, i.e. relational distance or dissimilarity to external reference points.
- We measure 'Europeanisation' in terms of research funding, in terms of scientific connectedness (intra- vs. extra-EU co-publications & co-patents), networking (FP network

analysis) and spatial knowledge spillovers (spatial dependence of patenting in cross-border regions). The calculation of three indicators of Europeanisation of knowledge outputs has revealed that most ERA (and certainly EU) countries exhibit high levels of Europeanisation. However, examining data over the last decade or so, most indicators show no consistent change over time. These findings corroborate the stability observed in the performance function with respect to public R&D funding.

- We also measure the direction of technological change in European national innovation systems, defined as the social aggregate of decisions on the distribution of knowledge-generating resources across sectors by various institutional actors in a dynamic setting. We find that the weight of high expectation sectors (ICT, Biotech and Nanotech) has increased collectively for much of the period considered.
- Looking at the structural change, results from the shift-share analysis provide evidence of a different behaviour between more mature and emerging research and innovation systems. On the one side, more mature systems (US, EU and Japan) appear to be less reactive in shifting resources and thus produce patents in emerging fast growing sectors. On the other side, emerging research and innovation systems (EU-12 and BRICS) seem to be more flexible, thus catching up. In any case, Europe appears to maintain a certain competitive advantage in the chemical sector, and Biotechnology.

In general, we observe that European Member States have a portfolio of technologies that are becoming more and more related over time.

- We put forward a set of readily calculable indicators to measure the extent to which the direction of technological change is aligned between the various subcomponents of the system (public and private actors). Governments can choose different structural policy intervention strategies to pursue the general objective of increasing national competitiveness (strengthen existing comparative advantages, shift resources away from existing comparative advantage, or a laissez-faire approach). Results show that it is difficult to establish any European-wide pattern, pointing at the importance of context-specific factors. Rather, individual countries exhibit a variety of structural configurations, pointing at the importance of *context-specific factors*. While, most Member States seem to prefer to strengthen the existing R&I capacity, certain of them show a certain degree of openness to shift resources towards new priorities. Only a small group of countries appear to shift R&D resources away from existing comparative advantages.
- As for the drivers of structural change, the results of our statistical analysis show that GERD acts negatively upon structural change. Only openness exerts a positive and statistically significant effect on our measure of overall structural change. Moreover, it is general, globalised international (which of course includes Europe) knowledge transfer, rather than European integration on its own, that has a measurable and quantitatively distinct effect on shifting capacity.
- Regarding the impact of structural variables on national innovative capacity, perhaps the most important conclusion is that context matters a lot. Even when individual

structural variables were found to have a statistically significant effect, the magnitude of this effect as well as its sign (positive/negative) change depending on the group of countries considered. We found that concentration across patenting sectors has a positive impact on national innovative capacity, but this effect is limited only to emerging R&I systems. For Old Member States, we found a negative impact of concentration on some high expectation sectors. This finding may be suggestive that the many years over which policy has supported such sectors have resulted in above optimal concentration. More research will however be needed to adequately explain this finding.

Conclusion

Our results have important policy implications. With respect to our first question:

- Our historical overview has corroborated Borrás (2004), in finding that ERIS has asymmetric, porous boundaries. ERIS possesses an incrementally built institutional framework closely resembling that of a national system – with regulatory framework. Infrastructure for policy intervention composed of policy and advisory bodies and administrative bodies resembling to national one which constitutes the European layer. Both public funding 'rules of the game' and private appropriability are becoming increasingly Europeanised (e.g. as reflected in the plans for a 'Community Patent')
- Yet, national authorities retain an important, effectively dominant role – namely in creating capabilities and steering national resources. We identify future avenues of research on the issue of boundaries identification.
- With respect to specific system functions, we observe increasing Europeanisation, at the funding function rather than performance. We question the extent to which this is linked to connections with the production system.
- Europeanisation in performance relatively stagnant and is according to our calculations (and by several other accounts) close to the limits imposed by cultural-linguistic fault-lines. Neither joint (co-located) research nor other forms of collaboration in terms of performance (as reflected in joint publications and patents) have witnessed much progress over the last decade. As argued by Ponds (2009), there are limits to the internationalisation of R&D performance.
- All these findings serve to moderate policy expectations about the scope for and limits to an 'Innovation Union'. For instance, as the European coordination of national policies is where most progress has been made recently, it is an area where it is reasonable to expect further Europeanisation in the short-term. However, policy makers hoping to gauge further integration by measuring patents and publications may be disappointed.

With respect to our second question:

- The existence of important differences with respect to structural change between emerging and mature R&I systems.
- The fact that structural variables do not impact on structural change highlights the limits of policy explicitly concerned with distributional decisions (including the emphasis on societal challenges and smart specialization) and suggests that the interfaces between policy and long-term structural change may be more complex than is commonly understood.
- The difficulty in ascertaining European trends and context-specificity imply that the national, or even the sub-national level, may be more relevant for policy on structural change. Familiar caveats against one-size-fits all policies seem particularly relevant to the case of structural change.

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R&D costs evolution, new R&D models and its implications for policy

Bianca Poti¹, Karl-Heinz Leitner², Rene Wintjes³

¹*CERIS, Italy;* ²*Austrian Institute of Technology, Austria;* ³*UNU-MERIT, the Netherlands*

Motivation:

Over the last two decades research costs have been increasing, however little is known in detail about the underlying drivers and trends of the costs across different regions, industries, and research fields. The paper builds on the results of a research study about the evolution of the costs of research commissioned by the DG Research and Innovation.¹ The study aims to deliver empirical evidence about the drivers and implications of increasing research costs. Empirical evidence about the characteristics of the evolution of the costs of research contributes to a better understanding of the strategies chosen by public and private R&D performers and can help to identify new directions for research and innovation policy.

The study addresses the following four questions: i) To what extent have research costs grown over the last years and what is the likely future development; ii) what are the main drivers for the evolution of research costs; iii) what are managerial responses to increasing research costs, iv) what are the long term impacts on the competitive R&D position of Europe. Has Europe perhaps become too expensive? Are we losing R&D activities to low cost countries? The paper presents firstly finding from the empirical study about the evolution of research costs addressing the aforementioned questions, secondly we discuss the implications for research policy in light of current policy strategies such as building ERA, achieving Grand Challenges and fostering smart specialisation.

Approach:

The study is built on original data, collected through comprehensive field research and case studies, together with an analysis of secondary data about R&D expenditure over the last 15 years and a scenario analysis. The survey sample consist of 103 companies from different sectors representing the most important European private R&D spenders and 64 small and large Public Research Organisations (PROs). The case studies cover

¹ Leitner, K-H., Butler, J., Cerulli, G., Dunnewijk, T., Kampik, F., Kasztler, A., Meijers, H., Poti, B., Thomas, M., Trier, E., Slipersæter, S., Wintjes, R., Youtie, J., (2011): "Analysis of the evolution of the costs of research – trends, drivers and impacts", Final report, Contract n°: RTD/B2/2009/COST-2009-01, European Commission, DG Research and Innovation.

the research cost issues in 16 European (e.g. Philips, BBC, Rhodia, Eni, Rolls-Royce) and 5 non-European large multinational, R&D intensive, companies and 16 European PROs (e.g. DLR, ELLETRA, INRA).

Research costs have been defined in the study as the product of input price and volume. The novelty of this approach compared to the well-known Frascati definition of R&D business expenditures is that it allows us to distinguish between price and volume changes. We asked companies to assess whether research costs have primarily grown due to price (e.g. cost increases due to an increase in wages per researcher) or volume (e.g. increases in the number of researchers). Furthermore, a breakdown of cost components of research such as labour, capital, management, financing, etc. allows to compare trends over time and across sectors.

Results:

The empirical study shows that research costs have grown in the past five years, on average by 47% across all industries and it was the "volume " effect that mostly characterised this evolution . Wage costs are the most important element of R&D cost, accounting for 50% of all cost in companies and 62% of the costs in PROs, but they are not regarded as the most significant contributor to the increase in R&D cost. Sixty percent of companies surveyed reported that, in the last five years, the main R&D cost increases were due to increases in capital costs (investments in infrastructure, machines, etc.). Companies expect that in the next five years the R&D cost increase will be more price than volume based and that the main component of cost evolution will be due to purchasing R&D services (48%) and cost of financing (41%).

Companies and PROs reported that the increasing complexity of the R&D process is the primary driver of the growth of research costs. Research complexity arises from factors such as the need for multidisciplinary projects, the fusion of technologies and research strategies, the development of platform technologies, and a more sophisticated and comprehensive capability to address technological, socio-economic and environmental issues. Environmental regulation and product market regulation are significant drivers for increasing research costs. This reflects the demands of society, employees, and customers for safer and more environmentally friendly products and healthy working conditions and can be further seen in relation to the EU Grand Challenges. At the same time, while legislation in these areas can be interpreted as a cost driver, it also offers new business and R&D opportunities for firms.

The study results indicate that spending on research is firstly considered as an investment by companies, a strategic choice and not as a cost "per se". R&D cost can grow as effect of companies' strategies facing for instance more complex environment. Also

the trend towards the internationalization of research, which will continue towards non-EU countries, is not motivated by lowering R&D costs, but by complementing and augmenting knowledge from research conducted abroad. The empirical evidence clearly indicated that companies and PROs are increasingly collaborating and therefore sharing costs with other companies, universities, and research organizations. These trends imply a further increase in the use of open innovation strategies and new approaches to financing research activities and for the same reason companies expect that the costs associated with purchasing research services will be the main increasing component in the next future.

Conclusion and policy implications:

The study provides evidence for a changing paradigm of research characterized by multiple and diverse collaborative arrangements, the growth of research services, new funding models, and the evolution and integration of efficient knowledge eco-systems within new business models. What are the implications for policy?

While collaboration can significantly reduce the cost of research by cutting risk, sharing costs and allowing expertise and capability to be distributed in a network, they (can) bring new costs into focus that policy should seek to identify and mitigate.

Research policy should continue to focus on improving the quality and excellence of research: since companies' research choices are driven by the return on investment together with the direct cost of research, the focus in Europe on improving the quality of research conducted and the outputs remains appropriate. However the public and private organizations' trend towards more collaboration and networking may further heighten an existing tension in European R&D policy between fostering scientific excellence and supporting broader patterns of collaboration, hence we need a policy that reconcile that tension and further foster diversity of participation together with excellence.

The study found that global firms are able to exploit positive spillover effects from research done outside the EU, providing the opportunity for 'reverse technology transfer' to emerge as a positive feature of geographically dispersed R&D. This evidence suggests that policy should strengthen the ways in which the returns from research spending abroad can be appropriated in Europe.

Public research organizations suffer from the mismatching between the increasing relevance of project funding as source of fund and the almost constant need to collaborate, attract the best researcher and to invest in leading edge equipment. Despite the European programs to foster R&D infrastructures (ESPRi program), more attention is needed to cover the different demands from PROs.

Finally the study addressed the role of regulation, which can serve as both, driver of research costs and business opportunity, stimulating research directed towards societal challenges, but this will be achieved only if there is a harmonization of regulation across Europe.

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Assessing strategies for promoting environmental innovation: a case study of India's National Solar Mission

Rainer Quitzow

Environmental Policy Research Centre, Freie Universität Berlin, Germany

Sustainable development can only be achieved by extensive innovation in environmental technologies and their rapid international diffusion. Studies have shown that markets for environmental technologies are highly dependent on government intervention, and, with few exceptions, market development has been "policy driven" (Jänicke and Jacob, 2004, Jacob et al., 2005, Ernst&Young, 2006). In other words, the role of the State in stimulating and sustaining green technologies is crucial.

It has also become increasingly clear that emerging economies play a key role in this global process of green economic development. Not only are the contributions to global GDP – and hence greenhouse gas emissions – increasing rapidly in large emerging markets like China, Brazil or India, but these countries have also become important players in the global development of clean technologies (Levi et al., 2010). As in the industrialized countries, most markets for environmental technologies in these rapidly industrializing countries remain dependent on policy (Lewis, 2010, Arora et al., 2010, Gordon et al., 2010). In other words, the role of government remains crucial for promoting the development of clean technologies. But what does this mean in practice? What approaches are these countries using to promote innovation in green technologies?

This paper proposes a framework for assessing policy approaches for promoting environmental innovations that can serve as a basis for comparing activities across countries, including industrialized and emerging countries. After presenting the framework, it is applied to the analysis of India's National Solar Mission, the government's recently launched strategy for promoting solar energy in the country. Based on this empirical case, the paper elaborates a number of issues for further development of the framework and its application to the comparison of emerging and industrialized countries.

The proposed framework builds on existing literature that takes an evolutionary perspective on environmental innovation and technological change. A central finding shared by these studies is that innovation and technical change is a complex and multifaceted process that cannot be prescribed by the State. Rather it requires a nuanced and flexible approach to policy making (Klemmer et al., 1999, Blazejczak et al., 1999, Hemmelskamp, 2000, Hemmelskamp, 1999, Jänicke et al., 2000, Ekins and Venn, 2006, Oosterhuis et al., 2006, Geels et al., 2008). Jänicke and Lindemann (2010) call this "smart regulation" based on "instrument mixes" or "hybrid forms of governance".

Despite a widespread consensus on the need for such a smart policy mix, no comprehensive policy approach to promoting environmental innovation has been developed. Rather existing contributions highlight a number of different albeit complementary aspects of the policy making process. In this paper, four main streams of literature and their main policy proposals are identified. These include:

- the literature on sustainability transitions (Kemp, 1994, Rip and Kemp, 1998, Elzen et al., 2004, Geels, 2004, Geels, 2010, Geels, 2002) and the related governance approaches, i.e. Transition Management (Rotmans et al., 2001, Kemp and Loorbach, 2006, Kemp et al., 2007, Loorbach, 2007, Loorbach, 2009) and Strategic Niche Management (Kemp, 1994, Kemp et al., 1998, Schot and Geels, 2008);
- the systems of innovation approach with a particular focus on the concept of systems functions (Bergek et al., 2008, 2010, Klein Woolthuis et al., 2005, OECD, 1999, Edquist, 2002, Metcalfe, 2005, Reid, 2009, Chaminade and Edquist, 1997, Hekkert et al., 2007);
- the time-strategic approach to ecological innovation policy (Erdmann, 1999, Nill and Zundel, 2001, Nill et al., 2005, Sartorius and Zundel, 2005, Nill, 2009);
- empirical studies from the field of policy analysis (Klemmer et al., 1999, Blazejczak et al., 1999, Hemmelskamp, 2000, Hemmelskamp, 1999, Jänicke et al., 2000, Ekins and Venn, 2006, Oosterhuis et al., 2006, OECD, 2005).

Each of these approaches develops proposals that address different governance dimensions or different aspects of the innovation process without promoting any specific policy instruments or making universal policy prescriptions. The paper argues that these different policy lessons are complementary, yet individually they do not offer a comprehensive framework for the formulation or assessment of policies aimed at promoting environmental innovations. For example, while the system functions approach provides a comprehensive set of entry-points for policy design, it does not adequately address the dynamics of the policy cycle itself and how this may co-evolve with the given technological innovation system (Jänicke, 2012). The dynamics of the policy process do feature prominently in the studies from the field of policy analysis, which in turn fail to address the character of the innovation system.

To bridge these gaps, this paper attempts to integrate the policy lessons from the literature outlined above in one comprehensive framework. For this purpose, it introduces the concept of "strategy". By bringing together three central dimensions of policy making, strategies offer a coherent framework that enable the integration of policy lessons across the different policy dimensions that these studies address. The first dimension refers to the strategy content, including a set of policy goals and the measures designed to achieve them. The second dimension relates to the strategy process. This provides an entry-point for analyzing *how* policies are developed and adapted over time. Finally, strategies consist of institutional arrangements – both formal and informal

– that enable or constrain strategy development and implementation, including organizational units, networks, steering committees, advisory councils, etc.

The resulting framework provides a policy approach that is not only comprehensive but also dynamic. Strategies provide a flexible framework for assessing and adapting policies for the promotion of environmental innovations. Rather than focusing on individual policy instruments, the policy lessons derived from the literature define the various functions that strategies for promoting environmental innovations should fulfill. This allows variation in specific instruments and governance mechanisms over time and across different jurisdictions. As a result, it provides a basis for comparing governance approaches in countries with very different political systems and policy traditions. Moreover, conceptually, the concept of strategy functions makes the approach compatible with the system functions approach (Bergek et al., 2008, 2010, Hekkert et al., 2007). It thus also offers a basis for conducting further research on the role of policy in technological innovation systems.

The subsequent discussion of the National Solar Mission demonstrates the usefulness of the framework for assessing the government's approach to governing India's emerging innovation system in solar energy. It provides entry-points for analyzing the main policy objectives and how these influence the development of particular strategy features. Moreover, it provides the basis for assessing the governance functions fulfilled by the relevant actors, institutions and policy measures and how these interact with the broader technological innovation system. Finally, using the strategic framework as a benchmark, it helps point out the relative strengths and weaknesses of the Indian governance approach.

Having characterized the Indian National Solar Mission in this way, the paper concludes with a brief discussion of the chosen strategy within the broader context of India's development model. It then raises a number of questions on how India's approach to promoting solar energy may compare to strategies in other countries, such as China, Japan and Germany. Finally, it discusses how the strategic framework and the underlying policy lessons might be further developed to better reflect differences between emerging and industrialized countries.

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Towards indicators for 'opening up' science and technology policy

Ismael Rafols^{1,2}, Patrick van Zwanenberg¹, Andy Stirling¹

¹*SPRU – Science and Technology Policy Research, University of Sussex, UK*

²*INGENIO (CSIC-UPV), Universitat Politècnica de València, Spain*

Introduction

Recent years have seen much critical debate over the simplistic use of scientometric tools for formal or informal appraisal of science and technology (S&T) organisations (e.g. in university rankings) or individuals (e.g. the h-index) (Roessner, 2000; Van Raan, 2004; Weingart, 2005). As a reaction to these critiques, efforts have been made to improve the robustness of measurements by broadening the range of inputs considered in scientometric evaluations. Examples include the inclusion of books and national or regional journals (Martin et al. 2010), or more recently 'altmetrics' (i.e. metrics based on alternative data sources, see Priem et al., 2010). In doing so, the S&T indicator and policy communities have reverted to an early conventional wisdom that scientometrics should rely on multiple sources of data that may provide 'converging partial indicators' (Martin and Irvine, 1983).

While this 'broadening out' of the range of data used as 'inputs' in scientometric appraisal is, in our view, commendable (Stirling, 2003), we propose in this paper that a second dimension also needs to be considered. This relates to the extent to which the 'outputs' of appraisal 'open up' contrasting conceptualisations of the phenomena under scrutiny and consequently allow for more considered and rigorous attention to alternative policy options, both by decision makers and within wider policy debate (Stirling, 2005; Stirling et al., 2007, pp. 54-58; Leach et al., 2010 pp. 102-107). We use a recent comparative study on the performance and interdisciplinarity of six organisational units (Rafols et al, 2011) to illustrate the difference between increasing the range of inputs ('broadening out') and enhancing the diversity of outputs to policy decision making ('opening out'). In this way, policy appraisal can inform decision making in a more rigorous 'plural and conditional' fashion – acknowledging the way in which divergent normative assumptions and metrics can yield contrasting understandings of both the phenomena under scrutiny, and of appropriate policy responses (Stirling, 2008).

Conceptual framework: 'Opening up' versus 'broadening out' in policy appraisal

Many S&T indicators have been developed over the past 50 years as means to reveal the 'strengths' and 'weaknesses' of a given country's 'capacity' and 'performance' in

science and technology (Godin, 2003). Developments by the OECD and US National Science Board (NSB), were derived from 'a pure accounting framework based on the anticipated economic benefits of science' (Godin, 2007, p. 1388) and hence with a tendency to take an essentialist understanding of scientific excellence and production, influenced by economic concepts such as 'efficiency' and 'effectiveness' (Narin, 1987). Initial scientometric studies were careful to declare methodological limitations, for example stating explicitly that citations were proxies and 'partial and imperfect' measures of impact rather than quality (Martin and Irvine, 1983). But whether cautious or not, the emphasis of scientometric studies has traditionally lain in producing a 'good' measure of a given concept such as 'scientific excellence', rather than in providing contrasting perspectives on what the meaning of 'excellence' is.

In recent years, various parallel developments have begun to challenge this scientometric *status-quo*. First, the pervasive diffusion of simplistic (and very possibly damaging) scientometric measures such as the h-index at various levels of management has renewed the debate over abuse and misuse of indicators (Weingart, 2005). Second, traditional scientometrics is challenged by alternative data sources, like databases from hitherto excluded countries (e.g. Brazil's Scielo), and new web-based indicators such as publication download frequency or popularity in 2.0 websites like *academia.eu* (Priem et al., 2010). Third, new tools have emerged for data visualisation (e.g. Hans Rosling's *Gapminder*), for large network analysis (e.g. Rosvall and Bergstrom, 2008) and, for science mapping (Börner, 2010), which are radically easing the presentation of complex multidimensional quantitative information to non-experts.

Each of these trends is pushing S&T policy towards use of indicators based on more diverse data inputs. These broader portfolios of inputs can in principle make scientometric analyses more robust. However, we contend here that this improved 'breadth' of inputs need not necessarily translate into a more plural and conditional policy process. 'Opening up' is not just about 'more' indicators, nor is it only a matter of 'positioning' or contextualising (Lepori, 2006). It's about the design and use of indicators aimed explicitly at providing plural policy understandings and options. For S&T policy to be 'opened up', indicators used in appraisal need to be re-conceived as 'debatable devices, enabling collective learning' (Barré, 2010, p. 227).

In this way, we distinguish two dimensions in any process of policy appraisal, as illustrated in Figure 1. The first dimension, 'breadth' refers to the depth, extent and scope with which appraisal includes different types of knowledge that can describe the phenomena under scrutiny (Leach et al., 2010, p. 104). The second dimension, 'openness', refers to the degree to which the outputs of appraisal provide plural and conditional interpretations of the phenomena – and thus allow contrasting policy options to be rig-

orously debated. Unlike analytical tools that 'close down' appraisal by establishing an absolute ranking of 'best' choices, 'opening up' tools allow decision-makers to contrast how under different assumptions the analysis may result in different rankings of options.

Figure 1: Characteristics of appraisal methods. Source: Stirling et al. (2007, p. 57)

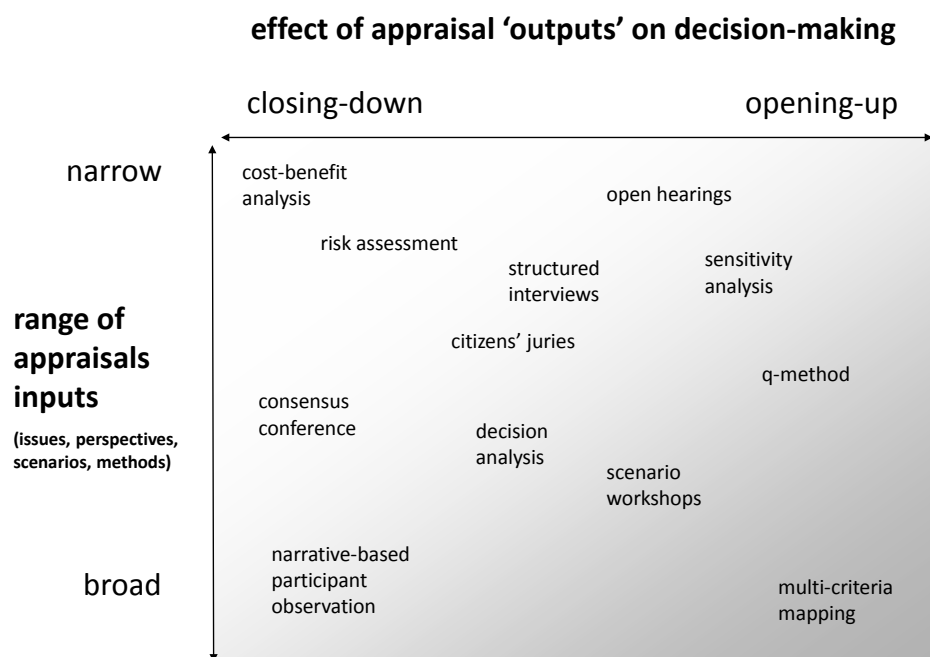
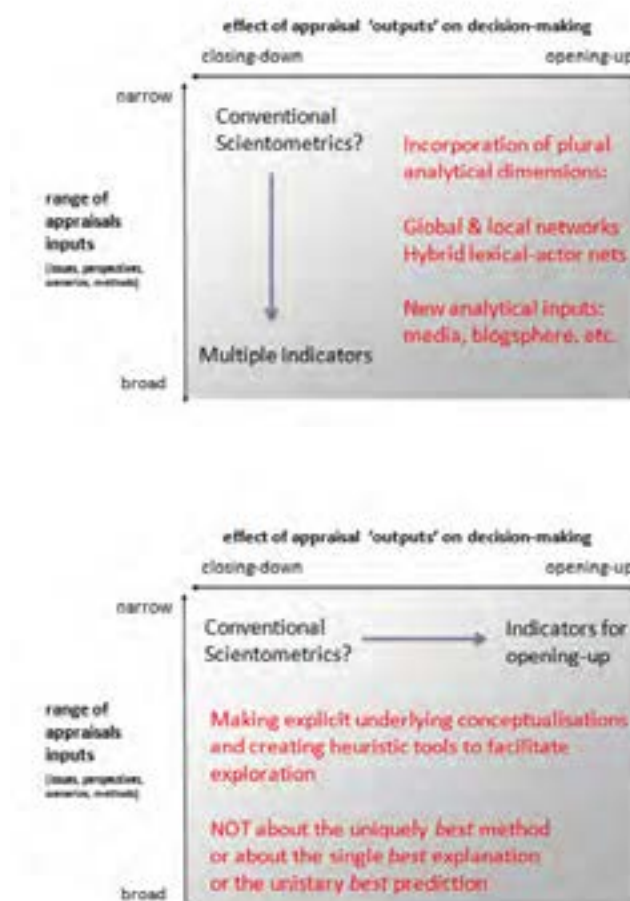


Figure 2: Difference between 'broadening out' the range of inputs used in indicators (left) and 'opening up' decision making.



Conventional scientometric appraisal is rather narrow: both in the breadth of inputs and the openness of outputs (as illustrated in Figure 2). As with cost-benefit analysis, this narrowness results from measuring performance only in one or two dimensions (e.g. production and efficiency, or number of publications and citations) and focusing disproportionately on artificially singular selections of allegedly 'best possible' methodological choices with which to handle empirical data (like normalisation routines or aggregation procedures) – even where equally reasonable alternatives yield disparate output rankings.

Some of the analytical tools in S&T indicators can be relatively broad in terms of the range of inputs. For example, the Shanghai ranking of universities takes into account six different inputs, and the European Innovation Scoreboard includes a total of 25 indicators. However, both tools create a composite index that uses simple weightings to

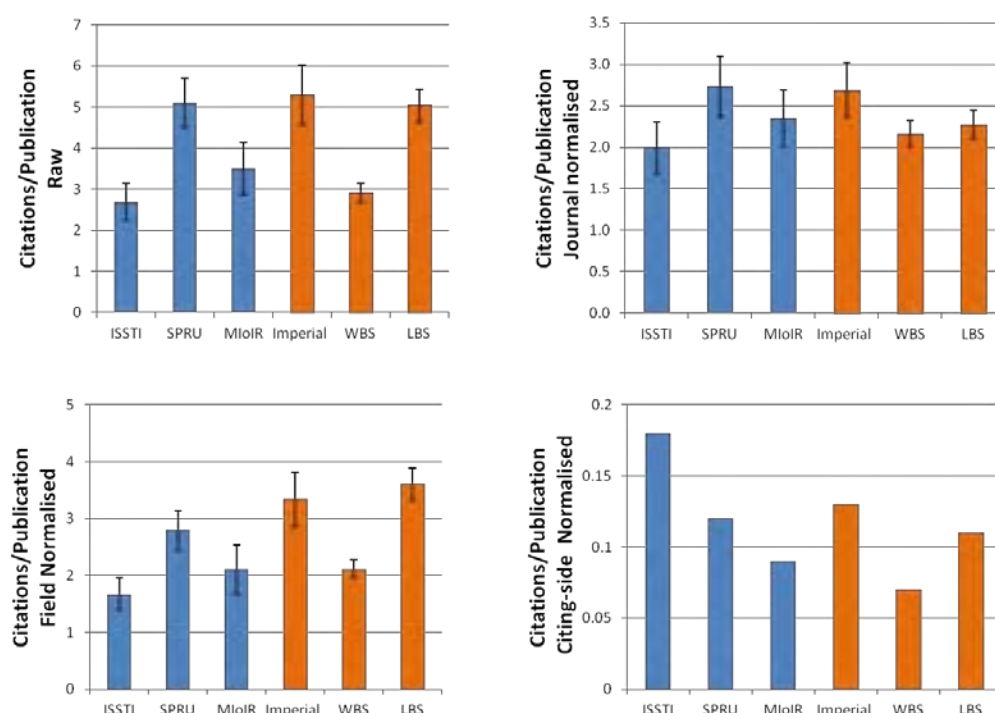
aggregate multiple dimensions into a single scalar. These are broad in inputs but narrow in outputs (as illustrated in the left side of Figure 2). Such scalar scores 'close down' debates on performance by univocally establishing which university is 'best' or which country is 'most' innovative. Such composite indicators have been shown to be potentially misleading as 'the scope for manipulation of scoreboards by selection, weighing and aggregation is great' (Grupp and Moggee, 2004, p. 1382).

An obvious way to handle plural input dimensions is to use multidimensional representations, such as 'spider' charts (Grupp and Schubert, 2010) –preferably after conceptually and mathematically grounded reduction of dimensions. But in scientometric (and even more so, in bibliometric) analysis, the range of inputs on a given property (productivity or citation impact) is often limited by the nature of data sources. In such cases, can quantitative studies capture and convey diverse outcomes under different analytical assumptions? Our answer is yes. Even when data sources are relatively narrow, there is still scope for opening up (on the right hand side of Figure 2). Even with narrow inputs, tools can be developed that help decision makers scrutinize how different conceptualisations and associated mathematical operationalisations may yield contrasting results (even of exactly the same data). By investigating how different assumptions lead to different methods and rankings, the analyst can provide 'plural and conditional' advice – and policy makers can be more reflective and explicit about the normative aspects of their choices.

Opening up measures of interdisciplinarity and performance

Here we will explore and illustrate the process of 'opening up' by reviewing a recent bibliometric comparison of performance and interdisciplinarity in six academic organisations (Rafols et al., 2011). Both 'performance' and 'interdisciplinarity' are complex concepts that can only partially be captured by bibliometric indicators. Indicators in question were derived from only two data sources: generic journal attributes and the references contained in each publication. Yet in spite of this narrowness of inputs, we show it is possible to conceive of different conceptualisations of interdisciplinarity and performance, and make multiple operationalisations of some of them (as illustrated in Figure 3).

Figure 3: Example of opening-up by using different normalisations to a measure of the average number of citations per publication in a given organisation



Conclusions and policy implications

This paper aims to illustrate that even analytical tools as narrow and apparently rigid as scientometric indicators leave room for policy usage that is more explicit about the dependence of analytic outputs on normative assumptions. We have argued that this 'opening up' is distinct (and complementary) to the 'broadening out' of the range of data inputs.

Indicators in S&T policy and management (as well as in other social spheres) have not only become pervasive as measurement tools, but constitute obvious 'technologies for governance' (Davis et al., 2011). Indicators play a performative role, incentivising and thus 'guiding' scientists towards particular understandings of 'good' performance. 'Statistical measures tend to replace political debate with technical expertise' (Merry, 2011, p. S83). Under these circumstances, it becomes imperative to bring out into more open debate the crucial normative choices underlying indicators (Barre, 2010). In short, both broader and more plural forms of S&T indicators and visualisation tools are needed, in order to facilitate the 'opening up' of more rigorous and accountable policy appraisal.

Understanding researchers' experiences, opinions and attitudes towards university-industry cooperation – Four Spanish regional case studies

Irene Ramos-Vielba¹, Richard Woolley²

¹Fundación Ideas, Spain

²Instituto de Gestión de la Innovación y el Conocimiento (Ingenio) CSIC-UPV, Spain

(1) The motivation

It is considered that industry's demands for new knowledge (Meyer-Krahmer and Schmock, 1998; Schartering et al., 2002) and universities' need for financing (OECD, 1999; Santoro and Gopalakrishnan, 2000) generate interdependence between them (Geisler, 1995) and drives them to collaborate. However, the complexity of university-industry interactions means that they do not fit in a single specific pattern (Thune, 2007). There is also an important lack of understanding of the links that bind them together (D'Este and Patel, 2007) necessary to examine the effects produced by current policies (Woolgar, 2007). There is a need to investigate the way cooperation-fostering measures operate and to pay closer attention to the multiple channels of knowledge transfer (Agrawal, 2001; Grossman et al., 2001; Cohen et al., 2002) as well as to the incentives that push the academic sector towards cooperation (McLellan et al., 2006). Only by understanding the different interconnection mechanisms and the processes of generation, maintenance and success of relations is it possible to properly assess and redirect stimulus policies that were hitherto unidirectional and indiscriminate – and therefore partly inefficient or with limited impact.

Normally scientists direct their activities according to a reputation-based science reward system, whereas the productive sector is guided by the imperative of producing tradable results (Dasgupta and David, 1994). This means that two diverging logics intervene here. The main limits to collaboration on the part of researchers lie in a complicated balance between their preoccupation with maintaining the economic viability of the organisations in which they perform their activities and the impact that collaboration with industry may have on their research freedom (Lee, 1996). Despite such disadvantages, the rendering of services and the participation in cooperative research continues to take place, and a plausible explanation for this could be found in individual responses to incentives, in the different trajectories of professional careers or in the presence of disparate goals (Perkmann and Walsh, 2007). Equally, we consider that scientists also obtain certain benefits from this exchange, as for example the awarding of funds that they can employ in acquiring equipment and materials or in the training of new researchers, together with a business vision of the problems they face

in their research lines (Lee, 2000). It has even been empirically demonstrated that the combination of research activities and relations with industry provides profitability both in terms of scientific production and in access to financing from competitive public sources (Manjarrés Henríquez et al., 2008).

Spain is no exception to the development of such multi-factor dynamics in university-industry relations. Added to this is another phenomenon in which it is also immersed: the multi-level governance of research (Edler et al., 2003), where one of the types of actors that acquires relevance is regional governments. This sets new challenges for studies of science, technology and innovation policies (Larédo, 2003).

(2) Approach

In this context, insufficient attention has been paid to the influence of sociological-type factors in the cooperation with the productive sector through the study of the professional values of researchers, their motivations and attitudes towards cooperation; whereas, however, it has been detected that this is one of the keys to a better understanding of the dynamic of knowledge transfer relations. Moreover, in Spain regional governments are gradually playing a greater role in the development of science and technology policies, but there is still a lack of comparative analyses. Our study seeks to cover both deficiencies by examining four regional governments with different degrees of scientific-technological development. We observe territorial resemblances and dissimilarities in regard to scientists' opinions and behaviours as well as in the participation of their research groups in cooperative activities in a quest for possible explanatory variables.

We therefore set out to compare scientists' readiness to cooperate with the productive sector and to use different knowledge-transfer channels in the regional spheres. The choice of regional governments mainly meets an objective criterion that alludes to the varying degree of scientific-technological development attained (disparity in the percentage represented by expenditure in R&D, staff employed in R&D activities and number of researchers compared to the national total). We thus complete a range of four regions with optimal disparate characteristics for the comparison and extrapolation of results.

We take research groups as our unit of analysis, as they represent the backbone of the research system in Spain. They are organisational units of a functional nature but with dynamic characteristics, representing advantages for the development of research activity due to the complementary nature of their components and the availability of an optimal critical mass for the performance of certain functions (Rey Rocha et al., 2008). Groups are also crucial for cooperative relations with the production sector in the

regions. For this reason it is of great interest to know how researchers assimilate those contradictions between trends that favour, and others that hinder, the transfer of knowledge at the same time. The opinions of scientists heading the research groups will be projected on to the experiences of the collective. This interaction represents the core of our object of study, which we tackle by means of a comparative regional analysis through a survey among the heads of the research groups.

Regarding the characteristics of the survey, its universe is constituted by the total of active research groups in universities and public research centers following up-to-date official regional sources. From these we obtained a final sample of 851 research groups made up of sample units from each one of the four regional governments covered in the study. The methodology applied has consisted of a self-completed online survey, with telephone reinforcement. The field work was performed between October and December 2011, applying the corresponding statistical consistency controls to the principal data.

(3) (Expected) results

We first seek to obtain a general overview of the cooperation which the research groups have engaged in and the territorial differences that exist between the regions in the following aspects:

- Profile and level of cooperation with industry: percentage of groups that perform these types of activities, which characteristics they present, which knowledge transfer channels they use, how many firms they are involved with.
- Most common dynamic in the way cooperation operates: who launches the initiative, the location of the businesses with which they cooperate, most frequent size of the companies, who takes charge of maintaining the relationship.
- Public financial support: whether they receive funds from programmes designed for this purpose, whether European, national or regional, and the effects they generate on cooperation.
- Assessment of the cooperation experience for the development of scientific activity: in general, depending on initial expectations, the obtaining of different results, the importance for the group, repercussions for research agendas and changes that might produce an increase in their cooperation.

Secondly, with the purpose of discovering the factors that define researchers' assessment of the cooperation relations they have maintained with industry, a factor analysis of principal components is performed to allow for a greater understanding of the phenomenon while synthesising it by rejecting any items that do not contribute to its explanation.

(4) Conclusion and/or (policy) implications of the work

This study will enable us to assess how accumulated experience, together with researchers' opinions on and attitudes towards cooperation with industry, affect the degree of participation of their groups in knowledge transfer activities and in conducting scientific research.

Moreover, the structure and activity of research groups has acquired increasing importance for the purposes of evaluation, among other issues in assessing the success achieved (productivity, impact). Included among the influential group characteristics are structural as well as functional factors (see, for example, Martin-Sempere et al., 2002; Adams et. al. 2005; Lee and Bozeman, 2005). We understand that, in the same way, certain combinations of group features are better disposed to the transfer of knowledge. It is expected that the consolidated groups (size, accumulated experience) display greater willingness to cooperate.

In addition, the absence of a clear alignment in the values and opinions expressed by the heads of research groups would prompt some further analysis on the importance of territorial factors, at least when compared the apparent general influence of professional values. This is linked back to the set of values and rules that shape the scientific ethos defended by Merton, as summed up in the CUDOS acronym. We expect to make advances in discussion of this aspect through comparisons between regionally based samples.

Ultimately, discovering which factors define researchers' assessment of their cooperation relations with industry will yield useful insights for evaluating stimulus policies and their potential for readjustment and improved targeting.

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Shifting power in higher education policy making – The influence of the evaluation agencies for transforming universities knowledge production

Emanuela Reale

Institute for studies on firms and growth - CERIS CNR, Italy

Aim of the paper

The emergence and the implementation of policy measures inspired with different rate and pace to principles and ideas linked to the New Public Management narrative, result in an increasing number of formal organizations for the governance of the public science. In many European countries new organizations were created for managing the allocation of resources (financial resources) and of reputation (rating of excellence) as well as for strategic planning, or the existing ones have been deeply transformed in order to better the capability of the research system to pursue excellence and competitiveness, as well as to pursue grand challenges emerging from national and supra-national policies. How these processes of reorganization, transformation and creation of formal organizations impact on research, changing the research performers and the content of the scientific activities is something that is still to be explored.

The aim of this paper is to contribute, by using the case of Italy, to deepen the influence the emergence of formal organization for the evaluation of the public academic research might have for transforming: a) the way in which the government authority is exerted on Universities, and b) the changes of the actors that have the control over the content of research produced, thus affecting the reputational processes. The research questions are: how the creation of a formal organization for evaluation at national level can modify the knowledge function of the Universities, namely the research function? What new actors are emerging as the relevant ones for influencing the knowledge production?

Theoretical background

Some pieces of literature (Rip and van der Meulen, 1996; van der Meulen and Rip, 1994) highlighted that the post-modern research systems include a strategic level between the political and the operational levels, which is populated by different intermediary bodies, funding agencies being the most relevant ones, since they assure the mediation between the political level and the performers level, of one key political function: resource allocation. Thus the intermediary level influences the existing and the new institutions and their functioning; the literature also shows how the intermediary level is

differently populated in the European country (van den Meulen, 1998) and how the differences are linked to the political culture, with different emphasis and orientation toward steering the system or promoting aggregations (Rip and Nederhof, 1986), and with different modes for shaping the type of delegation (Braun, 2003).

Braun (1998) investigating the role of funding agencies as intermediaries with strategic aims, influencing the cognitive development of the science, distinguished between three decision making levels, or arenas, where they are supposed to act: the selection arena (where funding projects are selected), the policy arena (where a second-step review is carried out by the scientific boards and occasionally additional boards), and the control arena (where a political board functions as an interface between the funding agencies and the environment). Different interests and norms dominating the three arenas, where the former is influenced by the ineffectiveness of peer review, and the second by the positioning of the new élite of senior well-known scientists in charge of research institutions, defending an anonymous scientific community, which show a tendency to integrate scientific disciplinary and external interests coming from the political needs. The latter arena dealing with a general formulation and selection has a very low influence on the science. Thus, beside the funding agencies, one can recognize that intermediary organizations are actors involved in different decision-making levels, where they could influence, with a more or less intensity, the structuring of academic research.

It is true that the intermediary level is increasingly populated by formal organizations dealing with evaluation. The new social contract between science and society which was stabilized from the eighties (Martin, 2003; van den Meulen, 1998), and the need science be able to produce usable knowledge for facing the big challenges coming from the economic system, let change the concepts of relevance and reputation, with evaluation at the core of the new apparatus of policy instruments, and the emergence of new élites within both the research institutions, and the disciplinary community. Looking at the Universities, the creation of dedicated agencies for quality assurance was a clear movement from the nineties in most European countries (Reale and Seiber, 2012), but some countries also create new formal organizations for managing research evaluation, and Italy was one of them.

Ouchi (1980) discussed some perspective existing in literature on why a formal organization exists, and why it is created, quoting the Barnard's idea of organizations coming from the need of "physical power, speed, endurance, mechanical adaptation, or continuity beyond the capacity of a single individual" (p.129), or the March and Simon's argument about the added value a collective action can give to each member of the organization going beyond the individual contribute, or the Blau and Scott's definition of organizations as entities pursuing "concerted effort toward a common and explicitly

recognized goal" (p. 129), or the Williamson's approach of transaction costs which underline that under certain conditions, bureaucratic organizations can be more efficient than the market mechanisms. Using these approaches, Ouchi suggested that organization efficiency could be analysed looking at the drivers of the costs for mediating between individuals, which are goal incongruence and performance ambiguity. Combining differently the mentioned drivers, three mechanisms emerged for mediation and control: "markets, which are efficient when performance ambiguity is low and goal incongruence is high; bureaucracies, which are efficient when both ... are moderately high; and clans, which are efficient when goal incongruence is low and performance ambiguity is high" (p.139-140).

Finally we can recall the Brown's proposal (Brown, 1978) of organizations as paradigms, that is "sets of assumptions, usually implicit, about what sorts of things make up the world, how they act, how they being together, and how they may be known" (p. 373). In this perspective organizations as paradigms impose control, or can be used by the dissidents; paradigms are cognitive and practical; they can be a resource or a constraint. The author suggests that formal organizations might become an instrument through which most powerful actors imposing rationales, ideas and views of action to the external world, contributing to concentrate the control not only on the means of production, but also on the definition of the reality: the organizational power "is most strategically developed in the design and imposition of paradigmatic frameworks within which the very meaning of such actions as making decisions is defined" (p. 376).

In this paper we want to investigate a new formal organization, the ANVUR – Agency for the Evaluation of University and Research, set up by the Budget law of 2006 by the centre-left government coalition led by Romano Prodi, and recently implemented with a regulation of 2011 by the centre-right government coalition, led by Silvio Berlusconi. ANVUR merged two existing national Committees for the evaluation of University (CNVSU) and for the evaluation of research (CIVR), and its mission is to evaluating the research organizations under the MIUR (the Ministry of University and Research) control, thus mainly universities and public research organizations.

We look at the different decision making arenas the Agency is supposed to act, and at the way in which the new formal organization is supposed to exert the power linked to evaluation, with what consequences, intended and unintended, for the evaluated organizations. Moreover, we want to look at actors that might emerge as a result of this transformation. Here another relevant piece of literature is the distinction proposed by Whitley between weak research evaluation system and strong evaluation system (Whitley 2007), and the consequences of strong evaluation systems in relation to the characteristics of the public science system (funding regimes, strategic independence and organizational capabilities of universities).

Method

For the empirical analysis we use rules and practices of the ANVUR as they have been implemented until now, as well as other administrative documentation related to the design of both rules and practices.

Rules

The analysis considers the motivations of the actual policy design of the ANVUR, how it has been implemented by the law and by the regulation, in order to positioning the organization within the governance of the Italian research system. Interestingly enough, ANVUR is the sole formal organization that is supposed to perform at intermediary level in Italy: funding agencies do not exist since 2000, when the National Research Council loses this functionality, becoming a research performing organization. Here the interest is to understand to what extent ANVUR is conceived in the government policy design as an actor at the intermediary level, participating/influencing the decision making level, or to what extent it would perform as a technical body providing evidences supporting the MIUR decision-making. Mission, objectives, functionalities, content of the delegation, composition and appointment of the Board, relationships with other policy levels and with external interests (disciplinary societies, representatives of the economic and social worlds), level of autonomy and independence, are key items to be analysed in order to highlight the possibility of the organization to be a strategic actors in the Italian research system. Understanding the mentioned items is essential in order to discuss the reconfiguration of power distribution and the emergence of new actors influencing the university research, eventually supporting the shift toward new thematic approaches more related to policy objectives.

Practices

ANVUR first actions included the production of two important evaluation instruments, which have had a great impact on the Universities, moving organizations, disciplinary communities and individuals toward discussing criteria and indicators best suited for research evaluation, but also challenging the individual and organizational perspectives toward publishing of research outputs.

The instruments relate to: a) the minimum requirements to be used by the selection committees for the national competitions for hiring the university professors. The mentioned requirements are standards in publication output, which are conceived as minimum threshold for participating to the competition; b) the implementation of the second research evaluation exercise for a seven-year period (2004-2010), which innovates from the previous one, the VTR, (Reale et al., 2007) in terms of criteria used and indicators,

with the explicit introduction of bibliometric analysis as a mean for assessing the quality of the publications. The impact of the announcement of the new rules in both cases was really large, involving universities and disciplinary communities, even in the phase of the design of the instruments, in discussion on evaluation indicators, techniques and specific features of the different fields, in order to influence the forthcoming implementation. Understanding the extent to which the instruments derived from strategies elaborated by the ANVUR, analysing what actors exerting influence and how, what kind of negotiations and representation of the different interests at stake were put into action, can supply further evidences on the conditions under which ANVUR as formal organization can produce a robust research evaluation system, and the organization efficiency for transforming the university knowledge production.

Results

The analysis shows a distance between policy motivations, rationales and further implementation of the ANVUR as formal organization. The organization is designed as an autonomous actor, but the possibility of becoming an intermediary strategic actor is uncertain, because of the characteristics of the Italian public science system (low investment for both block grant funding and government project funding, growing dependence of universities from external sources, uncertainties about the regularity of the research assessment exercise, absence of an accurate and transparent communication strategy of ANVUR toward the performers, low effectiveness of state and other public policy objectives into funding procedures), because of the absence of other formal organizations acting as strategic funding intermediary, and because of some incongruence between missions, objectives and tasks the ANVUR is supposed to perform.

Not becoming an intermediary does not mean that ANVUR will be powerless. On the contrary, it seems that the organization would be able to shape ideas and values that could strongly orient the structuring of university research. The rules of appointment of the Board, the procedures followed for designing the new rules for the university professor recruitment and for the research evaluation exercise reveal the willingness of orienting the disciplinary communities, but creating and managing tensions and conflicts between and within them. At the same time, the new rules could modify the composition of the actors influencing the knowledge production in universities, with the reinforcement of those individuals more involved in peer reviewing activities, and organizations more capable to colonize peer review committees. If this process is not counterweighted by a government action for structuring the mode of delegation and the population of the intermediary research policy level, in the medium-long run ANVUR could become an instrument for realizing a concentration of power on scientific élites which

gain access and control of the evaluation practices, influencing the type of output desired and the formulation of the research goals, but the capability of the system to address new explorative research themes might be seriously constrained.

More generally, the paper shows how the setting up of evaluation agencies is challenging the distribution of power for policy making, with potentially strong effects on the academic research.

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Role of a policy mix for innovation in low-carbon power generation technologies

Kristin Reichardt, Karoline Rogge

Fraunhofer Institute for Systems and Innovation Research ISI, Germany

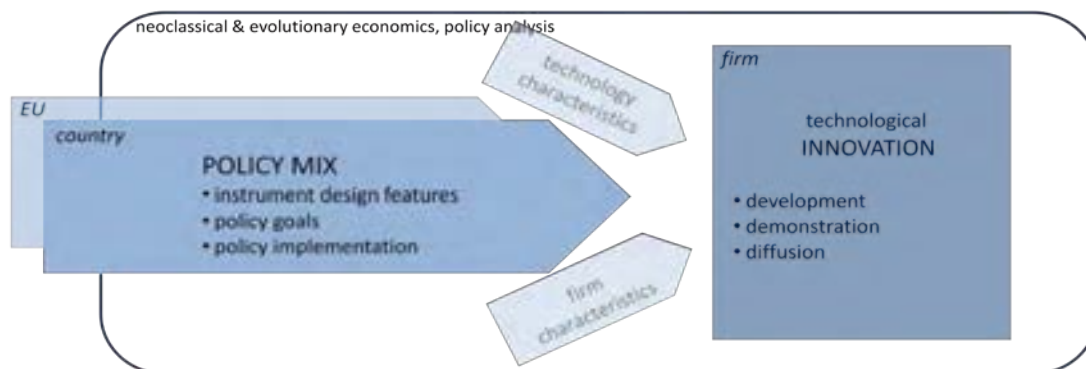
1 Motivation and objectives

Climate change poses one of the major challenges society faces in the 21st century. The energy sector, responsible for 40% of global CO₂ emissions, is a key contributor to this phenomenon, but at the same time offers a large potential for emissions reductions (IEA 2008). With fossil fuels currently being among the main sources of electricity, innovation in low-carbon power generation technologies (low-carbon PGTs) is a crucial part of the strategy to successfully mitigate carbon emissions.

Building on concepts from evolutionary economics, neoclassical environmental economics and policy analysis, this study analyzes how a comprehensive policy mix influences innovation. More precisely, taking the two contrasting cases¹ of low-carbon PGTs, wind offshore and carbon capture and storage (CCS) in Germany, as examples, we study the role of features of technology-specific policy mixes at different policy making levels for innovation activities of firms with differing positions along the value chain: technology providers (TPs) and power generators (PGs). Thereby, we also pay attention to other context factors of innovation besides policies, namely technology and firm characteristics. Figure 1 illustrates this research setting.

¹ Although both technologies contribute to mitigating climate change, wind offshore is a renewable energy technology and therefore stands for a new paradigm in power production, whereas CCS is an incremental innovation in the existing fossil fuel path. Furthermore, while for wind offshore in Germany there is a comprehensive and favorable policy mix in place and technological innovation seems to thrive, for CCS in Germany there is a major lack of political support and innovation seems to stagnate.

Figure 1: Research framework



Hence, our research framework considers a mix of innovation, climate and energy policies for individual technologies, which includes individual policy instruments together with specific design features. The research framework further includes characteristics of the overarching policy mix such as consistency or credibility. Eventually, this framework allows for more holistic policy recommendations. Likewise, the qualitative case study methodology applied allows for detailed understanding of causal relationships of how policies affect innovation in the young low-carbon PGTs studied. Thereby, the contrasting case design enables us to explore effects of both favorable and more detrimental policy mixes on innovation in low-carbon PGTs.

2 Approach

We base our analysis on three theoretical fields. First, neoclassical environmental economics provides a rationale for policy intervention in the case of low-carbon PGTs in identifying two market failures, namely negative (pollution) and positive (R&D spillovers) externalities. It further recognizes that a mix of policies can achieve emissions reductions at lower costs than any single measure (Popp et al. 2010). Second, evolutionary economics, in contrast to neoclassical economics, no longer sees innovation as a black box (Dosi 1982; Nelson, Winter 1982), but provides patterns of analysis for the complex innovation process. It also emphasizes the role of context factors, such as policies, for innovation. Third, the field of policy analysis provides further rationales for applying and further approaches for analyzing policy mixes. It argues that relying on just one policy instrument is not sufficient to successfully address complex, multi-aspect issues such as environmental problems (Gunningham, Sinclair 1997). This literature deals with issues such as the design of policy mixes so that individual instruments complement and reinforce each other (Kern, Howlett 2009). Combining these different streams of literature provides for a powerful theory basis to analyze effects of a policy mix on innovation.

The analysis is conducted using the case study approach, consisting mainly of in-depth desk research and subsequent interviews with representatives of CCS and wind offshore firms active in the German market. In a first step, information is gathered about the technologies under analysis and their markets and about the main corporate players. The policy mixes in place for the two technologies studied, both at the German and EU level, are identified and analyzed in depth. The second and main step consists of the conduction of interviews with representatives of major TPs and PGs, holding leading positions in R&D, business development and strategy, for instance. In doing so, we get insights into firms' innovation activities, their drivers and barriers, and the role of single policy instruments, their design features such as predictability and flexibility, and the policy mix in general for these activities.

3 First results

First results of our analysis suggest, on the one hand, that the policy mix in place for wind offshore in Germany has significantly accelerated the development and diffusion of the technology. The single most important policy measure for most innovation activities has been the Renewable Energy Sources Act (EEG) with its high and predictable feed-in tariff and its grid access regulation. However, policy-related barriers exist particularly for implementation of offshore wind parks. These include delays in grid access provision, which can increase costs significantly, and regulation concerning acoustic noise during pile driving of foundations. These problems are mainly due to policy implementation by public authorities, lacking experience and capacity for regulation of offshore wind parks, and hamper technology diffusion.

On the other hand, the policy mix for CCS lacks fundamental measures and design features that allow for deployment of the technology. Thereby, the non-implementation of the EU Directive on CCS into German law currently constitutes the major barrier for straightforward innovation activities, since currently there is no legal basis to store CO₂. Additionally, uncertainty in the policy mix constitutes a barrier for innovation. The existence of climate policy measures such as the EU ETS and binding CO₂ reduction goals as in the Kyoto Protocol are essential drivers for innovation in carbon capture technologies. However, both the future CO₂ price and details of a post Kyoto climate architecture are highly uncertain, so that investors do not know whether and when CCS will become economically feasible. As a consequence, innovative activities for CCS in Germany recently have decelerated.

4 Conclusion and first implications for policy

From these first preliminary findings, conclusions can be drawn regarding how different policy instruments are needed to make innovation in low-carbon PGTs happen. First, the wind offshore case illustrates the necessity for a mix of policies for stimulating technological innovation. The feed-in tariff alone is not sufficient, since it does not address issues like access to capital and infrastructure development. These failures need to be and actually are addressed by other instruments, which, in addition to the feed-in tariff, allows for more unobstructed innovation processes. However, policy implementation also greatly influences the speed and cost of innovation. Administrative delays and hurdles in place considerably delay technology diffusion and therefore increase costs. Second, for CCS technology push measures, e.g. generous demonstration support programs, are not sufficient to spur innovation, but market pull measures such as the EU ETS must be in place at the same time to create a market for CO₂. Further, the EU ETS must function more smoothly in order to better unfold its desired effects. However, legally enabling policies, e.g. a CO₂ storage law, need to form the basis of these push and pull measures.

Therefore, the cases demonstrate the fundamental role of policy mixes for innovation: incomplete policy mixes can decelerate or even impede innovation (thereby increasing costs), whereas rather comprehensive and favorable policy mixes can accelerate innovation. Moreover, although policy instruments in place for wind offshore and CCS differ a lot, both cases imply that even strong single instruments, such as the EEG in the case of wind offshore and the EU ETS in the case of CCS, are not sufficient a policy intervention for adequately fostering innovation in low-carbon PGTs.

These first indicative findings give room to a number of implications for policy making. For instance, besides putting in place a comprehensive policy mix, smooth policy implementation, particularly smooth administrative processes, needs to be ensured. This includes ensuring that policy instruments function as they should, e.g. in the case of the EU ETS. Also, in the case of CCS, a lack of certainty in the policy mix seems to constitute one major barrier for innovation. Therefore, although well-known, long-term predictability of policy instruments and policy making should be ensured for young technologies that still depend heavily on policy support.

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Mission-oriented policy and governance regimes in public services – the case of an innovation in sustainable public transport service

Rannveig Røste

*BI Norwegian Business School, Department of Innovation and Economic Organisation and
NIFU – Nordic Institute for Studies in Innovation, Research and Education, Norway*

This paper discusses the particular opportunity for creating sustainable innovation in public services through mission-oriented policy, and the challenges the transition meets in the path dependency of the public service regime. The paper aims at contributing to the understanding of how mission-oriented policy, addressing the grand challenge of the climate change, might create sustainable transitions by innovation in public services. The paper puts forward the theoretical perspective of the technological innovation systems to understand the opportunity and the path dependency for sustainable transition in the complex system of innovation in the public sector. The paper discusses how the technological innovation systems might contribute to understand innovation processes in public services, by discussing the sustainable innovation of the new public transport system for electric vehicles in the capital of Norway.

Motivation

Public services are not much studied from a system of innovation perspective (e.g. Koch and Hauknes 2005; Røste 2005; Windrum 2008; Howells 2010; Langegaard and Scheuer 2010). This is a fundamental knowledge gap, given the large and diverse scientific field of innovation (e.g. Edquist 1997; Poole 2004; Fagerberg et al. 2005; Fagerberg and Verspagen 2009) and the emphasise on services in the recent years (e.g. Sundbo 1997; Miles 2005; Gallouj and Savona 2010). Moreover, in the recent focus on sustainable transitions (e.g. Kemp et al. 1998; Geels 2005; Hekkert et al. 2007; Bergek et al. 2008; Markard and Truffer 2008), innovation in public services has not been discussed as a tool to meet the grand challenges of our times.

Understanding the mechanisms underlying innovation in public services is important to create sustainable transitions. Pressing public problems, of the environmental crisis, the ageing population and for example juvenile crime, urge for new solutions to be found. The public sector plays an extraordinary role in these problems, as controller and regulator but also as builder, in creating sustainable transport solutions in crowded urban areas, in social and medical care for the elderly and in crime prevention measures for young people. This paper aims at understanding how mission-oriented governmental policy might create such solutions and the difficulties the implementation of the new policy might meet in the established governmental regime.

The approach

The paper builds on the recent focus on sustainable transitions in the literature on systems of innovation (e.g. Kemp et al. 1998; Geels 2005; Hekkert et al. 2007; Bergek et al. 2008; Markard and Truffer 2008). The paper also builds on another recent perspective on innovation in public services, on various governance regimes for innovation in the public sector (e.g. Hartley 2005; Moore and Hartley 2008; Rashman et al. 2009). Both of these theoretical perspectives on regimes have pointed at the role of governmental policy to provide stability and structure – but also to create opportunity space for organisational learning and strategies. New policy decision is "(...) 'carving out' a space for people to put forward and share ideas" (Rashman et al. 2009, p. 481), creating opportunities for building new organisational practice in the implementation process.

This paper focuses in particular on how the perspective of technological innovation systems (Bergek et al. 2008; Markard and Truffer 2008; Markard et al. 2009) might contribute to study and understand how new organisational practice might be created and changed through mission-oriented policy in public services.

Results

The paper discusses the opportunities and challenges for creating sustainable innovation through mission-oriented policy in public services, in the meeting with the path dependent trajectories in the existing governmental regime. The paper analyses an example of a sustainable innovation in public transport services in the capital of Norway, which was initiated as a mission-oriented regional governmental policy. The policy created an opportunity space for organisational learning and new strategies for the public service organisation for traffic in Oslo, the Traffic Agency, but did also demand for change of the existing practice.

The selection of the case is sampled for theoretical reason, following the replication logic (Eisenhardt 1989; King et al. 1994; Yin 1994), where the single-case study serves as a distinct experiment contrasting and extending the emerging theory.

The innovation studied is the sustainable public transport service system for electric vehicles in Oslo, offering free parking and reloading of the batteries at 400 recharging points in the city centre. The innovation process started in the regional government of Oslo, in the policy decision of building up 400 recharging points for electric vehicles in the city centre in the time period from 2008 to 2011. The public service organisation for traffic, the Traffic Agency was given the task to implement the policy decision.

The Traffic agency was reluctant to the new task. They had no former services for electric vehicles, and described themselves as a "parking agency", which was profit-oriented and provided equal services to the citizens. The new service of recharging points for electric vehicles contrasted with this, offering free services to a small group of road users. Yet, they managed to build up the 400 recharging points within time and budgetary limits. Despite of the inherent scepticism to the radical new service, the Traffic Agency felt they were still obligated to put the policy idea into practice, which after all was their role as public agency. In doing this, they recognised the need to learn about electric vehicles and its need for power supply infrastructure, and networked with many various actors.

Conclusion

This paper focuses on the reluctance in the public service organisation of the Traffic Agency, in the clash between the existing competence and the exploration of the new possibilities, a classic problem description in search for organisational strategies. The paper brings in the perspective of the technological innovation systems to understand the systemic dynamic of these contradictions in the context of the public sector. By studying the sustainable innovation of the new public transport system for electric vehicles in Oslo, the paper aims at raise awareness of how mission-oriented policy might create opportunity space for sustainable transitions in public services, but how this opportunity is not enough for transitions to happen.

The innovation of the sustainable public transport service system shows us the challenge of path-dependency and technological trajectories also in the governmental regimes in the public sector. Hence, the paper shows the importance of attracting the attention of the policy makers not only to the decision-processes of mission-oriented policy, but also to how and why innovation processes in public services are successfully, or not, implemented.

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Knowledge Dynamics in the Emergence of a New Technology: A Multi-Perspective Analysis on the Case of Human Papilloma Virus (HPV) Molecular Diagnostic Tests

Daniele Rotolo, Michael Hopkins, Ismael Rafols

SPRU - Science and Technology Policy Research, University of Sussex, UK

Emerging technologies represent important opportunities for nations' growth and wealth. These technologies have potential to create new industries, and sub-sectors or change the existing ones favouring then technological change (Adner & Levinthal, 2002; Cozzens et al., 2010; Day & Schoemaker, 2000). Yet, complexity and uncertainty characterize the process of emergence. In fact, their development may undertake specific trajectories and reject others according to the numerous visions, objectives, and expectations multiple actors involved have on them (Bijker, 1995; Blume, 1992; Robinson, Huang, Guo, & Porter, 2011). Stakeholder groups, or relevant actor groups ("actor groups") generate a variety of options for change (Bijker, 1995) that are then subject to a "selection environment" that differentially favours particular options (Smith, Voß, & Grin, 2010). Change is therefore seen as strongly constrained by pre-existing socio-technical regimes. These are comprised of scientific/technical paradigms and routines that frame researchers' thinking (Dosi, 1982), vested interests, the organisational capital of incumbents, regulatory standards, sunk costs (Jacobsson & Johnson, 2000; Verbong & Geels, 2007), practices subject to economies of scale and positive network externalities (Arthur, 1989); prevailing social practices (Shove, 2003); dominant policies, legal frameworks and professional lobbying (William, 2000). This complexity means options can be obscured and never properly considered, and processes influencing change are difficult to trace, analyse, and manage. Network-incumbents also influence the selection environment, which maintains the momentum of established options, and creates technological lock-in and hegemonic stability (Stirling, 2009; Verbong & Geels, 2007). Authors suggest the resulting innovation pathways may therefore be suboptimal or even socially undesirable (Arthur, 1989; Stirling, 2008, 2009) which has lead to a body of research on Constructive Technology Assessment (CTA) to address these problems. Yet these approaches are only as good as their preparatory work, and this has been a limiting factor for CTA (Rip & Te Kolve, 2008). In this context we ask: (i) How can we find the selection mechanisms that occur during a technology's emergence? (ii) What the possible trajectories that could be pursued and which actor groups are supporting these? (iii) What role do epistemic communities play in the process of technological emergence and how do they integrate or align when a new technology emerges?

The present research aims to address these questions by investigating emerging technologies' knowledge dynamics from multiple angles including: scientific disciplines, technological areas, and the actors involved. We believe that approaching the analysis from multiple perspectives represents a key point to disentangle the complexity and uncertainty characterizing the process of emergence.

We focus the attention on knowledge dynamics characterizing one of the most promising technologies for cervical cancer screening which has emerged in recent years: molecular-based Human Papilloma Virus (HPV) diagnostics. This technology emerged in the 1980s into a technological landscape where an alternative technology for cervical cancer screening, Cytology-based testing using the Pap Smear already existed and was widely adopted (Casper & Clarke, 1998). However, traditional Pap testing is associated with a 15%-50% false-negative rate, and HPV diagnostics were seen by some as offering a reliable and sensible tests (Hogarth, Hopkins, & Rodriguez, 2011). HPV diagnostics are gene-based diagnostics based in the broader field of genetics and represent an instance of molecularisation whereby actors seek "to understand diseases at the (sub)molecular level of proteins, individual genes, and genomes" (Clarke, Shim, Mamo, Fosket, & Fishman, 2003: 12).

To fully reveal knowledge dynamics in HPV diagnostics, we base this study on a recent in depth case study on the process of emergence, since its conception in 1983 (Hogarth et al., 2011) with the aim of attempting to check how newly developed hybrid-qualitative-quantitative approaches using multiple perspectives match the picture constructed from interviewees and researcher-guided retrospective analysis of historical sources.

We expect the new techniques to be able to reveal other early developments that have been lost in the histories, as the comprehensive coverage by bibliometric mapping should provide a superior overview to more limited manual historical research. In particular, building on the work by Leydesdorff and Rafols (2011), we use overlay mapping technique as tools to interrogate how actors and technologies were positioned and how their networks evolve across time within global maps of scientific disciplines or technological areas. In line with our multi-perspective approach, we discuss the interpretation of those overlay maps by comparing them with insights interviews provided. Specifically, by using multiple data sources – as published scientific articles (ISI Web of Science, Scopus, and PubMed/MedLine) and granted patents (European Patent Office and U.S. Patent and Trademark Office) – we develop four different overlay maps on HPV diagnostics. First, we overlay HPV diagnostics' scientific knowledge production on the global map of science based on aggregated citation relations among the journals contained in the Science Citation Index and Social Science Citation Index (Leydesdorff & Rafols, 2011). Second, following a novel mapping techniques (Leydesdorff, Rafols, &

Rotolo, 2011), we overlay scientific articles related to HPV diagnostics on a global map of diseases based on the ("Diseases") categories of the Medical Subject Headings (MeSH) as provided by the MedLine database of the US National Library of Medicine (NLM). Third, we explore co-authorship/co-inventing networks to reveal links between groups working in the field. Fourth, capture the patenting activity around the HPV diagnostics by developing an overlay on the global map of patents based on International Patent Classification (IPC) (Newman, Rafols, Porter, Youtie, & Kay, 2011). Finally, by using Recombinant Capital (RECAP) database on pharmaceutical and biotechnology companies' alliances, we reveal strategic collaborative patterns that shaped the evolution of this emerging technology.

Preliminary analysis shows the emergence of HPV diagnostics mainly driven by two factors: (i) the potential the technology had as envisaged by actors who sought to develop more reliable tests and (ii) companies seeking for new technological opportunities to compete with Pap test and profit from these. However, as revealed by prior interviews and scientific and technological activity in the field, only with the action of key public and private actors (individuals and organizations) HPV diagnostics open as a new field of research and entered in the market for cervical cancer screening. Among these actors, two key scientists played a crucial role: first Harald zur Hausen (German Cancer Research Centre) and subsequently Attila Lorincz. Specifically, Harald zur Hausen was the first scientist to discover the association between the HPV type 16 infections and cervical cancer. While Attila Lorincz, building on Harald zur Hausen's work, made other important discoveries on this association. In addition, Lorincz focused his efforts in developing an application of these discoveries and he finally co-funded Digene Corp. as the first company to market successfully a kit for HPV detection. We observe this phenomenon through the lenses of overlays maps that show HPV diagnostics starting from few scientific disciplines – as "Infection Diseases" and "Pathology" ISI subject areas – spread across multiple scientific areas and especially in "Obstetrics Gynaecology" and "Oncology". Similar trends can be observed in overlays on map of diseases and technological areas. In addition, observing Digene's action across those different lenses – interviews, overlay maps, and collaboration – we show how Digene succeeded in HPV diagnostics building on acquisition of knowledge and competences, establishment of inter-organizational links with key public and private actors in the field, and a strong IPR strategy. Surprisingly, despite the Digene's success in taking the lead of this emerging technology, HPV diagnostics started to co-exist with the old technologies rather than replace them.

Our work is ongoing but we present preliminary findings that may suggest how key actors' can be motivated to support an emerging technology and give clues as to the effectiveness of policy levers to stimulate and push the given technology towards development.

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Chinese *Shanzhai Innovation* as a Central Challenge for Europe

Jean-Marie Rousseau¹, Kathrin Peters²

¹TAO-ITINeRIS - Initiatives in Territorial Intelligence & Regional Innovation Strategies, Belgium

²Policy Advice and Evaluation, UK

Motivation:

The geography and characteristics of innovation are shifting at a rapid pace. While there is a desire for Europe to maintain its scientific and technological edge, there is concern that this lead has become challenged in recent years. There is evidence that incremental and more local forms of innovation contribute to worldwide economic and social development, and that Europe is not sufficiently geared up to benefit from opportunities arising from these changes.

Low- and middle-income economies increased their share of global R&D expenditure by 13 percent between 1993 and 2009. China accounts for the lion's share of this increase, propelling it to become the world's second largest R&D spender in 2009. After enjoying a decades-long economic boom built on cheap labour and the intensive use of energy, China is diversifying the sources of its economic growth. Since 2005, China began to access foreign technologies by developing "spin-off/spin-on" strategies and started to become increasingly active in pursuing domestic innovation.

This emerging "grown-up" dynamic can be described as '*Shanzhai Innovation*'.

Shanzhai Innovation in fact consists of a process of imitation and reverse engineering that enables Chinese producers to bring products to the domestic market which combine the quality features of previously imported products at an attractive price for Chinese consumers. While originally labelled as counterfeit or pirate production, the concept of *Shanzhai Innovation* has gradually evolved and is now understood as a process of scanning knowledge to create locally adapted products and processes offering competitive advantages to Chinese producers. These locally adapted innovations are not mere copycats: they tend to keep the core features of products but tweak them in a way that differentiates and improves them when compared with the original. These products fully fit Chinese consumers' needs, while being affordable for local consumptions as well as attractive for export markets. *Shanzhai Innovation* are set to increase in importance as China will have to focus more on its domestic market to balance the reduction in exports to the US and Europe. It will also help China to emerge as a strong exporting nation.

Approach:

Some western partners have become increasingly reluctant to provide, exchange or transfer advanced technology information to China due to the country's reverse engineering practices. By contrast, other partners want to cooperate and share the results of a more open innovation culture. There are distinct variations in how countries or trading blocks are responding to the challenges faced by *Shanzhai Innovation*. Three different types of approaches can be distinguished:

1. The U.S. is applying extreme care in exporting critical components and sensitive equipment to China in order to safeguard national security and ensure on-going competitive edge.
2. Some smaller countries, for example Ukraine in aircraft technologies and Israel in new clean energy technologies, approach China as a market where innovation originating in their own countries can be transferred, further to be developed into large scale profitable ventures; these countries treat China as an opportunity further to enhance their domestic products to guarantee market access in China and elsewhere in the world.
3. By contrast, Europe's approach to China has not undergone a positive strategic change. While there is no doubt that China's innovation and industry policies strongly affect Europe's economic wellbeing, it continues to treat China as an emerging country, rather than the global force it has become; Europe is not paying sufficient attention to the opportunities China offers as a market and test case for its high technology manufacturers, and is vacillating between liberal or protectionist economic attitudes, exacerbated by the disunity of 27 distinct approaches.

Results:

China is strategically acquiring European companies and progressively accessing their cutting-edge technologies, thereby reshaping the global distribution of R&D and innovation. The European response to these trends seems naïve and short of analysis and imagination. Einstein himself claimed that, in terms of international politics as for science: *"imagination is more important than knowledge"* and *"the significant problems we face cannot be solved at the same level of thinking we were at when we created*

them¹." European policies towards China might be deprived of imaginative capabilities, creativity, responsiveness and anticipation.

Globalisation trends remain strong, with investment, research capabilities and industrialisation migrating to optimal locations, and new countries entering the mix of those committed to R&D as a national strategy. China's profile as the second-largest sponsor of global R&D continues to increase, whether measured in terms of funding or generation of intellectual capital. Even so, the U.S. continues its historic and world-leading commitment to innovation as an essential catalyst for prosperity and growth while Europe risks stagnating.

Manufacturing remains vitally important for the EU economy. The industrial base in Europe represents a far greater share of the economy than the basic statistics imply, and industrial productivity should be the motor driving EU wealth creation. Moreover, new technologies such as clean technologies, renewable energy, nano-technologies and bio-technologies may help Europe to address a number of societal challenges in addition to securing growth and wealth creation. There is a wide range of commercialisation and supply chain opportunities stemming from these emerging and niche technologies.

Shanzhai Innovation could turn into the central pillar of the new global economy and it requires an urgent response from Europe in terms of a coherent strategy for surviving and thriving in the global competitive market.

While this is valid for China as an attractive or promising market, it could become a harsh reality for traditional or potential export markets of Europe (including those in Africa) which could be challenged by Chinese competitors. Examples of things to come are high-speed trains for Turkey and California, Airbus aircrafts for Arab fleets, mobile phones for Africa, Maghreb or South-America, and recently Europe itself...

Conclusions:

The reconfiguration of the global economic and R&D landscape requires Europe to adopt innovative approaches. This *Janus double-face* – "*God of beginnings and transitions*" – looking to the past and the future, challenges traditional approaches and re-

¹ This is extracted from an interview of Albert Einstein by George Sylvester Viereck in '*The Saturday Evening Post*' by 26 October 1929. In a conversation between Albert Einstein and János Plesch – see "*János: The Story of a Doctor*" reported by János Plesch in 1947, Albert Einstein also might have said: "*When I examine myself and my methods of thought I come to the conclusion that the gift of fantasy has meant more to the man than my talent for absorbing positive knowledge*".

quires Europe to explore new conceptual developments around innovation and R&D policies. The *Lund Declaration*, stating that "*European research must focus on the Grand Challenges of our time moving beyond current rigid thematic approaches*", prompted us to suggest a contribution to this *Fraunhofer* call for paper, essentially focusing on "*New patterns, drivers and models of innovation*".

An attempt to include social innovation issues in research and innovation policies in Colombia

Mónica Salazar¹, Martha Angélica Barrantes², Diana Lucio-Arias¹

¹*Colombian Observatory of Science and Technology, Colombia*

²*Social Sciences and Humanities Programme, Colciencias, Colombia*

Introduction

Since 2010 in Colombia the concept "social innovation" was put in the public policy agenda, not only regarding science, technology and innovation (STI) policies, but also economic development, social development inclusion, and competitiveness. Even if the concept is being used by different government and multilateral agencies, no consensus has yet been reached.

In the current national development plan, titled "Prosperity for all", innovation was set up as one of the great pillars upon which sustainable economic development will be built. Innovation is not seen exclusively for the productive sector; instead, as it is stated in the plan, the country needs to impregnate a culture of innovation and entrepreneurship in all State's spheres, including the productive sector, universities and the civil society. For doing so, the government will set up an "institutional arrangement" for the promotion of social innovation. How is understood social innovation in the Colombian context, according to the development plan?

- A process of design and implementation of ideas and projects that provide a solution to social, cultural economic or environmental problems. The solutions sometimes come from adverse conditions, in contexts where the market has not provided alternatives, or the public sector has not responded the necessities and claims of the population; they are characterized for being more effective, efficient and sustainable than existing solutions, generating positive externalities to the society (República de Colombia, Plan Nacional de Desarrollo 2010-2014 "Prosperidad para todos")¹.

Certainly the intentions expressed in the plan are worth to follow and monitor; this is the main motivation of this paper.

A wave of statements, studies, and definitions are being discussed by various governmental agencies, which are trying to coordinate actions and to define their niche. We will approach the study by documenting and analyzing the different initiatives set up by Colombian public agencies in the last two years, such as Colciencias (the national agency in charge of STI promotion and funding), SENA (technical training), the Ministry

¹ Can be retrieved from <http://www.dnp.gov.co/PND/PND20102014.aspx>

of Information and Communication Technologies, and the Department of Social Prosperity (newly created agency spin out of Presidential Council). We have identified few roles that governmental institutions are performing with respect to social innovation:

- Fostering social entrepreneurship in local communities,
- Diffusion, communication and social appropriation of S&T,
- Supporting open innovation, and
- Documenting successful stories of local communities solving their problems.

The case of Colciencias

Colciencias has elaborated a document attempting to define social innovation for their purposes: the promotion of science, technology and innovation activities. They have tracked the concept back to 1989 (Wolfgang Zapf), and intervention programmes mainly in Anglo-Saxon countries (e.g. Canada, Australia, Finland, United Kingdom). Following some of the definitions of social innovation that they have identified:

- "The process of inventing, securing support for, and implementing novel solutions to social needs and problems" (2003 Editors' Note of the Stanford Social Innovation Review, as cited in Phills, Deiglmeier, & Miller, 2008).
- "A novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals" (Phills, et al., 2008)
- "Social Innovation refers to new ideas that resolve existing social, cultural, economic and environmental challenges for the benefit of people and planet. A true social innovation is systems-changing – it permanently alters the perceptions, behaviours and structures that previously gave rise to these challenges" (Centre for Social innovation, Canada)².
- "Social innovation refers to new strategies, concepts, ideas and organizations that meet social needs of all kinds – from working conditions and education to community development and health – and that extend and strengthen civil society " (Wikipedia)³.
- "Social innovation refers to innovative activities and services that are motivated by the goal of meeting a social need and that are predominantly diffused through organizations whose primary purposes are social. Business innovation is generally motivated by profit maximization and diffused through organizations that are primarily motivated by profit", such as firms (Mulgan, 2006, p. 146).

² Retrieved from <http://socialinnovation.ca/about/social-innovation>, in February 2012.

³ Retrieved from http://en.wikipedia.org/wiki/Social_innovation, in February 2012.

- Application of new ideas, concepts, products, services, methodologies and practices, that contribute to obtain a better quality of life for citizens (García, 2009).
- Social innovation is an endogenous action or an exogenous intervention of social development, via a novel or original change in the delivery of a service or the production of a product, that attain positive results respect of poverty, marginality, exclusion, discrimination or social risk situations, which have the potential of being reproducible and replicable (Hopenhagen, n.d.).

What can be drawn from these definitions that orient Colciencias' action, if it wants to incorporate the social innovation dimension in STI programmes?

- To be open to local communities, civil society and non-expert demands (not only universities, R&D centres, firms and government).
- To facilitate dialogue between different knowledge traditions.
- To identify social demands, and then to identify who could attend them, i.e. to be a broker (see severe innovation deficits in Mulgan, 2006: p 147).

According to what was said above, social innovation is going to demand a lot of changes and innovations within Colciencias, regarding users, programmes, priorities, etc. Different dimensions or approaches to social innovation can be identified, which may help us to analyze the objectives and target users that Colciencias should pursue and attend:

- Innovations that have a social purpose (e.g. microcredit, distance learning),
- Innovation in public policy and governance (e.g. new models of intervention, novel ways of delivery of social services),
- Innovation in the educational system (e.g. conflict management in public schools),
- Innovation in the non-profit sector (e.g. new models of social organization, community defenders).

The implications of the work will be to provide recommendations to Colciencias on how to incorporate social innovation issues in the national and regional research and innovation policies, plans and programmes.

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Constructing sustainable cities

Roar Samuelsen, Ove Langeland

NIBR Norwegian Institute for Urban and Regional Research, Norway

1. The motivation

This paper discusses the role of cities in promoting sustainable transitions by focusing on system innovation related to climate change. Cities are focused because they have a key role to play in the global agenda for addressing the challenge of climate change and environmental problems. As key engines of the global economy, cities are responsible for the bulk of national output, innovation and employment, and they constitute the key gateways of transnational capital flows and global supply chains. Cities function as integrated systems, consisting of many closely interlinked sectors of economic activity and complex types of infrastructure. A well-functioning infrastructure is decisive for cities to be both competitive and liveable places. However, under current climatic circumstances this functionality is frequently challenged and cities face pressing problems pertaining to their technological network. A wide range of urban transformation projects are observed across the globe, often associated to term 'smart cities' and aiming at the promotion of clean technologies, smart grids and smart buildings. Such projects may lead to increased efficiency and improved practices both in specific sectors and across sectors. Whether these massive efforts will facilitate the necessary transition to sustainability is an open question. It depends, among other things, on their "urban capability", i.e. how cities utilise their resources, organise knowledge transfer and learning processes, practice their different governance modes and exercise knowledge management. Reflecting on the capacities of cities to meet such problems, Hodson & Marvin (2010)¹ asks the following question: 'Can cities shape socio-technical transitions and how would we know if they were?' We share with these authors the concern that the role of cities seem to be uncertain, fragmented and often implicit in transitions approaches.

The paper focuses on system innovation related to climate change mitigation and adaptation measures for urban infrastructure within the frame of a specific policy program, the Cities of the Future-program (2008-2014). Norwegian environmental authorities and the political-administrative leaders of the 13 largest cities in Norway share the following vision: achieve large-scale transformative changes at the system level of urban infrastructures in order to meet challenges related to current climate change and resource

¹ Hodson, M. and Marvin, S. (2010). 'Can cities shape socio-technical transitions and how would we know if they were'? *Research Policy*, Vol.39 :No.4, pp.477-485.

utilisation in Norway. Through a wide range of innovation projects – focusing on energy, transport, buildings, waste and climate adaptation – the Cities of the Future-programme aims to re-construct these 13 cities as sustainable cities. Thus, our empirical point of departure is that the cities participating in the Cities of the Future-program aim to shape socio-technical transitions within their respective cities and thus contribute to transitions to sustainability in society at large.

In a 3-year research project scrutinizing the transition efforts within 5 case cities² selected from the Cities of the Future-program, a set of pertinent research questions are pursued:

- What do cities do, in terms of constructing new socio-technical solutions to pressing urban problems?
- How do they do it, in terms of processes of innovation, governance and learning at micro (firm/niche), meso (system/regime) and macro (societal) level?
- What are the results, in terms of potential or actual socio-technical transitions to sustainability? Can cities really shape socio-technical transitions?
- What are the lessons, in terms of experience and learning within and between cases in the Cities of the Future-program and more generally?

2. The approach – case studies and conceptual analysis

This paper will present the tailoring of a conceptual framework that can enable both theoretical and practical insights into the issues of *what* cities do and *how* they do it. Concerning the empirical arena where this takes place, the five case cities represent four areas of climate innovation and six fields of environmental technologies (see table below). Three of the four areas of collaboration within the joint action program of Cities of the Future are focusing on mitigation measures and one is focusing on adaptation and resilience measures. These areas correspond to six fields of environmental technologies. Several of the CotF cities are hubs in technological clusters of high relevance to their respective cities and regions and to the overall national climate innovation system. In Trondheim, for instance, there are strong clusters within both energy science and technology and building and materials science and technology and in the Oslo region there is a strong and fast-growing business environment within energy and environmental technology.

² Oslo, Bergen, Stavanger, Trondheim and Tromsø.

Areas of collaboration	Fields of environmental technologies
Land use and transport	<u>1. Transport</u> : new fuel (batteries, hydrogen and bio), transport from road and air to rail and sea; intelligent transportation systems.
Consumption and waste	<u>2. Waste</u> : waste management, including waste reduction and recycling.
Energy and building	<u>3. Energy</u> : energy efficiency, low/zero energy homes, smart grids, smart energy systems <u>4. Buildings</u> : environmentally friendly buildings (materials/equipment/ services), smart buildings
Climate change adaptation	<u>5. Water</u> : management and treatment of drinking water and wastewater <u>6. ICT</u> : environmental ICT, development of monitoring programs

Concerning the conceptual framework used, this is based on a combination of the two systems approaches in transitions studies, the innovation system approach (Jacobsson and Bergek 2011)³ and the multi-level perspective (Geels 2011)⁴ and the way the MLP is used to critically examine the role of cities in transitions to sustainability (Hodson and Marvin 2010). An explicit socio-spatial perspective will be used in order to analyse how specific local or regional circumstances may stimulate or hamper sustainable transitions, and if and how experiences can be transferred between different spatial contexts.

By combining conceptual analysis with in-depth empirical case studies of innovation projects in the 5 largest cities of this programme, the project will shed light on the following issues:

- How innovation processes are organised and coordinated through transition governance and learning processes, and what the results in terms of sustainability transition are,
- How different urban and regional development trajectories can be identified and what the characteristics of these are,
- What the implications of the embeddedness of the innovation projects are in different urban and regional institutional regimes for transition efforts and results.

The paper argues that the system approaches jointly are useful to identify and analyse different modes of organisation and coordination of the transition efforts. Such modes

³ Jacobsson, S.B., Bergek, A. (2011). 'Innovation system analyses and sustainability transitions: contributions and suggestions for research'. *Environmental Innovation and Societal Transitions* 1, pp. 41–57.

⁴ Geels, F.W. (2011) 'The multi-level perspective on sustainability transitions: responses to seven criticisms'. *Environmental Innovation and Societal Transitions* 1, pp. 24–40.

differ while innovation projects follow specific trajectories, the characteristics of which will be identified and analysed through these approaches.

3. The expected results

The expected results of the project that this paper reports from will be

- i) theoretically, to contribute to the further development and refinement of the applied systems approaches as research tools for studying sustainability transitions;
- ii) empirically, to contribute knowledge pertaining to a better understanding of the organisation and coordination of innovation and learning processes in the 5 cases, the nature of the various urban development trajectories observed and the implications of the innovation projects embeddedness in different urban and regional institutional frames.
- iii) practically, to provide knowledge relevant for targeted intervention in constructing more sustainable cities – in the short run – and enabling transitions to sustainability in the longer run.

4. Conclusion and/or (policy) implications

The conclusion of the paper is that the cities in the Cities of the Future-program can shape socio-technical transitions pathways. Given the right conditions, the relevant actor may be able to construct and implement new sociotechnical solutions that take the cities further towards sustainable futures.

Based on the results of the project, the paper will also present policy lessons in the form of knowledge relevant for targeted intervention in constructing more sustainable cities – in the short run – and enabling transitions to sustainability in the longer run. The policy lessons will be based on experiences and learning within the five cases but should be highly relevant for actors both within the Cities of the Future-program and for other efforts for transition to sustainability.

Explaining public support for government spending on science and technology

Luis Sanz-Menéndez¹, Gregg G. Van Ryzin², Eloisa del Pino¹

¹*Institute of Public Goods and Policies (IPP), Consejo Superior de Investigaciones Científicas (CSIC), Spain*

²*School of Public Affairs and Administration (SPAA), Rutgers University-Newark, USA*

Using data from a large national survey in Spain, this paper analyzes public support for government spending on science and technology (S&T). It develops multivariate models to test the relevance of diverse predictors of the choice of science and technology as a priority spending area (from among other policy areas) and for explicitly stated support for increased government expenditure on science and technology. Findings identify several variables that are clear and consistent predictors of public support for government spending on science and technology: respondent's educational level, interest in science, knowledge of science, and positive values and views of science and technology. However, the effects of other variables, some of which have been associated with general support of science in prior studies, are less clearly associated with more specific support for government S&T spending.

I. Introduction

World expenditure in Research and Development (R&D) in 2007 totaled more than 1.1 trillion US dollars (estimated in PPP), representing more than 2% of world annual GDP (NBS-NSF 2010); and over the last 15 years, global R&D expenditure has doubled in the real terms. Despite the fact that science and technology have become powerful sources of innovation and economic benefits for private actors, governments finance almost half of global expenditure on R&D. Additionally, there are more than 6 million researchers worldwide, and many more than half work either for governments or public higher education institutions (OECD, 2011).

Predicting citizens' support for government spending on science and technology (S&T) is an important topic for several reasons. First, government S&T spending has become a salient and significant policy issue and, increasingly, it is linked to ambitious policy targets. Many countries have established political commitments to increase gross expenditure in R&D (e.g. EU Lisbon Objectives up to 3% in 2010) and public funding of research (Sheehan & Wyckoff, 2003).

Second, there is a tension between elites (experts and policy makers) calling for substantive increases in the R&D expenditures by government and the general public, who often appear indifferent towards science and technology policy. Third, despite recognition of the connection between growth rates and investment in science and technology

(as sources of innovation and international competitiveness), governments facing fiscal consolidation have to make choices where and how much to cut among many different programs. Public opinion becomes an important element or constraint for making choices, leading governments to align their decisions with the preferences and priorities of citizens. These issues are especially relevant to governments in times of uncertainty or political crisis, when chances for reelection depend on the dominant trends of public opinion.

Last but not least, very little is known about the factors that explain public support for government spending on S&T, compared with what is known about citizens' support for other areas of government spending. Moreover, science and technology policies have become a major activity in fields such as public policy and management sciences, but surprisingly there is still a limited amount of research on the interaction between public opinion and S&T policies.

Since the early eighties US and European opinion surveys have asked periodically whether the "government is spending too little, too much or about the right amount for the "conduct of scientific research" (Miller 2004) but citizens' support for S&T policy is an issue that has mainly been analyzed indirectly, through the study of citizens' interest and knowledge of science, and mainly associated to debates on scientific literacy, public understanding of science or public attitudes towards S&T. To advance our knowledge, the main objective of the paper is to examine various predictors of public support for S&T policies, understood as government spending to promote, execute or finance research and technological development.

The paper is organized as follows: in section 2, we provide a background review of the problem and we construct the main hypothesis of the paper. Section 3 describes the data, variables constructed and the statistical methods. Section 4 presents the findings of our analysis. Finally, we discuss the results, policy implications and suggestions for future research.

2. Background, theory and hypothesis

Public understanding of science has developed with the implicit idea that the support for public funding of S&T policies correlates positively with more general attitudes towards science. The literature on citizen attitudes toward government spending has focused particularly on social welfare policies; however, its findings can contribute to the analysis and understanding of public opinion towards science and technology policies.

Both streams of research have their origins in the empirical studies of public opinion in democratic societies that emerged after the World War II. The study of citizens' prefer-

ences toward public spending became relevant, in the 1960s and 1970s, when government economic intervention began to be questioned. The vast public spending in science, exemplified by the Apollo space program, prompted public debate; in response, the US National Science Foundation promoted the systematic analysis of public opinion regarding science issues and, since 1984 the American National Electoral Studies began to ask citizens about their assessment of federal spending on science and technology, among other policy domains.

Early studies of attitudes toward government and public spending [e.g. Free & Cantril (1967) or Sears & Citrin (1985)] have found ambivalent attitudes. On one hand, citizens seemed to be wary of state intervention, taxes, and public spending in general. On the other, citizens appear more open and supportive of increased public spending in specific areas of policy or on particular public goods or programs. This ambivalence has led some politicians favour cuts in public spending to defend their ideas in general terms, while those who support continuing government intervention frame their proposals in terms of specific policies and programs (Jacoby, 2000). Citizens' preferences and their determinants vary substantially depending on the sector of public policy analyzed; for example, public preferences toward welfare state policies (health, education, pensions, or unemployment benefits) seem to respond to a more coherent structure of determinants (Jacoby, 1994). Nevertheless, even with these welfare policies, the recent research on public opinion finds different patterns of determinants depending on the aspects of social welfare policy being examined. The different contexts, the nature, features or outcomes of these policies are likely to condition citizens' attitudes toward public spending too (Svallfors 2003). As a summary, a single structure of determinants of attitudes towards public spending can not be applied across all policies and programs (Monroe 1979; Carrillo and Tamayo 2011).

In the case of S&T policies, there is a lack of studies on public support and preferences for government spending, even if much research has been devoted to public attitudes toward science and technology. Early studies found a relatively low level of awareness and substantive knowledge concerning science policy issues by the public; the seminal work by Miller (1983b) tried to link citizens' views of science to decision-making in science policy, but their results strengthened the assumption that public opinion was not an influential element in the design of S&T policies. The growing interest in scientific literacy (Miller 1983a; Miller 1999), concerns about the limited scientific knowledge of the public and the strengthening of public understandings approach, has contributed to focus the efforts of researchers in the explanation of citizens' attitudes towards science. Scholars have tried to identify public preferences for specific areas of S&T spending and findings show more positive attitudes on the part of citizens regarding areas of science related to personal wellbeing and improvement of the quality of life, while other

areas of S&T remain clearly controversial; research on health or general medical issues receives strong support from citizens, while other medical topics seem to meet with controversy and opposition (Bauer 2002, Nisbet 2005, Nisbet & Goidel 2007). As a result, there is some ambivalence among citizens' attitudes and, as in other policy sectors, it becomes difficult to identify a single structure of determinants of public opinion about the S&T policy.

In general, the issue of public preferences for public spending in S&T either has been neglected or approached from a descriptive view (e.g. Bauer et al 1994; Evans and Durant 1994; Durant et al 2000; Miller 2004). A more recent exception is the paper by Muñoz et al. (2010, forthcoming in PUS) try to identify characteristics that distinguish Spaniards who support public S&T spending from those who do not. Indeed, Muñoz and colleagues use the same Spanish data that we use in this paper¹. But their analysis is exploratory, relying on bivariate techniques and a stepwise discriminant analysis to search for empirically relevant predictors from about 100 items in the survey. They find that stated interest in science and technology is the predominant discriminating variable, followed somewhat distantly by a rather ambiguous set of secondary factors. Indeed, Muñoz et al (2010) conclude that: "Once this variable on interest in science and technology is included in the model, the others can be considered to be incidental or indeed superfluous" (p. 10). Thus, there remains much to be learned still from these data about what other variables, beyond interest in science, predict public support for government S&T spending in Spain. Muñoz et al (2010) encourage future research "to identify variables related to the public understanding of science that are useful for characterizing the group of people who clearly support public funding of science" (p. 11). It should also be noted that the somewhat inconclusive results of their study could reflect high multicollinearity from not having first reduced the survey data (using factor analysis or multi-item scales) before selecting predictors, their choice of discriminant analysis instead of logit or probit (which have less restrictive assumptions), and their decision not to weight the survey data (even though the survey involves disproportionate sampling by region). We will discuss our approach to these methodological issues in a later section. Finally, in addition to the dichotomous variable of choosing S&T as a priority for public spending (or not), which is the dependent variable used by Muñoz and colleagues, we also consider an alternative dependent variable that is a more explicitly stated level of support for S&T spending.

¹ We completed our analysis of the CIS data prior to finding out about the Muñoz et al. (2010) study, but we believe our analysis compliments and extends their work as explained in the text.

Thus, we aim to contribute to a better understanding of public support for government S&T spending – by considering a broader set of hypotheses (beyond interest in science) developed from a close examination of the literature on the determinants of attitudes toward public spending in other policy areas, as well as the research on general public attitudes toward S&T. Although we focus primarily on individual-level factors that might condition support for S&T spending, we also consider the economic and policy contextual of the respondents' region. Under each group of hypotheses, we have identified a set of relevant variables for empirical testing.

1) Demographic and socio-economic factors

Since the early studies of public opinion, it has been assumed that citizen preferences toward taxes and government spending in different policy areas depend on, among others factors, a rational calculation of personal interests determined by demographic and socioeconomic characteristics (Birdsall 1965; Blekesaune & Quadagno 2003). Thus, gender, age, income, level of education, employment or student situation have all be hypothesized as playing a role in shaping public support for various forms of government spending. For example, women and younger people have been shown to be more favorable toward government spending, with women are particularly interested in social programs (Sanders, 1988; Carrillo & Tamayo 2011). Positive attitudes towards science have been linked with scientific literacy of young, male and educated people (Miller 1983b), although gender and age are sometimes not significant predictors in multivariate analyses (Hayes & Tariq 2002; Nisbet et al 2002; Sturges & Allum 2004). Education level has been shown to be a strong predictor of support to science (Miller et al 1997) positively related with support of many types of government spending, except perhaps military issues and public safety. However, more educated people sometimes appear more ambivalent regarding S&T (Lujan & Todt 2000, Torres 2005) or with stronger positions (Pardo & Calvo 2002). In general, lower income people are more supportive of government spending, while high income people tend to oppose it (Tuftle 1978), with the exception of education policy (Carrillo & Tamayo 2011).

From these somewhat contradictory findings, we might expect that education will have a positive effect on support of government S&T spending and gender (women) a negative effect, although the prior evidence is mixed. We also have mixed expectations regarding the effect of the other demographic and socioeconomic variables, such as age and income. Still, it is worth testing such variables, to the extent they are measured in the survey, because of their central role in much prior public opinion research.

2) Partisan factors and religious belief hypotheses

Concerning ideology and religious beliefs, attitudes to public spending are affected by people's moral values, specifically those related to economic redistribution and social justice. Left oriented and non-Catholics have been shown to be somewhat more supportive of science developments (Miller et al 1997). At the same time, empirical studies suggest that individuals that hold more egalitarian values are much more prone to support social spending than individuals holding more individualistic beliefs (Linos & West 2005). Religious beliefs play a role also in accounting for diverse attitudes towards governments spending, with less religious people more in favor of a stronger government role (Sanders 1988); religious beliefs play also a moderator impact of the awareness in support of science (Nisbet 2005).

3) The interest and attentive public hypotheses

General interest in and attention to an issue has been shown to be a relevant factor in accounting for support of government policy and spending as well as science (Nisbet et al 2002). Miller's (1983b) study of "attitudes towards science and technology issues and policies" used Almond's concept of "attentive public", (interested, knowledgeable and informed) and he developed the idea of a stratified model of public policy formulation to deal with the problem that science policy was not a salient topic for most of Americans. And as mentioned earlier, Muñoz et al (2010) found interest in science to be by far the strongest discriminator of those supportive of government S&T spending. Therefore, we would clearly expect interest in science and technology to be a key predictor of government S&T spending also—although one of many significant predictors.

4) The knowledgeable people hypotheses

The level of substantive knowledge, or so-called scientific literacy, has been highlighted as a relevant factor explaining general public support of science. In fact, knowledge is the key element of the deficit model (Bauer et al 2007; Allum et al 2008). Moreover, it has been found that the role of the scientific knowledge (even if measured through what has been called textbook knowledge) has a significant, but sometimes weak, relation with support to scientific research (Bauer et al 1994; Evans & Durant 1994; Miller et al 1997). Thus, we should expect that people with more information and knowledge of science and technology will be more favorable toward science and technology policies and government spending.

5) The values and beliefs about science and technology hypothesis

Although more knowledge or information on scientific issues is associated with greater support for scientific activities (Sturgis & Allum 2004), there are some important exceptions regarding controversial areas of research and technology, such as stem cells, embryo research, GMOs, biotechnology, nanotechnology, or nuclear technology (Bauer 2002; Gaskel et al 1999; Gaskel et al 2004; Weldon & Laycock 2009;), where acceptance is reduced (Gupta et al 2011). Knowledgeable citizens may be ambivalent regarding many aspects of modern science; much depends on the concrete area of S&T, on beliefs regarding the ethical and moral aspects of science, and on assessment of the pros and cons of S&T in society.

Even if people lack the scientific knowledge to understand many of these issues, citizens use shortcuts or heuristics to give opinions and construct their policy preferences. The way in which people construct the cognitive devices for choosing preferences appears to be based also on the degree of confidence they have in institutions in charge of making decisions and of managing scientific activity or in their acceptance of scientific authority (Brossard & Nisbet 2000). If people have confidence in scientists as a profession or believe that scientists are altruistic people (Cristchelly 2008), then this would increase the probability of support for government S&T spending.

In sum, we should expect that people with a positive attitude towards S&T, will be more in favor of S&T policies and more spending. Also citizens with higher levels of trust in scientists as a profession and in their altruistic motives will be more inclined to support science policies.

6) The political and policy attitudes effects

General interest in politics and public affairs influence attitudes towards public policies (Delli Carpini & Keeter, 1996); the level of understanding of the political process and of the functioning of political institutions is a relevant factor in explaining the propensity to support S&T issues (Sturgis & Allum 2004). Additionally, the level of information or knowledge about policy goals and the perceived standing of science and technology in one's country, compared to competitor nations, could be used as a proxy for the level of interest and knowledge of the goals of science policy.

7) The diversity of socio-economic context and the post-materialist hypothesis

Recently, attention has been paid to the interaction between individual factors and contextual factors that could account for differences in support for government spending (Andreß & Heinen 2001). Individual beliefs vary greatly from one society to another,

according to various institutional factors and social structures, such as the way in which the state is configured. Different factors —such as the level of income, the different social structures, of varying expenditure levels in a policy area—may affect attitudes toward public spending. A high level of development of a country (or a region) and a high income level tend to moderate the demands of citizens for public intervention and the preferences toward more materialist or postmaterialist policies (Inglehart, 1990).

Researchers have found a significant variation in national attitudes towards science; the comparison among countries in Europe has allowed identification of an inverse U shaped function connecting the level of development and industrialization of societies and the level of support or acceptance of science (Bauer et al 1994; Durant et al 2000). Most developed societies have become more cautious regarding some side effects of S&T (Gaskel et al 1999), but the postmaterialist transformation (Inglehart, 1990) has been used to account for the non linear relationship between the level of economic development (post-industrialism values) and ambivalence regarding science.

Additionally, the relationship between citizens' preferences toward public spending and policymakers' responsiveness are relevant (Monroe, 1979; Page & Shapiro 1992). There is a wide consensus that public opinion matters (Burnstein 1998) and that there is a clear association between policy budgets and the spending preferences expressed by citizens (Soroka & Wlezien 2010). As a thermostat, policymakers are responsive to the demands of citizens and, at the same time, citizens are also responsive to changes in public spending patterns.

In the context of a single country, we have the opportunity to control for the effects of different regional variables related to income, position of S&T in the economy, and the role of S&T in regional government budgets. The general expectations are that living in a more scientifically developed or advanced region will influence positively the level of support for S&T policies and spending. Alternatively, if the postmaterialist expectation and the responsive policymakers hold, the most developed regions may reduce their support for the allocation of public resources to science and technology.

3. Data and Method

The data for our study come from a comprehensive survey of public attitudes toward science and technology in Spain conducted in 2006 by the Spanish Center for Sociological Research (*Centro de Investigaciones Sociológicas* [CIS] 2006/2652) in collaboration with the Spanish Foundation for Science and Technology (*Fundación Española*

para la Ciencia y la Tecnología –FECYT)². The survey involved in-person household interviews of 7,056 randomly selected adult residents of the 17 regions of Spain, ranging from 308 thousand to 8 million inhabitants. The survey design, however, called for approximately equal-size random samples from each region, resulting in disproportionate probabilities of selection by region. Thus, sampling weights were constructed (representing the inverse of the probability of selection) and applied in all analyses reported here³. The survey asked a wide range of questions about interest in, knowledge of, and attitudes toward S&T, as well as basic social, economic, and political characteristics of respondents. Based on the theory discussed above, we selected the following measures as our main dependent and independent variables.

a) Dependent variables

To measure public support for government spending on S&T, our dependent variable, we constructed two measures from the survey. The first measure comes from an early question in the survey in which interviewers first asked respondents to "imagine for a moment that you could decide where to spend public funds," and then showed respondents a card with the following sectors listed: "public works, public safety, transportation, science and technology, environmental protection, defense, justice, culture, and sports."⁴ Respondent could choose up to three of these sectors for public spending. Thus, we created a dummy variable that indicates respondents who chose "science and technology" as one of their choices on the list. Interestingly, only about 20 percent of respondents selected science and technology as an area for public spending, as shown in Table 1 (weighted results). This is the dependent variable used by Muñoz et al (2010) in their bivariate and discriminant analysis of these data.

Later on in the interview, respondents were asked a series of more direct questions, in line with traditional questions of PUS questionnaires, about their general support for science and technology spending by government (with the relevant responses starred and in bold, as explained shortly):

2 Data, general results and questionnaire are available at the CIS web page: http://www.cis.es/cis/opencm/ES/2_bancodatos/estudios/ver.jsp?estudio=7800&cuestionario=9014&muestra=14225 (Last access in 31 October 2011).

3 Stata 11 was used for the analysis, including the procedures for probability weights.

4 The list of policies offered in this question deliberately excluded health, education and pensions because these programs enjoy a wide popularity among Spanish citizens and are known to be selected as the first choices for public spending (Calzada and Del Pino, 2011); two of the authors (Eloisa del Pino and Luis Sanz-Menéndez) were involved in the design of the questionnaire.

- Do you believe the **central government** dedicates too much, the right amount, or ***too little** resources to science and technology?
- Do you believe the **regional government** dedicates too much, the right amount, or ***too little** resources to science and technology?
- Do you favor, or ***oppose**, a reduction in spending on science and technology by the **central government**?
- Do you favor, or ***oppose**, a reduction in spending on science and technology by the **regional government**?

We created a summative index of these questions by counting up the starred (*) responses across all four questions, from 0 (none of the starred responses chosen) to 4 (all four of the starred responses chosen). To facilitate interpretation, we then rescaled the variable from 0 to 100 (by multiplying by 25). Thus, the variable has a mean of 57.95, as shown in Table 1 (weighted results), and provides a measure of the degree to which respondents express support for increased government spending on S&T⁵.

It should be noted that, in contrast to Muñoz et al (2010), we use two different dependent variables because, although similarly focused on respondents' preferences for government spending on S&T, they measure such preferences in two distinct ways. The dummy variable for selecting S&T from among other possible areas of government spending is a more implicit measure of preference or support. Moreover, this question appeared early in the interview and thus respondents were not prompted in any way to consider S&T. In contrast, the 0-100 index comes from a later set of questions in the interview that explicitly asked respondents for their views about government spending on S&T. Interestingly, the correlation between the two variables is only $r = .18$, suggesting that they do indeed measure different dimensions of preference or support. But still we consider both measures to be valid and interesting dependent variables for analysis.

b) Independent variables

We conceptualize and analyze our independent variables in blocks, following the hypothesis discussed above, including: demographic and socioeconomic characteristics, ideology, interest in science, knowledge of science, values and beliefs about science,

5 We also ran regression (probit) models separately for each of these questions, coded as individual dummy variables, but the results (not reported here) were substantively similar to those for the models using the aggregated 0-100 measure as a dependent variable. Indeed, the correlations of the aggregate measure with each of the individual questions are all .80 or higher.

policy attitudes, and regional context. Table 1 presents the definition and descriptive statistics for each of the variables.

The demographic variables include sex, age in years, and an ordinal measure of education. The socioeconomic measures include income in Euros and dummy variables for being employed and student. And the ideology variables include a dummy variable for practicing Catholics, as well as A measure of political ideology on a 1-10 (left-right) scale.

Interest in science was measured by two variables. The first is a direct self-reported level of interest in science on a 1-5 scale (very uninterested to very interested). The other measure comes from a series of yes-no questions that asked respondents if they attended various activities or events in the last year, including the theater, movies, art museums, and also science and technology museums as well as Science Week in Spain (a national series of events dedicated to the promotion of interest in science). Those who visited a science museum or attended a Science Week event were coded as 1, the rest were coded as 0.

We use two measures of knowledge of science. The first is a self-reported level of being informed about science on a 1-5 scale (from very uninformed to very informed). The second comes from a series of 10 true-false questions on a card that tested the respondent's actual knowledge of scientific facts⁶. Thus, the variable ranges from 0 (no correct answers) to 10 (all 10 questions answered correctly) and provides a measure of knowledge of scientific facts. We also include a dummy variable for those with a university degree in science.

The survey included a number of questions concerning values and beliefs about science from which we selected a few distinct measures. The first is a summated scale of trust or confidence in the work of professional scientists, engineers, and medical doctors. For each of these three professions, respondents indicated on a 1-5 scale whether they valued their work very little to a great deal (thus the scale ranges from 3-15). Next we constructed an index of respondents' general outlook on the benefits of science composed of four agree-disagree statements, three mostly positive statements and one clearly negative one. The statements read: Science and technology are the ultimate expression of prosperity in our society; Science and technology serve above all to resolve problems; Science and technology resolve problems but also create them; Science and technology are a source of nightmares for our society. We created a

⁶ The card displayed statements such as "the sun rotates around the earth" (false) or "the oxygen we breath comes from plants" (true), following the "textbook" knowledge model.

sum of these items (with the last item reversed) to create our measure of respondents' general outlook on the benefits of science. In addition, we include in the model a dummy variable from a summary question that asked respondents if, on balance, the positive aspects of science outweigh the negative. Finally, we included a dummy variable that indicated whether respondents believe scientists are motivated primarily by the search for new knowledge and the solution of problems (coded 1 for altruistic motives) or by prestige, money, a flexible schedule, good working conditions, or inertia (all coded 0 for more selfish motives).

The next block of two variables aims to represent respondents' interest and attitudes toward public policy. The first is a 5-point measure of stated interest in politics and policy, ranging from very uninterested to very interested. The next is a dummy variable from a question that asked about Spain's position, relative to the average for other European countries, with respect to research in S&T. Those who felt Spain was behind the European average were coded 1, while those who felt Spain was at the same level or more advanced (or did not know) were coded 0. We use this variable as a proxy for awareness of the science policy pressures on Spain relative to the rest of Europe and the policy targets.

Finally, we include a set of variables measured at the regional level to capture the context of individual responses. As mentioned, there are 17 regions in Spain which vary a great deal in social, economic, and policy context. We chose four regional variables for inclusion in the model: GDP per capita, as a measure of the general economic prosperity of the region; research and development as a percent of regional GDP, as measure of the share of the regional economy involved in S&T; percent of the 18-24 population enrolled in university, as a measure of relevance of the knowledge society; and percent of the regional government's budget devoted to S&T, as a measure of the regional government policy commitment.

Again, the definitions and descriptive statistics for all of these analytical variables can be found in Table 1. It should be noted that, to reduce missing data in the multivariate models, substitution of the mean or median (for ordinal variables) was employed for selected variables with high levels of don't know or no answer (Bauer 1996; Pardo & Calvo 2002). This substitution of missing data provides for more consistency in the size of the sample across analytical models and did not influence the substantive results.

4. Analysis and Results

Table 2 shows the results of our probit models predicting the proportion of respondents who selected S&T as a preferred area for government spending. We use probit regression because the dependent variable is dichotomous and in order to show the coeffi-

cients in the form of a change in probability of $Y=1$ (for a one unit increase in X , with the other independent variables fixed at their means)⁷. Although Muñoz et al (2010) used a discriminant analysis, probit is a robust alternative that has less restrictive assumptions and provides more accurate statistical inference (Aldrich & Nelson 1992). We also estimate our models using survey weights and clustered (by region) robust standard errors. And we enter each block of variables (corresponding to the sets of hypotheses presented in section 2) in a cumulative fashion to show how the results change (or remain stable), depending on the inclusion of other variables, and to probe for possible evidence of mediation.

As the basic demographic Model 1 in Table 2 shows, females are less likely than males to select science and technology as a preferred area for government spending. Respondents with higher levels of education are more likely to select S&T, as are those who are employed and those who are students. Model 2 adds the two indicators of ideology, only one of which is significant: respondents on the right politically are less likely to select science and technology as a preferred area for government spending. Both models explain only about 6 percent of variance in the dependent variable (pseudo R-squared).

Model 3 adds the two measures of interest in science, both of which are strong and statistically significant predictors; explained variance more than doubles from the previous models, to nearly 13 percent. The coefficients indicate that respondents who express an explicit interest in science as well as those who report being actively interested (by attending science museums and events) are much more likely to choose S&T as a preferred area for government spending. It is interesting to note that the coefficient on gender is no longer significant in this model, suggesting that interest in science is a mediator of the gender effect observed in the previous models. Similarly, interest in science also appears to be a mediator of the current student effect, which also disappears in this model.

Model 4 adds the indicators of knowledge of science, all of which are statistically significant predictors. Respondents who say they are informed about science, those who score objectively higher on the 10-item battery of science knowledge questions, and those with a science degree are all more likely to select S&T as preferred area for government spending. Explained variance rises a bit to just under 14 percent in this model.

The next model, Model 5, includes the addition of values and beliefs about science, two of which turn out to be significant although not especially strong predictors. Respon-

⁷ Based on the `dprobit` command in Stata 11.

dents who believe that the benefits of science generally outweigh the dangers, and those who believe that scientists are motivated primarily by altruistic purposes, are more likely to select S&T as a preferred area for government spending. Moving on to Model 6, neither of the two policy attitudes – interest in politics/policy and holding the view that Spain is behind the EU average in S&T – turn out to be important predictors. Explained variance remains a little over 14 percent in both models.

Finally, Model 7 includes the regional context variables, two of which are significant. As expected, respondents are more likely to choose S&T as a preferred area for government spending in regions in which the regional government dedicates a greater share of its resources to S&T. But contrary to expectations, respondents in regions in which a greater percentage of young adults are enrolled in university turn out to be less likely to select S&T as a spending area. This final model, which includes all of the predictors, explains nearly 15 percent of variance in the dependent variable.

Table 3 presents the results of our ordinary least squares (OLS) models predicting the degree to which respondents express support for government spending on S&T, as measure by our 0-100 index (explained above). Although expressed support for science and technology spending by government would seem very similar to choosing S&T as a preferred area for government spending (from a list of other government spending areas), as noted earlier these two dependent variables actually measure different dimensions of public preference or support (and the correlation between them is only $r = .18$). Thus, although we would expect some similarities to the previous results, the array of significant predictors is likely to be different in these models.

Model 1 of Table 3 includes the basic demographic and socioeconomic predictors. Similar to the previous set of results, females are less likely than men to express support for government spending on S&T. And respondents with higher levels of education are more likely to express such support. Model 2 adds the ideology variables, neither of which turn out to be significant predictors. In contrast to the previous results, political ideology is not related to express support for S&T spending by government. The explained variance (R-squared) in both models is about 9 percent.

Model 3 adds in the two measures of interest in science, and consistent with the previous findings both are significant and strong predictors. Specifically, respondents with a self-stated interest in science and those with an active interest are much more likely to express support for government spending on S&T. In contrast to the previous results, however, interest does not fully mediate the gender effect.

Model 4 adds the measures of knowledge of science, and only objectively assessed knowledge of science (using the 10 factual questions) is positively related to support for

S&T spending. Curiously, having a science degree has a negative association. And being informed, as self-reported, is unrelated to support. The explained variance rises to 15 percent. With both interest and knowledge of science now in the model, the gender effect diminishes below statistical significance. This suggests that, in the case of expressed support for S&T spending, knowledge of science (along with interest in science) mediates the gender difference in support.

Model 5 adds the four measures of values and beliefs, three of which are statistically significant predictors. Respondents with a generally positive outlook on the benefits of science, those who believe the benefits outweigh the harms, and those who believe scientists have altruistic motives are all more likely to express support for government spending on S&T; the explained variance increase to over 18 percent in this model.

Model 6 adds policy attitudes, and the striking result here is a large effect for viewing Spain as behind the EU average in S&T. Specifically, respondents who see Spain as lagging the EU are 12 points more likely to support government spending on science and technology. Curiously, this variable was not a significant predictor at all in the previous models. General interest in politics and policy is not associated with such support, as before. The explained variance rises to over 20 percent.

Finally, Model 7 adds in the regional context variables, only one of which is statistically significant. Respondents in regions in which the regional governments devotes a greater share of the budget to S&T express less, rather than more, support for government spending on science and technology. None of the other regional variables are significant, and the explained variance goes up a bit to about 21 percent.

5. Discussion

The results of our analysis provide empirical insights on some key predictors of public support for government S&T spending in Spain, operationalized both as the choice of S&T as a priority spending area and as explicitly stated support for government S&T spending. Our predictors included a wide range of factors that have proven useful in accounting for support for other public policies as well as those shown to be relevant for explaining public attitudes toward science more generally. These factors included socio-demographic characteristics, ideology and religion, interest and knowledge in science, values and beliefs about science and technology, various political and policy attitudes, and the regional context. Our study advances the work of Muñoz et al (2010) by considering a wider array of predictors as well as employing methodological refinements in the weighting and analysis of survey data.

Several variables emerged in our study as having some potential to explain support for science and technology policy, depending to some extent on how support for public spending on S&T is measured. To start with socio-demographic factors, our results confirm that those people with higher levels of education are more likely to select S&T policy as a priority and to support increased public spending in this area. Although educated people sometimes appear ambivalent concerning science and often have stronger attitudes (Pardo & Calvo 2002), more educated individuals seem more aware of the importance of public expenditure in this policy area (Miller et al 1997), as well as related policy areas such as education or culture (Carrillo and Tamayo 2011). Perhaps more educated Spaniards also perceive public investment in S&T as a way for their country to transform its current "productive model", which is often seen as too dependent on unskilled labour in construction and tourism (issues that have been salient in the Spanish media and political debates). On the other hand, comparing Tables 2 and 3, our results confirm that other demographic variables such as age or level of household income are not significant. Although the basic demographic models indicate that women are generally less supportive of spending on S&T than men, when other variables are included in the model sex became non significant. This suggests that the gender difference in support for spending on S&T is perhaps due to sex differences in other variables (Hayes & Tariq 2002), such as interest in or knowledge of science. Finally, the attributes of being employed and a student have different effects in the probit and OLS models. In the probit models, being employed has a significant positive effect on choice of S&T spending, perhaps because of an interest in pro-growth policies. In the OLS models, being a student has a negative effect on expressed support for S&T spending, perhaps because of a more critical orientation toward S&T or as a result of their personal experiences with the educational system.

As suggested by the ideology hypothesis, our results show that citizens on the political left and those with weaker religious beliefs are more supportive of government S&T spending. Perhaps those on the political right were less likely to select S&T because the list of choices offered did include policies associated with the usual preferences of conservatives, in particular security, justice, and public works. For citizens on the left, however, the list excluded health, education and pensions that are often preferences associated with progressives. Thus, the significant effect of political ideology may be somewhat of a methodological artefact. With respect to religion, in both models it becomes non-significant when all variables are included. But perhaps religious beliefs would have more of a relationship to citizens' preferences if the spending questions had referred to more controversial science topics, such as biotechnology or the use of stem cells in research.

As the interest hypothesis suggests and the prior study by Muñoz et al (2010) found, both measures of interest in science (a direct self-reported interest and at various activities related with science) have a significant effect on public support for government S&T spending. The coefficients of both the probit and OLS models are highly significant, even when controlling for other variables, and the magnitude of the effect is noteworthy. Thus, our findings are consistent with those Muñoz and colleagues who also found interest in science to be a strong predictor of support for government S&T spending, although in our study interest is just one of several important predictors.

Somewhat more striking are the findings about the three variables that measure citizens' knowledge about science. As expected from the knowledge hypotheses, respondents cognizant of science issues are more likely to select S&T as their preferred area for public spending. However, the effect of having a science degree shows a different and somewhat surprising effect: those who have a science degree, even if it is only marginally significant, are actually less prone to express support for government S&T spending. In contrast, the effect of the "textbook" knowledge of science (the 1-10 index of knowing scientific facts), which is not significant when choosing more spending in S&T, become significant in the expected direction as a predictor of expressed support for government S&T spending. In sum, when citizens have to choose among several public spending priorities, those more informed and with a science degree are more prone to select S&T. When asked explicitly about their support for more spending (and fewer cutbacks), citizens with more knowledge continue to express support but those with a science degree express the opposite view. The explanation could be that those with science degrees might be more aware of the efforts that governments have already made in the sector in recent years and thus might believe that spending is sufficient for the moment. As we discussed earlier, citizens are able to adjust their preferences in response to changes in budget allocations for different policies. And indeed, people with more knowledge on an issue are more sensitive to real variations in spending.

As we expected in our hypotheses about values and beliefs, more positive values and beliefs about science do indeed have a positive effect on support for government S&T spending. But again citizens were asked about their support toward public spending on S&T in general, as well as their values and beliefs about science in general, and not asked about specific research programs, which could possibly result in more ambivalent positions. It is interesting that science values and beliefs produce effects in the directions expected in both models (probit and OLS), with most of the effects appearing significant except for one (trust in science professionals). Thus, those that believe that the benefits of S&T are positive both select science and technology as a priority area and explicitly support increased spending in this policy area.

Contrary to our expectations, interest in politics did not have a significant effect on support for S&T spending. However, seeing Spain as lagging behind other countries in the EU in terms of S&T was a significant and strong predictor of expressed support for increases in government S&T spending, highlighting again the relationship between knowledge (in this case of a policy situation) and the general demand for increasing government efforts to cope with the problem. The connection disappears, however, when the issue becomes a matter of choosing and selecting S&T policy over other areas of government spending.

Finally, when we examined some contextual effects associated with the 17 Spanish regions, we found that citizens were somewhat more likely to identify S&T as priority in regions that were already spending a relatively large share of their budget on S&T, suggesting a kind of correspondence between the preferences of citizens and regional policy makers. But when looking at expressed support for government S&T spending, regional spending on S&T appears to have the opposite effect – discouraging expressed support for more spending in this area. One interpretation might be that in those places where government is already spending a large share on S&T, cutbacks are more possible. This striking finding could also be connected with the previously mentioned *thermostat effect*: when spending reaches a threshold, citizens' support for additional public spending may moderate in response. In any case, we must be very cautious with these results since we only have 17 regions and the heterogeneity is less than between EU countries. Moreover, additional observations, or data at different points of time, would be needed to refine and qualify these findings. Regarding the other two variables related to the prosperity of the region, GDP per capita and share of the regional economy involved in S&T, they do not have significant effects. Finally, the percentage of population between 18-24 enrolled in university has a somewhat unexpected negative effect, with respondents in regions with more university students in the age cohorts appearing less likely to select S&T as a preferred area for public spending.

In conclusion, these results help to shed light on some of the factors that may explain public support for S&T policy. Can it still be assumed that citizens who have positive attitudes toward S&T are always more supportive of spending public resources on the sector? Comparing the two models (Tables 2 and 3), there are several variables which are clear and consistent predictors of the support for government S&T spending: respondent's educational level, interest and knowledge in S&T, and having positive values and views of science. However, the effects of other variables, some of which have been associated with general support of science, are somewhat mixed. Having a science degree, being a student, and living in a region with a higher public budget allocated to science and technology all show varying effects, depending on the model. On the one hand, those citizens show a preference for spending on these policies vis-à-vis

others; but, on the other, they are less supportive of additional public spending (or more flexible with possible budget reductions) in science and technology. What this seems to indicate is that some of the variables associated with these unexpected effects are linked to higher "substantive knowledge" (science degree, student) of individuals, in regional situations characterized by relevant efforts in S&T or with high relevance of knowledge society, could provide support for a postmodernism interpretation.

There are several caveats and limitations to our study. To begin with, because the questions used to construct the index of expressed support for S&T spending were placed later in the interview, respondents were well aware that it was a survey about science and technology and had time to reflect on the issue. In other words, the measure of expressed support for S&T spending may well suffer from a social desirability bias, which may explain some of the differences we found across models. A more fundamental limitation is that we used measures from a cross-sectional survey in which the causal order of many of the variables remains uncertain. But we would argue that the background demographic and socioeconomic factors, ideology, interest and knowledge of science, and even values and beliefs about science are likely to have been established relatively early in a person's life and thus can be viewed as valid antecedents of support for government S&T spending. Still, it is possible that there remain some omitted variables that are common causes of both general attitudes toward science and specific preferences for government S&T spending that may be biasing our results (Remler & Van Ryzin 2011). Thus, our results should be viewed as evidence of statistical associations that suggest ideas about possible causal explanations, rather than a demonstration of causation as such.

Future research might help to further account for support for S&T policies. For that it would be useful to reflect on several issues and improve the research design through various means: It would be useful to include several countries and regions in our analysis, with different economic and cultural features, as well as different policy trajectories in science and technology. At the same time, more observations of the same country, at different points in time, would be needed to confirm some of our findings, for example, regarding the thermostat effect, that is to say, the relationship between the co-variation of public budgets and citizens' preferences about public spending on S&T. Moreover, a larger series of data would allow us to observe differences between contexts of economic prosperity and crisis. In times of crisis, for example, citizens preferences usually alter, prioritizing welfare policies (health, education and pensions) and weakening support for public spending in other policy areas (Del Pino et al. 2011). Although we have a large series of data about other policy domains in Spain, we lack information about S&T policy, specially the priority of choosing science and technology in comparison with other fields. Finally, our findings could have been different had we

asked for spending preferences regarding specific research programmes or areas inside S&T. Further research should concentrate on support for these programs, which are sometimes more controversial in public discussion.

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TABLE 1. Descriptive statistics						
	N	Min	Max	Mean	SE	
Dependent variables						
Selecting S&T for public spending (1=yes, 0=no)	7056	0	1	0.197	0.0061	
Expressed support for government spending on S&T	6894	0	100	57.950	0.5701	
Demographic and socioeconomic characteristics						
Female (1=yes, 0=no)	7056	0	1	0.513	0.0076	
Age (in years)	7056	15	98	44.729	0.2796	
Education level of respondent (ordinal 1-8)	7018	1	8	5.197	0.0220	
Income of household (in 000 Euros)	7056	10	70	18.806	0.1158	
Respondent is employed (1=yes, 0=no)	7056	0	1	0.487	0.0075	
Respondent is a student (1=yes, 0=no)	7056	0	1	0.103	0.0046	
Ideology						
Practicing Catholic (1=yes, 0=no)	7056	0	1	0.266	0.0067	
Political ideology (1=left to 10=right)	7056	1	10	4.528	0.0251	
Interest						
Interested in S&T (1=very uninterested, to 5=very interes	6967	1	5	2.904	0.0188	
Attends science museums and events (1=yes, 0=no)	7056	0	1	0.166685	0.0057	
Knowledge						
Informed about S&T (1=very uninformed, to 5=very inforr	6936	1	5	2.561	0.0173	
Knowledge of science (0-10 scale)	7056	0	10	5.700	0.0327	
Respondent has science degree (1=yes, 0=no)	7056	0	1	0.055	0.0036	
Values/beliefs						
Trust in scientific/technical professionals	6613	3	15	12.254	0.0360	
General outlook on the benefits of S&T	7056	5	20	14.437	0.0338	
Benefits of S&T outweigh the harms (1=yes, 0=no)	6956	0	1	0.453	0.0074	
Motivation of scientists (1=altruistic, 0=selfish)	7056	0	1	0.266	0.0067	
Policy attitudes						
Interest in politics (1=very uninterested to 5=very interes	7056	1	5	2.341	0.0211	
Spain is lagging the EU in S&T (1=yes, 0=no)	7056	0	1	0.579	0.0076	
Regional context						
GDP per capita	17 (7056)	15.16	29.20	22.38	----	
R&D expenditure as a percent of GDP	17 (7056)	0.29	1.96	1.04	----	
Percent of pop. 18-24 in university	17 (7056)	5.90	39.00	22.22	----	
Percent of regional gov budget for S&T	17 (7056)	0.35	1.26	1.26	----	

NOTE: Weighted means and proportions reported above. Taylor linearized standard errors. The regional variables are disaggregated from 17 regions to 7056 individual respondents.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
1 Demographic and socioeconomic characteristics							
Female (1=yes, 0=no)	-0.0316 **	-0.0305 **	-0.0091	-0.0032	-0.0036	-0.0021	-0.0013
Age (in years)	0.0002	0.0004	0.0009 *	0.0009 *	0.0008	0.0007	0.0008
Education level of respondent (ordinal 1-8)	0.0569 **	0.0561 **	0.0325 **	0.0208 **	0.0180 **	0.0164 **	0.0177 **
Income of household (in 000 Euros)	0.0010	0.0010	0.0007	0.0001	-0.0002	-0.0002	-0.0004
Respondent is employed (1=yes, 0=no)	0.0340 **	0.0325 **	0.0354 *	0.0325 *	0.0290	0.0292	0.0312 *
Respondent is a student (1=yes, 0=no)	0.0712 **	0.0739 *	0.0435	0.0370	0.0281	0.0299	0.0330
2 Ideology							
Practicing Catholic (1=yes, 0=no)	---	-0.0136	-0.0180 *	-0.0179 *	-0.0208 *	-0.0204 *	-0.0208 *
Political ideology (1=left to 10=right)	---	-0.0081 **	-0.0061 *	-0.0062 *	-0.0070 **	-0.0068 **	-0.0056 *
3 Interest							
Interested in S&T (1=very uninterested, to 5=very interested)	---	---	0.0794 **	0.0600 **	0.0563 **	0.0552 **	0.0569 **
Attends science museums and events (1=yes, 0=no)	---	---	0.0553 **	0.0451 **	0.0470 **	0.0458 **	0.0451 **
4 Knowledge							
Informed about S&T (1=very uninformed, to 5=very informed)	---	---	---	0.0306 **	0.0315 **	0.0312 **	0.0314 **
Knowledge of science (0-10 scale)	---	---	---	0.0081 *	0.0066	0.0058	0.0061
Respondent has science degree (1=yes, 0=no)	---	---	---	0.0820 **	0.0752 **	0.0779 **	0.0768 **
5 Values/beliefs							
Trust in scientific/technical professionals	---	---	---	---	-0.0010	-0.0010	-0.0008
General outlook on the benefits of S&T	---	---	---	---	0.0019	0.0019	0.0036
Benefits of S&T outweigh the harms (1=yes, 0=no)	---	---	---	---	0.0553 *	0.0543 *	0.0518 *
Motivation of scientists (1=altruistic, 0=selfish)	---	---	---	---	0.0249 *	0.0227 *	0.0215 *
6 Policy attitudes							
Interest in politics (1=very uninterested to 5=very interested)	---	---	---	---	---	0.0056	0.0051
Spain is lagging the EU in S&T (1=yes, 0=no)	---	---	---	---	---	0.0209	0.0186
7 Regional context							
GDP per capita	---	---	---	---	---	---	0.0045
R&D expenditure as a percent of GDP	---	---	---	---	---	---	0.0027
Percent of pop. 18-24 in university	---	---	---	---	---	---	-0.0028 *
Percent of regional gov budget for S&T	---	---	---	---	---	---	0.0226 *
Observations (n)	7018	7018	6931	6857	6778	6778	6778
Pseudo R-square	0.0602	0.0617	0.1289	0.1373	0.1429	0.1439	0.1478

Note: Coefficients shown are marginal changes in probabilities from dprobit in Stata 11. Significance tests based on clustered (by region) robust standard errors. * p < .05 ** p < .01

TABLE 3. OLS models predicting expressed support for government spending on science and technology									
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7		
1 Demographic and socioeconomic characteristics									
Female (1=yes, 0=no)	-4.4229 **	-4.0794 **	-2.6243 **	-1.5006	-1.6646 *	-1.4475	-1.6624		
Age (in years)	0.0204	0.0497	0.0823	0.1181 *	0.0922 *	0.0904 **	0.0590		
Education level of respondent (ordinal 1-8)	7.7755 **	7.7035 **	5.7090 **	4.6901 **	4.0264 **	3.6031 **	3.1961 **		
Income of household (in 000 Euros)	-0.0105	-0.0074	-0.0410	-0.0743	-0.1509	-0.1367	-0.1107		
Respondent is employed (1=yes, 0=no)	0.0603	-0.1657	-0.1130	-0.8091	-0.8309	-0.8609	-1.5238		
Respondent is a student (1=yes, 0=no)	-1.0234	-0.7390	-3.0811	-4.8540	-5.9653 *	-5.3237 *	-5.8677 *		
2 Ideology									
Practicing Catholic (1=yes, 0=no)	---	-3.1147	-2.9684	-2.4686	-2.8884	-2.2773	-2.0155		
Political ideology (1=left to 10=right)	---	-0.3129	-0.0960	-0.1849	-0.4153	-0.3421	-0.4757		
3 Interest									
Interested in S&T (1=very uninterested, to 5=very interested)	---	---	6.4023 **	5.9963 **	5.0951 **	4.6972 **	4.5744 **		
Attends science museums and events (1=yes, 0=no)	---	---	6.4260 **	5.8966 **	6.0740 **	5.4291 **	5.2037 **		
4 Knowledge									
Informed about S&T (1=very uninformed, to 5=very informed)	---	---	---	-0.4238	-0.5815	-0.4426	-0.4413		
Knowledge of science (0-10 scale)	---	---	---	2.6601 **	2.3046 **	2.0564 **	1.9488 **		
Respondent has science degree (1=yes, 0=no)	---	---	---	-4.2369 *	-5.5171 *	-5.2001 *	-4.9416 *		
5 Values/beliefs									
Trust in scientific/technical professionals	---	---	---	---	0.5256	0.5393	0.4867		
General outlook on the benefits of S&T	---	---	---	---	1.8777 **	1.9222 **	1.6654 **		
Benefits of S&T outweigh the harms (1=yes, 0=no)	---	---	---	---	8.1590 **	7.5411 **	7.9481 **		
Motivation of scientists (1=altruistic, 0=selfish)	---	---	---	---	5.7536 *	4.8392 *	4.8986 *		
6 Policy attitudes									
Interest in politics (1=very uninterested to 5=very interested)	---	---	---	---	---	0.0252	0.1274		
Spain is lagging the EU in S&T (1=yes, 0=no)	---	---	---	---	---	12.1828 **	12.2768 **		
7 Regional context									
GDP per capita	---	---	---	---	---	---	0.0857		
R&D expenditure as a percent of GDP	---	---	---	---	---	---	0.3499		
Percent of pop. 18-24 in university	---	---	---	---	---	---	0.1557		
Percent of regional gov budget for S&T	---	---	---	---	---	---	-3.8668 *		
Contant	19.1587 **	20.2710 **	8.7696	0.6449	-25.6417 **	-28.7370 **	-20.6726 *		
Observations (n)	6858	6858	6781	6711	6641	6641	6641		
R-squared	0.0911	0.0924	0.1366	0.1521	0.1835	0.2062	0.2133		

Note: Significance tests based on clustered (by region) robust standard errors. * p < .05 ** p < .01

Shaping the future – Participatory foresight at the intersection of design and technology

Martina Schraudner¹, Michael Rehberg², Kora Kimpel³

¹*Research Strategy, Fraunhofer Headquarters & Department of Machine Tools and Factory Management, the Technical University of Berlin, Germany*

²*Research Strategy, Fraunhofer Headquarters & Institute of Geography, the University of Giessen, Germany*

³*Institute of Time-based Media, the Berlin University of the Arts, Germany*

1. Motivation

High-Tech Strategy 2020 was the first German initiative to establish long-term national research trajectories and to attempt to unite the primary stakeholders around a joint goal. Between 2007 and 2009, the German Ministry of Research and Education, BMBF, supplemented this strategy by defining seven interdisciplinary areas of prospective research as being particularly promising with regard to innovation. Recognizing the value of involving the public in the innovation process, BMBF then introduced its *Bürgerdialog* programme in 2011 – a four-year series of discussions between decision-makers and laypersons about the future of national scientific and technological development.

While clearly focused, these two programmes remained predominantly field-oriented and independent from one another, and lacked any method for systematically integrating public input into the agenda-setting process. By enabling the co-shaping of scientific and technological advances, participatory foresight can both accommodate the public's expectations and promote socially-shared visions of the future.

In the proposed talk, we intend to focus initially on the theoretical background that undergirds participatory foresight and then to present our answers to the central research question of which methods might best further its aims.

2. Approach

Mode 2 knowledge production (Gibbons et al. 1994) gives rise to the increasingly complex scientific interrelationships that support innovation, which in turn increasingly orients it toward public demand. The needs and wants of prospective end-users are regarded as a key driver of customer-centric innovation (Edler 2007; Edler & Georghiou 2007; Edler 2010), which indicates the importance of including laypersons in research and development. This approach has been repeatedly emphasized within academic literature, with regard both to participatory innovation in general (Smits 2002) and to customer-centric product development in particular (Hippel 2006; Oudshoorn and Pinch 2003).

2.1 Participatory foresight

Based on the concept of societal and technological co-evolution (Hekkert et al. 2007; Jørgensen et al. 2009), foresight supports priority-setting and addresses potential challenges in both short- and long-term research and development (Schoen et al. 2011, pp. 235-236). For roughly the past two decades, it has established itself in Germany as an effective instrument for the determination of areas likely to be of particular future significance. Use of this instrument, however, has been predominantly field-oriented, and the primary participants have been experts and decision-makers from research, business, and political organisations. (BMBF 2008) It is under that approach that BMBF identified the seven strategic areas of future national research (BMBF 2010).

Successful development of these areas, however, requires an orientation toward laypersons as prospective end-users of innovations and their diverse perspectives that can best be achieved by systematic social discourse (Cuhls et al. 2009, p. 15; Erikson and Weber 2008, p. 466). Participatory elements enable both the public and the scientific community to refine their understanding of the particular demands of laypersons through an ongoing learning process based on recurring feedback (Boon et al. 2011), which in turn validates scientific and technological developments to the public (Hippel 2006; Loveridge & Saritas 2009; Popper 2008, p. 72). This approach to innovation is closely related to the *social shaping* approach to technological foresight (Jørgensen et al. 2009).

Methods that facilitate participatory foresight are currently in different stages of development (Boon et al. 2011; Warnke et al. 2008) and have included scenarios, creativity techniques, and surveys such as panel studies and Delphi polls (Cuhls 2008, p. 154). Due to their flexibility, creativity methods have been found to be particularly effective (Cuhls 2008, pp. 151-155) in encouraging laypersons to explore their needs and wants and to envision them as potential innovations.

Fraunhofer's *Shaping Future*, funded by BMBF and conducted in cooperation with the Berlin University of the Arts, seeks to develop an original participatory foresight methodology. Motivated by the principles of collaborative ideation and remaining mindful of the "dilemmas of participation" (Helm 2007, pp. 6-13), the interdisciplinary team engages non-specialists in their exploration of the following questions:

- Which methods, formats, and environments will enable and encourage laypersons to participate in foresight?
- How will these methods and formats function in these environments?
- How can the results be presented to greatest effect?
- How can they be promoted to the public?

2.2 Research design and methodology

Collaborative ideation has its roots in movements such as German *Bauhaus* and Scandinavian *Nordic Design* of 1920s and 30s, which regarded design not as an independent act but as a mode of collective creation always embedded within particular societal and political contexts (Ehn & Badham 2002). With the rise of human-centric design in the 1980s, emerged the term *design thinking*, which was popularized by, among others, David Kelley, founder of the IDEO firm and the Stanford d.school; it refers to a methodology that draws from both design and engineering, engages both creativity and rationality, and is more outcome-oriented than problem-focused. This methodology in turn gave rise to the concept of *enabling spaces*, which are transformable along a number of both physical and psychic dimensions such as social, cognitive, and emotional (Peschl 2007, Peschl 2008). The co-ideational process can be realised through the joint exploration and shaping of such a space. The interplay between the act of co-ideation and the effects that the emerging space has upon the participants provides an inspiring environment and fosters new forms of knowledge, creation, and interaction.

In the digital age, traditional modes of ideation such as oral and written are being supplemented with an ever-widening variety of new formats that are interactive on more levels. These formats include performances, installations, and, in particular, a variety of forms of *co-prototyping* such as *PROVOtypes* (Mogensen, 1992) and *design placebos* (Dunne & Raby, 2001). These new formats can also be used to present the results of the co-ideational process to the public in both "traditional" spaces such as showrooms and "new" spaces such as social media.

Drawing from these approaches, exploring these formats, and considering the specifics of foresight, *Shaping Future's* team is honing their methods through a qualitative exploratory case study (Popp 2006). To acquire data, the team is designing a set of diverse enabling space in which a series of diverse workshops are occurring. Each group of participants is diversified based on age, gender, education, occupation, etc.

Of the seven strategic areas set by BMBF, human-machine "cooperation" was selected for the project because its varying degrees of proximity to the prospective end-user (Dahlin 2012) made it particularly suitable for addressing both short- and long-term public expectations toward technologies (Rasmussen et al. 2007, Spennemann 2007).

3. Expected results

Engaging the public in scientific and technological development and ultimately in the determination of its future directions is vital to innovation. To this end, finding ways to

encourage laypersons to transcend habitual thinking and cast their minds into the distant future might be particularly rewarding.

Drawing from a range of approaches and exploring the possibilities of collaborative ideation, *Shaping Future* is developing original methods to foster participatory foresight and to promote it to the public. For the chosen domain of human-machine "cooperation" the team is also focused on the development of a comprehensive lexicon capable of distinguishing among its ever-emerging forms.

4. Conclusions and implications

Foresight facilitates the collaborative shaping of innovation, channels diverse agendas into single joint strategy, and addresses the challenges of inclusive research and development (Boon et al. 2011). The presented approach supplements foresight with elements that encourage the public to participate in scientific and technological advances and ultimately to co-define their long-term trajectories. By contributing to the development of widely-shared visions of the future, these elements particularly promote socially and environmentally responsible utilization of resources.

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Third-party funding as a challenge to international academic co-publishing

Torben Schubert^{1,2}, Stephanie Daimer¹

¹*Fraunhofer Institute for Systems and Innovation Research; Karlsruhe Germany*

²*CIRCLE, Lund University, Sweden and Berlin University of Technology, Faculty of Economics and Management Chair of Innovation Economics; Germany*

1. Motivation

The objectives of public universities are diverse. This has important implications, because the scarceness of available resources leads to a trade-off between the main three missions (teaching, research, knowledge transfer, compare OECD, 2000). This implies that strengthening one activity necessarily occurs at the expense of the other, while it can lead to situations of tensions and aim conflicts that may be hard to deal both on the level of an organization or at the level of individual scientists (Schmoch and Schubert, 2010).

However, also at more disaggregate levels of agenda setting contradictory expectations can arise. In this abstract we point at one such relationship. In particular, during the last years the aim of increased internationality – be it in the field of research or teaching – has been more intensely emphasized. This internationality can be understood in a variety of ways, among which the most important are international (student and researcher) mobility and research cooperation. At the same time, the fiscal stringencies in financing public research have become more severe, which both raised expectations to increase efficiency via structural reforms as well as a higher share of self-financing of universities via third party funds (Jansen et al. 2007, Schubert, 2009). However, in particular the change in the funding structure towards conditionally provided funds by third parties (public funding agencies, enterprises, governmental organizations) away from unconditionally provided base funds can strongly shape and alter the institutional and organizational environments in which research is performed. In this abstract we analyze inasmuch research funded by third parties impacts on the propensity to engage in internationally collaborative research. We find a strong tendency of third party funds to reduce internationality, which, however, depends on the funding source.

Observe that this establishes a clear link to the conference topic, because we find basic and applied research being affected in different ways. In particular, difficulties in financing international collaboration in basic research as well as the likely focus on applied research by mission-oriented funding policies cause trade-off situations for researchers.

2. Approach

We base our analysis on two combined data sets relating to the reference year 2006. The first data set is from a micro-level survey of inputs, outputs, and governance issues for German research groups in the fields of astrophysics, biotechnology, nanotechnology, and economics. This data was gathered by one of the authors in a research project funded by the Deutsche Forschungsgemeinschaft (DFG; FOR 517). On the research group level also data on the third party funding shares differentiated by funding source is provided. The second set consists of bibliometric data for the research groups and compiled from Thomson Reuter's Web of Knowledge. This data was collected based on the list of employees working at the institute when the survey took place. Based on this data also shares of international co-publications (i.e. the share of research group publications with at least one non-German coauthor) is available. To determine the effect of the share of third party funds on the co-publication rate, we use multivariate regression techniques that also allow for potentially confounding variables, such as size of the research group, other governance influences, disciplinary background etc. In particular, we build on Tobit-regressions which account for the fact that the explained share of co-publications varies between 0 and 100%.

3. Results

Our results indicate that the effects of third party funding share on international co-publications differ by funding source. In particular, high funding shares by the DFG, some federal ministries, and other third parties mainly comprising private German research foundation (e.g. Thyssen or VW-Stiftung) tend to reduce the share of international co-publications significantly. For all other funding institutions the coefficient is not significant, yet for none (including the European Union) it is estimated to be positive. That means even for the institutions where we observe a non-significant effect, the tendency is rather internationalization-decreasing than increasing. Exemplarily, we present some of the regression results in Table 1, where we do not explicitly print the results for the included control variables for the sake of brevity.

Table 1: Regression results (Tobit regression with cluster robust errors)

Variable	Share international co-publications		
	coef.		s.e.
Share DFG research	-0.0019 *		0.0011
Share ministry of educ. and res.	-0.0019 *		0.0011
Share Länder-ministries	-0.0015		0.0015
Share EU	-0.0008		0.0020
Share industry	-0.0001		0.0011
Share other sources (national found.)	-0.0025 *		0.0015
Constant	YES		
Other control variables	YES		
sigma	0.2289		
n	181		
#Cluster	49		
pseudo-R ²	0.59		

Furthermore, we can show that internationally collaborative research is a phenomenon that occurs primarily in basic research and to a lesser degree in applied research. Here it seems also to be a driver of productivity. Therefore, the internationality-reducing effect of third party funds is particularly undesirable with respect to the DFG, which funds the primarily basic research but consistently discourages internationally conducted research (most commonly implicitly by setting application rules that are detrimental for international applications; various examples of such rules and their enforcement in practice can be named).

This result also offers an explanation for finding no significant relationship between EU-funding and international publications. One can witness an increased turn to thematic priorities in the EU's framework programmes, which are of a strongly applied nature, and – in recent years – are increasingly designed to contribute to the societal challenges of our time. This trend tends to reduce resources for thematically open funding and thus for bottom-up research ideas, which are more likely to address basic research questions and to result in international co-publications.

So, while EU funding per se implies of course internationality, it does not necessarily result in international co-publications. This has the potential to create a trade-off situation for researchers at universities who are in strong need to publish in academic journals, as publications remain to be the most important "currency" to them.

4. Policy Implications

It seems to be generally accepted that both increasing internationalization and better abilities to self-financing are important objectives that universities are subjected to.

However, the structure of third party funds as the major source of non or semi-state competitively acquired funds seem to restrict the engagement in internationally collaborative research. Thus, under the current modes of third party funding both objectives are, at least to some degree, contradictory. The reasons for this may differ depending on the funding source. This effect may be less problematic in the context of third party funds that are of more applied nature (e.g. industry funds or funds of the governments), where internationality often (not always) is less crucial for successful research. On the contrary, it may be more undesirable for the more basic research oriented funds by the DFG and other national research foundations.

Because of that the institutional settings of these agencies that provoke this negative effect should be closely investigated. As already mentioned, in particular the application rules are likely to be a major obstacle for international collaboration in third party funded projects. For example, the cooperation of a German and a non German partner in a DFG-project usually requires the foreign scientists to apply for funds at their national funding agency, which often is a completely separate project application. This mechanism seriously reduces the chances of a successful application because both projects have to be evaluated positively independently. This undesirable effect even happens to occur when partnership agreement between the DFG and other non-German funding agencies exists, because the institutional procedures to ensure an integration of both projects are often lacking. This once again leads often to a de facto separation of projects in during the review process.

Therefore, these rules should be critically called into question and ways to facilitate international research collaboration also in joint projects should be sought. Consequently, the funding scheme of ERA-Nets at EU-level is of utmost relevance, as the coordination between national funding agencies in joint calls exactly tackles this problem.

However, while it is desirable to facilitate international research collaboration in general, it is particularly desirable to facilitate international academic co-publishing via third-party funding. Otherwise university researchers tend to find themselves in a trade-off situation, as academic publications remain to be the most important "currency" for them.

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Innovation without R&D – heterogeneous innovation patterns of non-R&D performing firms in the German manufacturing industry

Oliver Som

Fraunhofer Institute for Systems and Innovation Research ISI, Germany

1) Motivation

During the last decades, research and development (R&D) activities have become the most substantial pillar of innovation research in the attempt to explain the innovation ability and competitiveness of enterprises sectors and economies (Rammer et al. 2009; Santamaría et al. 2009; Raymond/St. Pierre 2010). Subsequently, the terms of "innovativeness" and "R&D intensity" of firms or economies have been increasingly equated by mainstream innovation literature in the past. "There is ample empirical evidence supporting the hypothesis that R&D expenditures are a sine-qua-non for the firm's level of innovation activities" (Shefer/Frenkel 2005: 25).

However, empirical studies showed early on that a significant number of firms does not invest in own R&D (Cohen et al. 1987; Bound et al. 1984; Galende/Suarez 1999). Not long ago, Arundel et al. (2008) found out that slightly over half of all innovative firms in Europe do not perform R&D. Most recently, Rammer et al. (2011) supported this finding for the German manufacturing industry. Their analyses revealed that about 44% of all innovative firms did not perform internal R&D. Most surprisingly, both studies could neither identify any significant differences in the economic performance, the economic outcome nor the mortality between non-R&D-performing innovators and their R&D-performing counterparts.

But these insights have hardly been translated into new standard indicators, although the latest edition of the OSLO Manual (OECD 2005) shows some promising improvements regarding innovation sources other than R&D. Today, the majority of scholarly research and policy documents on innovation still focus almost entirely on R&D, ignoring other methods that firms use to innovate (Arundel 2007: 50; Becheikh et al. 2006: 655f.). Thus it has to be stated, that particularly empirical research has not managed to overhaul the linear science-push model of innovation (Arundel 2007: 51). But if only R&D indicators are used to measure innovation capability, non-R&D-performing firms will not be captured adequately, and in consequence will be classified as non-innovative or even be excluded from innovation studies. As a result, firms that do not perform formal R&D have been largely neglected by empirical innovation research and, in particular, by the policy community. But given their confirmed level of innovative-

ness and competitive performance, innovation and technology policy that is solely focussed on the support of R&D-performing firms might overlook substantial potentials for its economy's international competitiveness.

This contribution thus aims to step into this research gap and opens the "black box" of non-R&D-performing firms to enhance scientific knowledge about their different kinds of innovation strategies and thereby to increase the scientific and political awareness of competitive and innovation strategies beyond mere R&D.

During the last years, a growing volume of innovation literature has focused on the sources of innovativeness of non-R&D-intensive firms. However, previous research has hitherto suffered from a major shortcoming: it is frequently based on the implicit assumption that non-R&D-intensive firms represent a more or less homogeneous group of firms, either because they are affiliated to a certain category of "low-tech" industries, or they all lack the same innovation resource of formal R&D. As a result, the existing findings about non-R&D-performers are scattered, fragmented, and in some cases even contradictory. For example, some studies say that they have a higher propensity to collaborate with external partners (Huang et al. 2010; Rammer et al. 2009; Santa-maría et al. 2009; Barge-Gil 2010), while others state that they have a lesser propensity to participate in innovation cooperation than R&D-performing firms (Arundel et al. 2008; Tsai/Wang 2009; Kirner et al. 2009).

This paper takes the identified short-comings of previous research as a starting point for a more detailed theoretical and empirical investigation of heterogeneous firm level innovation patterns of non-R&D-performers. Its basic assumption is that the scattered, fragmented and partially inconsistent findings so far are an indicator of a high level of inter-firm heterogeneity of non-R&D-performing firms'innovation strategies. It is suggested that these existing findings are only part of a broader set of heterogeneous innovation patterns of non-R&D-performing firms and thus probably could be integrated by a more detailed empirical analysis that explicitly takes firm heterogeneity into consideration.

Thus, the main research question of this contribution can be formulated as follows: *Do heterogeneous innovation patterns of non-R&D-performing firms exist in German manufacturing industry, and, if so, by which dimensions can these patterns be distinguished?*

Hence, it is the explicit aim of the paper to provide comprehensive, pioneer empirical evidence of heterogeneous innovation patterns of non-R&D-performers on the basis of quantitative firm-level data.

2) Approach

To answer this research question, this study strictly refers to the evolutionary economic perspective (Nelson/Winter 1982; Srholec/Verspagen 2008; Leiponen/Drejer 2007; Jensen et al. 2007) to explain why heterogeneous innovation patterns of non-R&D-performing firms can generally be expected. Following the resource-based approaches of strategic management literature (Barney 1991; Prahalad/Hamel 1990; Teece et al. 1997; Kogut/Zander 1992; Dyer/Singh 1998), it then derives indicators of innovation resources by which innovation patterns of non-R&D-performing can be assumed to manifest themselves and which serve as a starting point for the subsequent empirical work.

The empirical analysis is based on cluster analysis of 492 non-R&D-performing firms of the German manufacturing industry. Firm-level data is taken from the 2009 wave of the "German Manufacturing Survey" conducted regularly by the Fraunhofer-Institute for Systems and Innovation Research. To leave maximum room for inter-firm heterogeneity, the firms are not pre-grouped by means of size, sectoral affiliation or other structural variables. But having identified the innovation patterns by cluster analysis, they are ex-post validated and interpreted using innovation and economic performance variables as well as structural indicators.

3) Results

As its core result, the study identifies five innovation patterns of non-R&D-performing firms in the German manufacturing industry: i) knowledge-intensive product developers, ii) customer-driven, technical process specialists, iii) occasional B2B product developers, iv) low-innovative, labour-intensive manufacturers, and v) volume-flexible, specialized suppliers.

Each of these innovation patterns can be interpreted, verified and supported by reference to measures of innovation output, economic performance, and structural characteristics. The results reveal that there are many other innovation sources for firms' innovativeness besides mere R&D to gain competitive advantage and economic success. The heterogeneity within the use of these innovation inputs shows that – even in the case of non-R&D-performing firms – there is no single one-best-way to achieve competitive advantage in innovation systems.

4) Conclusion and policy implications

The identified innovation patterns provide novel quantitative support to previously qualitative and quantitative findings as they closely correspond to the existing empirical

literature by following different modes of innovation. Non-technological, organisational process innovation is of equal importance for certain innovation patterns as the use of cutting-edge manufacturing technology, sourcing of expert knowledge in terms of highly skilled employees or external R&D knowledge, as well as internal, experience-based or customer-related stocks of knowledge. Regarding the issue of innovation cooperation which sometimes led to contradictory results, the identified patterns show that some firms heavily rely on innovation cooperation, while others do not, or not with similar intensity or different partners. Thus, the previous contradictory findings no longer appear problematic, as they can be integrated as reasonable elements of the different, heterogeneous innovation patterns of non-R&D-performing firms.

From the policy perspective, the division of industry into sectors of low, medium and high technology according to R&D intensity can only distinguish a more or less valid entity of firms with different levels of R&D. But it certainly does not reflect the actual empirical reality. In reality, there are no true "non-R&D-intensive sectors". Instead, what we observe is a significant share of non-R&D-intensive or non-R&D-performing firms which permeate to varying degrees into sectors with high or very high R&D.

Policy-makers should therefore not expect a homogeneous group when they think of non-R&D-performing firms. Non-R&D-performing firms successfully survive in market competition which is not necessarily only driven by costs and product prices but also by quality, flexibility and innovation. Hence, an innovation policy which only aims to stimulate R&D activities tends to overlook the particular strengths of these firms by forcing them into an innovation strategy that does not fit their individual situation. It is thus a key task of innovation policy to adopt a broader understanding of innovation and the insight that innovative ability should no longer be equated with R&D activities alone. It should support activities and measures to raise the awareness for non-R&D-intensive firms and their specific needs and conditions according to their functionally differentiated, systemic interrelations within industrial value chains.

To conclude, if policy makers stick to a linear, R&D-focused model of innovation they are liable to neglect a very important group of firms. But as industrial knowledge bases are increasingly distributed across highly interwoven innovation systems of multiple actors, solely focusing innovation policy on the innovation resource "R&D" means disregarding the alternative strategies of both R&D-performers and non-R&D-performers to obtain successful innovation in the 21st century, and thus overlooking valuable potentials to increase the economy's competitiveness and economic growth in the long run.

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The Emerging Role of Academic Institutions in Innovation and Economic Development: A Case Study of Biopharmaceutical Patent Indicators in Italy and in Norway

Enrico Sorisio

*PharmaNess scarl, Pula (CA), Italy and Centre for Technology, Innovation and Culture (TIK),
University of Oslo, Norway*

Motivation

The paper is devoted to the analysis of the so-called "third mission" of the university, and its emerging role in promoting innovation and economic development. Most European countries have developed policies for disseminating knowledge from the universities to the broader society. In addition there has been devoted large attention from policymakers on how universities can participate more actively in economic development.

The question on who should be the owner of intellectual property rights to the invention, the professor or the research institution, has been the subject of a long debate in several European countries. The increased focus on the university's role in innovation and economic development has led to change in policy in many European countries, among others Italy and Norway have been chosen to compare the rationale for the policy changes and their immediate effects, because these countries made quite contemporaneously opposite reforms on the ownership of academic research results, both aiming at increasing patenting and innovation at the universities: Norway removed the teacher's exemption (or "professor's privilege"), while Italy chose a strategy opposite to Norway, introducing it towards the end of year 2001. The teacher's exemption is a rule that gives researchers at institutes of higher education the sole right to capitalise on their research results.

While Norway's strategy was to provide incentives for university to increase technology transfer activities, Italian policy maker were primarily focused on the individual's incentive to patent research results.

Approach

This paper tries to determine what are the effects of the teachers' exemption on infrastructure for commercialisation of research results, by making a comparative analysis aiming at understanding how do Italy and Norway differ in their strategies for promoting the third mission of the universities. This is evaluated on different aspects of the implementation of the policies. First, the potential incentive effect on university researchers' rate of involvement in technology transfer activities due to the change of the

teacher's exemption rule is studied. It is also asked if the teacher's exemption enhances or reduces the level of collaboration between university and industry and if a systematic shift as a result of the policy implementations is observable in both countries.

In order to provide a closer outlook on the impact of the policy changes in Italy and in Norway, a case study on biopharmaceutical patent indicators is presented, by using a unique database based on US patent data during years 1999 to 2008. The dataset has been constructed by including only patents whose at least one inventor was part of academic or governmental research organizations at time of application. Many patents where academic researchers are listed amongst the inventors have been assigned to firms; in order to avoid the potential selection bias of studying only university-owned patents, the so-called university invented-company owned patents are included in the dataset together with all other patents of academic origin that are assigned to other organizations or to individuals. The dataset consist of 331 academic patents in the field of biopharmaceuticals granted from 1999 to 2008, 214 to Italy and 117 to Norway.

Preliminary descriptive observations show that in the period considered some notable changes occurred in academic patenting trends of both countries, but it is not possible to conclude that the reason for this is due to the changes of Intellectual Property Rules (IPR) that occurred both in Norway and in Italy. In order to test the hypothesis that such changes are due to the reform of IPR in both countries, a simple econometric model of analysis has been developed. The analysis is based on the construction of four different patent indicators: market potential, measured by patent family; relative importance, measured by patent citations; relative size (references to previous patents and literature); knowledge diffusion, measured by the number of claims in each patent.

Patent data are analysed with the use of a fixed-effect econometric model controlling for unobserved heterogeneity. Each of the four variables is included in a linear equation and regressed over various dummies that control for pre- or post-reform period, country of inventors, technological category, and assignee type. The parameters are estimated via Ordinary Least Squares (OLS).

Results

From a general perspective it has been found that the policy does not have a direct and unequivocal effect on the rate of commercialisation from the academic institutions. Both countries have developed infrastructure for commercialisations in terms of establishing TTOs and there has been an increase in reported outputs such as declarations of invention, spin-offs and licenses, and in patent indicators in the biopharmaceutical sector.

The case study on biopharmaceutical patents shows that the coefficients for all variables are positive and higher (excluding importance) in the post-reform period, thus indicating a positive effect by opposite reforms in both countries, in particular data taken by application year show a greater increase than the same data classified by grant year; all data with few exceptions are statistically significant at least at a 1% confidence level.

The patent statistics suggests that while the countries introduced opposite reforms, innovative activity increased in both countries. Results show an increasing trend in some patent indicators after the reforms in both countries. Another interesting result is the emergence of two different business models of academic technology transfer.

Conclusion and policy implications

The teacher's exemption rule appears to have an effect on the rate of spin-offs from the university. Italian researchers increased dramatically this type of activity immediately after the introduction of the teacher's exemption. In Norway there appears to have been a skewing from spin-offs towards licenses. This could indicate that the change of policies has an effect on the type of commercialisation. However, there are several factors that influence the choice of commercialisation strategy – like existing national industry, taxations etc.

Despite of this, incentives towards either the university or the researcher appears to have the same effect and one might suggest that it is the influence of international trends and an increased accept in the academic community for the third mission that contributes to these changes.

The case study on patents in the fields of drugs and biotechnology in Italy and in Norway shows an increasing trend in some patent indicators after the reforms in both countries. This could be a signal that the reforms, although done in opposite ways, combined with other policy instruments had a positive incentive effect on patent applications and to some characteristics of patents granted after the reforms, such as their potential market value, technological and economic relevance, relative size and knowledge diffusion, although it can be argued that more data (and more time) are required in order to better understand which are the real effects of the policy changes on academic patenting activity.

The fact that opposite reforms yielded similar results might be explained by the existence of other factors that affected academic research, the most important being probably the broad autonomy and independence granted to the researchers by the academic institutions. This reflects the general perception that even after the reforms

the researchers had the power to publish or more in general to do whatever they wanted with the results of their work

Another interesting result is that two different business models of academic technology transfer emerged. The industrialization of academic research in Italy was mainly done by firms (probably through licensing agreements); a frequent direct exploitation by universities and academic institutions is observed, while spinoffs and technology transfer officer own few patents. The Norwegian model is based on firms and on dedicated organizations that have been created to support industrial exploitation of academic innovation; the number of patents directly owned by universities and other academic institutions is negligible. Patenting rules and the policy change have a strong impact in determining the different business models of biopharmaceutical innovation stemming out from academia.

Towards effective governance of multilateral science, technology, and innovation (STI) co-operation to address global challenges

Andreas Stamm, Aurelia Figueroa

German Development Institute – Deutsches Institut für Entwicklungspolitik (DIE), Germany

1. Motivation

Global challenges, such as climate change, eroding energy and food security or (re-) emerging infectious diseases require adequate responses from scientific research, technology development and innovation. "Adequate" means that research outcomes must a) have a deep impact on the matter at stake and b) that this impact must be swiftly achieved. Both efficacy and urgency can be derived from fundamental normative reasoning: Global challenges are related to either acute harm to the *current* or *future* generations of the world. Many global challenges are also characterised by complex systems behaviour. For a rather long time, systems may remain stable, based on control loops, even if one of its elements is changed unidirectionally over some time. However, once certain threshold levels ("tipping points") is reached, the whole system may become unstable and self-perpetuating forces lead to system collapses (Scheffer et al. 2001).

For policies targeting advancements stemming from collaborative research for global challenges, two aspects can be seen as characteristic and distinguishing them from more conventional STI policies: a) They pursue normative goals beyond the effectiveness of the innovation process as such and b) the timing of the innovation process is marked by an externally imposed imperative of urgency. These externally set norms make the governance of STI policies complex, as it involves policy intervention into the direction, the content and the speed – and not only the rate – of innovations.

International co-operation is an important lever to tap the full potential of STI and related expenditures. Bundling financial and intellectual resources can lead to cost savings related to economies of scale, and economies of scope (due to cross-fertilisation of ideas and complementarities of resources and skills). Additionally, global challenges may affect different world regions in a differentiated way, requiring the contribution of local scientific expertise to adequately analyse the impact chains and to develop adapted response strategies.

Empirical evidence exists that international co-operation can increase the impact of STI, e.g. the rate of citation of a scientific papers increases with the number of institutions a research organisation is networked with (OECD 2011, 47, Royal Society 2011,

59). However, there is also evidence that governments are very reluctant to fund international STI co-operation. Even within the EU – after six decades of integration efforts – some 85% of all public research and development (R&D) is programmed, financed, monitored and evaluated at the national level (European Commission 2008).

This reluctance can at least in parts be explained by the path dependency of STI policy making. Decision makers will find it easier to fund national STI programmes, as the routines in this area are well established and the actor landscape oftentimes less opaque. At the same time, there is the fact that transaction costs – and related risks – rise with the outreach of co-operation networks and the diversity of the actors, regarding STI capacities and the cultural embeddedness of the innovation systems.

2. Approach

In order to tap the potential of globally distributed STI capacities and activities without raising transaction costs and risks to prohibitive levels, it is crucial to improve how international co-operation is organised along the innovation cycle. The governance of international STI co-operation to address global challenges has been addressed by a network of experts advising the OECD Committee on Scientific and Technological Policy (CSTP). These experts came from both OECD Member and non-Member countries. The research project lasted from 2008 to the beginning of 2012.

Governance of international STI co-operation was operationalised as consisting of five processes related to a) agenda and priority setting, b) funding and spending, c) regulation of intellectual property, d) bridging research into practice and e) capacity building for research co-operation. Experts conducted seven case studies of existing multilateral co-operation schemes and background papers digging deeper into these five processes of governance ("governance dimensions"). The paper provides a condensed summary of the main findings of the project.

3. Expected results

While the complexity of global challenges and STI responses to them does not allow for the easy definition of "best practices" along the five governance dimensions, it is possible, based on the research outcome, to a) single out more as opposed to less promising modes of governance and b) clarify trade-offs and difficult decisions that policy makers must face when setting up international STI co-operation schemes for global challenges.

Given the still prevailing reluctance of national policy makers and executing agencies to significantly scale-up funding for international collaboration, one first governance chal-

lenge is mobilising actors, attention and resources for international STI efforts for global challenges. The paper delineates policy options to address this global challenge, reaching from linking international STI co-operation to a high-level political mandate to the organisation of strictly decentralised "bottom-up" processes, where the actors themselves perceive clear advantages of international co-operation.

Agenda and priority setting can involve a broad set of diverse actors or can be confined to a limited number of specific actors and experts. Both approaches have their advantages and limitations (see the paper submitted by Florian Holzinger and Wolfgang Polt to this conference).

Funding of international STI co-operation is still very much characterised by the intention of national decision makers a) to largely maintain control over the content of the research and b) to satisfy to a large extent "*juste retour*" expectations (in the case of the strong funders). This conduces a generally low funding of international collaborations and an imbalance between core institutional and directed, project-based funding.

Knowledge sharing and intellectual property is especially critical when global challenges are concerned. The trade-off between maintaining economic incentives for private research, development, and deployment and assuring a fast diffusion of solutions can be addressed through innovative arrangements, often combining STI co-operation and public support (Official Development Assistance) or charity money, such as the Advanced Market Mechanism, in the case of essential drugs and vaccines.

Bridging Research into Practice can be accelerated by close and iterative interaction between actors belonging to different communities (research, policy, business) and cannot follow a linear approach, with the outcome of research being translated and communicated to policy makers or commercial innovators. The demands on the involved actors not only related to the cognitive skills but also emotional intelligence are high, what might imply reconsidering conventional modes of staff selection and training.

Capacity Building for Research Co-operation should be conceptualised as an integral component of international STI co-operation. Given the conventional funding schemes, this entails combining different budget lines from STI funders, bi- and multilateral donor agencies. South-south STI co-operation offers opportunities for capacity building that to date have only partially been tapped.

4. Conclusions and potential policy implications

The research substantiating this paper provides lessons for policy makers regarding all functions that innovation systems should fulfil (on the functions approach in innovation

systems research see Jacobsson / Johnson (2000). Furthermore covering multiple areas of global challenges in the broad topics of agriculture, energy, and health, this research was conducted on a variety of institutions which were focused upon through case study analysis. Recommendations for policy makers and other implementers is reached through a cross-case analysis. By reviewing institutions in various world regions, globally applicable lessons are formed which indicate a model of improved governance of international co-operation in STI across a variety of frameworks and circumstances.

5. Literature

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The Neglected Transformation of Socio-Technical Systems: Discontinuation Governance

Peter Stegmaier, Stefan Kuhlmann

Department of Science, Technology, and Policy Studies (STePS); Institute for Innovation and Governance Studies (IGS); School of Management and Governance (SMG), University of Twente, the Netherlands

The governance of socio-technical systems has preferentially been associated with advancement and innovation. *Discontinuation* of socio-technical systems is, at most, discussed as regime change, innovation setback or failure – as if advancement and innovation was the only direction in which socio-technical development and its governance would go. This paper aims at a better understanding of the governance of the abandonment of socio-technical systems. As observed since Schumpeter's (1942) insight concerning the symmetry of creation and destruction, the anticipation of discontinuation and fading out is as important as the driving expectations concerning innovation and progress itself. It is crucial to see how technologies are recombined, getting unpopular, liquidated, how promises dissolve – in short: disappear over the horizon of a different future than the one, which was anticipated in the past.

Currently there are relevant cases of purposeful discontinuation of socio-technical systems and their surrounding infrastructures. Recent examples of discontinuation discussed in this paper indicate the significant pace and political momentum that can be acquired in such phenomena. We will sketch four cases, which allow us to indicate the spectrum of discontinuation governance, two of them in some more detail: incandescent light bulbs in the Netherlands, as well as nuclear energy in Germany. The cases refer to socio-technical systems that are either symbolised through large-scale apparatuses (nuclear power plant), or smaller devices (light bulb). But since they are always embedded in larger systemic contexts and infrastructures spreading over many different layers and dimensions, they mean rather complex tasks for (discontinuation) governance. Governments and companies currently invest enormous resources into quick reversing of these systems.

We will capture how different objects and contexts of discontinuation governance lead to distinctive dynamics through looking into the governance of discontinuation by observing and analysing relevant institutions, actor networks, governance strategies, and governance pathways in multilevel perspective. We will combine the theoretical framework provided by actor-centred institutionalism with an agency perspective that allows for an integrated view on structures and actors (Mayntz/Scharpf 1995; Scharpf 2000). The focus is on relevant (hard, soft) institutions, actors, and their relations and negotiations. The (boundedly rational) actors and institutions are analysed in terms of how

they relate and interact in networks holding the explicit function of discontinuation. This may include cabinet decisions and company strategic acts as much as public-private collaborations, public debate, regulation, and media as actors as well as more or less organised citizens' groups. To an extent greater than in much innovation studies, it is also necessary to consider the formative role of social movements and civil society organisations – equally as 'sub-political' (Beck 1996) arenas for the institutionalisation of innovative normativities; as sources of distributed political pressures and as nurturing environments for niche experimentation.

The patterns of development of socio-technical systems have been studied broadly (cf. e.g. Mayntz/Hughes 1988), especially concerning the growth and the governance of large technical systems (Coutard 1999, Bauer/Schneider 2009), issues of path dependency (Garud/Karnøe 2001, Meyer/Schubert 2007) or the transformation of established systems, e.g. by regime change (Geels 2007, Markard/Truffer 2006; Konrad et al. 2012). However, the success of a new technology goes hand in hand with the hybridisation, fading out, marginalisation, or failure of existing technologies. The number of studies addressing this kind of development is rather small. Latour (2002) tells the story of a technological system called "Aramis" that was ceased politically after some years of intensive research and development at the height of the investment activities, but before the new transport technology had generally been brought into use. Here, the old systems survive and new ones are developed in the continuity of the old. Utterback (2004), while describing the role of technological evolution and innovation, also narrates how the U.S. harvested ice industry demised as the result of the technical feasibility and economic success of first machine made ice and later electric refrigerators. Even deeper elaborated is the very recent analysis by Turnheim & Geels, in which they describe a "neglected aspect of the transitions literature: the destabilisation of existing regimes and industries" (2012: 1). In contrast to 'discontinuity' as market phenomenon (Utterback) and 'destabilisation' as a regime transition phenomenon (Turnheim & Geels), our attention is firmly focused on the somewhat neglected issue of explicit, deliberate, dedicated governance measures for the discontinuation of established socio-technical systems and their associated regimes – in other words, on 'discontinuation' as purposeful governance action *sui generis*.

The core question can be formulated in a terminology that asks what discontinuation means as a 'problem of action' for policy-makers. From this point of view, continuity and breaks can be investigated as 'governance of problems' (Hoppe 2010). In this way, the rather abstract concept of 'discontinuation governance' becomes recognizable as effects of social action and tangible as for systematic empirical investigation. At the end of the day, the empirical and theoretical results of both major perspectives (discontinuity and governance of discontinuation) must be compared, and it must be seen how far

system, institution and action, or socio-historical regime development and dedicated governance action result in one overall picture.

On this basis, a set of "discontinuation governance practices" reflecting the options and limitations of dedicated discontinuation governance will be pioneered providing relevant strategic intelligence for all involved actors. The project will help to thoroughly understand, for the first time, how the discontinuation of socio-technical systems works and to define the options and restrictions on such governance activities.

The paper is partially based on research ideas recently developed by a consortium of researchers from the STePS, University of Twente (Stefan Kuhlmann, Peter Stegmaier), SPRU Sussex University (Andrew Stirling, Frank Geels), IFRIS, Paris (Pierre-Benoît Joly, Marc Barbier, Frank Dedieu), and Technical University of Dortmund (Johannes Weyer, Marc Mölders). The group at STePS in Twente has initially coined the core research question, and with this paper we spin a few thoughts out beyond the proposal.

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The Norwegian Innovation System Decomposed: Where are the synergies and which is the role of the universities?

Øivind Strand¹, Loet Leydesdorff²

¹Aalesund University College, Norway; ²University of Amsterdam, Amsterdam School of Communications Research (ASCoR), the Netherlands

(1) Motivation

Innovation is often assumed *ex ante* to be systemic, for example, at the national and/or regional levels or within sectors (Carlsson, 2006). From a different motivation (Triple Helix), we further develop an indicator that allows us to test for systemness in terms of synergy in multivariate distributions. The Norwegian innovation system is studied because data is available at the national level (from the statistics office), but the synergy at the national level can be decomposed. The geographical distribution of synergy is compared to the levels of R&D funding, location of universities, and indicators for foreign direct investments (FDI). The results can also be compared with previous studies for the Netherlands, Germany, and Hungary, and the limitation of studying national systems as given can further be specified.

Our unit of analysis is the firm, and we analyse the complete population of Norwegian firms at various geographical scales (cf. Park *et al.*, 2010). We first generalize the Triple Helix model to a neo-evolutionary model by defining the three strands as functional dimensions of an innovation system: (i) economic wealth generation, (ii) socially organized knowledge production, and (iii) normative or regulative control. We then combine with the perspective of regional economics (Storper 1997) to define proxies for each of these three knowledge functions: an organizational indicator for the knowledge exploitation, a technology indicator for the knowledge exploration, and a geographical indicator for regulative control (Lengyel & Leydesdorff, 2010; Leydesdorff & Fritsch, 2006).

By combining the use of entropy statistics and this triple-helix model, we propose a tool for measuring the extent to which innovations have become systemic. The synergy among the three knowledge functions can also be considered as an indicator for the operational quality of the innovation system in a knowledge-based economy.

(2) The approach

Our approach is quantitative using descriptive statistics. The data consist of information about 481,819 firms. The figures were collected for the fourth quarter of 2008 from the web site of Statistics Norway (2011). These data cover the complete population of

Norwegian firms. All records contain the three variables which can be used as proxies for the dimensions of geography, technology, and organization.

Geography is indicated by a four-digit code for municipalities (NUTS5); this data can be aggregated straightforwardly into higher-level units such as counties, regions, and the national system.¹ At each level one can ask for the synergy, the in-between group synergy, and compare units in terms of their synergy. As noted, comparisons with other nations (Germany, the Netherlands, Hungary) are also possible.

The organizational dimension is indicated by company size in terms of the number of employees. The data are divided into eight classes ranging from self-employed enterprises without personnel to (666) firms with more than 250 employees. Technology is indicated in our data using the two-digit sector classification of the OECD (NACE)² at the firm level.

In the case of three interacting dimensions, the mutual information can be defined as follows: $T_{XYZ} = H_X + H_Y + H_Z - H_{XY} - H_{XZ} - H_{YZ} + H_{XYZ}$ (McGill, 1954) in which $H_X = -\sum_X p_X \log_2 p_X$ and $H_{XY} = -\sum_X \sum_Y p_{XY} \log_2 p_{XY}$, etc. (Shannon, 1948). Each

two-dimensional distribution can also be considered as a matrix (or an Excel worksheet), whereas the three-dimensional distribution is contained in a cube of information (or an Excel workbook). The computation is done by using macros in Excel and dedicated software.

(3) Expected results

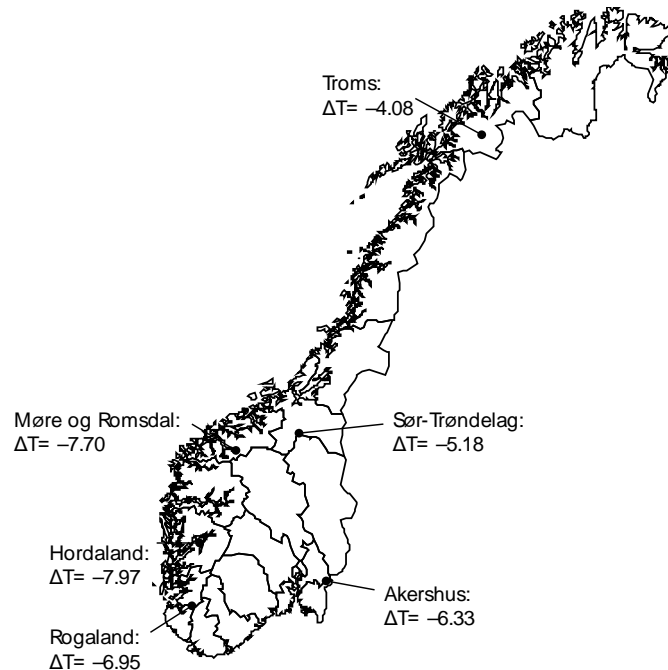
This indicator allows us to show the values for synergy as reduction of uncertainty (that is, negative values for ΔT). The assumption that knowledge spill-over from academic institutions is important for the industry structure will be tested. Synergy can be quantified at county, region or national level. This allows us to estimate to what extent a regional, or national innovation system can be expected. The effect of institutional thickness (Onsager *et al.* 2007) and high human capital density (Henderson, 2007) on the synergy indicator can be specified.

A map showing the counties (NUTS-3 level) with highest level of synergy is found in Fig. 1. Unlike these results, the pro capita R&D funding (2009 figures) is highest in the county Sør-Trøndelag, where the main technical university (NTNU) and the largest technical research institute (SINTEF) are located, in Trondheim.

¹ *NUTS is an abbreviation for Nomenclature of territorial units for statistics.*

² *Nomenclature générale des Activités économiques dans les Communautés Européennes*

Figure 1: Counties with highest synergy (lowest negative ΔT value)



Sør-Trøndelag is followed by Oslo (with the largest university), Troms (with a university) and Akershus where a lot of major research institutes are located. The pro capita R&D funding is seven times higher in Trøndelag, than in Møre og Romsdal, but the latter region has a higher level on the synergy indicator. Data on export values (2008 figures) show that the highest values occur in Hordaland, Rogaland, and Møre og Romsdal. Over 35% of the FDI in Norway (2009 figures) is associated with the oil-and gas industry, mainly located in Hordaland and Rogaland – that is, regions with high levels of synergy.

(4) Conclusions and policy implications

Politicians sometimes expect academic institutions to take roles as "knowledge hubs" or "innovation motors." Our findings suggest that academic institutions have not succeeded in this role hitherto in Norway. The roles of FDI (Riveira Vargas, 2010) and the industry structure are not to be neglected. In accordance with findings for the Netherlands (Dolfsma and Leydesdorff, 2008) we conclude that 'medium-tech' industries are more important than 'high-tech' industries for integration in the knowledge base of the economy of Norway.

May it be that global knowledge spillover from factors such as FDI, foreign ownership, and global customers are more important for enhancing innovation and competitiveness in industry than national knowledge spillovers from universities and research institutes? Are these findings only applicable to small, open, resource-based economies like Norway or can the results be generalised (as hypotheses) to other European countries? Are academic institutions still in their 'ivory towers,' receiving R&D funding from the government, but decoupled from the industry? Given that the highest level of synergy can be found in areas dominated by 'medium-tech' industries and outside the urban areas, there are reasons to believe so in the Norwegian case.

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Frontier research and mission oriented policies in university-based innovation centers – towards a new hybrid order?

Taran Thune, Magnus Gulbrandsen, Siri Brorstad Borlaug

*Center for Technology, Innovation and Culture, University of Oslo and NIFU – the Nordic
institute for studies of innovation, research and education, Norway*

1. Motivation

The aim of this paper is to empirically analyze the role that university-based innovation centers play in enabling universities to respond to innovation and mission-oriented policy paradigms. Making academic science relevant for industrial needs through research collaboration, knowledge transfer and commercialization initiatives has been a long-lasting trend, whereas the last five years has seen increasing weight on science's possibilities to contribute solving society's grand challenges such as climate changes, global health problems, and global energy needs. In this paper we address one mechanism that universities implement to handle increasing expectations to the relevance of academic science – university based "Innovation Centers"¹. Our perspective is that innovation centers constitute *hybrid spaces* – they represent a strategic and organizational mechanism for universities to establish an interface between traditional university missions and values, and broader economic and societal goals stemming from mission oriented research and innovation policies. The overall question is whether these centers really live up to their dual goals, if they are rife with tensions, or if such centers only represent hybrid order "on paper"? And if there are differences between centers in how they cope with their hybrid character, what could explain them?

2. Theoretical and methodological approach

In this paper the aim is to make a contribution to the literature on responses to mission oriented policy paradigms by providing new empirical meso level data on innovation centers. To do so, we introduce a conceptual framework for understanding centers as hybrid spaces: university based innovation centers are entities created at the border

¹ University-based innovation centers are temporary organizational units set up to support one or more large research projects, doctoral training and other activities within a scientific speciality or overarching set of problems, as well as close cooperation with industrial or other external users, where the aim is both to carry out frontier research and contribute to broader societal or economic goals. Normally, centers are based on meeting high scientific standards and on a perceived potential for innovation or other societal impact. Many countries and universities have similar initiatives; we use the general term "university based innovation centers".

between universities and external funding programs and partners, and can thus be seen as having hybrid nature².

Hybrids are here defined as phenomena that mix concepts, people and practices of different origins in order to make novel combinations. Hybrid spaces are social arenas where such connections and combinations are developed, carried out, and eventually become institutionalized. Prior research has looked at different degrees of integration ranging from boundary crossing practices (individuals/tasks remain in one sphere), boundary organizations (that explicitly straddle two or more spheres) to "true hybrids" that represent a novel combination that cannot be taken apart and be reduced to its originating parts. Tensions arise because hybrids combine characteristics and practices from the originating spheres. Such processes are characterized by translation (Latour & Woolgar 1986), rather than diffusion and adoption of existing concepts and routine – whereby the hybrids develop characteristics that are unique to them.

Several different aspects of hybridity give rise to tensions. Such issues are for instance work orientation and professional identity, normative and cultural tensions connected to definition of goals, research practices and standards of research evaluation, definition of tasks and objectives, the distribution of resources towards different activities and the patterns of collaboration and communication. The process of translating different goals and practices takes time, and one would likely find hybrid organizations that vary along a continuum ranging from fully integrated, organizations that are partly integrated but rife in tensions, to merely symbolic integration. We use these concepts as three ideal models for investigating different modes of hybridity in university based innovation centers.

² Hybridity in science and technology has been addressed within the science and innovation policy literature (Guston 1999; Fransman 2001; Lynn et al. 1996), in discussions about the public and private character of science related to concepts such basic, strategic and applied research (Atkinson-Grosjean 2006), in research on university-industry linkages (Etzkowitz 1998; Lam 2009; Hagedoorn et al 2000) and in research on technology transfer (Owen-Smith 2003; Guston 1999).

Modes of hybridity	<i>Symbolic</i>	<i>Contested</i>	<i>Integrated</i>
Goals	Academic and industrial/external relevance	Academic and industrial/external relevance	Academic and industrial/external relevance
Organization and governance arrangements	Formal arrangements with equal representation of academic and external partners Avoiding conflicts	Formal arrangements with equal representation of academic and external partners Handling (effects of) conflicts	Less formal arrangements, development of many formal and informal arenas Routines for handling conflicts of interest
Research and innovation practices	Strong division of labor and little collaboration with users in practice	Division of labor, but many efforts at collaboration at bench level	New concepts and routines for research and innovation High degree of collaboration at all stages
Career structures and professional identities	Strictly academic	Mainly academic	Both academic and industrial, not seen as different career trajectories
Results	Academic publications	Academic publications, some commercial applications, patents etc.	Academic publications and different forms of commercial applications

The empirical part of the paper presents a comparative case study of seven innovation centers from two empirical investigations. The first followed three Norwegian centers for research driven innovation for a period of three years, and collected data from all involved participants along with extensive documentary evidence. The second is a comparative study of two Norwegian centers for research driven innovation and two Swedish Vinnexcellence centers. The empirical material covers approximately 80 qualitative interviews with policy makers, program coordinators, university leaders, center directors, administrative staff, academic staff, PhD students and industrial partners, and each case study provides detailed information of the workings of innovation centers in both engineering, social science and life science.

3. Some results and preliminary conclusions

We find considerable differences between the centers in terms of levels of integration and tensions.

In two of the cases integration between the goals of academic science and innovation exists mainly on paper, seen in articulation of goals, structural set-up, and work arrangements. Translations, in terms of developing new practices that may facilitate integration of knowledge production and use, are few. The staff members in such centers have multiple allegiances but associate mainly with their originating discipline, firm etc., and interaction between different categories of participants is infrequent, highly formal and often implies one-way communication.

Two of the cases demonstrate highly formal integration but also emerging collaborative practices and attempts at creating new routines, roles and practices to broaden the scope and level of integration. However, these processes are complicated and often unresolved. Tensions are manifold with respect to the participants' expectations and are also seen in processes such as the development and selection of research problems, and the extent of collaboration and commitment between partners.

Three of the cases demonstrate situations of fairly dense networks between academic research and commercial research, and integration between different traditions and structures is more mature. Over time, joint arrangements and common concepts and methods have developed through translations of existing practices and development of new practices. Scientists in these centers have a hard time classifying their work in regular categories and point to the inadequacies of the standard science policy vocabulary for the cutting edge work in their fields. Most combine different research activities with practical problem solving and technology development tasks, and interact with different external organizations in many different ways simultaneously. The academic staff identified more with the emerging techno-scientific field they work in rather than "university" or "industry".

Differences between the centers probably have several roots, but it is apparent that the maturity of the technologies involved and institutional networks plays a role. However, the four centers that demonstrate low level of integration and high level of tensions are all "mission oriented" innovation centers, whereas the three centers with high degree of integration are connected to innovation processes in established industries. In the mission oriented centers the partnerships are newer and they are set up to solve a major health or energy problem, whereas the centers connected to established industry are built on closely defined innovation problems and established scientific and technological networks. The policy and management implications of the findings are finally discussed.

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Identifying Hot Brazilian Science and Technology: Tech Mining Methods for Relating Sources of Knowledge and Emerging Research Areas

Hannes Toivanen

VTT Technical Research Centre of Finland, Finland

Objective

Identification of "hot" science and technology research areas (Chang & Breitzman 2009; Winnink & Tijssen, 2011) within national innovation systems provides strategic, future oriented, intelligence for multiple uses: It signals how responsive research is to emerging "grand challenges" and the like, it allows national policy makers to evaluate emergence of distinct domestic research areas and monitor evolution of research systems, supports the build-up of focused international collaborative research initiatives, helps companies to scout for new sources of knowledge and partnerships, and allows researchers and research organizations to benchmarking their own work, and so forth. The objective of this paper is to develop methodological and empirical perspectives to identify "hot" areas of scientific and technological research and augment existing practices with analysis of geographical sources of knowledge.

The empirical objective of the paper is to explore the nature of knowledge that gives rise to "hot" research areas in Brazil 2005-2009, and improve our understanding what the rise of emerging economies entails for the global innovation landscape. The thematic research focus and geographic sources knowledge are essential indicators of the strategic orientation of national innovation systems, as well as their relationship with other research systems. Indeed, Brazil's currently snowballing research capabilities are enveloping transformation of its national innovation system dynamics, and we cast light on this process as well as its global implications. Going beyond aggregate in- and output indicators, this paper builds upon our previous analysis (Ponomariov & Toivanen, *forthcoming*) on knowledge flows and bases of Brazilian research by examining in detail particular research areas and topics.

We identify both hot research areas and research topics within the Brazilian research 2005-2009, and analyze the geographic origin of sources of knowledge for most relevant areas of research in order to: (1) Identify "hot" research areas and topics within Brazilian research; (2) Assess to what degree different "hot" research areas rely on Brazilian knowledge bases vs. dependence on foreign ones.

Approach

Our approach is essentially based on advanced tech mining methods (Porter & Cunningham, 2005; Daim et al, 2006), mixing bibliometric and text mining methods, whereas our interpretative framework is that of national systems of innovation literature.

A relatively new field, analysis of "hot" research topics is about identifying research areas with relatively high influence on near future science and technology, measured typically as rapidly accumulation citations (articles and patents) as well as cascading research on the same subject (key words and key word clusters). Here, we define as "hot" Brazilian research either research topics that either have highest growth rates, total publications, or which appear to have generated more immediate citations as indicating high influence on contemporary research.

The analysis presented in this paper utilizes three sets of publication data (Brazil-associated articles in scientific journals indexed by the Institute of Scientific Information - ISI). The core data set (SOURCE dataset) is composed of the complete set of papers published between 2005 and 2009 (inclusive) where at least one of the authors had a Brazilian address. The total set of Brazilian papers for this period consists of 152,031 papers. For this paper, we limited the SOURCE data set to articles and conference proceedings, consisting of 127,826 papers, in order to focus exclusively on publications that manifest creation of new knowledge and represent the end-point for research efforts.

Every scientific article is based to some extent on prior knowledge. The set of articles cited can provide a basic picture of the "knowledge base" of each individual article or set of articles. To capture the characteristics of the knowledge based of Brazilian research overall, we also obtained the full set of papers (the CITED data set) that have been cited by the 2005-2009 SOURCE data set of Brazilian papers, consisting of more than one million records. SOURCE and CITED data sets were linked by using unique ISI identification number, thus allowing us to relate the full article level information of cited research to published research.

Text mining of "hot" research areas can be done best by using article level subject categories (over 120 available), key words, or abstracts. We identify promising research areas through subject categories, but move then to create clusters of key words in order to separate pools of papers that constitute "hot" research topics. Identification of key clusters can be done by text mining abstracts e.g. with Vosviewer (Van Eck, & Waltman, 2010), creation of matrixes of high-correlating key-words, and eventually by grouping related keywords together to allow extraction of papers that use corresponding keywords. We base our text mining strategy on bottom-up build-up process of key

word clusters, and believe that this works to minimize "noise" involved in using ready-made categories, such as article subject categories etc.

Expected results

This paper has methodological and empirical objectives: To explore the viability of new tech mining method to analyze the sources of knowledge, as well as to cast light on the character of Brazil's "hot" research and to consider its global implications. The key empirical result is a statistical analysis of a number of "hot" areas of research showing to what degree they rely on domestic vs. foreign knowledge bases.

Our earlier research (Ponomariov & Toivanen, *forthcoming*) has already demonstrated that Brazilian research is increasingly building on domestic capacities, and that its growth envelops significant transformation of the national innovation system. Here we focus on if "hot" Brazilian research has distinguished geographical sources of knowledge when contrasted with the picture of overall Brazilian research. Exploration of selected number of "hot" research areas breaks down the illusion of homogenous scientific and technological research, but also points out general patterns and structures.

This issue, on the other hand, is essential for our understanding of the growth dynamics of emerging economies. For example, it is well known that high-cited Brazilian papers involve high rates of international collaboration. (De Souza Vanz, 2009) Expected results allow us to see if strategic Brazilian knowledge areas behave differently, thus allowing us to separate high-cited research from domestically relevant one.

Furthermore, we explore in detail how different major global regions are relevant for Brazil's "hot" research areas. Previous research has already shown that Brazilian research involves new types of international relationships, as the relevance of research of some countries, especially China and India, for Brazil surges, whereas others, especially EU-27, suffers from the paradox of having largest volume but declining relevance.

Conclusions and policy implications

The unfolding transition of global knowledge creation is reconfiguring the strategic relationships of major research systems. The enhanced knowledge and innovation capacities of emerging economies, especially those of China, Brazil and India, reflect also differing strategic priorities from those of EU and USA. This paper provides subject and topic level map of Brazilian "hot" research, demonstrating its strategic research interests. Moreover, we examine in detail the sources of knowledge of such "hot" research areas, pointing out where Brazil is building upon domestic capacities and where it may be relying on international partnerships.

Furthermore, the methods developed and discussed in this paper allow policy makers evaluate and monitor how responsive research systems are to new paradigms, or "missions" or "grand challenges", as our method investigates in addition to output also the sources of knowledge. By examining in detail the latter, an enhanced understanding of the transitional dynamics of innovation systems wide transformations becomes possible, allowing an in-depth look not only in the output of research but also on up-take of new knowledge.

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Public procurement and innovation in an evolutionary framework: evidence from public sector suppliers

Elvira Uyarra, Jakob Edler, Luke Georghiou, Jillian Yeow

Manchester Institute of Innovation Research, MBS, University of Manchester, UK

Demand is an important element in evolutionary explanations of innovation, going beyond a passive selection environment to an interactive influence of user expectations on the rate and direction of technical change. Public procurement accounts for a significant proportion of overall demand for goods and services and is therefore likely to shape the demand environment in which suppliers innovate and compete, particularly those for whom the public sector is a significant customer. The use of public procurement as a 'demand side' innovation policy instrument has seen a renewed focus in recent years, however there are many potential barriers and likely structural failures which could inhibit its effective functioning in this context. In addition, although public procurement is increasingly realised as a major potential influence on the innovative activities of firms, there is little empirical evidence on *how* supplying to the public sector actually influences a firm's innovation capabilities and performance.

This paper tries to address this gap by analysing the practices of public procurement and its relation to innovation in supplying organisations. The paper uses an evolutionary perspective to consider what would be needed to overcome demand failures and investigates the effects of procurement on the innovation activities and subsequent performance of 800 firms supplying goods and services to the UK government. The framework used (CIVIC) considers the degree of *competition*, the potential for *interaction* between purchasers and suppliers, ways in which *variety* is promoted in the context of a purchasing decision, the *incentives* available to encourage innovation in the context of a purchase and the *capabilities* needed by the actors to manage innovation procurement. These characteristics are matched aspects of the procurement process including the degree of restriction on tenders, procedures for interaction between purchaser and supplier, outcome-based specifications and whole life costing, intellectual property terms and the degree of competence of procurement officials.

The survey carried out in 2011 targeted firms listed as suppliers to the UK central and local government and the National Health Service (NHS). The survey was conducted using CATI (Computer Aided Telephone Interviewing) technique with a target response rate of 10%. 94% of the respondents reported some form of innovation, 67% that public procurement has had an impact on that innovation and 25% that all of their innovation took place in the context of public procurement. Overall, large firms tend to be able to generate and sell innovation for public clients slightly more easily than medium and

smaller ones, but the disadvantage of smallness is limited. Central government departments tend to be slightly more prone to buying innovation than local authorities and NHS organisations; however, this is linked to the nature of the services and goods demanded by the former (professional services largely).

The survey provides evidence of the extent to which firms perceive the public sector as able to drive innovation through the public purchase of goods and services, as well as of the influence of different procurement practices on different types of innovation and on additional catalytic effects such as private sector sales or increased sales in foreign markets. It was found that: incorporating innovation in tender criteria and other considerations (such as sustainability) and generally considering quality and whole-life costing rather than price is relevant for all types of effect, communication is important, particularly for R&D effects (early interaction, and solutions that are discussed in dialogue with clients); restricted tenders are relevant for R&D impacts; an emphasis on quality and whole-life costing and sustainability is important for catalysing increased sales in public, private and foreign markets; and in general that tender modes (imposed by regulation) less important than practices and the knowledge/capabilities of professionals. It is concluded that the factors highlighted as being consistent with an evolutionary understanding tend to be the most significant in determining whether innovation outcomes are achieved. The survey also reveals that soft practices are generally more important for suppliers than formal procurement procedures, that practices belonging to the pre-procurement stage are much more effective in triggering innovation, and that some of the practices considered to be more relevant in promoting innovation are also the less frequently experienced. Finally, additional barriers are identified by respondents that hinder a broader demand for and roll out of innovation in public procurement, particularly for SMEs. The implications are discussed.

Unpacking the grand challenges of nanotechnology

Harro van Lente, Colette Bos

*Innovation Studies, Copernicus Institute of Sustainable Development, Utrecht University,
the Netherlands*

Abstract:

Important societal themes, such as sustainability or the ageing society, are referred to as 'grand challenges'. During the last decade, many funding programs were set up to address these and other grand challenges. While grand challenges have a moral component – it is difficult to contest that it is 'good' to address them – they do not convey clear-cut goals for action. When they are related to the actual development of new technologies, grand challenges are articulated in different ways. Articulations help to specify and legitimate a choice for a direction of research (Van Lente and Van Til 2008). In this paper we focus on the articulation of nanotechnology. The rise of nanotechnology is surrounded by large expectations that it will provide 'solutions' for societal problems. The idea is that nanotechnology, which draws from fields like physics, chemistry, optics, engineering and biology, has a large potential for possible applications, because of the unique properties of substances at this small scale.

approach

In this paper we will explore the complex articulation process in funding programmes on nanotechnology in which many actors on many different levels are making choices that relate to these grand challenges. These choices consequently lead to actions which can then again be used as ground for new choices and new actions. These dynamics also changes the nature of the challenges.

In our paper we make conceptual and empirical steps. First, a framework is be developed, by critically reviewing current literature on the political contract between science and society, the sociology of scientific activity, the sociology of expectations and the multiple level perspective. The focus will be on how grand challenges relate to emerging technologies. Second, we will perform a discourse analysis of the narratives of grand challenges of 'sustainability' and 'healthy ageing' at European and national level. We will compare and contrast the mission-oriented thinking in these different cases.

results

To unpack the term 'challenge' we study the constitutive components of the term. A challenge refers, first of all, to a problem. Yet, one of the reasons why the word challenge has become so popular is that it does not just state a problem: it implies a solution or at least an expectation of a solution. As a third ingredient we study the sense of urgency: the pressure that something cannot be ignored and requires action. See Figure 1.

Figure 1: Unpacking a challenge



EU reports have been analysed to find i) the wording of sustainability and ageing, ii) the links of these grand challenges to research themes and especially to nanotechnology and iii) how 'sustainability' and 'healthy ageing' are consequently linked to specific research projects.

The first cluster of texts consists of the texts about the European Research Area and the European Commission reports. In these texts the wording of grand challenges is used frequently. Grand challenges are presented as broad societal problems, for which the whole European Union needs to unite to address them.

The challenges of sustainability and ageing enter the stage in a particular way. Both sustainability and ageing enter the scene as carriers of economic issues – more specifically, the competitive position of the EU. The main focus of sustainability here is "sustainable growth" which should contribute to sustainability and competitiveness simultaneously. This can be done by investing in "green solutions and technologies", wherein Europe should maintain the lead and should not be overtaken by Asia or the US.

In addition, we studied reports of nanotechnology initiatives in the UK (NNI), Norway (Nanomat) and the Netherlands (NanoNextNL) with the same three questions: (i) how sustainability and ageing are introduced, (ii) how the grand challenges are linked to research themes in nanotechnology and (iii) how 'sustainability' and 'healthy ageing' are linked to specific research projects.

The term 'challenge', indeed, is used frequently, but not that often in relation to 'grand' challenges. Actually more 'specific' challenges can be found. Wordings like "challenges in nanotechnology" [II-NL2], "key R&D challenges" [II-NO1] and "technical challenges" [II-UK1] are prevalent in the texts. Even though much more of these specific challenges can be found in the Texts II, one of the UK texts also presents much referencing to grand challenges. The articulation of sustainability has a clear focus in the texts, namely energy-related issues. Whether it's about "new energy technologies" [II-NO1], "energy supplies and energy savings" [II-NL1], "solar and wind energy" [II-NL2], "energy efficiency" [II-NO2] or "meeting the future energy needs" [II-UK1], the potential of nanotechnology for addressing energy related issues is clearly stressed by the national governments.

Figure 2: Challenging nanotechnology

The articulation of ageing is mainly related to the solutions in health care which nanotechnology could provide. Not only does nanotechnology have a large potential in new drug development, also sensors for "personalised healthcare" in "in daily health-care and health monitoring." [II-NL2]

conclusions and implications

Together, the conceptual and empirical work helps to gain insight into the articulations of grand challenges and how these change when moving through research and innovation systems. It also provides a starting point for a further investigating mission-oriented funding through grand challenges.

The empirical text analysis elaborates the notion of specification and how it is necessary to 'divide' the grand challenges into smaller challenges in order to address them,

clearly comes forward. The smaller challenges, in their turn, gain legitimacy, for instance when specific national reports still refer to the problems of the grand challenges in their introduction. This creates legitimacy for the specification which follows this legitimacy claim.

Challenges, thus, get translated when moving from actor to actor, and thus from credibility cycle to credibility cycle. The perception of what a 'challenge' actually entails differs between the EU texts and the national reports: the articulations of sustainability and ageing change from a mainly economical concern to environmental and social concerns.

Credibility and legitimacy in policy-driven innovation networks: Resource dependencies and expectations in Dutch electric vehicle subsidies

Frank van Rijnsoever¹, Leon Welle², Sjoerd Bakker³

¹*Innovation Studies, Copernicus Institute of Sustainable Development, Utrecht University, the Netherlands*

²*Utrecht University, the Netherlands*

³*OTB, Delft University of Technology, the Netherlands*

Motivation

Collaboration between various actors in the innovation system (such as knowledge institutes or firms) is important for the development of emerging technologies. Subsidies for innovation network formation are a means to stimulate these collaborations. Policy makers need to legitimize their decision to grant subsidies to certain actors over others. Legitimacy is the social judgment of acceptance, appropriateness, and desirability of things. An important resource for the actors that apply for subsidies is their credibility, which is their trustworthiness, expertise and reliability. The aim of this paper is to empirically examine the influence of various types of credibility on the legitimacy of the decision to grant individual actors in small consortia an innovation network subsidy.

Our research is motivated by two observations. First, there is little research on the influence of intangible resources in inter-organizational networks and there is no research that looks that these resources in the formation of policy driven innovation networks between various types of actors. Second, we test the assumption that expressing expectations by individual actors about an emerging technology leads to direct individual benefits. Expectations are ideas about the future potential of an innovation and can provide legitimacy to further develop an emerging technology and are thus highly relevant to the study of innovation. When actors are only rewarded indirectly for voicing positive expectations of their innovation, through rewards for their technological community in general instead of on an individual basis, they are less likely to hype the emerging technology.

Approach

Theoretically we combine the resource dependence view with the sociology of expectations. We first hypothesize that consortium characteristics have a stronger influence on legitimacy than characteristics of individual actors participating in these consortia (H1). Further, we hypothesize that four types of credibility are positively related to legitimacy: scientific credibility (H2), market credibility (H3), expectation track record (H4), and

social capital (H5). Scientific credibility is the scientific trustworthiness, expertise and reliability of the actor or consortium in the domain of the emerging technology. Market credibility is the commercial trustworthiness, expertise and reliability of the actor or consortium. The expectation track record of an actor is its past history to openly voice expectations about the technology. Finally, social capital is defined as the goodwill that is engendered by the fabric of social relations that can be mobilized to facilitate action.

We empirically examine the case of Electric Vehicle Technology (EVT) subsidies in the Netherlands. Data was made available by the Dutch government and augmented with information from online data bases. The data comprised all projects that applied for an EVT subsidy in 2009 and information about whether subsidies were granted or not. In total 23 project consortia consisting of 78 unique actors applied, since some actors were involved in multiple projects this resulted in 118 observations.

Legitimacy is approached as a latent construct. It cannot be observed directly, but rather its value is inferred from the decisions to grant a subsidy or not to actor *i* in project consortium *j*. The observed variable is thus a dichotomous variable. Scientific credibility was measured as the number of published scientific articles by an actor. Market credibility was measured as the share of EVT products a commercial actor has in its product portfolio. Expectation track-record was measured by counting the number of positive statements an actor has made about the technology in the media. Social capital was measured by counting the number of partners the actors had in the consortium and in the entire network consisting of all consortia. Further, as control variables we measured age (actor age and average age of the consortium) and actor type (knowledge institute (KI), small and medium sized enterprise (SME) or large enterprise (LE)). Consortium characteristics were aggregated as the average of a variable over all participating actors in a consortium.

We tested our hypotheses by fitting a stepwise mixed-logit model containing a random intercept dependent on the individual actor. The types of credibility and control variables were added as independent variables.

Results

Our results showed that our model is excellent at predicting the granting of subsidies to actors in projects, though not all hypotheses are supported.

H1 was tested by comparing model performance of a model containing only actor level variables to a model with only consortium level variables. These results confirmed H1. Further, scientific credibility on the consortium level is negatively related to legitimacy, which contradicts H2. Market credibility of the consortium is positively related to legiti-

macy, supporting H3. Expectation track record on the consortium levels has a negative influence on legitimacy, which contradicts H4. The results from social capital are mixed: social KI capital positively influences legitimacy, while social SME capital influences legitimacy negatively. Social LE capital has no effect. H5 thus receives mixed support.

Conclusion and implications

This work extends the resource dependence view by focusing explicitly on the role of intangible resources in policy driven collaborations between science and industry. It also adds micro-foundations to the sociology of expectations by explicitly focusing on the rewards for individual actors for expressing technological expectations.

Our main finding is that factual achievements by consortia members are less important (or even damaging) for gaining subsidies than the composition of the consortium by type of actor.

The results lead to four recommendations that contribute to making the subsidy process more transparent and legitimate. First, policy makers that establish subsidy programs can easily increase legitimacy of the program by specifically adding factual achievements to the criteria of evaluating project proposals. Second, given the importance of expressing expectations in the innovation process, policy makers could take publicly expressed expectations into account as an extra criterion to grant subsidies on, or at least ensure that actors are not hindered by expressing expectations. Third, due to their power and resources LEs can play an important role in developing radical innovations and in overthrowing incumbent socio-technical regimes. Policy makers could reward the inclusion of LEs that are willing to truly make the new technology a success in a consortium. Finally, the model itself can be used as a quick evaluation tool of subsidy programs to check the extent to which public funds were allocated to the right consortia. Advisory committees and external auditors can check the overall consistency of subsidy decisions, which is especially useful in case of many applications for subsidy.

Smoke screens and sacred fires: Translational research and grand challenges in European biomedicine.

Etienne Vignola-Gagné

Fraunhofer Institute for Systems and Innovation ISI, Germany and Life-Science-Governance research platform, Institute of Political Science, University of Vienna, Austria

The talk of 'grand challenges' in European-Union level science, technology and innovation policy activities has recently emerged in response to increasing perceptions that the positive results of Framework Programmes activities and other European Commission-funded initiatives in terms of scientific advancement are not meet with equal contributions to solving societal challenges. Even more than before, it is felt that research funded through common programmes finds its ultimate justification in contribution to Europe's economic, social or environmental goals. It is argued that bringing 'grand challenges' in the focus of policy-making means arguing for greater integration of national capacities through joint programming that reduces the fragmentation of capacities across Europe.

A stepping stone in the emergence of this discourse, The *Rationales for the European Research Area* document (Directorate-General for Research 2008) uses biomedical research and development as an exemplary area of sub-criticality in European research systems. Whereas the document discusses empirical observations of structural fragmentation in relevant innovation systems, ultimate justification for this assessment is derived from broadly discussed statistics about the current observations of decreasing productivity in the pharmaceutical industry. These statistics show growing (sometimes exponentially so) investments in biomedical research and development (R-D) activities in recent years by the pharmaceutical industry, on the one hand, and a decreasing number of new therapeutic candidates reaching regulatory approval over the same period, on the other hand. Commentators have interpreted these two trends as the indication of an increasing gap between successful biomedical discovery research and the development of this research into clinical application. 'Fixing' this gap through the successful alignment of biomedical research efforts towards clinical innovation is increasingly argued as a privileged means to meet biomedicine-related grand challenges identified in the Lund declaration (BMS Research Infrastructures 2010).

In parallel, problems of decreasing productivity in biomedical R-D have for some time already been discussed under the heading of 'translational research' or 'translational medicine' (TR). Proponents of TR use the term to denote a new, specific scientific and institutional approach to biomedical innovation in public or public-private networks, with greater attention to the determinants of successful innovation, increased multidisciplinary

narity (especially in mixing clinical and laboratory expertises) and complex experimental platforms, and tight management practices. Advocates vocally argue that the TR models of organising biomedical R-D would succeed in better aligning the aims and practices of laboratory and clinic contexts, consequently fixing the 'leaking pipelines' of biomedical R-D. Following the diffusion of these concepts, TR approaches have now been implemented in a number of pan-European and national initiatives, including networks funded by recent infrastructure initiatives. Building capacity for TR has also been an explicit priority of health and biotechnology research programmes in Framework Programmes 6 and 7.

Translational research : a new model of biomedical innovation?

The proliferation of well-funded TR initiatives in recent years prompts questions: how is TR different than biomedical R-D, as it has been done up to now? What can TR initiatives accomplish that biotechnology firms, the pharmaceutical industry and academic laboratories can't do? Are the propositions of the TR advocates the groundwork for a new model of innovation, or hype and well-tuned rhetoric aiming to drum up renewed support for biomedical and pharmaceutical research at a time when commentators are expressing doubts about the justifications for massive public support to these enterprises.

In this presentation, I will argue that we cannot so easily classify the TR approach as either empty hype (smoke screens) or valid new models of innovation. Rather, the rhetorical and discursive work around the construction of grand challenges in biomedicine is interdependent with the emergence of new configurations of actors, institutions and experimental practices situated around TR initiatives. This includes configurations advocated by medical investigators with more grounding in clinical realities than previous waves of biomedical innovators have had (and who thus justify their claims to authority through their dedication to patients, through 'sacred fire').

Research Strategy

This presentation will discuss research results from recent empirical work conducted in Austria, Finland, Germany, as well as in pan-European networks and in the USA, and as part of the TRi-Gen (Translational research in genomic medicine: Institutional and social aspects) multinational consortium (<http://trigen.isi-projekt.de>). It draws on 60 interviews with leaders of TR initiatives, advocates of the approach, policy-makers and stakeholders to characterise the emergence of TR as a distinct concept in biomedical policy, and to capture the kind of epistemic, material and institutional practices (Keating and Cambrosio 2003) taking place within TR initiatives. My analysis also draws on ex-

tended documentary research using editorials, reviews and commentaries published in the biomedical peer-review literature, as well as policy documents formulated by governmental, professional or advisory bodies.

For this presentation, specific attention will be given to subsets of empirical material dealing with the European Strategy Forum on Research Infrastructure (ESFRI) initiatives, the Innovative Medicines Initiative, and recent German responses to the TR discussion, including the National Health Research Centres. The international discussion on TR has been shaped by early American initiatives in the area, and I will also reflect on how European actions compare to and relate with US activities.

My analysis of this empirical material is framed by recent discussions in science, technology and society scholarship which have just started to locate and characterise both TR practices in relation to the broader landscape of biomedical and pharmaceutical innovation (Lander and Atkinson-Grosjean 2011, Brown and Kraft 2008, Webster, Haddad and Waldby 2011) and the specific classes of actors that enact them (Wilson-Kovacs and Hauskeller, forthcoming).

I will also mobilize a strand of the policy sciences called argumentative policy (Fischer 2003) analysis to discuss interdependencies in the construction of science, technology and innovation policy (such as grand challenges in biomedical research) and the construction of new models of innovation (such as TR initiatives). TR must be understood as a proposition for biomedical policy articulated by a specific coalition of actors, who have shaped both policy and models of practice around their vision of how biomedical R-D ought to be conducted.

Results: the construction of grand challenges

On what grounds could current TR initiatives lay the foundations for a new model of biomedical innovation? A number of features may be identified: A) TR advocates argue that their initiatives bring closer interaction between the laboratory and clinical contexts, at a time when, it is felt, the increasing complexity of molecular biology makes it more disconnected from practical application than ever. This connection is strengthened, in many initiatives, by reinforcing the role of a class of investigators traditionally dedicated to TR, clinician-scientists, who personally practice both clinical care and either laboratory or clinical research. B) TR initiatives are typically realised through the establishment of large-scale public or semi-public research collaborations which include core experimental equipment of an amplitude previously reserved to the pharmaceutical industry. C) TR initiatives reinforce the adoption of sophisticated management practices within academia as a mean to align the numerous research teams and their experimental platforms mobilized along a specific aim. D) Finally, TR initiatives draw at-

tention to the multiple technological areas of development where clinically useful innovations can be attained outside of strictly profit-mediated endeavours such as pharmaceutical industry innovation processes.

I also show that defining features of TR projects can be traced back to specific policy narratives, as they are articulated in the policies of EU or USA governmental agencies but also in the editorials, commentaries and reviews of peer-reviewed biomedical journals. The construction of 'translation' as a grand challenge is partly done by discourse coalitions of biomedical actors. Among others, some coalitions have stakes in renewing support for sites of biomedical innovation often left aside in recent biomedical policy, including clinics and hospitals, while others react to structural reconfigurations in the pharmaceutical industry by positioning academic centers as emerging providers of advanced product candidates in an increasingly outsourced R-D market.

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University research system dynamics: Can policies effectively boost research system performance?

Jian Wang^{1,2}, Diana Hicks¹

¹ School of Public Policy, Georgia Institute of Technology, United States

² Institute for Research Information and Quality Assurance (iFQ), Germany

1. Motivation

University research is a substantial element of every national innovation system, and the university research environment has been undergoing profound change in recent decades. Aiming at higher efficiency, international competitiveness, or excellence, a variety of policies have been designed and implemented in many countries (Hicks, 2012). However, evidence-based analysis of policy effects is scarce. On the one hand, quantitative analysis confronts many methodological challenges; on the other hand, scientists' perceptions mismatch the realities (Butler, 2010). Therefore, solid evidence-based assessments of policy effects are needed for further policy learning. In response to such a call, this paper develops methods for evaluating the effect of university research policy on university system research input-output dynamics.

2. Approach

We assume that a national university research system has stable dynamics between research inputs and outputs, and effective policy change introduces external interventions and therefore structural changes in the system. Different from classical policy analysis approach which has a specific policy in focus and aims to evaluate impacts of this focal policy, our proposed approach starts with evidence-based empirical data analysis to screening out successfully cases, and subsequently identifies factors for policy success. This approach consists of three components: (1) modeling system dynamics, (2) detecting structural change, and (3) mapping policy change.

2.1 Data

21 countries are selected for analysis because of data availability: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. Their time series data between 1981 and 2007 are analyzed.

Output: *PUB*, which is the number of Thomson Reuters Web of Science journal publications (classic four: articles, letters, notes, and reviews), with at least one university

affiliation, and in research fields other than clinical medicines or biomedical sciences (which have significant involvement of hospital and private sectors and more alternative funding sources, and are less receptive to national research policy).

Input: *HERD*, which is the annually higher education R&D expenditure (HERD) in constant 2000 prices and discounted for purchasing parity power collected from OECD, and ***STOCK***, which is constructed following a standard perpetual inventory methodology to account for previous HERD expenditure (Franzoni, Scellato, & Stephan, 2011):

and ***STOCK*** for the initial year is:

$$\text{STOCK}_0 = \frac{\text{HERD}_0}{g}$$

where ***g*** is the average growth rate of HERD.

2.2 Modeling System Dynamics

Three models are constructed for the dynamics between research input (***HERD*** or ***STOCK***) and output (***PUB***): a power law model, a transfer function model, and a vector autoregressive model.

Power Law Model

We assume ***PUB*** and ***STOCK*** follow the following relationship:

which is justified by Katz' power law correlation theory (Katz, 2000, 2006), and by the Cobb-Douglas production function in economics, and by our empirical data (Appendix 1).

Therefore, a structural change in the system would be reflected by a change in the scaling factor α . We further estimate α in year t as:

$$\alpha_t = \frac{\text{PUB}_t}{\text{STOCK}_t^\beta}$$

To simplify the notation, we define:

hence,

Transfer Function Model

We assume that PUB depends on lagged PUB and HERD:

where d , m , and n are determined following the procedure proposed by Andrews, Croke and Jakeman (2011).

In this model, HERD is treated as exogenous, that is, HERD is not affected by PUB. This assumption is more relevant on the national level.

Vector Autoregressive Model (VAR)

We assume that both PUB and HERD depend on lagged PUB and HERD:

where m and n are determined by AIC criterion, following the procedure presented in Hamilton (1994).

In this model, HERD is treated as endogenous, that is, there is a feedback loop between PUB and HERD. This assumption is more appropriate on the institution level, because more productive institutions are also more competitive in seeking funding.

2.3 Detecting Structural Change

The next step is to test if there is any significant structural change in or linear regression systems for the transfer functional model and VAR model. Two methods are used for structural change detection: (1) the cumulative sums of standardized residuals method (CUSUM) firstly proposed by Brown, Durbin, and Evans (1975); and (2) Chow's test initially proposed by Chow (1960).

2.4 Mapping Policy Change

Data of policies in selected countries are collected primarily from journal publications, books, reports, and other archive sources. In addition, we also interview experts for better understanding of national policy context.

We map the timeline of detected structural changes together with national policy changes, and conduct case studies to identify factors for policy success.

3. Results

3.1 Pilot Study Results

The reliability of the method is tested by a pilot study on Australian case study. We find a significant structural change in 1989. Butler (2003) has presented the policy changes in Australian higher education system around 1989 and noted a remarkable change in Australian university publication output around 1989. A scrutiny of policy changes in Australia reveals revolutionary changes occurred around 1989, namely the Dawkins Revolution which converted College of Advanced Education (CAEs) into Universities. CAEs did not conduct research and were not eligible for national research funds before this change. In addition, several universities started to use bibliometric measures to evaluate faculty members.

3.2 Larger Scale Study Results

The Australian case study demonstrates the reliability of our proposed method. We apply the method on all 21 countries, and identified many structural changes in different countries (TABLE 1).

Table 1: Structural changes detected

Country	Breaking Point	95% Confidence Interval
Australia	1989	[1986, 1993]
Belgium	1991	[1985, 1994]
Canada	1985	[1980, 1986]
	2002	[2001, 2006]
France	1993	[1991, 1997]
	1997	[1996, 1999]
	2004	[2003, 2005]
Greece	2000	[1995, 2003]
New Zealand	2003	[2000, 2007]
Portugal	1992	[1989, 1995]
Spain	1986	[1985, 1989]
	2003	[2002, 2008]
United Kingdom	1989	[1988, 1990]
	1995	[1991, 1997]
United States	1984	[1981, 1987]
	2002	[2000, 2005]

3.3 Work in Process

"Mapping policy change" is in process. We are collecting policy data for case studies, to understand what policies have changed the dynamics of the national research system, what are common factors of effective policies, and what conditions are needed for achieve the policy goal of boosting productivity.

4. Implications

We propose a new policy analysis method with three steps: modeling system dynamics, detecting structural change, and map policy change. It is motivated by the scarcity of evidence-based assessments of policy effects. This method screens country profiles to identify countries which have succeeded in introducing structural change(s) that boost the efficiency of the research system. The resulting evidence provides a foundation for cross-case comparison to reveal successful policy practices and prerequisite conditions, and shed light on future policy studies and practices.

Arts and Humanities Research Policy and Practice in Ireland

Elaine Ward

*Higher Education Policy Research Centre, Centre for Social and Educational Research,
Dublin Institute of Technology, Ireland*

Motivation

In a time when policy makers and governments are being held increasingly accountable to the public for expenditures, institutions of higher education are being called to justify themselves and their operations. Particularly, the relevancy of teaching and research to the needs of the economy, employees and employers, is at the forefront of both policy and administrative debates. Curriculum needs to be overhauled and research can no longer be a luxury for the sake of research alone. Now more than ever before, research needs to demonstrate its value to society.

It is a time of change and uncertainty in Ireland, not just in terms of the economy but also in terms of the research policy and funding landscape. There is no doubt that the two are inextricably connected, as many believe that the economic and financial future of Ireland will in large part be attributed to vibrant research and innovation across the academic and commercial sectors. In 2010, the Minister for Enterprise appointed a taskforce to identify priority areas for research and smart economy government investment. The charge of the taskforce, known as the Research Prioritisation Steering Group, is to identify up to twenty target areas where the Government should focus its research funding. In 2010, the government is said to have invested 598 million Euro on academic and commercially-focused research and development. There is a commitment to sustaining Ireland's commitment to quality research and development. Yet, as research gets continually yoked with economic potential and "commitments to research commercialization, through patenting, licensing and product development, increasingly reflect institutional, industrial and government priorities" (Harpur, 2010), where and how this investment gets spent is a concern, particularly for arts and humanities researchers. In 2011, the Irish Research Council for the Humanities and Social Sciences (IRCHSS) saw its budget cut from 18 million Euros to 10 million Euros. The Council has concerns about how it will continue to support and grow research in the arts and humanities with such cuts.

A further shift in the research policy landscape in Ireland, again due to the economic downturn and need to save wherever possible, is the pending merger in 2012 of Ireland's two research councils, IRCHSS and the Irish Research Council for Science, Engineering, and Technology (IRCHSET). Bringing these two research councils together may save money but the impact on the research landscape of Ireland is yet to be realized.

This paper explores the debate in Ireland regarding the value, benefits and impact of arts and humanities research, with a particular focus on the value perceived and experienced by policy makers.

Approach

The intrinsic value of arts and humanities research is often stated with certainty and accepted within academic and disciplinary circles and the related profession of literary and creative industry as a given. Yet, the unquestioned acceptance of the perceived high value of arts and humanities research can no longer go unquestioned; rather the very premise needs rigorous examination.

The three country (the Netherlands, Norway, and Ireland) HERAVALUE research project attempts to increase the understanding of the value of arts and humanities research by learning how multiple stakeholders view and articulate their understanding of this value, by then making those implicit values more transparent by drawing them together and articulating a common understanding of the real and perceived values of arts and humanities research to the collective disciplinary base.

The Irish National Case Study

This qualitative case study seeks to understand the value multiple stakeholder groups – researchers, policy makers, and members of civil society – place on arts and humanities research. Semi-structured interviews explored questions on how arts and humanities research was defined and understood by each stakeholder group, what forms the research takes, how quality is defined and assessed as well as the perceived impacts and benefits of the research to society and to the economy.

The study is grounded in a literature review of understanding and defining arts and humanities research and the national research policy context through a review of policy reports and documents.

Two focus groups were held, the first with arts and humanities researchers themselves, the second with policy makers. The guiding questions for the researcher focus group included how do you define research in your field? What form does your research take? How is your research assessed? What are the outcomes of the PhD in your field? How would you assess the impact of your research? How do you distinguish between research, scholarship, creative practice and engagement in your work? The guiding questions for the policy maker focus group included – what do you view as the contribution that arts and humanities research makes to society/the economy? What are the best ways to measure and assess the societal impact and benefits of arts and

humanities research? Given the extent of the global economic crisis, are there special attributes that arts and humanities research can contribute to society and the economy? What are the implications for research policy? Sixteen people attend the two meetings and represented city and national policy bodies, enterprise, higher education institutions and researchers themselves.

Data from these focus groups were used to finalize the interview protocol for the semi-structured interviews. Purposive and snowball sampling methods were used to locate participants for our study. Semi-structured interviews were conducted with thirty participants across the three stakeholder groups. The interviews lasted between thirty and eighty minutes. The interviews were audio taped and transcribed. The research software NVivo was used to facilitate coding and data analysis of our findings.

Results

While we have findings across all three stakeholder groups, for the purpose of this paper, our preliminary findings (interviews are to be completed by mid March) focus on research policy related to arts and humanities research.

The policy landscape is shifting in Ireland and its unfolding status will continue to influence the analysis of our findings. Ireland clearly values arts and humanities yet having this reflected in the funding of arts and humanities research has yet to be realized. The current economic climate is shifting research priorities ever more toward economic and commercial ends. This said, the study uncovers a desire for policy makers to firstly, have arts and humanities researchers to continue their research that is beyond a mere utilitarian purpose in order to provide the kind of knowledge that will benefit society into the future. Secondly, for arts and humanities researchers to have a clear sense of the purpose of their research, their 'end game', rather than a focus on metrics, but rather to be clear about "what you want to do with the arts and humanities" and once this is clear how one measures it will follow. Thirdly, for arts and humanities researchers to come out of the academy and participate more fully in national dialogues of issues of public concern and not omit themselves from the difficult conversation of the times.

The individualistic nature of arts and humanities research is an outdated methodology and from the formation stage, new A&H researchers should be exposed to and helped interact with those outside of the academy. The socialization process needs to assist new researchers become confident in their ability to interact with society in an effort to have their research become more relevant and of benefit to society. Early socialization will encourage researchers to be able to articulate these benefits more clearly beyond their discipline specific academic peers.

There is an increased need for national and international research frameworks and platforms that not only encourage but facilitate cross disciplinary – especially across science and technology and the humanities – research capacity building.

Conclusion/Policy implications

While it is premature to draw definitive conclusions, there are certainly emerging policy implications of this work. This is the first national study that asks multiple stakeholder groups about the value and benefits of arts and humanities research. These varying understandings can be brought together to influence policy and practice at both a national and institutional levels. Moving the conversation beyond the binary debate of science and technology versus arts and humanities research to a place where multiple stakeholders can begin to articulate their understanding of the benefits and values of their research beyond the academy is a timely conversation to be having in Ireland. The merging of the two national research councils reflect the need for arts and humanities researchers to claim and be better able to articulate the value of their work over taking a defeatist and victim mentality and subsequently feeling lost in the process as Ireland prioritizes its research and development goals. There is an opportunity for arts and humanities researchers in Ireland that hopefully will not be lost.

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Systems of Innovation, Production and Consumption

A systems perspective on goal-oriented transformative change to tackle Grand Challenges

Matthias Weber¹, Harald Rohracher²

¹Austrian Institute of Technology, Austria; ²IFZ, Austria

Motivation

The notion of Grand Challenges has turned into a major issue in recent debates about research and innovation policy, and about the role of government in general. Innovation is supposed to play a major role in tackling these challenges, but most Grand Challenges require in fact major transformative changes in the patterns of production and consumption, thus calling for radical and broadly understood innovations to be realized and widely implemented.

The conventional innovation systems framework that has come to dominate our thinking about research and innovation policy due to the compelling policy rationales it provides is not geared towards addressing processes of transformative change and matters related to the direction of technological change.

Competing with, but also complementary to the innovation systems approach, the multi-level perspective (MLP), and associated to it the approach of transition management, puts the emphasis on long-term processes of regime-shifting change and on the normative orientation of such change processes, often towards sustainability objectives.

A closer conceptual integration of the multi-level transition perspective and innovation system approaches promises to both, theoretically enrich our understanding of transformation dynamics and practically enhance the compatibility of transition thinking with (and thus also its relevance for) policy discourses and framings.

Approach

With this paper we want to go beyond initial steps already taken to explore synergies between the multi-level and innovation system approaches (Markard and Truffer 2008). Based on a systematic comparison of both approaches in terms of focus, innovation dynamics, and policy rationales, we develop a more comprehensive framework for explaining the dynamics of transformative change, which builds on an actor-centred innovation systems perspective, but incorporates key elements of the multi-level perspective.

Among the key insights from the multi-level perspective (Grin et al. 2010) to be taken into account are a) the long-term character of regime-shifting transformative change, b) the explicit orientation towards normative goals, c) the shift in perspective from innovation activities of firms towards innovation involving society, and d) the consideration of the wider uptake and diffusion of innovations.

Building on these two streams of literature, we propose a conceptual framework and heuristics to explain processes of transformative change called Systems of Innovation, Production and Consumption (SIPC). With this framework we want to make the main types of mechanisms driving the dynamics of transitions – understood as multi-level phenomena – explicit. This will be achieved by drawing first on explanatory patterns borrowed from innovation systems research (in particular the critical role of actor strategies and guiding institutions), and secondly on key concepts from complex systems research.

It is on the basis of this broadened conceptual framework and the associated understanding of how processes of transformative change come about that an extended set of rationales for legitimizing government intervention in transformative change will be proposed; a set that goes beyond the conventional market and system failure arguments.

Expected results

Systems of Innovation, Production and Consumption (SIPC)

System of Innovation, Production and Consumption (SIPC) as the locus of long-term transformative change can be defined at different levels. Typically, the focus will be on the provision of a rather generic type of products or service at a particular territorial level. Policies (and analysis) are dealing, for instance, with regional systems of water provision, with national mobile communication systems, or with the international system of air travel. These systems are characterised by particular technologies and production structures, by particular actors, forms of interaction and social practices (e.g. characteristics of firms in this field, consumption practices) and by particular institutional frameworks of various kinds (regulations, governance structures etc.).

Of crucial importance for our analysis are the intersections and interdependencies of our focal SIPC with other innovation systems at different levels (e.g. emerging new technological innovation systems, different sectoral systems or the national innovation system). These interdependencies may exert an important influence on the achievability of system innovations and the dynamics of transformative change. Seen from the perspective of an individual actor in an SIPC, the different institutional layers of these innovation systems exert an influence on his/her activities., i.e. on strategies, interac-

tions and decisions. We can distinguish on the one hand territorially defined innovation systems (e.g. regional, national or – to the extent it is regarded as a system in its own right – European), and on the other hand thematically defined innovation systems along the lines of specific technologies or sectors (e.g. Technological Innovation Systems TIS, Bergek et al. 2008; Sectoral Systems of Innovation and Production SSIP, Malerba 2004). The SSIP concept is particularly important because it provides the linkage with the production systems, and ultimately also with consumption. Obviously, several different SSIPs can contribute to and be part of a SIPC. The institutional elements of each of these systems shape and influence the evolution, and eventually the transformation, of a SIPC. In this perspective, we obtain a multi-layered institutional frame that can be differentiated along a territorial and a thematic dimension, which make up the institutional context for innovation in and transformative change of an SIPC.

In line with Dolata's (2009) argument that transformative change is about the "general interrelation of technological, socioeconomic and institutional change", it is necessary to consider the institutional layers of different coupled innovation systems, but also the socio-economic structures, the actor constellations, interactions and decisions, and the technologies and knowledge that are either in place or in the making:

- As regards the conceptualisation of **actors and their constellations**, much can be borrowed from the prevailing Innovation Systems literature: the systems are populated by firms, research organisations, universities, ministries, education and training organisations, users, agencies, financing bodies and other intermediaries. Obviously, beyond the actors that are characteristic of innovation systems, consumers in their different roles also need to be considered prominently in SIPCs.
- **Institutional frameworks** are defined at each layer of the two dimensions, implying that there are territorially and thematically specific institutions that are inter-twined to shape a system of innovation, production and consumption. Jointly these institutional frameworks shape and frame the innovation, production and consumption activities and interactions at micro-level that give rise to patterns of innovation, knowledge creation, production and consumption.
- The **technologies, infrastructures and knowledge** developed and used, and the path-dependencies they entail, represent a further important element of SIPCs. Apart from providing the physical basis of production and consumption, they represent the intangibles on which actors can draw for taking innovation decisions.

This differentiated approach opens up the possibilities to distinguish several different decision arenas in an SIPC, associated to each of the conventionally defined systemic levels of innovation. And in fact, the policy debates on innovation often take place in parallel at regional, national and European level, or in the context of technological or sectoral fora.

Understanding the dynamics of transformative change

Another central concern of this paper is to provide an explanation of transformative change on the basis of the SIPC perspective outlined above. "Dynamics", in our understanding, requires more than providing a phenomenological systematization of different dynamics patterns. A model of dynamics that shall serve as foundation for policy needs to provide the mechanisms that determine the patterns of change we can observe. In order to achieve this, we build on notion of complex systems thinking, along the lines of the adapted Complex Adaptive Systems framework CAS (5).

At a first level, it is interesting to look at the **dynamics of innovation at the micro-level**. In fact, by relying largely on the established actor-centred innovation systems approach, much of the explanations of the patterns of innovation at firm level can be maintained, but there are two novel elements of our SIPC perspective, namely a) the activities at micro-level are seen as shaped by and embedded in the institutional frame of reference that is composed of several hierarchically and non-hierarchically nested innovation systems, and b) the focus is not on innovation activities only, but equally on the production and consumption activities that prevail in the SIPC.

In the context of this paper, the more interesting aspect of dynamics concerns the question of how **transformative change** can be explained in a SIPC. In essence, transformative change requires a co-evolution of all three types of system elements: institutions, socio-economic structures/actors, and technologies and knowledge of production and consumption.

An important issue is to understand where an initial impulse for transformative change can come from. In principle, one might argue that they may come either from outside the SIPC, i.e. from the system environment ("landscape") or from within the SIPC (creation of new technological opportunities). However, in practice, this is likely to be a tight interplay between external and internal forces. As the institutional layers in SIPC are defined in terms of different territorially and thematically defined innovation systems, changes in these systems (e.g. new European regulation, socio-political dynamics at regional level, sectoral innovation strategies, etc.) can exert a major influence on the transformation dynamics in SIPC. The actual influence that these impulses can exert will depend to a large extent on the receptiveness and adaptability of the SIPC, but also on the ability of actors from the SIPCs to contribute to the definition of these impulses to ensure that they formulated in such a way that they can actually be absorbed in the SPIC. In other words, the negotiation of interventions at the interface between SIPC and other innovation systems is crucial for a harmonised transformation strategy.

These impulses may eventually trigger a process of transformative change resulting from the interplay between two different layers, namely the interplay between SIPC-external and SIPC-internal developments that result in an co-evolutionary process of change. This kind of mechanism is of more general relevance to our understanding of system dynamics, and its generalisation is based on insights from **complex systems** science that provides useful models and explanations of the mechanisms at play in the course of a system transformation. Once the process has been set in motion by an impulse that is mediated by one of the innovation systems that feed into the SIPC, it is further nurtured by the internal dynamics of the SIPC. In essence, and in line with the model of Complex Adaptive Systems, transformative change is regarded as a self-organising and emergent phenomenon, resulting from circular causalities in the system, i.e. resulting from self-reinforcing, self-defeating and stabilising mechanisms operating between the different layers and elements of the SIPC, i.e. between actors, institutions and technology.

Policy implications

With this paper we provide an understanding of processes of transformative change that builds on prevailing systems thinking along the lines of the innovation systems literature, but enrich it by key insights from research from a multi-level perspective on regime shifts towards sustainability in major areas of production and consumption. Such a perspective is regarded as being closer to the explanation of change processes needed to tackle Grand Challenges than the conventional innovation system perspective, while at the same time maintaining their rigor in terms of deriving clear-cut rationales for policy intervention. However, SIPC allows us to identify an extended set of policy rationales, which can be differentiated into structural and transformative system failures (Weber and Rohrer, 2012). In other words, the SIPC framework provides the foundation for a justifying and legitimizing the kinds of policy interventions needed to tackle Grand Challenges.

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Integration and coordination dynamics of the European Research Area. A measurement framework and its application

Matthias Weber¹, Remi Barré², Luisa Henriques³, Dimitrios Pontikakis^{3, 4}

¹*AIT Austrian Institute of Technology, Department Foresight & Policy Development, Austria*

²*CNAM, Laboratoire interdisciplinaire des sciences de l'action (LIRSA), France*

³*European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Spain;*

⁴*Northumbria University, UK*

Motivation

This paper is concerned with the reconfiguration of national research and innovation (R&I) systems towards a European Research Area (ERA). Since the formulation of the goal to realise the European Research Area (ERA) in the year 2000, we have seen an intense debate about the objectives, the process and the means to achieve it. The ERA concept re-invigorated the debate about the Europeanisation of research which had been rather latent in the years before. It culminated in the ERA Vision 2020 document where the medium-term perspectives for the future of research in Europe are outlined (Council of European Union 2008).

However, the debate about Europeanisation is not new, not even with respect to R&D. A lot of academic and policy thinking was done during the early years of the European Union when the fundamental goal of Europeanisation as such was still heavily contested. The Euratom treaty and the creation of the Joint Research Centre (JRC) in 1957 give evidence of the significance of research in these early debates. The establishment of the Framework Programmes (FP) in the early 1980s was another important historical cornerstone. These two examples mirror the fundamental tension in this debate, with the JRC standing for an integrated and centralised model of research performance, and the Framework Programmes representing a coordinated and decentralised model of research performance, both being funded through a centralised re-distribution mechanism.

One of the crucial challenges in the context of the Europeanisation debate is how to capture the process of change by way of meaningful analysis and measurement. This in turn pre-supposes a good conceptual understanding of different types of Europeanisation models against which to compare progress. Both conceptualisation and measurement are essential for monitoring progress towards "the ERA", and thus for the ability to steer the process of Europeanisation in a transparent and evidence-based way.

It is against this background that we aim to contribute to a better understanding of integration and coordination in research as the two basic modes for describing the dynamics of Europeanisation, as well as to the development of better measurement approaches for tracing this process.

More specifically, the main objective is of a conceptual and methodological nature, namely to propose a novel methodology for measuring the dynamics of Europeanisation in research. The paper thus also has an empirical element in that it revisits the quantitative knowledge on the Europeanisation of research accumulated during the past twenty years by applying a rigorous indicators-based methodology.

Approach

Starting with a review of the theoretical and empirical literature on the emergence of a European research system, we propose a two-dimensional conceptual framework of how the Europeanisation of research can actually be mapped. We conceptualise R&I activities as being either integrated at European level, co-ordinated with other European partners or nationally juxtaposed. We argue that such a conceptualisation can be usefully applied to the measurement of progress towards the ERA along the lines of three functions of R&I systems: providing orientation for R&I, programming and funding of R&I, and performing R&I. This framework is then used to trace in a qualitative way the evolution of research in Europe since the 1950s.

It serves as background for the formulation and application of the new quantitative approach to measuring the Europeanisation of research, which is applied using data for the past ten years. For this quantitative analysis, we concentrate on programming – funding and research performance functions in order to simplify the data collection.

We conclude with some remarks on the trends in Europeanisation in terms of its different modes and on the implications this raises for the monitoring of future evolution of the ERA.

Main results

From a longer historical perspective, the evolution of the Europeanisation of research can be described the following way: in the post-war period until the late 1970s, Europeanisation of research meant sharing integrated big science infrastructures dealing with both programming and performance of research and being of relatively small size in comparison to the research systems as a whole – hence relatively low levels of Europeanisation, equally concerning programming and performance, coordination being almost absent.

In the 1980s and 1990s, while the big science organisations of the previous period – which were mostly intergovernmental organisations – developed at only moderate pace and without expanding to new areas, the Framework Programme became the new arm of Europeanisation. It allowed the flourishing of research consortia – which means co-ordination – among research performance organisations throughout Europe: in 2000, the index of coordination for the performance function became higher than its index of integration. In the same time, Structural Funds applied to research (mostly research infrastructures) – develop; it leads to coordination in programming, which shows through the take-off of the corresponding index – though still at a modest level since this funding scheme is limited to the less developed regions.

In 2000, Europeanisation reaches quite high levels, balanced between the programming and performance functions, the integration mode being still more important than the coordination one. This level of Europeanisation in this model reaches a limit since (a) big science integrated infrastructures do not constitute any more a priority and (b) coordination is focussed on the performance function – through FP consortia, which overall volume is limited by the size of the FP.

After 2000 with the launch of the ERA and the FP6 ERA-dedicated instruments another model of Europeanisation has emerged as a superposition of the two previous models (big science integrated infrastructures and performance coordination through the FP) – completed by a whole new scheme, namely coordination of the programming function. This latter feature has more than tripled in volume in 7 years, becoming the most important of the four pillars of Europeanisation (the others being the two related to integration and the coordination of the performance function). In this new model, Europeanisation is mainly based on the programming function and on the coordination mode.

Conclusions

Our estimates show that Europeanisation of R&I has increased substantially over the past ten years, and that this is due in particular to the emergence of new forms of multi-laterally coordinated R&I activities among Member States. As compared to the well-established, but sometimes contested integration mode, coordination has been growing much faster and developed into the dominant mode of Europeanisation. Moreover, the coordination mode has become influential for the programming & funding function. This is the expression of the ERA vision, where Europeanisation is no more limited by the volume of the Framework Programmes as the main form of integrated programming – its limit being the political will of the member states.

The data show that Europe has entered into a new phase of Europeanisation of R&I, a phase that opens up the opportunity of achieving a further intensification of Europeanized R&I, but in a flexible manner and under the direct control of Member States.

Moreover, the conceptual framework and the associated indicators developed for tracing the process of Europeanisation of R&I could be used as a building block of a comprehensive system of monitoring progress towards the European Research Area.

Forward Commitment Procurement Practical Pathways to Buying Innovative Solutions

Gaynor Whyles¹, Joram Nauta², Hendrik van Meerveld³

¹*Department of Business innovation & Skills (UK)*

²*TNO – Dutch Centre for Health Assets; the Netherlands*

³*University of Twente, the Netherlands*

Introduction and motive

Access to better goods and services is critical to the pursuit of society's goals, be they sustainability, healthcare, adaptation to climate change, or information security. This requires innovation. However, innovative goods and services face significant barriers before reaching their customers.

Traditional policy tools to address this, such as product development grants, are extremely helpful but inadequate on their own as evidenced by the number of promising prototypes that do not make it to the market. This is rarely because they are not needed or are ineffective. More often it is because the uncertainty of future sales makes the investment in bringing them to market too risky. Many new companies that do take this risk all too often fail when the pace of market entry proves too slow and profits are not realised.

For example, innovative good and services will be essential in the move towards a low carbon economy. These products and services are often not available, too expensive, unproven or struggle to break into the market. The result is that many promising solutions fall by the wayside and buyers are faced with few, often unpalatable, options.

The public sector may seek to stimulate supplier innovation through short-term pilot projects but often does not carry through the ideas into longer term procurements. There is a tendency to opt for low-risk solutions, low-margin players and mature technology. Innovation is not routinely welcomed or rewarded. Yet the potential of innovation to deliver the efficiency savings and step changes in environmental performance and sustainability is considerable.

In 2006 the Environmental Innovations Advisory Group (EIAG)¹ proposed the Forward Commitment Procurement (FCP) as a 'simple yet powerful tool to deliver environ-

¹ DTI (Department of Trade and Industry), November 2006. *Environmental Innovation: Bridging the Gap Between Environmental Necessity and Economic Opportunity* (in Association with DEFRA). First Report of the Environmental Innovations AdvisoryGroup.

mental innovation'. They then set out to develop and test a model of how FCP could be applied in practice in the public sector environment. Two demonstration projects have yielded both important lessons and positive outcomes and the approach is now being tested in further pilot projects as part of the Low Carbon Building (LCB) Healthcare project², funded through the European Commission's Lead Market Initiative³.

Forward Commitment procurement: a tool to stimulate better solutions for the public sector and opportunities for innovation.

Both developing and buying new goods and services can be risky so the Forward Commitment Procurement model was designed to help manage this risk. Forward Commitment Procurement is a practical tool for public sector procurers that brings together progressive thinking and best practice from the private sector and the innovation and procurement communities, together with the understanding of the demand side barriers to the commercialisation of innovative goods and services identified by the EIAG in 2006 to bring new cost effective goods and services into the market.

Although designed to address the particular barriers to market faced by environmental innovations, the FCP approach is also used to deliver efficiency savings and support the procurement of innovative solutions in other markets, such as sustainable development, healthcare and construction.

The FCP concept

Delivering social objectives (such as environmental sustainability) often requires new solutions that are either not available in the market or are available at excessive cost, because they aren't available, customers don't demand them; because there is no demand, the solutions do not receive the investment required to enter and be competitive in the market. Consequently, public sector objectives are compromised by lack of affordable and effective products and services to deliver them.

The FCP approach unlocks this stalemate by making the market aware of genuine needs and requirements. It offers to buy solutions that meet these needs once they are available at a price commensurate with their benefits. This 'credible articulated demand' provides the necessary market pull to galvanize supply chains and unlock investment to deliver the requirement.

² Website: <http://lowcarbon-healthcare.eu/>

³ Website: <http://ec.europa.eu/enterprise/policies/innovation/policy/lead>

With future markets more certain the theory is that industries and enterprises will invest in innovation to meet demand and grow, and by buying smarter, public services can become more efficient. A critical factor for suppliers of new products is the confidence that there will be a market once the solution is proven. The amount of investment made by product developers and by their supply chain depends on this confidence. The future customers of the new products can significantly affect investment decisions by making the future market as certain as possible (while retaining competition). FCP is a way for public procurers to make this future market visible and credible without either procurer or supplier incurring unmanageable risks.

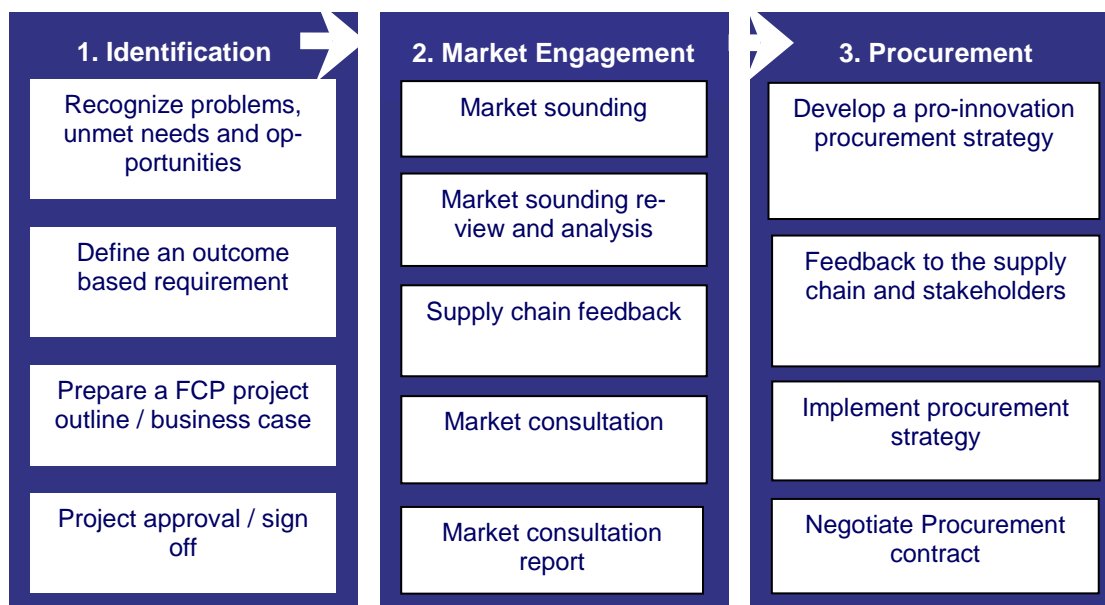
The FCP model translates – into the public sector – the approach taken by business in using supply chain management and procurement to promote investment in new products. Private sector companies actively manage their supply chains to promote investment in innovation and new or improved products. They do this by engaging with their suppliers and providing credible information about their future requirements and purchases. This provides the incentive and security for the supply chain to invest in delivering what is needed, when it is needed, at a price that is affordable. By mirroring this approach FCP provides an early market engagement tool for the public sector to create the conditions for their supply chains to flourish and deliver new cost effective solutions in a way that manages the risk for the customer and the supplier.

The FCP procedure provides a framework that enables procurers to engage with the market at an early stage to tap into the wealth of creativity that the supply chain is capable of given the right messages from its customers.

The FCP process

In brief, FCP provides the supply chain with information of specific unmet needs and, critically, with the incentive of a Forward Commitment: a commitment to purchase a product or service that currently may not exist, at a specified future date, providing it can be delivered to agreed performance levels and costs. FCP provides the incentive, confidence and momentum for suppliers to invest and deliver innovative solutions.

Overview of the Step by Step FCP Procedure



FCP is a relatively new tool but following two successful demonstration projects, the approach is now being adopted more widely. The LCB-Healthcare network (consisting of parties from the UK, the Netherlands, Poland and Norway), is piloting the approach in number of case studies. In this presentation we will present the process and outcomes of three cases studies that are being conducted in the UK and the Netherlands.

Expected results and presentation

In the presentation, we will demonstrate how several public healthcare parties from the LCB-Healthcare network are experimenting with implementing the FCP methodology in specific procurement projects. We will present the implications this new approach has had for both public procurers and market parties. Furthermore, we will discuss any first results from a comparative study that are available when the conference is due.

The presentation will present the theory behind FCP, how it was developed and tested, and share the lessons learned and outcomes from the case studies. This action research provides real life examples to inform further developments in innovation procurement theory and practice.

Process Intermediation in Public Procurement of Innovation

Jillian Yeow, Jakob Edler

*Manchester Institute of Innovation Research, Manchester Business School,
University of Manchester, UK*

Buying and applying innovation in public service has benefits both for the delivery of the service and for the firms that generate and supply the innovation. For those two reasons, public procurement of innovation has come to the fore of innovation policy as well as strategies to innovate within the public sector. This has been recognised widely and there are all kinds of policy initiatives, reports, guidelines, and handbooks that promote public procurement of innovation and suggest ways in which it could be achieved.

The procurement of innovative solutions has the potential to improve delivery of public policy and services. However, as a 2011 OECD and report indicates, despite a roll out of public procurement of innovation initiatives across the EU (Izsak and Edler, 2011) innovation procurement is still hampered by a range of systemic failures. Challenges of public procurement of innovation identified in many case studies and surveys include the lack of procurer capability and competence (Phillips et al., 2007; Edler et al., 2011); procuring agencies struggle with shifting their routines and rationales towards a more risk-taking, interactive and long-term approach. There is a lack of capabilities to actually define needs and demand and subsequently purchase an innovation. The organisational reasons for this lack are manifold and given the lack of progress we observe across the board of public sector organisations, it appears that they are structural and basic.

This article tackles the issue of how innovation can be generated and adopted in complex public sector settings. It analyses the complex interaction between potential suppliers and buyers. Discussing a set of concrete case studies from the UK NHS, we argue that there is a role for intermediary organisations that have specialised capability to overcome systemic failures, to support the procuring agency in its specific activities rather than – as often advocated – centralise and standardise procurement functions. Starting from our knowledge on obstacles and shortcomings in innovation procurement, we argue that intermediation between supply and demand as well as within complex, multi-layered organisation can overcome structural obstacles in the interface between the buying organisation and the supplying market.

The role of intermediation in innovation has been widely discussed (for an overview see Howells, 2006), whereby intermediaries perform all sorts of functional roles in innovation systems. This literature has not, however, been mobilised to understand how

intermediaries can support the relationship between public buyers and suppliers. This is an obvious gap, as the source for deficiencies in procuring innovation are multiple information asymmetries, both inside organisations and between buying organisation and the market. Internally, there are challenges of definition of need within public organisation as well as with the ability and willingness to diffuse and use an innovation. Vis-à-vis the market, public organisations do often not know about the capabilities of suppliers or the performance and long term cost-benefit of innovations. Equally, suppliers often do not find the right entry points into public buyers and are not able to make strong business cases at the beginning of innovation cycles.

To understand those challenges, and the functions of intermediaries, we need to distinguish two types of public demand:

- Triggering demand: whereby public bodies define a new need or define a need differently to ask for something that has to be produced (radical innovation)
- Responsive demand: whereby the public body is able and willing to adopt a process, service or product that is new for itself, but already exists in the market.

For both triggering and for responsive demand this has different kinds of obstacles and application and adoption of an innovation.

Despite previous attempts to procure innovation, the cases we explore highlight several factors that have previously hindered successful innovation procurement, and that could be overcome through intermediation. In our first case, we explore a case of responsive demand in which multi-level intermediation mobilisation was vital to overcome the hurdles of adoption of an innovation that already exists in the market but had failed to diffuse in the system for many reasons. In particular, the innovation failed to gain momentum in a fragmented and complex organisation with multiple entry points, suffered from a lack of strategic leadership and ownership, and cost-benefit asymmetries of procuring the innovation. To address this issue, a multi-level intermediation strategy was implemented; firstly, at the regional level to ensure strategic leadership and commitment to the innovation, and secondly, at the level of individual Trusts and hospitals to elicit clinical and managerial buy-in and allocate dedicated resources to the project. This was done through the set up of a dedicated project team consisting of members with specialised knowledge and expertise in different areas, who were able to focus the necessary resources to engage the relevant stakeholders and overcome bottlenecks in the system. The case demonstrates that intermediation was necessary to address information asymmetries and provide specialised knowledge and dedicated resources to propel the innovation to be more widely diffused in the system.

Our second case explores an instance in which demand for a new product was triggered as there was no viable solution available in the market. Previous attempts to procure a new blood donation chair from the existing market failed; part of the problem was a lack of clear articulation of need to the market and a lack of knowledge specifically related to the procurement of innovation and its related processes. The organisation decided that a chair had to be produced specifically for their purpose, and to go down the pre-commercial procurement route to do so. Intermediation occurred in the form of an external organisation with specialist knowledge on identifying innovation needs in the health sector, how to articulate that need in a pre-commercial procurement phase and how to proceed towards commercial procurement. The solution was a multi-stage intermediation process; firstly, by decoupling the design from the manufacture process and ensuring both stages were tendered for separately. The design stage consisted of bringing together relevant stakeholders to a session facilitated by an expert to compile a list of needs that the innovation needed to satisfy. These needs were then translated into a design specification for which potential suppliers could tender to design and build a prototype. Through a dedicated project manager, a suitable prototype was chosen, tested and further developed in a closed environment to understand how the innovation would impact on work and organisational processes so that a further specification for the commercial procurement (manufacture) of the final "innovation" could be drawn up. The project manager was also integral in ensuring that the procurement of innovation was not controlled solely by the procurement function, and undertook the procurement as part of a larger strategic change initiative project. This helps to address the issue of specialist knowledge needed when procuring innovation, which a procurement department might not necessarily possess in relation to dealing with day-to-day, standardised general procurement. The result has been the design of a new chair that is user-centred, enhances the donation experience and improves staff working experience. Additionally, the procurement function (and indeed the organisation) has gained new knowledge in terms of alternative procurement processes that could be undertaken when addressing innovation, and have further set up new processes within the organisation to consider innovation in all their future procurements.

Our study shows that intermediation can occur in many different ways; indeed, in complex multi-layered organisations like the NHS, intermediaries can be helpful at all levels and at different stages of the innovation procurement process, in a variety of roles to address a wide range of challenges. Our case studies highlight the use of multi-level intermediation intervention for responsive demand for innovation and a multi-stage process intermediation to facilitate instances in triggering demand for innovation. In both cases, such intermediation aims to address the information asymmetry issue and improve the level of interaction between potential supplier(s) and buyer(s) through pro-

viding specialised capability and competency. This is particularly crucial in the procurement of innovation, which often requires a different set of skills and resources from standard, business-as-usual procurement.

The article makes the claim for increased effort to build up those intermediaries across procurement systems to support agencies in concrete procurement and, in doing so, build capacity for more intelligent public buyers. We contribute to the growing empirical and conceptual literature public procurement of innovation and, more generally, the role of intermediaries in innovation systems.

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New ways of solving problems in applied research: The example of a joint French-German research programme

**Andrea Zenker¹, Elisabeth Baier¹, Emmanuel Muller^{1,2}, Volker Tippmann³,
Jean-Alain Héraud²**

¹*Fraunhofer Institute for Systems and Innovation Research ISI, Germany*

²*Université de Strasbourg, Bureau d'Économie Théorique et Appliquée (BETA), France*

³*Headquarter of the Fraunhofer Gesellschaft, Research Planning Department, Germany*

Introduction

The Lund Declaration formulates the need for European research to focus its efforts and resources on the Grand Challenges of today's world. This claim includes a "new deal among European institutions and Member States", the involvement of a broad range of actors and the bundling of resources and competencies towards tackling global challenges. Besides the European requirement of a knowledge community, the eco-efficiency of Europe's future economy is emphasised: Available knowledge should be focused on resolving current challenges, one of the most crucial being ecological questions. In the research sphere, this mission calls for new concepts besides "current rigid thematic approaches" since potential solutions are limited through a pure vertical way of researching and applying research findings. The challenges can be tackled more efficiently through recourse to wide fields of research, as well as by proceeding horizontally and inter-disciplinarily.

In our contribution, we would like to extend this "issue-oriented" approach into an "issue- and strategy-oriented conception", using the example of a transnational French-German research programme in applied research. The programme brings together organisations from both countries to focus on applied, i.e. market-oriented research in fields such as energy, security, automotive, medicine technology, as well as information and communication technologies. This bilateral proceeding allows for the integration of human and financial resources, infrastructure and methodological approaches, as well as access to industries and markets. In addition, working together beyond national borders includes the integration of diverse cultural knowledge and experience which leads to the broadening of intercultural competencies of participating research actors. The "winners" of such bilateral programmes are not only the funding bodies who receive high-ranking research results but also the researchers who are able to access wider resources, and – particularly important in the case of applied research – the European industry that can be provided with high-quality solutions answering to companies' specific problems.

1. Motivation

This contribution aims to illustrate the French-German joint research programme PICF (*Programme Inter Carnot Fraunhofer*), its mission, objectives, bi-national governance and the implementation process. On the French side, the call addresses institutes of the *Association des Instituts Carnot*, while in Germany the focus is on institutes of the *Fraunhofer Gesellschaft*. The basic idea of this joint programme relates to the awareness that today's supra-national challenges should be encountered on a supra-national scale, i.e. that high-ranking challenges are more efficiently met by transnational means. In addition to a focus on specific topics and technologies as mentioned above ("issue-orientation"), the programme follows the strategic aim to promote long-term stable partnerships between the participating French and German institutes and research teams.

This joint programme is an example of transnational research coordination and governance through institutional cooperation. It illustrates the challenges of conceiving a bi-national research programme embedded in two individual research and innovation contexts: Although France and Germany have co-ordinated education and innovation policy instruments over a long period of time – starting with the Elysée Treaty in 1963 – both countries are characterised by differences in their policy traditions, the design of their innovation policies and the operation of their research and innovation systems. We envisage pointing to the advantages and synergy effects of such a bi-national programme that can be considered as part of the internationalisation process of research support. Furthermore, we think that the learning effects achieved through PICF can be of high use to other players acting in the field of cooperative research.

2. Approach

With a joint programme in applied research, France and Germany pursue the goal to create cooperations and strategic alliances between their prominent actors in applied research, the *Instituts Carnot* and the institutes of the *Fraunhofer Gesellschaft*. This contribution traces back the evolution of the programme, analyses its implementation and management and derives conclusions from the first bilateral experiences.

From a methodological point of view, our findings are based on the accompaniment of the PICF programme, including insights into the programme rationales and the bilateral projects performed. In this context, personal interviews and discussions with programme participants were performed, leading to a range of conclusions that are presented in a systematic manner. As a result of these investigations, effects on different levels have to be considered: on the level of the general framework conditions for (applied) research in both participating countries, on the policy and programme management levels and finally on the level of the participating research teams. Different con-

clusions can be drawn with respect to success factors and learning effects of this bi-national programme which can be helpful for further cooperative efforts.

In summary, our approach includes the discussion of the research programme on a conceptual level, switches over to the implementation process and then passes to synoptic analyses on the partnership level. In doing so, we aim to discuss the advantages of a transnationalisation approach in (applied) research, and the preconditions for stable research alliances in the context of finding answers to increasingly cross-cutting questions of today's world.

3. Expected results

This contribution shows how current global problems are reflected in the field of applied research: internationalisation in research is considered a strategic response to answering to global challenges while joint projects in selected (technological) fields tackle specific issues which need to be resolved. Our hypothesis is that transnational research can respond better to global issues since it includes a broad fund of resources whose combination leads to widened – sometimes even unexpected – solutions. These resources do not only include financial means, competencies and infrastructure, but also rather indirect resources. We refer here to tacit effects of transnational research cooperation in terms of experiences and learning effects obtained. These effects are obtained on the policy, administration and programme management level (policy learning), and also on the level of the individual researchers and research teams (intercultural learning).

Results obtained so far show that as well as "hard factors" of joint projects (research objectives and agendas, resources and capacities, infrastructures and methods, etc.) "soft factors" such as for instance project management habits play a pertinent role. These are rarely perceived in the course of a joint project and rather become evident in retrospect. Often under-estimated, they may be a key to successfully realizing a project and – even more so – can be important success factors for bi- and international cooperation since they give an insight into different working and management processes, but also different market and client structures, different communication practices or mentalities. Including these factors into joint activities may lead to pertinent competitive advantages – an effect that is even more important in long-term strategic partnerships as favoured by the joint French-German research programme presented here. Full consciousness and appropriation of both hard and soft factors are not only beneficial for both markets considered, but also lead to competitive advantages on the European level.

4. Conclusions and policy implications

In how far can bi-national or multi-national research programmes contribute to the resolution of current challenges? In fact, considering learning effects as a starting point, such a programme benefits from the experience accumulated thanks to different research traditions and landscapes; different modes of research support and research programmes already existing at national levels.

More generally, and addressing the applied character of research performed in the frame of the French-German programme considered, it must be emphasized that bringing together researchers and institutes from two different national cultures implies not only that different solutions to the (same) problem may emerge but that even the (same) problem may be defined (and re-defined) differently, which consequently opens up new possibilities for a solution. In other words, a striking issue is here to consider to what extent such bi- or multinational applied research programmes not only constitute a good approach to "solve new problems" but in addition reinforce an ability to "discover new problems". This in turns favours a capacity to generate new "bijections" between "problems" and "solutions" spaces.

In summary, grand challenges require grand solutions to conceive successful development paths. In our view and from the experiences gathered so far, a transnational research strategy is one highly beneficial instrument to address those global challenges. However, a strategy of this kind goes farther than supporting joint research projects – it implies the development of a stable research structure in which transnational projects are embedded. This issue has a multilevel character: Following the joint policy decision and vision building process, joint reflections on the organisational level are indispensable for such a research strategy to be implemented and realised. And finally, the levels of individual researchers and research teams have to be involved, since they are at the core of transnational research activity. In this respect, the French-German PICF programme takes an important step towards a strategic and long-term oriented approach.

Elevator Pitch – Abstracts

Development of synthetic biology – a patent analysis

Davy van Doren

Fraunhofer Institute for Systems and Innovation Research ISI, Competence Center Emerging Technologies, Germany

In over 100 years, synthetic biology has developed from a mental concept into an exploitable field for biotechnology. However, it is unclear to what extent synthetic biology has matured enough for being 1) subject of patent activity, and 2) commercially exploitable. By means of a patent analysis, this study shows that there is an increasing trend in filing synthetic biology patents. Although the majority of retrieved patents are focussing on enabling technologies and understanding biological systems, there is also some initial activity concerning direct development of synthetic biology based application. The analysis shows that most activity has been carried out by the USA, with Japan and a number of European countries considerably trailing behind. The results comprise a starting point for follow-up studies concerning the identification of drivers explaining the observed trends in synthetic biology development.

Societal impact assessment of research programmes

Stefan de Jong, Tjerk Wardenaar

Rathenau Institute, the Netherlands

Universities are more and more expected to engage with society. In this context, many governments have introduced network programmes in which universities collaborate with e.g. ministries and private companies. We claim impact of these programmes should be assessed at programme level, rather than assessing impacts of individual projects.

We have compared two large Dutch national network programmes. For each project within these programmes, societal impact; parameters concerning its position in the overall project network; and parameters concerning project composition in terms of involved partners have been determined. Between the programmes there are differences in average societal impact of a project that can be explained by network position of the project and project composition. Within each programme, impacts of individual projects cannot be explained by these parameters.

Additionally, we found differences at programme level in management of interaction with external societal actors and embedment of the programme in its relevant societal context; and management of project composition that can explain network characteristics and project composition.

Context

The project is in its finale stage; currently a scientific paper is being written. Stefan de Jong is first author of the paper and has been involved in a societal impact analysis of one of the research programmes. He also has done the additional research and analyses required for the project that is subject of the elevator pitch. Tjerk Wardenaar is second author and has been involved in a societal impact analysis of the other programme.

The project is part of a research line on evaluation and organization of societal impact of academic research. Stefan aims to write a PhD thesis based on studies in the fields of architecture, law, ICT, technology & policy science, climate science and medical science. Focus is on factors that drive and hamper societal impact of academic research.

Time Lags in Dynamics of GERD and GDP: Cross-country Analysis

Maxim Kotsemir

National Research University Higher School of Economics (HSE), Institute for Statistical Studies and Economics of Knowledge, Research Laboratory for Science and Technology Studies; Russia

The main idea of this paper is to estimate the time-lags between the impact of GERD structure and the dynamics of GDP in different countries. I examine the interaction between these two variables. Of course, investments in research and development are not the only key driver of GDP. However, the aim of this paper is not to develop a complex model, linking the investments in the economy of knowledge and other variables with economic growth, but to create a simple and intuitively clear model of lag structure which can be used for policy making. Evidence of the existence of a significant lag (in 4 - 5 years) of the impact of GERD on GDP will be useful to develop more stable, consistent and coherent STI policy. Cross-country analysis helps us to explore the situation in different countries, which turns out very useful in development of recommendations for STI policymakers. The aim of this research is to assess the lags (its length and structure) of impact of total investments in the national innovation system (not only the business sector investment) on economic growth. Therefore, I will use aggregate data which allows to run a comprehensive cross-country analysis.