# Innovative MNEs' Subsidiaries in different domestic environments

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## Resumen

Las empresas multinacionales realizan actividades de generación de conocimiento, tales como las de I+D, en el extranjero y no solo en sus países de origen. Este hecho tiene implicaciones diversas en los sistemas de innovación, lo que se revela en un doble sentido: por un lado, las actividades de I+D de las empresas extranjeras pueden contribuir a la generación de innovaciones y a la mejora tecnológica de las economías receptoras; por otro, la dinámica de innovación de las empresas foráneas puede quedar condicionada por las características de los sistemas de acogida. Por todo ello, el objetivo de este trabajo es analizar la importancia relativa de los condicionantes locales a través de las fuentes para la innovación que utilizan las empresas extranjeras, el papel de los fondos públicos y las formas de organizar su trabajo en red. La muestra de empresas procede de la Encuesta Europea de Innovación (CIS3) y el análisis se realiza para tres países europeos: Alemania, España y Noruega. El objetivo es tratar de valorar hasta qué punto los efectos debidos al país y los vinculados a las industrias inciden en las actividades de innovación de las subsidiarias de empresas multinacionales.

**Palabras clave:** CIS 3; empresas extranjeras; intensidad innovadora; Fuentes de innovación; sistemas de innovación.

## Abstract

Foreign firms performing R&D abroad present two types of implications for the local systems of innovation, which can be described as a loop going in two directions: R&D-intensive affiliates may contribute to the generation of innovation, upgrading the technological level of the host economy; on the other hand, their innovation dynamics may be conditioned by locations. The aim is to analyse the local *embeddedness* of foreign firms measuring the impact of the innovation sources, the role of public funds and the cooperative relationships in the innovativeness of foreign firms. The sample is constructed on data from the Community Innovation Survey (CIS 3) and the analysis is replicated for three European countries: Germany, Norway and Spain. Our aim is to asses to what extent there exist countries' and industries' effects on the innovative activities of MNE subsidiaries.

**Key words:** CIS 3; Foreign firms; Innovative intensity; Innovation sources; Location

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# 1. Introduction

According to the OECD, the internationalisation of R&D activities is one of the most dynamic factors of globalisation (OECD, 2008). In fact, R&D expenditures of multinational enterprises (MNEs) have grown three times more than those of national companies. In spite of this definitive kind of data, the preoccupation caused by the increasing internationalisation of innovative activities is still a matter of a relatively reduced number of academic researchers and policy makers.

The growing internationalisation process is the result of a combination of different and heterogeneous forces among which three factors can be highlighted: First, the profound changes which have happened with regard to innovation requirements, such as increasing costs, cross fertilisation of technologies and rapid obsolescence. Secondly, the very rapid growth of the necessity for combining firms´ internal knowledge and that coming from external sources, which obliges substantial shifts to be made in the organisation patterns of companies. Finally, the competence framework arising from the globalisation process in which markets tend to be multinational and innovation occupies a central role in current competitiveness.

Most of the literature has focused the attention on the understanding of forces driving enterprises –mainly MNEs- to decentralise their innovative activity (Granstrand et al., 1993; Cantwell, 1989; Patel and Pavitt, 1991; Archibugi and Michie, 1995; Ho, 2007; Von Zedtwitz and Gassman, 2005; Castellani and Zanfei, 2006, Karlson, 2006). However, much less effort has been made to analyse the consequences of that process for host economies and/or to fully understand the role of domestic factors in such a dynamic.

The aim of this paper is to contribute to a better understanding of the interaction between the innovative activities of MNEs´ subsidiaries and domestic forces. To carry out that study microdata from the Community Innovation Survey (CIS3) have been used. The consideration of different countries belonging to distinct socioeconomic contexts and the introduction of a sectoral taxonomy will help us to understand similarities and differences across countries and sectors.

In the next section, we revise some available contributions both theoretical and empirical background on the role of subsidiaries in national systems of innovation. The third section is devoted to a basic description of the sample. Section four contains the econometric model and the discussion of the results obtained from the estimations. Finally, in section five we present some main concluding remarks.

# 2. Foreign subsidiaries in national systems of innovation. Theoretical background

From a broad perspective, the issue of subsidiaries' innovative activity is part of the wider process of the internationalisation of innovation. In this context, MNEs have longstanding experience in managing different international scenarios which have to be adapted to new requirements of innovation and globalisation. The capacity for adjusting to current conditions is neither cost-free nor automatic; thus, the acquisition of those capabilities is seen today as a critical competitive factor to transfer from the traditional to the distributive mode of innovation (Cantwell and Molero, 2003; Narula, 2005; Karlson, 2006). Furthermore, the situation is increasingly more complex as a consequence of at least two new factors: on the one hand, the growing number of countries participating both as recipients of subsidiaries' technological activities and as headquarters of new MNEs (UNCTAD, 2005, Karlson, 2006, Athreye and Cantwell, 2007). On the other, the entrance of new MNEs that cover new activities (i.e. services), or act in a radical new international organisation (*born global*).

A way of summarising existing contributions is to group them in the following areas: i) factors favouring the decentralisation of innovative activities; ii) factors in the siting of subsidiaries technological tasks; and iii) consequences and interaction with host economies.

## 2.1 DECENTRALISING FACTORS.

There is a wide coincidence in grouping the variety of factors dealing with the internationalisation of technology (innovation) in two

main categories: market/demand forces and technology/supply ones (Granstrand et al., 1993; Von Zedtwith and Gassman, 2002; Ho, 2007; Castellani and Zanfei, 2006). The simplest market/demand factor has to do with supporting technological activity to sustain foreign productive activities of MNEs, as a consequence of the specific and applied character of technologies. Further on, a "natural" evolution of the activity of those subsidiaries can take place, incorporating aspects of local markets, such as different tastes, traditions or regulations. Usually it involves more intensive technological activities (including R&D) and a deeper relationship with local innovative firms and institutions. Moreover, we can add governments´ demands, either as a prerequisite to authorise a direct investment or as a deliberate policy for encouraging its externalities[3].

Recent changes have led to the increasing presence of technological decentralisation based upon supply factors. Even within the mainstream tradition it is reasonable to admit the possible existence of lower costs for technological inputs, including wages of highly-trained personnel, or higher productivity of innovative tasks. More in the line of the evolutionary theory of innovation there is a need for having access to a broad range of knowledge and skills, needed for the current innovative processes[4]. In this regard, the role of the sector of activity has to be underlined (Cantwell and Glac, 2004; Patel and Pavitt, 1991; Patel, 1995); although there is not a definitive agreement, there are analysts who suggest that internationalisation is more likely to grow in mature sectors (Patel, 1995, Johanson and Lööf, 2006). Nevertheless there are great differences according to different levels of innovative activities; just by separating R from D we realise that the concentration of research is clearly higher than that of development tasks (Von Zedtwitz and Gassman, 2005).

There are other nuances to consider; in fact, conditions for technology internationalisation depend not only on sectoral, regional or country characteristics, but also on intrinsic features of R&D and firms (Meyer-Krahmer & Reguer, 2000; Patel & Pavitt, 1991; Von Zedtwitz & Gassman, 2005). An outstanding feature has to do with the tacit and sticky character of technological knowledge, which means for its appropriation it is necessary to be near to it and to catch it through direct interchange and experience (Cantwell & Mudambi, 2005; Cantwell & Molero, 2003).

The former notwithstanding, the case in which MNEs concentrate the central elements of their technological competence in the country of origin is still very widespread, while most of their decentralisation has to do with other complementary, albeit very important, knowledge and skills (Cantwell & Glac, 2004; Cantwell & Molero, 2003). Very different are the cases of *world mandate subsidiaries* which receive the mandate for creating world competencies in a specific area; in these cases, a combination of firms and local advantages is needed to create a virtuous circle which would reinforce that mandate for the subsidiary (Castellani & Zanfei, 2006; Pearce, 1999; Simoes, 2003; Cantwell & Mudambi, 2005).

### 2.2 FACTORS IN THE SITING OF INNOVATIVE ACTIVITIES.

The main issue of the debate is the capacity that countries have to attract the "new" MNEs´ technological activities. From what has been said in the former section, we must emphasise that different types of innovative activities require different local support. Then, if we take the distinction between home-based exploiting (HBE) and home-based augmenting (HBA) kinds of decentralisation strategies, we can assert that for the case of HBE (market or competence exploiting) there are traditional factors still operating: that is the case of the size, the growth of the market and the favourable legislation.

On the contrary, if we move to HBA (asset or competence seeking) strategy, two factors have been pointed out as critical for attracting intensive innovative tasks: the availability of qualified and abundant human resources and the existence of adequate research facilities (Cantwell & Mudambi, 2005; Canwell & Molero, 2003). Qualified human capital, in turn, refers to education and training systems which have interiorised the new demands of innovative enterprises: flexible curricula with significant command of foreign languages,

[3]The first two arguments constitute the core of what recent literature classifies as MNEs' strategies to *exploit home based advantages* of the firms (HBE). Other authors name this strategy as *market seeking* or *competence exploiting* (Balcet & Evangelista, 2005; Cantwell & Molero, 2003; Cantwell & Mudambi, 2005; Castellani & Zanfei, 2006; Kuemmerle, 1999; Narula, 2004; Patel & Vega, 1999; Pearce, 1999).

[4] By performing these other strategies, MNEs can increase *home based advantages* (HBA) (Kuemmerle, 1999); other ways of referring to the same process is to call it *asset seeking* or *competence seeking* strategies.

interdisciplinary programmes, continuing education and lifelong training among the most important ones.

Research facilities refer to a complex public-private structure. The first part has to do with public research centres and universities (Cantwell & Ianmarino, 2003; Elder, 2003; European Commission, 1998; Khanma & Singh, 2002; Meyer-Krahmer & Reguer, 2000). In fact, on analysing the case of European MNEs migrating to USA it has been shown that it is the lack of that type of research – at least in the quantity and quality required for the current way of innovating- which drives a significant number of firms to look for that in the USA (Dosi et al, 2006, Pavitt, 2001). Private facilities refer to the existence of a significant number of firms carrying out high technology innovative tasks. The agglomeration effect is behind this issue and refers to spontaneous and systematic concentration over time and the potential for attracting other players (European Commission, 1998; Söjvel & Zander, 1995).

A number of studies have shown that R&D activity carried out abroad by MNEs is likely to happen in sectors in which host economies show technological advantages and human capital (Cincerra, 2005; Kumman and Aggarwal, 2005; Teirlinck, 2005; Molero and Garcia, 2008). As far as the quality of the research is concerned, *home base augmenting* strategies confirm their superior integration with domestic firms and institutions in Germany (Molero, 2002). This strategy is carried out preferably in sectors in which host economies have technological advantages (Balcet & Evangelista, 2005). In other words, it can be stated that there exists a virtuous circle between the presence of local facilities and the location of MNEs' innovative activity (Ho, 2007).

### 2.3 EFFECTS ON HOST COUNTRIES

As previously explained, most available research has considered either less developed countries, where the hypothesis of MNE superiority can be reasonably sustained, or highly developed countries belonging to the "triadic" cluster, where a relatively balanced interchange can be established between origin and host economies with reciprocal effects. Among the theoretical tools which can help us to understand the impact of MNEs' innovative activities on host countries we can mention three: the crowding out effect, the existence of spillovers and taxonomic exercises.

A very relevant, although scarcely investigated, topic for host countries is the crowding out effect MNEs' activity can produce on local economies. One related question has to do with mergers and acquisitions (M&A). Although there is a long tradition of studying different effects of M&A, there is a lack of systematic effort to identify the impact on innovation, manly if we refer to cross-border M&A. There are studies which insist on the fact that cross-border M&As have among their determinants the increase in acquiring firms' technological possibilities (Anand & Delios, 2002; Anand & Kogut, 1997; Harzing, 1999), although they do not differentiate clearly between increasing basic capabilities (which correspond to HBA strategies) or a broader exploitation of existing capabilities. Just a few studies establish conditions for the clarification, thus Cantwell & Mudambi (2005) assert that in the case where the resulting company has a competence creating mandate, the final result probably will be the increase in R&D expenditures; the opposite would happen where that mandate does not exist at all.

Regarding spillovers, the underlying hypothesis is the technological superiority of foreign subsidiaries in comparison with local firms[5]. That assumption has some empirical support when the host economy is a backward area, but it is difficult to generalise that superiority if we take into account other more advanced recipient countries. Moreover, irrespectively of the existence of technological differences with local companies, empirical research is very inconclusive in showing that spillovers take place (Narula, 2004; Lööf, 2006). Particularly interesting is the contraposition of those arguments in favour of the importance of the technological gap between foreign and local enterprises as a source for a catch up dynamic, with others asserting that the higher the domestic absorptive capacities the higher the expected benefits from inward FDI (Bloomstrom and Koko, 1998; Cantwell, 1989; Castellani and Zanfei, 2006; Narula, 2005).

Precisely due to our categorical perspective, former taxonomic contributions are of particular interest to make the diversity of cases comprehensible. From them, we can underline

[5] in a previous paper we have offered a summary of the international literature: Alvarez and Molero (2005).

some especially oriented to better understanding the relationship with host economies. Just to mention a few, we can distinguish two kinds: one group of cases is according to the importance of demand and supply driving factors; thus we can have subsidiaries which exploit already acquired technological capacities in foreign markets as tactical organisation versus those others which seek new assets to increase group capabilities as a strategic decision (Cantwell, 2005; Kuemmerle, 1999; Narula, 2004; Pearce, 1999). The interaction with host economies and policy implications is significantly different in both cases. The second group consists of typologies which combine driving factors in origin with attracting ones in destination economies (Meyer-Krahmer & Reguer, 2000; Molero & Buesa, 1993; Patel y Vega, 1999). This way of classifying subsidiaries gives more importance to the proximity to local economies and absorptive capabilities, making for a deeper insight into the probable impact.

Summing up the available knowledge, we can expect that innovative activity of MNEs will respond to the following research guideposts:

1. Their behaviour will neither be the same nor completely different in different socioeconomic scenarios. Therefore, the country (or region) and the sector of activity are two crucial factors to understand the actual innovative character of MNE subsidiaries.

2. Looking at the individual behaviour, we expect that in terms of resources and results in a broad sense, MNE subsidiaries would show higher parameters, particularly in more technology-intensive sectors, regardless of the country in which they are established.

3. The interaction with local firms and institutions will be greater in those sectors in which the local economy has reached a particular level of technological specialisation in the international scenario.

# 3. Innovative firms abroad: A basic description

Our starting point is that for approaching the *embeddedness* level of foreign affiliates in the local context we would take into account the possible differences that could be due to both local strengths (active policies of R&D funding), the structural aspects of industries (size, concentration, sectors), as well as the type of cooperation relationships in both the national and the international context. At this stage, a crucial idea is that affiliates have different strategies and different degrees of responsibility abroad. The latter can be defined by both their technological strategies (they perform R&D or not) and their market orientation (they export or not).

The natural complexity of the innovation process (Kline and Rosenberg, 1986; Nelson, 2008) gives rise to a renewed discussion about its measurements and the development of new indicators. These aspects justify the efforts made by the OECD and also by the European Statistical Office (EUROSTAT) to carry out a common survey on innovation; namely, the Community Innovation Survey (CIS). In this work we use the microdata from the CIS3 for Germany, Spain and Norway. The choice of these three countries is based on data availability in CIS3 as well as to the interest of carrying out international comparisons including different European economies. Regarding the industry classification that we include in the analysis, it responds to the general Pavitt taxonomy that has resulted in both academic and policy fields in a kind of industrial classification (Pavitt, 1984). In fact, there has been a tendency to assimilate the categories of this taxonomy basically by trying to identify supplier dominated trajectories to lower tech sectors, while production intensive and science-intensive would be to high-tech ones. The classification of industries by NACE code a-ccording to the Pavitt's groups can be found in the Appendix.

Regarding sampling features and the statistical validity of the results, Spain and Norway have a response rate of over 90% but for Germany it is about 20%. However, it is assumed here that there is not a relationship between the lack of response and innovation indicators that would lead to a serious bias for national and international comparisons. Even so, there are some methodological differences among countries,

such as the use of public firms' census, the treatment of missing values in the surveys as well as the structure and design of it, aspects that could lead to a certain bias. Nonetheless, it should be mentioned that available information about each country sampling scheme is not easily found. On the contrary, weights are assigned without further indications; stratification is usually made over sector, firm size and geographic strata and the use of weights in regression models for a selected cluster of firms (foreign innovative firms) can lead to some bias. For this reason, we have compared the differences observed when applying weights to the models and the same models without considering them, and they are very small. Therefore, we present the results of the analysis carried out without using weights. This choice has been made taking into account that the usual strata allocation in the CIS is proportional, it is carried out for a reasonable sample and subsample sizes, such as the one on foreign innovative firms that can be considered as representative of its group.

Some main description of the sample for categorical variables included in our analysis corresponding exclusively to innovative foreign subsidiaries can be found in Table I. The first aspect to mention is related to the different size of the samples across countries; although, this aspect is not very important because we are not exploring restricted cases. Looking at the distribution of the sample by countries, the size of innovative foreign firms in Spain is larger than in Germany and Norway. The significance of the market orientation also differs by countries: while the domestic market is more important for firms in Spain and Norway, the international market is a more frequent aspect in Germany. Nonetheless, the pattern of export propensity is similar for the three countries with a slightly higher proportion of exporting firms in Germany. On the other hand, Spain shows the largest proportion of non-cooperative firms while firms cooperating with international partners are more frequent in Norway. Regarding the distribution of firms that received R&D funds from public institutions, it can be noted that most of the foreign innovative firms in the three countries did not receive this funding. Nevertheless, the largest share of firms funded by European and national funds are located in Germany while local funding sources are more important for firms in Norway. Finally, taking into account the distribution by industries, the share of firms in the sample differs by industries, it being noticeable that Germany shows a larger share of innovative foreign firms in the science-based group.

**Table I. Descriptive Statistics for categorical variables, by industries and countries**

| | | | SIZE | | | SIGMAR | | COO | | | EXPORT | | FUNEU | | FUNGMT | | FUNLOC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | 1 | 2 | 3 | 1 | 2 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| COUNTRY | SECTOR | | | | | | | | | | | | | | | | | |
| Germany | Prod | 27 | . | 37 | 63 | 25.9 | 74.1 | 48.1 | 33.3 | 18.5 | 3.7 | 96.3 | 88.9 | 11.1 | 77.8 | 22.2 | 88.9 | 11.1 |
| | Sci | 61 | 4.92 | 41 | 54.1 | 16.4 | 83.6 | 54.1 | 21.3 | 24.6 | 3.28 | 96.7 | 85.2 | 14.8 | 78.7 | 21.3 | 90.2 | 9.84 |
| | Supp | 8 | . | 12.5 | 87.5 | 12.5 | 87.5 | 62.5 | 25 | 12.5 | 12.5 | 87.5 | 75 | 25 | 75 | 25 | 62.5 | 37.5 |
| Norway | Prod | 46 | 8.7 | . | 91.3 | 54.3 | 45.7 | 47.8 | 21.7 | 30.4 | 10.9 | 89.1 | 91.3 | 8.7 | 76.1 | 23.9 | 100 | . |
| | Sci | 90 | 31.1 | 22.2 | 46.7 | 57.8 | 42.2 | 45.6 | 17.8 | 36.7 | 15.6 | 84.4 | 90 | 10 | 77.8 | 22.2 | 97.8 | 2.22 |
| | Supp | 36 | 27.8 | 25 | 47.2 | 66.7 | 33.3 | 50 | 13.9 | 36.1 | 5.56 | 94.4 | 94.4 | 5.56 | 75 | 25 | 94.4 | 5.56 |
| Spain | Prod | 143 | 3.5 | 32.9 | 63.6 | 54.5 | 45.5 | 79 | 9.09 | 11.9 | 4.9 | 95.1 | 94.4 | 5.59 | 76.2 | 23.8 | 76.9 | 23.1 |
| | Sci | 188 | 9.57 | 14.4 | 76.1 | 68.6 | 31.4 | 66.5 | 12.2 | 21.3 | 13.3 | 86.7 | 92 | 7.98 | 70.7 | 29.3 | 85.6 | 14.4 |
| | Supp | 68 | 7.35 | 23.5 | 69.1 | 77.9 | 22.1 | 80.9 | 16.2 | 2.94 | 19.1 | 80.9 | 95.6 | 4.41 | 86.8 | 13.2 | 89.7 | 10.3 |
| Germany | | 96 | 3.13 | 37.5 | 59.4 | 18.8 | 81.3 | 53.1 | 25 | 21.9 | 4.17 | 95.8 | 85.4 | 14.6 | 78.1 | 21.9 | 87.5 | 12.5 |
| Norway | | 172 | 24.4 | 16.9 | 58.7 | 58.7 | 41.3 | 47.1 | 18 | 34.9 | 12.2 | 87.8 | 91.3 | 8.72 | 76.7 | 23.3 | 97.7 | 2.33 |
| Spain | | 399 | 7.02 | 22.6 | 70.4 | 65.2 | 34.8 | 73.4 | 11.8 | 14.8 | 11.3 | 88.7 | 93.5 | 6.52 | 75.4 | 24.6 | 83.2 | 16.8 |
| ALL | | 667 | 10.9 | 23.2 | 65.8 | 56.8 | 43.2 | 63.7 | 15.3 | 21 | 10.5 | 89.5 | 91.8 | 8.25 | 76.2 | 23.8 | 87.6 | 12.4 |

Note: According to Pavitt's taxonomy, the sectors correspond to the following categories:
Prod: *Production-Intensive* industries; Sci: *Science-based* industries; Supp: *Supplier dominated* industries

Table II shows some main description for the ordinal and interval variables included in the analysis. We can observe that regarding the sources of information for innovation, there is a notable similarity among the three countries. Nonetheless, firms in Norway give a higher importance to internal and institutional sources of information for innovation, while in Germany the market has a higher importance as a source of information.

The importance of internal sources for innovation is very similar for the three types of industries although higher values correspond to firms in science-based activities; the highest values of the source of information based on the market also corresponds to this type of industries. On the other hand, institutional sources are more diverse: in Germany, the high value of this variable is obtained for production intensive firms; in Norway, firms belonging to supplier-dominated industries have the highest values; and, in Spain, it corresponds to science-based firms.

Finally, regarding innovative input and output, Spain shows the lowest value in R&D intensity. By industries, firms belonging to science-based industries show the highest R&D intensity, as it would be expected, and the differences with regard to the other industries are more marked in the case of Norway. Looking now to the share of turnover corresponding to innovations, Germany has the highest mean value in this variable. The best results in terms of innovative output correspond to science-based industries in both Germany and Norway, but not in Spain where firms belonging to production intensive industries show the highest mean value for this variable.

**Table II. Descriptive Statistics for ordinal and interval variables, by industries and by countries**

| | | INTERNAL | MARKET | INSTITU | LOGRATIO | LOGTURNIN |
|---|---|---|---|---|---|---|
| **COUNTRY** | **SECTOR** | | | | | |
| **Germany** | **Prod** | 4.52 | 5.41 | 1.59 | -4.1 | -1.9 |
| | **Sci** | 4.31 | 5.11 | 1.43 | -3.2 | -1.4 |
| | **Supp** | 4.13 | 4.25 | 1.5 | -4.6 | -2.6 |
| **Norway** | **Prod** | 4.3 | 4.89 | 1.85 | -4 | -1.9 |
| | **Sci** | 4.43 | 4.98 | 1.62 | -2.8 | -1.5 |
| | **Supp** | 4.5 | 4.81 | 2.11 | -4.5 | -2.3 |
| **Spain** | **Prod** | 4.28 | 4.4 | 1.27 | -4.3 | -1.6 |
| | **Sci** | 4.41 | 4.68 | 1.74 | -3.8 | -1.7 |
| | **Supp** | 4.12 | 3.49 | 1.32 | -4.5 | -2.1 |
| **Germany** | | 4.35 | 5.13 | 1.48 | -3.6 | -1.6 |
| **Norway** | | 4.41 | 4.92 | 1.78 | -3.5 | -1.8 |
| **Spain** | | 4.32 | 4.38 | 1.5 | -4.1 | -1.7 |

Note: According to Pavitt's taxonomy, the sectors correspond to the following categories:
Prod: *Production Intensive* industries; Sci: *Science-based* industries; Supp: *Supplier-dominated* industries

# 4. The econometric model and discussion of results

The main question of our analysis is to try to observe whether there exists a pattern of external relationships for foreign innovative firms inside the national system of innovation framework. Particularly, we focus on three main aspects: the collaboration between firms and other agents, the sources of information for innovation and the degree of access to R&D public funding programmes. A General Linear Model is applied to investigate the relationship between innovation intensity, measured as the natural logarithm of the rate of innovation expenditures as a proportion of the firm' sales, and the set of exposed variables of interest. For the estimation we use the LS (*least squared*) method. The estimation of the parameter uses the zero equality constraint for the last category of nominal variables and the interpretation of the significance level as well as the sign for these variables are related to the last category.

The analysis has been divided into a differentiated conception of innovative performance. As a first step, we try to observe the effects on inputs and outputs of innovation including the effect of the sector and controlling by countries. Our dependent variables will be, first, R&D intensity as a measure of the proportion of the turnover devoted to R&D, and second, the proportion of turnover that corresponds to innovation. As the second step, estimations are carried out by sectors and countries simultaneously.

### 4.1. INNOVATIVE EFFORT

In Table III, the results of the estimation for the general model of innovation inputs show the importance of both market and internal sources of innovation. The inclusion of the firms' size reveals that the effort in inputs for innovation is more important for innovative small and medium firms than for the larger ones. Regarding the industry effects, according to the innovative pattern of innovation behaviour, the positive effect for the firms belonging to science-based industries is notable. On the other hand, firms that receive a lesser amount of funds from public institutions and for which the national market is less important, are also those firms that devote least efforts to innovate. Country differences are mainly observed in the case of the investments in innovation carried out by foreign firms in Spain in comparison to the others.

This general pattern varies for the different industries. For the science-based industry, we found the same results in terms of size, sources and country effects, while for both specialised suppliers and large producers a different profile can be observed; market as a source of innovation is an important aspect for the latter while the positive sign of the size variable is confirmed for the smallest firms in the specialised suppliers group.

**Table III. Results of the GLM for all countries and for all sectors (dependent variable: logratio.)**

| | Sci | Prod | Supp | ALL |
|---|---|---|---|---|
| **Intercept** | **-4.0*** | **-3.18*** | **-4.03*** | **-4.01*** |
| **Size=1** | **1.55*** | 0.74 | **1.02*** | **1.23*** |
| **Size=2** | **0.62*** | 0.40 | 0.22 | **0.41*** |
| **Size=3** | | | | |
| **Coo=0** | -0.21 | **-0.90*** | 0.38 | -0.26 |
| **Coo=1** | 0.12 | **-0.85*** | -0.08 | -0.17 |
| **Coo=2** | | | | |
| **Fungmt=0** | -0.18 | **-0.67*** | **-1.22*** | **-0.46*** |
| **Fungmt=1** | | | | |
| **FunEU=0** | **-0.59*** | 0.17 | 0.20 | **-0.41*** |
| **FunEU=1** | | | | |
| **FunLoc=0** | 0.02 | -0.21 | -0.71 | -0.22 |
| **FunLoc=1** | | | | |
| **export=0** | 0.16 | 0.22 | 0.13 | 0.21 |
| **export=1** | | | | |
| **Sigmar=1** | **-0.34*** | **-0.39*** | -0.14 | **-0.24*** |
| **Sigmar=2** | | | | |
| **internal** | **0.16*** | 0.01 | 0.056 | **0.09*** |
| **institu** | 0.04 | -0.004 | -0.03 | 0.009 |
| **market** | **0.077*** | 0.07 | 0.05 | **0.07*** |
| **Country=GE** | -0.26 | -0.17 | 0.02 | -0.12 |
| **Country=SP** | **-0.57*** | -0.19 | 0.33 | **-0.27*** |
| **Country=NO** | | | | |
| **Sector=Sci** | | | | **0.89*** |
| **Sector=Prod** | | | | 0.24 |
| **Sector=Supp** | | | | |
| | | | | |
| **R2** | 0.23 | 0.15 | 0.21 | 0.23 |

Note: According to Pavitt's taxonomy, the sectors correspond to the
following categories: Prod: *Production-Intensive* industries; Sci: *Science-based* industries; Supp: *Supplier-dominated* industries
* denote the parameters significance at 0.10.

In the estimation of R&D inputs, measured by the proportion of total expenditures in innovation as a share of turnover, we can observe different patterns by countries in each industry -Table IV. Particularly, in science-based activities, Spanish firms of smaller size show a more notable R&D intensity; this is also positively related to non-exporting firms and the role of internal sources for innovation. In Germany, there is a profile for these industries characterised by the relevance of medium sized firms and those which cooperate with external agents. However, there is not a clear pattern of behaviour in this type of activities in Norway.

The estimation for specialised suppliers shows the positive significance of the small size of firms in both Spain and Norway. Also observable is the fact that those firms which do not receive funds for R&D from public institutions are also those with the least innovative efforts in Spain.

For industries based on scale economies, non-cooperative firms and those not publicly funded are the least R&D intensive ones in Spain. The greater orientation toward the domestic market is a feature in Germany since non-exporting firms present a more significant relationship with R&D intensive behaviour. In Norway, there is a positive and significant effect by the smallest firms as well as in the information obtained from external institution for innovation.

**Table IV. Results of GLM for each country and sector (dependent variable: logratio)**

| | Sci | | | Prod | | | Supp | | |
|---|---|---|---|---|---|---|---|---|---|
| | **GE** | **SP** | **NO** | **GE** | **SP** | **NO** | **GE** | **SP** | **NO** |
| **Intercept** | **-2.98*** | **-4.86*** | **-1.98*** | -2.26 | **-4.11*** | -2.97 | | **-2.99*** | **-3.82*** |
| **Size=1** | 0.63 | **1.12*** | **1.36*** | . | 0.81 | 0.93 | | **1.48*** | **1.58*** |
| **Size=2** | **0.70*** | **0.62*** | 0.43 | 0.45 | 0.35 | . | | -0.03 | 0.59 |
| **Size=3** | | | | | | | | | |
| **Coo=0** | **-0.70*** | 0.23 | -0.08 | -0.91 | **-1.18*** | -0.87 | | -0.05 | 0.28 |
| **Coo=1** | -0.37 | 0.55 | -0.39 | -0.66 | -0.90 | -0.94 | | -0.03 | 1.01 |
| **Coo=2** | | | | | | | | | |
| **FunGmt=0** | 0.14 | -0.34 | -0.37 | -0.08 | **-0.58*** | -1.13 | | **-1.51*** | -1.31 |
| **FunGmt=1** | | | | | | | | | |
| **FunEU=0** | -0.88 | -0.57 | -0.52 | 0.46 | 0.79 | -0.62 | | 0.07 | 0.19 |
| **FunEU=1** | | | | | | | | | |
| **FunLoc=0** | 0.18 | -0.01 | -1.68 | -1.28 | -0.15 | 0.00 | | -0.97 | -1.03 |
| **FunLoc=1** | | | | | | | | | |
| **Sigmar=1** | 0.30 | | -0.01 | -0.09 | -0.33 | -0.71 | | **0.81*** | 0.25 |
| **Sigmar=2** | | | **-1.09*** | | | | | | |
| **Export=0** | -1.24 | **0.57*** | -0.31 | **3.85*** | 0.05 | -0.63 | | 0.02 | 0.69 |
| **Export=1** | | | | | | | | | |
| **Internal** | 0.05 | **0.24*** | 0.09 | 0.16 | -0.02 | 0.02 | | 0.12 | -0.19 |
| **Market** | 0.04 | 0.06 | 0.08 | -0.28 | 0.11 | 0.26 | | 0.13 | 0.07 |
| **Institu** | -0.01 | 0.02 | **0.26*** | 0.04 | 0.04 | -0.24 | | **-0.30*** | 0.28 |
| | | | | | | | | | |
| **$R^2$** | 0.25 | 0.17 | 0.29 | 0.29 | 0.32 | 0.14 | | 0.31 | 0.40 |

Note: According to Pavitt's taxonomy, the sectors correspond to the following categories:
Prod: *Production-Intensive* industries; Sci: *Science-based* industries;
Supp: *Supplier-dominated* industries
* denote the parameters significance at 0.10.

### 4.2. INNOVATIVE OUTPUT

The estimation of innovative output, measured as the proportion of sales due to innovation, allows us to observe in Table V that firms obtaining information from the market and those that are more R&D intensive achieve a higher value of innovation output. The size of the firms has also a significant effect, which is more notable for smallest firms. On the other hand, regarding the different sectors, it is more likely that firms belonging to science-based industries as well as those characterised by scale economies will be able to obtain more innovative outputs. The results of the estimation also show the importance of collaboration and public policies enhancing innovation. Particularly, the firms that do not have cooperative relationships as well as those that do not receive funds from Public institutions are also those that proportionally have less innovative output.

When taking into consideration the industries, this latter result related to collaboration is reinforced for both science-based firms and scale economy industries or production-intensive activities while the importance of public funds is revealed only for the latter. This profile is more notable in Spain, a country that differs from the other two economies included in the sample. On the other hand, size has a positive and significant effect for the smallest firms in the specialised suppliers, for which European funds seems to be notably significant[4]. Finally, R&D intensity, as well as the importance of the market for sourcing information are the most relevant aspects for the firms included in the science-based group.

On the other hand, Table VI allows us to observe that the factors explaining the innovative output are more visible in the case of science-based industries for Spain. In this country, the proportion of turnover due to innovations is negatively related to the cooperation behaviour of firms, and it is less likely that non cooperative companies and those that cooperate with national agents would obtain innovative outputs. Moreover, the firms that make a higher use of internal innovation sources are less innovative too. On the contrary, the domestic market and the medium sized firms have a positive and significant effect on innovation outputs, as well as those firms with a higher R&D intensity. This last aspect is also shared for firms in Norway while it is not common for firms in Germany.

Regarding scale economies-based industries, there is a profile that reveals the importance of public funding in Spain since those firms that are non-publicly funded by both national and European programmes obtain fewer innovative outputs as a share of their turnover. And lastly, for specialised suppliers, we can point out the importance that European funds have for foreign firms in Norway and the larger significance for smallest firms. On the contrary, there is not any other special aspect in the other two countries included in the analysis.

**Table V. Results of GLM for all countries and for all sectors (dependent variable: logturnin)**

| | Sci | Prod | Supp | ALL |
|---|---|---|---|---|
| **Intercept** | **-0.92*** | **-1.85*** | **-3.20*** | **-1.94*** |
| **Size=1** | 0.22 | 0.54 | **1.00*** | **0.40*** |
| **Size=2** | 0.18 | 0.04 | -0.28 | 0.11 |
| **Size=3** | | | | |
| **Coo=0** | -0.22 | -0.41 | 0.33 | -0.18 |
| **Coo=1** | **-0.35*** | **-0.64*** | 0.25 | **-0.33*** |
| **Coo=2** | | | | |
| **FunGmt=0** | -0.14 | **-0.50*** | -0.61 | **-0.26*** |
| **FunGmt=1** | | | | |
| **FunEU=0** | 0.14 | 0.21 | **1.05*** | 0.16 |
| **FunEU=1** | | | | |
| **FunLoc=0** | -0.12 | **0.38*** | -0.35 | 0.08 |
| **FunLoc=1** | | | | |
| **Sigmar=1** | -0.02 | -0.02 | 0.028 | 0.00 |
| **Sigmar=2** | | | | |
| **export=0** | 0.29 | -0.08 | -0.11 | 0.13 |
| **export=1** | | | | |
| **internal** | -0.05 | -0.00 | 0.03 | -0.01 |
| **institu** | -0.03 | -0.01 | 0.02 | -0.02 |
| **market** | **0.05*** | 0.05 | -0.06 | **0.04*** |
| **logratio** | **0.14*** | 0.027 | -0.07 | **0.08*** |
| **Country=GE** | 0.23 | 0.11 | 0.02 | 0.19 |
| **Country=SP** | 0.07 | **0.39*** | 0.26 | 0.17 |
| **Country=NO** | | | | |
| **Sector=Sci** | | | | **0.51*** |
| **Sector=Prod** | | | | **0.52*** |
| **Sector=Supp** | | | | |
| | | | | |
| **R2** | 0.199 | 0.10 | 0.15 | 0.13 |

Note: According to Pavitt's taxonomy, the sectors correspond to the following categories: Prod: *Production Intensive* industries; Sci: *Science-based* industries; Supp: *Supplier dominated* industries
* denote the parameters significance at 0.10

[4] The number of observations included in the sample for Germany was rather small. For this reason, we have not considered the supplier industries for specific estimations.

**Table VI. . Results of GLM for each country and sector (dependent variable: logturnin)**

| | Sci | | | Prod | | | Supp | | |
|---|---|---|---|---|---|---|---|---|---|
| | **GE** | **SP** | **NO** | **GE** | **SP** | **NO** | **GE** | **SP** | **NO** |
| **Intercept** | **-1.65*** | -0.13 | -1.08 | -1.07 | **-1.54*** | -1.96 | | -1.58 | -1.76 |
| **Size=1** | 0.25 | 0.01 | 0.13 | . | 0.64 | 1.03 | | -0.12 | **1.30*** |
| **Size=2** | -0.29 | **0.55*** | -0.09 | 0.01 | 0.09 | . | | -0.60 | -0.49 |
| **Size=3** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 |
| **Coo=0** | 0.43 | **-0.45*** | -0.25 | 0.11 | -0.38 | -0.40 | | 0.64 | 0.01 |
| **Coo=1** | 0.24 | **-0.51*** | -0.37 | -0.25 | -0.10 | **-1.06*** | | 0.76 | -0.75 |
| **Coo=2** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 |
| **FunGmt=0** | -0.27 | -0.29 | 0.01 | -0.49 | **-0.70*** | -0.32 | | -0.19 | 0.14 |
| **FunGmt=1** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 |
| **FunEU=0** | -0.20 | 0.00 | 0.54 | -0.22 | -0.00 | 0.95 | | 1.19 | **-2.95*** |
| **FunEU=1** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 |
| **FunLoc=0** | -0.12 | -0.12 | 0.00 | -0.10 | **0.55*** | 0.00 | | -0.28 | -0.59 |
| **FunLoc=1** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 |
| **Sigmar=1** | -0.34 | -0.11 | 0.40 | 0.08 | -0.21 | 0.54 | | -0.69 | 0.79 |
| **Sigmar=2** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 |
| **Export=0** | 1.06 | **0.47*** | -0.17 | 0.45 | -0.27 | -0.10 | | -0.17 | -0.73 |
| **Export=1** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 | 0.00 |
| **Internal** | 0.09 | **-0.10*** | -0.09 | -0.14 | 0.11 | -0.17 | | -0.13 | 0.40 |
| **Market** | 0.07 | 0.04 | 0.06 | 0.10 | 0.01 | 0.12 | | -0.11 | -0.15 |
| **Institu** | 0.11 | -0.07 | -0.11 | 0.05 | -0.05 | 0.02 | | 0.13 | 0.17 |
| **Logratio** | 0.10 | **0.14*** | **0.23*** | 0.02 | 0.01 | 0.09 | | 0.12 | -0.14 |
| | | | | | | | | | |
| **$R^2$** | 0.19 | 0.16 | 0.19 | 0.33 | 0.14 | 0.21 | | 0.12 | 0.60 |

Note: According to Pavitt's taxonomy, the sectors correspond to the following categories:
Prod: *Production-Intensive* industries; Sci: *Science-based* industries; Supp: *Supplier-dominated* industries
* denote the parameters significance at 0.10.

# 5. Concluding remarks

The aim of this empirical analysis has been to try to show to what extent the potential internationalised patterns of innovative subsidiaries in foreign contexts can differ accordingly to both countries and industries. The changing pattern in the global value chain makes it extraordinarily important to consider the organisational aspects related to the internationallised networking relationships of MNEs. Particularly, this starting idea allows us to assume that the strategies of foreign subsidiaries vary according to their own evolution and their specific mandates (Cantwell & Mudambi, 2005). The growing decentralisation of R&D activities in the world context is the result of higher levels of autonomy that subsidiaries gain inside the international group. In fact, this would allow a more precise assessment of the impacts that internationalised firms generate in host economies since spillover effects can be observed in different directions. The relationship between the innovative activities

of subsidiaries operating in foreign contexts and the features of the host economies provide new and interesting insights.

The main question in this piece of empirical research is based on the relevance of locations to understand the innovation dynamics of foreign firms. The results would confirm the existence of differences among type of sectors as well as the role of country components that could satisfactorily answer it. Particularly, regarding country differences, we must say that the difference in the innovative effort of foreign subsidiaries is more pronounced in the case of Spain in relation to both Germany and Norway. Moreover, the access to public funding and the cooperation relationships for innovation are less frequent in the Spanish economy than in the other two European countries, the cooperation with foreign agents being more relevant for Norway than for Germany. Although the information sources for innovation are similar in the three economies, the market is more important for the firms in Germany while internal and institutional sources are more relevant in Norway. Nonetheless, it should be noted that the innovative sources of information is more notable in the firms belonging to science-based industries. It can be affirmed that the level of R&D intensity that foreign subsidiaries perform seems to be described by the use of internal and market sources of information as well as the access to public funding not only at national level but also acceding to international programmes such as the EU funds, underlying the role of science-based activities.

On the other hand, for a higher innovative output, the cooperation relationships that firms establish with other agents in the national system seem to be a crucial aspect. Beyond the innovative efforts, the access to public funds increases the likelihood of augmenting the sales due to innovation and this profile is found in both science-based activities and production intensive industries.

Then, to try to summarise the main findings, the interpretation of the differences that arise when taking into account the different type of sectors (*à la Pavitt*), allows us to conclude that it is also possible to find country effects on the innovative effort of foreign innovative firms:

- First, for subsidiaries belonging to science-based industries, cooperation is a significant factor for firms in Germany, exports are crucial for firms in Norway while sales in the domestic market have notable importance in Spain. Then, there is a profile in which the relationships of subsidiaries is a determinant factor in the more technological advanced country and market size becomes crucial for the other two economies.

- Secondly, the profile changes when considering the subsidiaries in the production-intensive industries since in Germany the domestic market becomes very important, while cooperation and public funding are two relevant factors for those subsidiaries in Spain. These results are more closely linked to each national economy's own industrial specialisation.

- Third, in the specialised supplier industries, the critical factors for the innovative foreign firms in Spain would be the access to public funds, the institutional source of information and also the domestic market orientation. It would mean a higher dependence level on the domestic environmental context.

Following the same rule, innovative outputs of MNEs' subsidiaries can be interpreted according to the different sectors, in such a way that:

- First, for those belonging to science-based industries, beyond the amount of investments in R&D, the importance of cooperation links and the domestic market orientation are the crucial factors in Spain.

- Second, in production-intensive sectors, an aspect to underline is that innovative output of foreign subsidiaries is mainly defined in the Spanish economy for the access to public funds.

- And thirdly, for innovative foreign firms belonging to specialised supplier, the most notable aspect is the relevance of European funds for firms in Norway.

With this empirical analysis we try to make a contribution on the behaviour of innovative MNE subsidiaries operating in different environmental contexts. Our findings are not definitive; on the contrary, we should mention that there are important limitations due to the availability of statistical and comparable data for temporal series, the size of the samples by countries as well as the need to have data for more economies. These aspects would open up new questions and would certainly show more light on the topic throughout further research on this topic.

# APPENDIX

## List and definition of variables included in the analysis

| | |
|---|---|
| **Country** | Germany, Norway and Spain |
| **Size** | Denoted as 1 if the firm has between 10-49 employees, 2 for 50-249 and 3 for more than 250 employees. |
| **Sector Group** | Sci=Science based; Prod=Production intensive; Supp=Supplier dominated (1) |
| **Sigmar** | Most significant market of the firm, denoted as 1 when National, or 2 when International (2). |
| **Coo** | Cooperation, denoted by 0 if the firm has not made any cooperation arrangements during 1998-2000; 1, if the cooperation was only national and 2, if the cooperation was at least international (3). |
| **Export** | Variable denoting 0 if the firm declares having 0 income in exports of good and services, and 1 if this income was positive |
| **FunEU** | 1 if the firm had financial support coming from the EU, 0 if not. |
| **FunGmt** | 1 if the firm had financial support coming from the Central Government, 0 if not. |
| **FunLoc** | 1 if the firm had financial support coming from local or regional authorities, 0 if not. |
| **Internal** | Ordinal variable (0-6) indicating the degree of internal sources of information for innovation (4). |
| **Market** | Ordinal variable (0-9) indicating the degree of market sources of information for innovation (5). |
| **Institu** | Ordinal variable (0-6) indicating degree of institutional sources of information for innovation (6). |
| **Logratio** | Innovation Intensity: measured as the natural logarithm of innovation expenditure over total sales. |
| **Logturnin** | Natural logarithm of the percentage of turnover due to new or significantly improved products. |

(1) Based on Pavitt (1984) taxonomy, three groups of sectors are used: *Supplier-dominated*, *Production-Intensive* and *Science-based*. The groups are created from the NACE classification given by the CIS3 survey. In the table below, only NACE codes present in the survey sample (restricted t to Multinational innovative firms) are named.

| Nace Code | Sector |
|---|---|
| 10 to 22, 45 | Supplier dominated (supp) |
| 26 to 29, 34 to 37 | Production Intensive (prod) |
| 23 to 25, 30 to 33, 40 to 41, 72 to 74 | Science based (sci) |

(2) In CIS3, originally variable *sigmar* had four categories and they have been naturally recoded to 2 .
(3) Coo has been created adding original national cooperation variables *Co11, Co21,…Co81*, adding also international cooperation variables and checking whether the sum was 0 in one, neither or both variables.
(4) built through the addition of the two three-level ordinal variables *sent* and *sgrp*.
(5) built through the addition of the three three-level ordinal variables *ssup, scli* and *scom*.
(6) built through the addition of two three-level ordinal variables *suni* and *sgmt*.

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