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Collaboration between multinational subsidiaries and local universities: evidence from Spain

Presented to 'New perspectives on enduring research questions in university-society interaction?'

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1. INTRODUCTION

The aim of this paper is to explore how the subsidiaries of multinational companies (MNC) collaborate with universities in local contexts, including collaboration in research and development (R&D) and in higher education and training. Such collaboration is an issue of strategic importance both for host countries and for the MNC. From the host country perspective, linkages between MNC subsidiaries and local universities generate the conditions for mutual learning and knowledge spillovers. Moreover, the embeddedness of MNC subsidiaries in the national innovation system increases the likelihood of an upward evolution of subsidiaries towards higher value added activities; and ultimately towards becoming centers of excellence within global innovation networks. This, in turn, has important implications in terms of the potential contribution of MNCs to the upgrading of the domestic economy. From the perspective of the MNC, there is an increasing interest in tapping into international sources of knowledge to improve innovative capabilities. Indeed, the possibility to collaborate with foreign universities abroad is precisely one of the main drivers of the internationalization of business R&D (Broström *et al*, 2009; OECD, 2011; UNCTAD, 2005). With regard to collaboration in higher education and training, it may have positive effects in terms of the ability to recruit talented employees and by providing specific training to future or existing employees. In addition, it is often conceived as an important component of corporate social responsibility agendas.

The theoretical anchoring of this paper combines contributions from the international business literature and from research and innovation studies. On the one hand, the international business literature has explored widely the embeddedness of MNCs in local contexts, but it tends to focus on collaboration between MNC subsidiaries and local firms (suppliers, customers and competitors), with insufficient attention to collaboration with universities or public research centers. On the other hand, research and innovation studies are richer in analyzing university-industry collaboration, but rarely differentiate between firms under national or foreign ownership. This paper brings together these two strands of literature with the aim of attaining a better understanding of the collaboration of MNC subsidiaries with local universities.

Building on that theoretical framework, this paper provides an analysis of MNC-university collaboration in Spain. The focus lies on exploring the degree and types of MNC-university collaborations; the underlying motivations; the institutional modes of collaboration; and the implications that follow. The empirical evidence encompasses three complementary levels of research:

- An aggregate overview based on available statistical sources, including OECD statistics of the R&D expenditure of MNC subsidiaries; the FDI Markets database on new FDI in R&D projects; and the community innovation survey administered to firms by the Spanish statistical institute.
- A new survey targeted to innovative MNC subsidiaries in Spain, with 89 valid replies. This survey was administered in 2011 by a research team including the author, with support from Invest in Spain, the Spanish government's investment promotion agency.
- A multiple case study comprising 7 multinational subsidiaries with significant R&D activities in Spain, including personal interviews with the firms' R&D managers.

Spain is an EU country characterized by holding an intermediate position, in the sense that it does not reach the technological excellence of the core EU countries (like Germany or France), nor can it compete based only on costs with other peripheral members (like Eastern European countries and most other Southern European countries). Indeed, according to the synthetic innovation indicator elaborated by the European Commission, Spain's below-average performance in science and technology is characteristic of a *moderate innovator* within the EU (EU, 2011). Moreover, the interest of MNCs in setting up significant R&D centres in Spain is a relatively recent phenomenon, following growth and catching-up of the Spanish economy during the last two decades and recent trends in the

internationalization of corporate R&D. Therefore, as we shall show, linkages between MNC subsidiaries and local universities have been established very recently, mainly from 2005 to 2010. For all these reasons, the case of Spain provides a good context for analysis relevant to other catching-up economies around the world.

2. THEORETICAL BACKGROUND

Recent research in international business suggests that R&D has evolved from a centralized and hierarchical function of corporate supply chains towards one that builds upon a network of geographically disperse R&D centers (Cantwell and Molero, 2003; Narula and Zanfei, 2005). Through R&D internationalization, MNCs aim at tapping into resources and capabilities from multiple local contexts to integrate and leverage them into competitive advantages (Meyer et al, 2011).This opens up new windows of opportunity for the subsidiaries of MNCs (and for host countries), which are now more likely to become engaged in innovative activities if the appropriate conditions are in place.

In parallel to internationalization, a complementary trend in the organization of MNCs' R&D activities is the higher reliance on external sources of knowledge; a gradual and ongoing process which has been described as the transition from a closed to an *open innovation* model (Chesbrough, 2003). Clearly, open innovation increases the likelihood of a localized collaboration in R&D between MNC subsidiaries and domestic actors, including other firms (customers, suppliers and competitors), universities and public research centers, and government agencies.

Following Dunning's eclectic paradigm, firms invest in foreign locations not only to exploit their *ownership advantages* but also to access *location-specific advantages* that can be *internalized* by the firm in order to enlarge its knowledge base. This gives rise to the distinction between *competence-exploiting subsidiaries* and *competence-creating subsidiaries* (or centers of excellence) (Cantwell and Mudambi, 2005). Competence-creating subsidiaries are more autonomous and embrace strategic activities that transcend the confines of the local market, such as R&D or (regional) headquarter functions. MNC subsidiaries that engage in R&D need access to well trained engineers and researchers, and actively seek to draw inputs from local sources of knowledge, including universities. Thus, this kind of subsidiaries are often more closely embedded within the regional innovation system where they are located, and it becomes plausible to expect a co-evolution between the scope of the subsidiary's mandate and the extent of its local embeddedness (Álvarez and Cantwell, 2011; Andersson et al, 2002; Heidenreich 2012). The embeddedness of MNC subsidiaries is also a critical element to evaluate the developmental impact of FDI on host regions, because local linkages provide for greater knowledge spillovers, learning by interacting, and access to international markets.

In the international business literature, empirical studies dealing with the embeddedness of MNC subsidiaries tend to focus on linkages with domestic firms (e.g. Javorcik, 2002; Santangelo, 2009; Phelps et al, 2003), with insufficient attention being paid to linkages with universities. However, research and innovation studies have analyzed widely the rationales and modes of university-industry collaboration, regardless of whether the firm that collaborates is nationally-owned or an MNC subsidiary. Indeed, university-industry collaboration has been the subject of a very large number of studies, focusing on the motivations and mechanisms for university-industry relationships in different countries and sectors (e.g. Feller and Roessner, 1995; Koschatzky and Stahlecker, 2010; Pisano, 1990), on the emergence of start-up companies and the commercialization of patents (e.g. Bruneel et al., 2010; Shane, 2004; Valentín and Jensen, 2007), on the partner characteristics which affect the formation of a collaboration (e.g. von Raesfeld et al, 2012) and on the type of management systems that enable successful collaborations (e.g. Gray et al, 2011; Morandi, 2011).

From the corporate perspective, Feller and Roessner (1995) classify the factors that motivate firms to engage in partnerships with universities into research, education, technology transfer, dissemination and networking. Key outcomes that firms search from universities are patents, licenses, graduates hired, new products, and lead time in new product introduction. The typical reasons for firms to

engage in collaboration with universities include gaining access to complementary scientific or technological knowledge, risk reduction, cost reduction, access to public funding and incentives, and the desire to influence the overall teaching and research agenda of universities. Collaboration with universities improves the capability of firms to introduce more advanced innovations (Kaufmann and Tödtling, 2001). Along these lines, Meeus et al (2004) explain how as firms engage in more complex innovative activities, the probability of internal resource deficits increases, and thus they become more interested in searching for complementary resources elsewhere through collaboration.

From the university perspective, typical motivations to collaborate with industry include the enhancement of teaching, access to funding, reputation enhancement, and access to empirical data from industry. Another significant motivation is that universities are subject to increased political pressure to become a driving force for regional economic growth (Laukkanen, 2003). Indeed, since the 1990s shifts in the strategic missions of universities can be observed, with a higher emphasis on their contribution to meeting the needs of firms and to the larger role of universities in economic and social development (Breznitz and Feldman, 2010; Laredo, 2007). This shift is clearly reflected in the growing popularity of the "triple helix" conceptual framework (Etzkowitz and Leydesdorff, 2000), which stresses the importance of university-industry-government interactions and advocates for the formation of hybrid organizations at the interface of these networks, in order to improve the socio-economic returns of national research systems.

These wide ranging motivations may be articulated through different institutional modes of university-industry collaboration, including contract and cooperative research, licensing, use of lab facilities, technical services and consulting, personnel mobility, information dissemination through publications and new venture creation. Hagedoorn et al (2000) distinguishes between informal and formal collaboration modes, with the former being associated to equity partnerships, contracts, research projects and joint projects. Collaboration may be short-term (related to on-demand problem solving with predefined results) or longer-term (strategic, open-ended, without clearly predefined objectives) (Schmoch, 1999). Short term collaborations are generally articulated through contract research, consulting and licensing, while longer term collaborations are associated with joint projects and public private partnerships (including private-funded university institutes or chairs, competence research centers, joint university-industry research centers, research consortia of several firms and universities, etc.). This kind of arrangements allow firms to contract for a core set of services and to periodically re-contract for specific deliverables in a flexible manner (Koschatzky and Stahlecker, 2010). This provides a flexible and multi-faceted platform where firms can develop a stronger capacity for problem solving in the long run, building upon the capabilities, methods and tools of universities.

In one of the few studies focusing on the collaboration between MNC subsidiaries and local universities, Brostrom et al (2009) develops a comprehensive taxonomy of why and how such collaborations arise, based on a set of case studies covering 3 European clusters. The most frequent modes of collaboration in the cases analyzed were joint research, consulting, commissioned R&D, and shared staff (for example, in the form of adjunct professors and PhD students with formal connections to the firm). These authors also stress that the extent of MNC subsidiary–university collaboration in R&D depends upon the strategic function of that R&D subsidiary within the overall R&D strategy of the corporation. The case studies also show that the modes of collaboration with universities evolve over time, such that certain collaborations may be upgraded or downgraded depending on the perceived results. From a different perspective, Cui et al (2010) analyzes how R&D cooperation between MNC subsidiaries and local (Chinese) universities leads to technology spillovers that benefit the host country. In this paper we contribute to this strand of research by providing some evidence on MNC subsidiary – university collaboration in Spain.

3. MNC SUBSIDIARIES IN SPAIN AND COLLABORATION WITH UNIVERSITIES: GENERAL OVERVIEW

Multinational subsidiaries play a very important role in the Spanish innovation system, as evidenced by the fact that they account for around one third of total business expenditure in R&D (OECD, 2007). This proportion is similar to the EU average and is larger than in France, Italy and Germany, although lower than in other countries like the UK, Sweden or Ireland. According to FDI Markets database[1], in the 8 years from 2003 to 2010 there were a total of 71 new R&D centers created by MNCs in Spain, representing 11.1% of the EU total. This places Spain as the 3rd most attractive destination for FDI in R&D in the EU during that period, after UK (20.2%) and France (13.5%), and in same position as Ireland (11.1%). On average, each of these R&D centers opened by foreign MNCs in Spain generated 77 new jobs and an investment of around 15.6 million USD (making for a total of 5437 jobs and 1108 USD million investment). In regional terms, 65 per cent of all new R&D centers were located in Madrid or Catalonia. By sector, most were in pharmaceuticals (25.4%), Software & IT services (16.9%), Chemicals (7%) and Communications (7%), followed by a broad range of other sectors like Non-Automotive Transport OEM (5.6%), Industrial Machinery, Equipment & Tools (4.2%), Metals (4.2%), Business Machines & Equipment (4.2%), Electronic Components (2.8%), Alternative/Renewable energy (2.8%) and Plastics (2.8%).

Empirical studies comparing MNC subsidiaries with national firms in Spain show that the latter tend to operate to a larger extent in high technology sectors and invest more in R&D and training (Álvarez and Molero, 2005; Molero and Álvarez, 2003). This forms the basis for evaluating the positive impact of foreign MNCs in the Spanish innovation system, although such differences attenuate when controlling by industry and size of the firm (Añón et al, 2011). Along these lines, other studies find that the innovative performance of MNC subsidiaries is similar to that of large national firms, while both appear as more active technologically than Spanish SMEs (Molero and García, 2008). Moreover, the analysis of the spillovers associated with the presence of foreign MNCs in Spain concludes that such effects are positive and especially significant in industries with higher absorptive capacity (Álvarez and Molero, 2005). In any case, a recent study based on a survey to a sample of 125 MNC subsidiaries in Spain (Miravitlles et al., 2010) shows that the R&D performed by MNC subsidiaries in Spain tends to be development rather than research, often related to the adaptation of products and processes to the local market rather than to radical innovation.

Focusing now on collaboration, according to our analysis of the latest data from the Community Innovation Survey (Álvarez et al, 2012), the proportion of MNC subsidiaries in Spain that collaborate to innovate (30 per cent) is significantly higher than among national firms (25 per cent). In particular, 12.5 per cent of all MNC subsidiaries in Spain responding to the Community Innovation Survey declare to collaborate with Spanish universities. Firms under foreign ownership also show a higher propensity to collaborate with local universities than firms under national ownership, even after controlling by size of the firm.

3.1. RESULTS FROM A SURVEY

In order to explore further the collaboration of MNC subsidiaries with Spanish universities and firms, in 2011 we performed a new survey across different Spanish regions (Álvarez et al, 2012). This survey was funded by Invest in Spain and counted with the support of the Spanish regional governments. Invest in Spain asked each of the relevant departments of the 17 Spanish regions to send the survey to 10 MNC subsidiaries in their region that collaborate in R&D with local firms/universities.

[1] This database is compiled by Financial Times Group and comprises only greenfield FDI project announcements, excluding M&As. Despite its limitations, it is one of the few sources available to measure FDI in R&D, because it provides information not only of the sector but also of the business activity associated with each investment announcement.

Therefore, despite the regional stratification, the sample is not representative of the general population of foreign firms in Spain but rather of the most innovative among them. A total of 89 valid replies were obtained. Table 1 shows some characteristics of the sampled firms, and below we discuss briefly some of the main results[2].

Table 1 Characteristics of the survey sample

Sample size	89
Country of origin	EU (72%), US (16%), Other (12%)
Entry mode	M&A (53%) Greenfield (47%)
Average total employees (2010)	652
Average R&D employees (2010)	15
Average R&D expenditure (% of sales, 2010)	9.32%

Source: Authors' survey, 2011

Besides structural variables of the surveyed firms, the questionnaire collected information about the modes of collaboration with universities, public research centers and other firms, as well as information on the motivations behind collaboration and the relative importance of different modes of collaboration. Most of the sampled firms collaborate in R&D with external partners. The most frequent partners in R&D collaborations are universities, followed by R&D centers and other firms (Table 2). It can also be observed that collaboration is more likely with agents located in the same region, followed by other Spanish regions and other countries. The importance of distance seems to be more important in the case of collaboration with universities than in the case of collaboration with suppliers or customers, a result which is consistent with Abramo et al (2011).

Table 2 Collaboration in R&D by partner type and location (percentage of sampled firms)

	In same region	**In other Spanish regions**	**In foreign countries**
Universities	55.06	40.45	21.35
R&D centres	52.81	40.45	30.34
Suppliers	52.81	52.81	43.82
Customers	51.69	44.94	35.96
Competitors	20.22	16.85	13.48

Source: Authors' survey, 2011

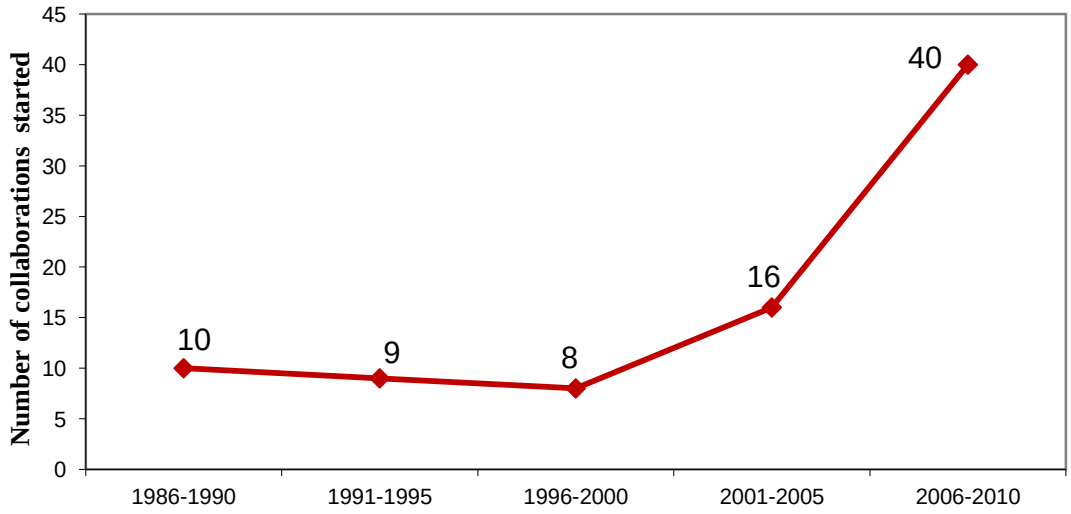
The survey also shows that, even in this sample of some of the most innovative MNC subsidiaries in Spain, collaboration in R&D with universities is a relatively recent phenomenon, which takes-off in the early 2000s and accelerates in the second halve of the decade (Figure 1)[3]. Collaboration with universities is gaining a higher strategic importance in recent years, which can be explained from different perspectives. First, MNCs are progressively adopting an open innovation model with a higher emphasis on gaining access to external sources of knowledge and on collaboration with other agents in innovation systems, which applies equally to international subsidiaries. Second, as

[2] The full results of this survey are available in Spanish in the project's final report (Álvarez et al, 2012).

[3] In the case of leading countries in university-industry collaboration like Germany and the US, Schmoch (1999) finds a dynamic increase of university-industry relations since the 1980s, and it would be reasonable to assume that this phenomenon is reaching less advanced countries like Spain with some years of delay.

multinationals engage in higher value added, competence-creating mandates, they need access to a more advanced base of knowledge and skills, which calls for a stronger collaboration with local universities and research centres. Third, Spanish universities have also become more interested in collaboration with firms reflecting changes in management and incentive systems, as well as a growing pressure from policymakers.

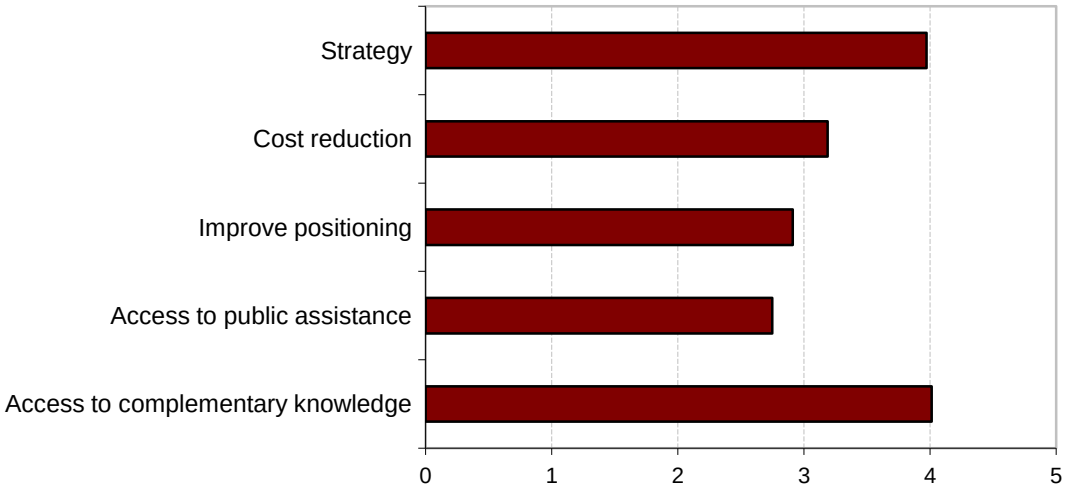
Figure 1 Starting year of R&D collaboration with universities in region



Source: Authors' survey, 2011

Most MNC subsidiaries engage in R&D collaborations to access to complementary knowledge, and because of strategic, long-term reasons (Figure 2). Another related motivation, specific to MNC subsidiaries, consists in improving the position of the subsidiary within the global network of the MNC. Finally, other key reasons for collaborating are related to cost reduction and to the access to public funding and incentives.

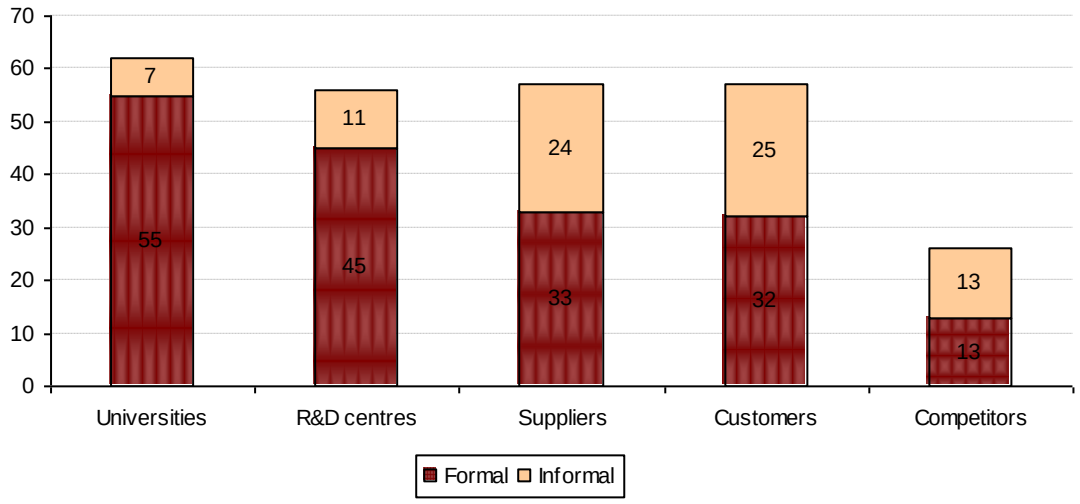
Figure 2 Main reasons for collaborating in R&D (mean values)



Note: Based on Likert scale from 0 (not important) to 5 (very important)
Source: Authors' survey, 2011

Another interesting finding is the clear preference for formal modes of collaboration, as suggested in Hagedoorn and Ridder (2012). This reliance on formal modes of collaboration is especially acute in firm's collaboration with universities, compared with other possible R&D partners (Figure 3).

Figure 3 Nature of R&D partnerships



Source: Authors' survey, 2011

4. INSIGHTS FROM CASE STUDIES

To complement the previous findings we analyze further a set of seven MNC subsidiaries which have deepened the scope of their R&D activity in Spain in recent years and have built closer linkages with local universities along the way. As shown on Table 3, these MNC subsidiaries are large firms with 5223 employees in Spain on average, out of which 148 on average were R&D employees. Four of the companies are headquartered in the US while the other three are of European origin. A diverse group of industries are represented, including manufacturing and services, and both high- and low-technology sectors. In any case, as it is well known, the case study methodology does not seek a representative sample that enables for statistical generalization, but rather aims to provide a deeper understanding of the phenomenon that may enable some extent of analytical generalization (Stake, 2005; Yin, 2003). This is not a representative sample of the whole population of foreign subsidiaries in Spain, but rather of the most innovative among them, which can be characterized as excellence centers within the MNC structure, holding global R&D mandates in certain products and technologies. The decision to focus on the most innovative MNC subsidiaries can be described as "extreme case sampling" (Patton, 1990). Behind the selection of the specific case studies there is also an ex-ante attempt to search for complementarity, such that each case sheds new light into different modalities and motivations of MNC-university collaborations.

The information was gathered through semi-structured interviews with the managers of these companies supplemented with a review of secondary sources like websites and material provided by the interviewees. Normally the interviewee was the director of the R&D center, and the interviews were structured around a questionnaire covering 3 dimensions: 1) R&D activities of the firm in Spain

(location, scope, evolution) 2) Collaboration with universities (nature, motivations, evolution) 3) Attraction factors of Spain for R&D location and policy implications.

Table 3. Case studies of innovative subsidiaries in Spain: key descriptors

Company	Country of origin	Activity in Spain	Total employees	R&D employees
3M	USA	Health, security, office supplies, chemicals	650	30
Accenture	USA	Technology consulting	12000	n.a.
Atos	France	Technology consulting	5700	200
HP	USA	ICT and hardware	8600	450
Nutreco	Netherlands	Food	4000	35
ThyssenKrupp	Germany	Elevators, escalators	5500	150
Yahoo!	USA	Internet	109	25
Average	-	-	5223	148

Note: Employment figures refer only to operations in Spain.
n.a. = not availabe
Sources: personal interviews and survey

These case studies provide further support to some of the results from the broader survey presented in the previous section, such as for example the finding that collaboration with universities has taken-off from a very low base in the 2000s and especially since 2005. In addition to an increase in collaboration agreements, we also observe a deepening in the extent of collaboration, often following an evolutionary path from collaboration in education and training to collaboration in R&D. In other words, collaboration in education and training may be seen as a "seed" which can later lead to collaboration in R&D.

Indeed, the case studies were useful to better understand the dynamic and evolutionary nature of MNC-university collaborations, with an expected evolution from a focus on recruitment and training, towards arms-length collaboration in research projects and services, and at a later stage towards longer term, strategic research partnerships. This reflects the evolving motivations and needs of MNC subsidiaries, as well as the changing technological capabilities of universities. Collaboration with universities becomes more intense when the subsidiary becomes a center of excellence, adopting higher value added innovative mandates of global (regional) scope. Competence creating mandates are associated with a closer collaboration with universities, because the subsidiary aims at contributing to global innovation networks, generating new products and technologies to be applied globally by the MNC.

Collaboration in R&D takes place through subcontracting and through joint participation in research projects. In addition, an interesting finding is that private-funded Chairs are becoming an increasingly popular institutional vehicle for MNC subsidiary-university collaborations, because they provide a stable and flexible structure that transcends the horizon of individual projects, while minimizing the administrative burden. Collaboration in graduate training also takes many different forms, like funding of specialized programs; participation of MNC employees in teaching; offering scholarships, prizes and traineeships; joint supervision of master and PhD thesis; and inviting PhD students to develop their research within the premises of the MNC.

When asked about the attraction factors of Spain as a location for MNCs' R&D centers, most of the interviewees mentioned the availability of well-trained engineers and researchers at lower cost than in other European countries. In addition, these case studies show that MNCs have established R&D centers in Spain in areas where the country's firms and universities are becoming technological

leaders, such as renewable energies, train transportation, and infrastructures, among others. Other of Spain's attractiveness factors for international R&D include the country's EU membership, links with Latin America and capacity to attract international talent.

Many interviewees also emphasized the importance of fiscal and financial incentives, as well as the possibility to participate from Spain in EU-funded R&D projects thanks to the development of the European Research Area. According to some of our interviewees, public funding of R&D is very important for MNC subsidiaries not only because of the funds per se, but also because of the *signalling effect*, that is, because receiving incentives is a recognition of the project's quality and relevance that contributes to attracting headquarter's interest in the project and commitment of additional resources. In many of the case studies it also became apparent that public incentives have had a significant *behavioural additionality* effect (OECD, 2006), that is, they have influenced the propensity of MNCs to collaborate in R&D with local universities because most of the available business R&D funding schemes (from the central government, the regional governments, and the EU) focus on research consortia.

Beyond these general findings, in the rest of this section we elaborate further on each of the seven individual case studies, in order to illustrate in further detail how MNC subsidiaries have embraced a stronger collaboration with universities in recent years.

4.1. A GROWING INTEREST IN COLLABORATION WITH UNIVERSITIES IN R&D AND TRAINING: THE CASE OF HEWLETT-PACKARD

In 1985 HP located in Spain its main factory for large printers, but in the year 2000 the manufacturing activities were off-shored to different Asian countries. Despite the loss in manufacturing, the Spanish subsidiary managed to retain a global mandate for this product line including R&D, finance, operations and marketing, and in subsequent years this mandate was extended to other products like paper and digital pen. This illustrates how the evolution of MNC subsidiaries towards larger scope R&D mandates might occur even in manufacturing off-shoring contexts. Since 2005, the Spanish R&D center also coordinates the work of two other R&D centers that HP acquired in Israel and Minnesota. According to the R&D director of HP Spain

> *"During the last few years we have undergone a fast transition towards an open innovation model, leading to a much stronger collaboration in R&D with Spanish universities, technology centers and local firms" (…) "in order to retain and expand our R&D mandate, we need to foster a deep network of local R&D partners to bring in complementary knowledge and capabilities. This is something which is becoming ever more important in the minds of senior HQ managers which evaluate our work and future potential".*

Along these lines in recent years HP Spain has launched several new strategic collaboration agreements with local universities. For example, since 2003 HP Spain funds the HP Chair in Digital Image and Editing hosted at the Polytechnic University of Catalonia, which provides a platform for joint research activities (in areas like image processing, remote diagnosis systems, printing technologies, color management devises, and others) as well as for training (through the participation in PhD education and through an annual prize for the best student projects). Another example is the Leon Technological Observatory created in 2005 in partnership with the University of Leon, which has developed a joint training program. During the training period students work in R&D projects under the joint supervision of HP managers and university professors, and some of these projects have later had a direct application to HP's business. Many of the students that participate in this program are later hired by HP, so that it is being used as a tool for attracting talent and providing training to future employees. This model was replicated in another Spanish region in 2010 under the name of the INNO-TALENT25 project, by virtue of which the company provides 25 annual internships to recent graduates who receive tailored training and contribute to HP's R&D projects. The main

objective of this program is to attract and train new talented employees, which are later often hired either by HP or by its network of subcontractors.

4.2. WHEN COLLABORATION IS AT THE ORIGIN: THE CASE OF YAHOO!

In 2006 Yahoo! established in Barcelona its first R&D center in Europe (its other global R&D centers are located in New York, California, China, India, Israel and Chile). The Spanish R&D center specializes in internet search systems and is located within the premises of the University Pompeu Fabra. Thus, this is a case of an R&D center which was born out of collaboration with a university, as opposed to the most typical pathway consisting in the initial establishment of an R&D center which engages in collaboration with local universities only sequentially in time. Location within the university offers Yahoo! significant advantages such as access to equipment and infrastructure, as well as administrative support in the management of EU-funded projects. The R&D director of Yahoo! Spain refers to this as "research hosting", whereby the university hosts the R&D activity of an MNC providing incentives in the form of office space, equipment, support services, etc., as well as the capacity to build linkages with university researchers and an attractive environment for employees. Since its creation, Yahoo! Spain R&D center has developed several R&D projects and technology platforms, most of them co-financed by the EU Commission in partnership with other Spanish and European firms and universities.

When Yahoo! was considering different locations for its first R&D center in Europe, the key reason behind the selection of Spain was the influence of Ricardo Baeza-Yates, a leading expert in search technology formerly working at the University Pompeu Fabra, who offered Yahoo! to join the company as leader of the new R&D center if it was located in Barcelona. Baeza-Yates, a Chilean national, had arrived to Barcelona in 2004 with a research fellowship financed by the regional government under a program to attract international talent called ICREA. He then became affiliated to the University Pompeu Fabra and engaged in a project to promote the ICT and media cluster in the region financed by the regional government. This is thus a good example of how governments can catalyze "triple helix" interactions that lead to the attraction of international talent and of R&D-intensive FDI.

4.3. MULTIPLE MODES OF COLLABORATION WITH UNIVERSITIES ACROSS DIFFERENT SPANISH REGIONS: THE CASE OF THYSSENKRUPP

Thyssenkrupp hosts two R&D centers in different regions in Spain specialized in people transportation systems. The center in Asturias is one of the three global R&D centers that the company operates for horizontal transportation systems (escalators, moving walks, passenger boarding bridges, etc.), with the other two located in Germany and China. The center in Madrid specializes in vertical transportation (elevators), and it is one of the eight global R&D centers within this business line (the others are in Germany, the US, Canada, France, Brazil, China and South Korea).

In recent years the Asturias center has developed new products which have been applied globally, such as the so-called Turbotrack, a horizontal transportation system which was installed in the Toronto airport and won the 2007 ThyssenKrupp Innovation Contest as the most innovative project developed globally in the company that year. The center in Asturias has established a deep collaboration with the University of Asturias both in R&D and in training activities. It is also involved in a recent regional initiative called Manuf@cturias which aims at accelerating the transformation of regional industrial companies by stimulating innovation and comprises several local firms, universities, technology centers and the regional government. This illustrates the company's ongoing efforts to deepen its regional embeddedness to its own benefit and to the benefit of the region.

On the other hand, the R&D activities in Madrid were significantly expanded in 2011 and relocated inside the Mostoles Technology Park, with significant support from the regional government. The new center brings together and expands the R&D activities that were previously scattered throughout different locations in Madrid. It hosts a state of the art testing tower with eight elevators

as well as over 400 square meters of dedicated labs with the latest equipment to perform noise and energy efficiency tests, among other features. This center also collaborates closely with different universities in the region both in R&D and in training. For example, in 2011 the company established a collaboration agreement with the University Rey Juan Carlos, which is also located in the Mostoles Technology Park, illustrating the importance of proximity for the establishment of linkages. This collaboration is initially focused on education and training, by offering internships to engineering students and participating in postgraduate teaching and training activities. However, the R&D manager of the company that we interviewed states it is expected that in the near future the collaboration will extend to joint R&D projects. Besides a limited extent of joint R&D projects with some universities such as Carlos III, the ThyssenKrupp R&D center in Madrid also relies on universities such as the Polytechnic University of Madrid as providers of metrology and quality control services, for example to test and certify the security of its new elevators. This allows the company to tap into the infrastructure and knowledge of certain university departments.

4.4. SPAIN AS A PLATFORM TO PARTICIPATE IN EU-FUNDED R&D PROJECTS: THE CASE OF ATOS

This global IT services company hosts in Madrid its main global R&D center, called Atos Research and Innovation (ARI). According to one of its managers interviewed for this study, the main reason to locate in Spain was related to "a very favourable balance between the cost of labour and the availability of highly educated managers and researchers". ARI's research focuses on emerging IT solutions and technologies, and it is currently managing or participating in 135 R&D projects, out of which 96 are EU-funded. Thanks to its accumulated experience, besides participating directly in R&D projects, ARI also provides R&D project management and outsourcing services to other units of the firm across the world and to its customers.

Collaboration with universities is intense, as a result of participation in R&D projects financed by the EU or the national government which focus on research consortia bringing together firms and universities from different Member States. In several cases, following the first project, collaborations with specific universities have become more strategic through the preparation of new proposals and the joint participation is subsequent projects. Collaboration is particularly intense with computer engineering departments of Spanish universities, not only from Madrid but also from many other regions. Besides joint participation in R&D projects, in 2011 the company launched the first edition of the so-called IT-Challenge competition in collaboration with five Spanish universities, targeted to university students who present innovative IT project proposals.

4.5. PRIVATE-FUNDED UNIVERSITY CHAIRS AS AN INSTITUTIONAL MODE OF COLLABORATION: THE CASE OF ACCENTURE

The Spanish subsidiary of Accenture has progressively turned into a strategic node within the firm's global network, not only because of its large market share in the Spanish market but also because it has become increasingly engaged in competence building activities and because the Spanish subsidiary is also responsible for coordinating Accenture's operations in Southern Europe and Africa. Several new services and business models first developed in Spain have later been applied throughout other global locations of Accenture, such as software platforms for the banking sector and offshore software development centers. Alongside with the adoption of more creative and competence building functions with a global scope, Accenture Spain has placed a higher emphasis on collaboration with clients, suppliers and universities to spur innovation.

A clear example of the creation of closer linkages with local universities is the UAM-Accenture Chair in the Economics and Management of Innovation, founded in 2009. The objective of this Chair,

financed by Accenture and located at the Autónoma University of Madrid (UAM)[4], is to promote teaching, research and knowledge exchange in the field of the economics and management of innovation. The UAM-Accenture Chair supports the teaching activities of UAM's Master in the Economics and Management of Innovation, by funding research seminars and through the participation of Accenture employees in teaching activities or as co-directors of PhD and Master theses. The Chair is also a vehicle for joint research projects performed by senior professors and researchers in collaboration with Accenture, and for the joint participation in European research networks. Moreover, the Chair provides an annual prize to the best research paper on innovation studies, open to researchers from any Spanish and international university.

4.6. THE DYNAMICS OF R&D MANDATES AND COLLABORATION WITH UNIVERSITIES: THE CASE OF 3M

Contrary to the case of Yahoo! discussed above, collaboration with universities generally occurs sequentially, as illustrated by the case of 3M. Initially, the R&D of 3M in Spain was closely connected to its manufacturing plant located in Madrid, specializing in abrasive products for households and industry. These R&D activities were limited in scope, in the sense that they were oriented to the domestic market, focused on process rather than product innovation, and did not involve collaboration with universities. A further step towards a stronger embeddedness in the national innovation system was taken in the year 2000 with the constitution of the 3M Foundation, the primary mission of which is to collaborate with Spanish universities in education and training. However, the objective of this Foundation is not directly connected to the company's business divisions; rather, it responds to the company's aim to strengthen its corporate social responsibility agenda. The 3M Foundation has set an annual innovation competition for students of several Spanish Universities, and it also finances a Chair on Corporate Social Responsibility at the Alcalá de Henares University.

More recently, 3M Spain has become engaged in two new areas of research, renewable energies and infrastructures, which are considered as strategic by the company's headquarters, and where it is perceived that the Spanish innovation system has specific strengths. These R&D activities are global in scope, driven by the corporation's aim of expanding its knowledge base by tapping into local sources of specialized knowledge, suggesting that 3M Spain is evolving from a competence-exploiting to a competence-creating mandate. This evolution has been accompanied by a closer collaboration with universities and public research centers. In the case of renewable energies, the R&D activities focus on solar energy and are undertaken in close collaboration with the Institute of Solar Energy of the Polytechnic University of Madrid. Different modes of collaboration are used, including joint-projects, subcontracting of R&D, technology consulting services and the occasional use of the Institute's equipment and infrastructure by 3M research teams. In the case of infrastructures, several collaboration agreements have been established with different Spanish universities to jointly develop a portfolio of R&D projects including traffic security, energy efficiency, road construction and signaling, and others.

4.7. R&D SUBSIDIARIES IN LOW-TECH SECTORS AND COLLABORATION: THE CASE OF NUTRECO

The case of Nutreco illustrates how MNC subsidiaries operating in traditional sectors may also perform significant R&D activities and engage in collaboration with local universities. Nutreco hosts in Toledo, Spain, 2 out its 8 global R&D centers (the others are located in the Netherlands, Norway and Canada), which work on new technologies and innovative products to be implemented throughout the world. The first is the Poultry and Rabbit Research Centre, employing around 25

[4] As an example of the popularity of this kind of Chairs among MNC subsidiaries in Spain, it is worth stressing that in 13 out of 19 existing private sector funded Chairs at Universidad Autónoma de Madrid, the corporate partner was an MNC subsidiary (rather than a national firm).

researchers, which originates from the acquisition of a Spanish firm in the 1980s and has thereafter expanded significantly. The second is the Food research Center, which was created in 2004 and currently employs around 10 researchers specializing in food safety, meet processing technology and innovative packaging. Both centers collaborate actively with Spanish universities, and the company's R&D Director stated in our interview that collaboration with universities has clearly become more intense in recent years and is seen by the corporation as a strategic action to be further developed in the years to come. These R&D centers collaborate with Spanish universities (the most intense collaborations are those with the Agriculture Engineering School of Madrid and with the IRTA institute in Catalonia) as well as will other European universities (most recently from the Netherlands and Hungary). Another similar example is the case of Hero, a Swiss company that established an R&D center in the South of Spain in 2004, focusing on child nutrition and employing 25 researchers.

5. CONCLUSION

We have shown how collaboration between MNC subsidiaries and local universities is an important driver of the upgrading of MNC subsidiaries, and even a pre-requisite for an upward evolution towards becoming competence-creating subsidiaries or centers of excellence. Thus, such collaboration becomes necessary for better linking regions with the dynamics of global innovation networks. This rationale underscores the importance of an often overlooked mission for universities: to foster collaboration with MNC subsidiaries in order to facilitate their upgrading for the benefit of the national economy. This mission links well with the emergence of *transnational academic capitalism* discussed in Kauppinen (2012) and with the *global model* of research universities analyzed in Mohrman et al (2008). The global model implies a stronger internationalization in terms of recruitment of researchers and professors, alliances with foreign universities, recruitment of international students, etc. We shall add that it also implies a higher emphasis on building linkages with MNC subsidiaries.

In the specific case of Spain, our empirical research shows clearly how MNC-university linkages have increased substantially in scale and scope during the last decade, and especially since 2005. This kind of collaborations is seen as increasingly important in order to improve the country's positioning in global innovation networks. While promoting university-industry linkages has long been in the radar of Spanish policy-makers (Núñez-Sánchez et al, 2010), the specific case of MNC subsidiaries may require a more tailored approach, with specific policy instruments and incentives. The aim would be to promote new forms of strategic collaboration between universities and MNC subsidiaries in order to build longer term public private partnerships and competence centers, building on the experiences of technologically leading countries like Germany and the US (Koschatzky and Stahlecker, 2010).

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