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Are 'the best' foreign subsidiaries cooperating for innovation with local partners? The case of an intermediate country

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Abstract

We analyse a sample of firms that are representative of Spanish manufacturing industry, in order to understand the relationship between foreign status and local cooperation for innovation. We focus on foreign subsidiaries (FS) displaying innovation intensity, newness of technology or the ability to build complex networks with local innovators. Foreign status increases the probability of local cooperation for innovation. However, FS displaying these characteristics are not necessarily more prone to cooperate locally for innovation than similar affiliated domestic firms. The distribution of cooperative FS tends to be even across sectors and this is confirmed for advanced FS. This suggests that FS look for general capabilities in local partnerships, rather than for specific expertise. The strategies of domestic affiliated firms seem to influence the relationship between foreign status and local cooperation for innovation.

Key words: foreign subsidiaries; multinational enterprises; cooperation for innovation; networks of innovators.

1. Introduction

Policy-makers often wish to attract foreign direct investment (FDI) because they see it as a potential source of skills and new knowledge for the host country. Although these expectations are sometimes too optimistic, competition to attract R&D-intensive FDI has increased in recent years (Guimón 2011). According to the empirical literature, technology transfers are facilitated when foreign subsidiaries (FS) build linkages with local partners (UNCTAD 2001). After reviewing EU policies aimed at benefiting from the globalization of corporate R&D, one study concluded that more policy intervention focused on linkage facilitation is needed (Guimón 2011). One such linkage is cooperation for innovation with local partners.[1]

However, a number of circumstances (e.g. high transaction costs) may limit the local embeddedness of FS and, hence, their potential for transferring knowledge to the domestic economy. FS may not be able to build local linkages similar to those of domestic firms. A literature mostly based on the EU's Community Innovation Survey (CIS) has investigated whether FS are more prone to engage in cooperation for innovation (or, in local cooperation for innovation) than domestic firms. The results are not conclusive. The impact of foreign ownership on local cooperation for innovation seems to change by country and sector (Ebersberger et al. 2011; Holl and Rama 2014; Knell and Srholec 2005; Molero and Heijs 2002).

This literature has provided important insights that are crucial for the formulation of informed policies. However, some aspects of the relationship between foreign status and local cooperation for innovation probably deserve further analysis; first, a specific focus on the patterns of local cooperation for innovation of those FS that may potentially make a greater technological contribution to the host country. Secondly, with some exceptions (Schmidt and Sofka 2009), previous studies have assumed that the impact of foreign status on local cooperation is almost exclusively attributable to the strategies of the FS. It may be useful to investigate, however, whether the cooperative strategies of domestic firms may indirectly affect the relationship between foreign ownership and local cooperation for innovation. Finally, most previous studies analyse highly industrialised countries. In our view, their results need to be complemented with studies on other countries in order to provide a complete picture of these cooperative activities. However, with few exceptions (Holl and Rama 2014; Srholec 2009), in-depth analyses of those countries are rare. We focus on Spain as a paradigm of an intermediate country. As in other cases, Spain shows a historical

imbalance between its technological development and its economic development. For instance, one study classifies Spain among high-income, low-R&D European countries (Ebersberger et al. 2011). Furthermore, Spain's technological development is also unbalanced (we return to this question in Section 3.1). These types of countries may be far from the technological frontier in some sectors, and close to it in others (e.g. in traditional industries). Our point of departure is the assumption that, in such types of economies, the relationship between FS and the national innovation system (NIS) shows significant peculiarities that need to be understood.

This paper attempts to contribute to this literature. Our ultimate objective is to understand whether foreign manufacturing subsidiaries are likely to make a contribution to domestic innovative capabilities. More specifically, we select for analysis FS displaying above-average intensity of innovation, newness of technology or the capability to build complex networks of innovators (see Section 3.3 for definitions). Although other criteria are certainly valid, FS showing some of these characteristics are considered here as 'the best' FS from the point of view of the host country. We address four questions. The first is whether innovation-intensive FS are prone to cooperate locally for innovation. We are interested in these companies because low-technology FDI may contribute little in terms of new knowledge and, instead, crowd out domestic firms (Buckley et al. 2007). The second question is whether FS operating in manufacturing sectors where technological change is rapid worldwide are prone to cooperate locally for innovation. The presence, in those sectors, of FS willing to provide opportunities for cooperation for innovation to local partners may help the host country to catch up with the rapidly changing technology. Different technologies do not have the same 'value' for host countries and these companies may, in theory, bring state-of-the-art technology not yet available locally. In a country such as Spain, the need for transfers of technology from FDI is probably less pressing in slow changing sectors. In these sectors, the host country is probably closer to the technological frontier, given the slow rhythm of international technological upgrading, than it is in the case of fast changing sectors. The third question is whether FS operating in fast changing sectors are significantly more prone to cooperate locally for innovation than FS operating in slow changing sectors. We know very little about the sectoral drivers of inward R&D flows (Alkemade et al. 2015) and virtually nothing about the preferences of FS concerning collaborative arrangements with local innovators across sectors. However, these sectoral aspects may have implications regarding national policies towards FDI in R&D. The fourth question is whether FS are able to build complex cooperative networks with local partners; and in which sectors (see Section 3.3 for definitions). Complex networks seem especially valuable from the point of view of the host country since they combine knowledge coming from different local sources (e.g. universities, research centres, suppliers), as well as from the multinational enterprise (MNE). They therefore display a substantial potential to generate new ideas (Faems et al. 2005).

Therefore, we explore whether FS displaying above-average intensity of innovation, newness of technology and the ability to build complex networks of innovators tend to be engaged in local cooperation for innovation. In doing so, we use a sample of firms that is statistically representative of the Spanish manufacturing industry. Local R&D cooperative behaviour is compared in FS and domestic firms affiliated to Spanish entrepreneurial groups. Additional comparisons are made with a subsample of innovation-intensive companies. Although our study provides some hints about the relative merits of domestic and foreign R&D, this is not our central objective. Rather, we use affiliated domestic firms as a control group in order to understand the specificities of FS. As stated, Spain is one of the most important recipients of inward FDI in the EU (UNCTAD 2012). FS account for 39.5% of national manufacturing R&D, with substantial differences between sectors (for instance, only 15.5% in food, beverages and tobacco, and 86.5% in office, accounting and computing machinery).[2] Some emerging economies and other peripheral European countries may be in a similar situation. Being substantial receivers of FDI, they may also expect to link their NIS to international flows of knowledge via FS, hence the interest of an in-depth analysis of the Spanish case.

Section 2 reviews the literature that informed our research, Section 3, presents the data and variables used in the quantitative analyses, and Section 4 presents our results. Section 5 contains the discussion and Section 6 draws our conclusions.

2. Literature review and research questions

2.1. FS and technology upgrading of host countries

Although most of the literature assumes that FS are able to make substantial contributions to the technological upgrading of host countries, this view seems at times unjustified. According to a review of the literature (Rama 2009), there has been concern that FS could siphon off a host country's accumulated knowledge, liquidate its independent science and technology base, access publicly funded R&D and bring in the wrong technology. There has also been concern in the opposite direction, that FS would not conduct R&D in host countries and would only bring their low value-added activities. A certain number of MNEs are not especially innovative, or only a few of their 'superstar' subsidiaries are innovative, and these are usually located in highly industrialised countries. Certain authors have, at least theoretically, posed the question of 'multinationals without advantages' (Fosfuri and Motta 1999). In contrast, in other countries, FS perform a substantial share of total innovation and some studies point to the risks involved in the concentration of technology in the hands of a few firms (Archibugi and Petrobelli 2003).

The idea of a transfer of technology from the FS to the local economy has sometimes been contested (Veugelers and Cassiman 2004). FDI may even have disruptive effects on the NIS since FS could displace innovative domestic firms (UNCTAD 2005). More specifically, in terms of cooperation for innovation, FS seem to behave differently in countries with different technological levels. In host countries that are not technology leaders, the risk of branch plant syndrome is greater (Ebersberger et al. 2011; Srholec 2009). Forms of organisation adopted by branch plants do not necessarily imply increased local embeddedness or better prospects for local development (Phelps 1993). The discussion specifically points to the importance of understanding the local cooperative behaviour of FS which have desirable characteristics.

2.2 Foreign ownership and local cooperation for innovation

MNEs increasingly tend to innovate abroad in order to adapt their products to national tastes and regulations, learn from foreign lead markets or lead customers, access the NIS, or use publicly funded R&D which is available in the host country (Dunning and Lundan 2009).

Although this seems to predict that FS will be prone to engage in local cooperation for innovation in their host countries, the empirical literature is not conclusive in this regard. In a study of 12 European countries, Srholec (2009) finds that FS tend to cooperate for innovation with external partners, especially those located

abroad (not in the host country). Working with data for the Czech manufacturing sector, Knell and Srholec (2005) observe that foreign status is a predictor of not only less local cooperation for innovation, but also reduced in-house R&D. A study of 22 European countries finds that it is positively associated with international R&D collaboration and negatively associated with domestic R&D collaboration (Ebersberger et al. 2011). The above mentioned authors conclude that the risk of branch plant syndrome is empirically supported, especially in those European countries that are not technology leaders (as is the case of Spain). Another study on European countries confirms this view (Srholec 2009). Despite Spain not being a technology leader, a study on service and manufacturing companies finds that, nevertheless, FS operating there tend to engage in local cooperation for innovation to a greater extent than do affiliated or unaffiliated domestic firms (Holl and Rama 2014).

The FS most likely to launch networks with local innovators seem to be those involved in local R&D. R&D expenditures approach the absorptive capacity of firms and therefore their capacity to profit from externalities (Cohen and Levinthal 1989). Frost (2001) finds that the likelihood that a FS patent cites patents produced in the host country, a proxy for R&D local collaboration in his study, is positively associated with the innovation scale of the foreign firm. However, a problem with patent analyses is that they use citations of domestic patents as a proxy for local collaboration, but do not measure the actual collaboration for innovation between FS and local partners. This methodological difficulty is overcome in studies based on the CIS of the EU or similar surveys, such as the Spanish Technological Innovation Survey (PITEC) which is used here, because these sources provide information on actual cooperation for innovation.

Some of these studies find a correlation between the nature of the R&D activities by the FS and their patterns of local cooperation for innovation (Álvarez and Cantwell 2011). Another study observes that manufacturing and service FS operating in Spain have a greater propensity than domestic firms to cooperate for innovation in the domestic market, with the only exception being those subsidiaries with no internal R&D expenditures (Holl and Rama 2014). The literature has termed as 'dynamic learning FDI' the investment undertaken by an MNE in host countries that are relatively strong in a specific technology (Le Bas and Sierra 2002). Dynamic learning FDI includes two categories: technology seeking FDI aiming to offset home-country weaknesses, and home base augmenting FDI targeting technologies in which both the MNE and the host country are relatively strong. FS that emphasise strategies which exploit their home base, seem less likely to cooperate with local partners for innovation (Álvarez and Cantwell 2011; Holl and Rama 2014). The discussion suggests that innovation-intensive FS are more likely to cooperate locally for innovation than non-innovation-intensive FS. The question left unanswered is whether innovation-intensive FS are more likely to cooperate locally than innovation-intensive domestic groups, and this question is addressed here. Therefore, we formulate the following research questions:

RQ 1a: Are FS more likely to cooperate locally for innovation than affiliated domestic firms?
RQ 1b: If yes, in which sectors?
RQ2 a: Focusing more specifically on innovation-intensive companies, are FS more likely to cooperate locally for innovation than affiliated domestic firms?
RQ 2b: If yes, in which sectors?

2.3 Sectors

The network and open innovation literature has argued that firms in high-tech sectors are more prone to cooperate for innovation because they face more risky and costly innovation processes. Thus, the argument goes, cooperation may allow them to share costs and enter new technological fields (Miotti and Sachwald 2003). R&D collaboration has been depicted as a kind of 'elite sport' mainly practised by the world's largest firms from the high-tech industries (Bojanowski et al. 2012). This point of view is confirmed by the empirical literature (Carboni 2013; Ebersberger et al. 2011).

Little is known, however, regarding patterns of local collaboration for innovation of FS across sectors. The literature suggests that FDI is drawn to host industries showing a large and dynamic demand, the presence of other global competitors also being an attractor. More specifically, FDI in R&D aims to tap into local fields of expertise. Cantwell et al. (2004) have shown that the sectors attracting US FDI in the UK have switched towards those fields that are British specialities. Similar results were found for Germany (Schmidt and Sofka 2009). Patent analysis suggests that two-way knowledge flows between FS and domestic firms are substantial, especially in developed countries, and that outflows are greater in sectors where the host country displays stronger technological capabilities (Singh 2007). FS may have additional reasons for focusing on those host industries. According to a study, the MNE usually invests in host industries that are more or less similar to the 'mother' industry, one of the reasons being the need to integrate local suppliers into its own technological culture, or at least those involved in design functions (Dyker 2004). The technological gap between the MNE and its local partners is likely to be smaller, in our view, in host industries which enjoy revealed technological advantages (RTA). Other studies suggest, however, that FS operating in those industries are not necessarily more likely to collaborate with local partners. For instance, in a study on Spanish service and manufacturing firms, foreign status was negatively and significantly associated with R&D collaboration with local universities in the food and drinks industry, and in the machine and equipment industry (Guimón and Salazar 2014). Following International Business (IB) theory, we would have expected a positive association with foreign status, since these are industries in which Spain has RTA (Molero and García 2008). In our view, the possible association of local R&D collaboration and foreign status may not depend exclusively on the RTA displayed by a specific host industry.

Some studies suggest that the behaviour of domestic firms may explain, at least in part, the presumed embeddedness of FS in some sectors of the host country and not in others. In some countries, technologically leading domestic firms may be able to secure the most suitable local partners for R&D collaboration and thus, their strategies may limit the access of FS to local partnerships (Álvarez and Cantwell 2011; Cantwell and Mudambi 2011). In this respect, the difficulties faced by FS may be especially pressing for in-host industries that are at the technical forefront (Schmidt and Sofka 2009). Previous research implies that, in some host industries, the strategies of FS might only be part of the picture, not the whole story. In our view, the cooperative strategies of FS across sectors should not be analysed in isolation.

As stated, we are especially interested in FS operating in sectors where technological change is rapid worldwide because these companies may be a vehicle for the international diffusion of state-of-the-art technology. Today, catching-up processes may pose difficulties for countries that are not technology leaders, given the rapid rhythm of technology creation at the global scale. It is in those fast

changing sectors that FS may have a role to play, given their privileged access to international sources of new technology. Consequently, we formulate the following research questions.

> RQ 3a: Is there a greater presence of cooperative FS in fast changing sectors than in slow changing sectors?
> RQ 3b: Focusing more specifically on innovation-intensive FS, is there a greater presence of cooperative FS in fast changing sectors than in slow changing sectors?

2.4 Networks of innovators

Complex local networks involving FS and different types of local partners are likely to combine different types of knowledge. Faems et al. (2005: 240) argue that:

> ... it is not the number of collaboration agreements per se but rather the diversity of the firm's alliances that influences the innovative performance of the firm.

Löof (2009), analysing MNEs in Sweden, concludes that R&D collaboration occurs as a network phenomenon rather than as a one-to-one process. The network itself could be a locus of knowledge production (Bojanowski et al. 2012). Other studies find statistical complementarities between collaboration with universities and collaboration with other types of innovation partners (Carboni 2013; Srholec 2014). On the other hand, the diffusion of 'soft' organisational innovation from the advanced countries to less developed countries is an important aspect of catching-up processes and MNEs may play a crucial role in this respect (Dyker 2004). Therefore, we formulate the following research questions.

> RQ 4a: Is the presence of multi-cooperative FS greater in fast changing sectors than in slow changing sectors?
> RQ 4b: Focusing more specifically on innovation-intensive FS, is the presence of multi-cooperative FS greater in fast changing sectors than in slow changing sectors?

Multi-cooperative FS are defined in Section 3.

3. Methodology

3.1 Research context

As in other intermediate countries, Spain shows structural imbalances between its general economic development and its technological position. More importantly for our purpose, the NIS also displays imbalances. Within the EU, an example of countries displaying such imbalances are those in the group of 'moderate innovators' (e.g. Italy, Poland, Spain), which are characterised by an average innovation performance, that is 50–90% of the performance of the EU (European Commission 2013). Countries which belong to the group of 'innovation leaders' (e.g. Denmark, Finland, Germany) combine a generally high performance with a good one on most parameters. According to the European Commission, the most innovative countries have a balanced NIS with strengths in all dimensions. In contrast, in the 'moderate innovator' cluster, a much lower level of general performance is combined with significant structural disequilibria between different indicators. For instance, some relative strengths of Spain are in international scientific co-publications or in a substantial sales share of new innovations. At the same time, it displays low expenditures on R&D in the business sector and a limited presence of small and medium-sized enterprises (SMEs) with product/process innovation.

3.2 Data and research strategy

First, we use data on actual local cooperation for innovation obtained from PITEC database, which provides anonymised microdata for both domestic and foreign companies. PITEC data is collected by the Spanish Statistical Office (INE). The PITEC sample is representative of manufacturing firms located in Spain in the period 2004–8. Around 1,965 companies have been selected, of which 35% are FS and 64% are Spanish firms belonging to a group or affiliated domestic firms (SFG). It should be noted that non-innovators are not included in our sample, as PITEC poses questions about cooperation for innovation only to firms defined by the questionnaire as 'innovative' (i.e. companies that have launched new products into the market, that have introduced new industrial processes, that have ongoing innovative activities or that have abandoned them during the two years prior to the survey). Other CIS-type surveys display the same feature (Ebersberger et al. 2011).

Secondly, this information is combined with patent data to identify highly dynamic sectors where technological evolution is particularly rapid worldwide. In doing this, we use a sector taxonomy based on patent analysis (Molero and García 2008). This taxonomy was selected for the following reasons. Being independent of any previous label placed on sectors, it provides a self-classification for any country, which can then be studied in the context of the international technological scenario. The taxonomy combines two axes to classify economic sectors: relative (or revealed) technology advantage (RTA) and global technological dynamism: their combination yields four types of cases. Each sector is classified according to: first, its position in recent years in the world's technological dynamism; and second, its RTA. RTA is a relative, not an absolute value of the technological position of a national sector as compared to the average technological position of the country in the world scenario. It therefore indicates if a national sector performs better (advantage) or worse (disadvantage) than the world average for the country, as 'revealed' by world patent data. Control for international technological dynamism is essential to assess the proximity of the national industry to the worldwide evolution of technology. Most previous taxonomies classify sectors for all countries as belonging to the same categories, irrespective of the relative position of a specific country. However, the method used here has the advantage of depending on the relative innovative performance of a country in a particular period of time.

Our research strategy is as follows. First, we perform a set of multivariate tests in order to explore RQ 1a, RQ 1b, RQ 2a and RQ 2b (see Equation (1)):

$$P(domCoopInov = 1 \mid X_i^T, \beta^T, \alpha_i) = \Lambda(\alpha_i + \beta^T X_i^T) \qquad (1)$$

Secondly, we perform Bonferroni tests to investigate RQ 3a, RQ 3b, RQ 4a and RQ 4b. As stated, SFG are used as a control group in order to better understand the specificities of FS. Appendix 1 shows the correlation matrix.

3.3 Variables

The variables used in our tests are presented below (see Appendix 2 for descriptions).

3.3.1 Local cooperation for innovation

Cooperative activities are defined here as two separate organisations joining forces to share and develop knowledge in order to enhance their innovative performance. These arrangements do not include the acquisition of R&D services via the market or via R&D

subcontracting. We use two different approaches to analyse local cooperation for innovation:

domCoopInnov. This is our dependent variable in the multivariate tests. It is a dummy variable, indicating whether the company has cooperated for innovation with external partners located in Spain in the last two years prior to the survey. 'External' refers to partners external to the business group of the focal firm. The variable is similar to that analysed in most studies on cooperation for innovation (Holl and Rama 2014; Srholec 2014; Veugelers and Cassiman 2004).

Breadth. This variable indicates the breadth of local cooperative activities and has three possible responses: first, the firm has not cooperated for innovation with external local partners in the last two years; second, it has cooperated with one type of local partner (for instance, universities); and third, it has cooperated with at least two different types of local partners. We use Bonferroni tests to analyse this variable. Our purpose is to understand whether or not FS operating in fast changing sectors tend to be engaged in complex local R&D networks (RQ 4a). We are particularly interested in innovation-intensive FS (RQ 4b). We define local R&D networks that include at least two different types of local partners in addition to the focal firm, as complex (hereafter, referred to as complex networks).

3.3.2 Independent variable of interest

Foreign ownership. This dummy variable indicates whether or not the company is an FS. The database distinguishes between two different categories of firms: unaffiliated companies and firms belonging to a group. Within the latter, information is provided about the location of the headquarters of the company. If they are located in a foreign country, the company is classified here as an FS. If not, the company is classified as an affiliated domestic firm (i.e. SFG). PITEC does not allow us to correctly identify native MNEs. The question deserves a brief digression since a study on Norway found that native MNEs had a greater positive impact than FS on the NIS (Ebersberger and Herstad 2012). Consequently, the comparison of FS, and native MNEs in particular, seems to be important. Nevertheless, in our view, the case of Norway cannot be extrapolated to the case of Spain. First, the few Spanish MNEs are mostly in banking and other services; and in energy and water (not in manufacturing). Secondly, in accordance with the Uppsala school of thought, a large share of the Spanish FDI stock goes to culturally close countries, none of which are technological world leaders. For instance, in 2012, 30% of total stock was invested in Latin America and, within the EU, Portugal was a major recipient (Fernández-Otheo and Myro 2014). These circumstances limit the international flow of knowledge received by the Spanish manufacturing industry via native MNEs. Consequently, we do not feel that the above-mentioned limitation of the PITEC data poses a serious problem in this case.

We compare FS to SFG or domestic affiliated companies, as this is a more symmetrical exercise, since by definition, all FS belong to a business group. Most studies that compare FS and domestic firms recommend that the nature of the latter companies (affiliated or unaffiliated) be taken into account, since group membership seems to play an important role in cooperation for innovation (Ebersberger et al. 2011; Molero and Heijs 2002). Most unaffiliated Spanish firms are SMEs, and many of these firms have clear difficulties establishing R&D collaboration (Fernández-Esquinas and Ramos-Vielba 2011).

3.3.3 Control variables

Some of our control variables denote intensity as compared to their respective two-digit industry (e.g. above-average size). For the calculation of averages, we used data for domestic firms (affiliated and unaffiliated) and FS. Intensity is indicated by an '*i*' before the name of the variable. If we excluded unaffiliated domestic firms from the calculations we would be generating a bias in the definition of the features and capabilities of each industry, since our aim is to understand the degree of embeddedness of the FS when characteristics of each industry are controlled for.

i_size. This dummy variable indicates whether employment is above the two-digit industry average. The size of the industrial plant has been reported as a predictor of cooperation for innovation, and more specifically of local cooperation for innovation (Holl and Rama 2014; Miotti and Sachwald 2003). Size may reflect the absorptive capacity of the firm to benefit from open innovation processes (Carboni 2013; López 2008).

i_export (intensity of exports as share of turnover, as compared to two-digit industry average). In a sample of service and manufacturing firms located in Spain, Holl and Rama (2014) found that exporters were more likely to be engaged in cooperation for innovation with either domestic or international partners.

i_RDpers_1 (number of employees involved in internal R&D, as compared to the two-digit industry average). This dummy variable denotes whether the focal company, domestic or foreign, hires more R&D personnel than the average company in its industry. Following Cohen and Levinthal (1989), the variable may indicate whether the focal firm enjoys more absorptive capacity than the average company in its two-digit industry—a crucial consideration for a firm attempting to benefit from cooperation for innovation.

i_new (share of new or improved products in turnover compared to two-digit industry average). We start by calculating the sales of new-to-the-firm innovations as a percentage of the focal firm's total turnover. We then calculate whether this percentage is above that of the average company in the two-digit industry. Fernández Sastre (2012) found that, in Spain, companies engaged in local cooperation for innovation were more likely to launch new products into the market.

EU_market. Indicates whether the firm markets its products in the EU market.

Local_market. Indicates whether the firm markets its products in a Spanish regional market.

3.3.4 Variable used to calculate intensity

Two-digit industries. The database contains information on the two-digit industry in which the company operates. The Spanish Clasificación Nacional de Actividades Económicas (CNAE), which is similar to the NACE Rev classification used in EU statistics, is used here to calculate whether the company is innovation-intensive above the average level in its two-digit industry (i.e. *i_innovExpend*) (see definition in Section 3.3.5). We also use this variable to calculate *i_size*, *i_export*, *i_RDperson_1* and *i_new*. This enables us to avoid size effects and other industry effects when we compare firms that operate in different industries.

3.3.5 Variables used to split the sample

i_innovExpend. While most previous analyses on cooperation for innovation analyse a single R&D variable, usually internal R&D expenditures at the company level, some studies suggest the need to approximate R&D from a variety of angles (Ebersberger et al. 2011; Vega-Jurado et al. 2009). Furthermore, the Oslo Manual has conceptualised innovation as a process involving a range of factors (OECD/Statistical Office of the European Communities, 2005). Although important, internal R&D is not the sole ingredient of innovative processes at the company level. Moreover, one of the strengths of the Spanish NIS

is its above EU-average share of new products, while one of its weaknesses is below-average business R&D. A substantial part of the innovative process may be taking place outside of R&D departments. Therefore, we start by constructing an aggregated index that includes seven types of innovation expenditures (see Appendix 2). We understand that a combined index is a better approach to the innovative capacity of firms than simply considering the internal R&D.

The selection of variables is in accordance with the criteria of the Oslo Manual to determine the scale of innovative activities. For each type of expenditure, we calculate a dummy variable indicating whether the innovation expenditures of the focal firm are above those of the average company in its two-digit industry. We then aggregate the seven dummy variables (one for each type of expenditure) and we calculate the two-digit industry average. Finally, we calculate a dummy variable (*i_innovExpend*) indicating whether the innovation expenditures of the focal firm are above those of the average company in its two-digit industry. For brevity, these companies are referred to here as advanced firms. In calculating averages, we take the full two-digit industry (not just the sample of FS and affiliated domestic firms) into account. Innovative non-affiliated domestic firms also contribute to defining the average intensity of innovation at the industry level. A comprehensive approach is crucial to understanding the possible role of flows of knowledge coming through FS.

Sector. As stated, we use a taxonomy (Molero and García 2008) that combines two complementary indicators calculated through patent analysis:

- national technological advantages (RTA)
- worldwide speed of technological change

Combining both classifications, the above-mentioned study arrives at four types of sectors:

- *Dynamic specialization* (the sector is dynamic worldwide and Spain displays technological advantages)
- *Lost opportunities* (the sector is dynamic worldwide but the host country shows technological disadvantages)
- *Stationary specialization* (the host country shows technological advantages but the sector shows scarce technological dynamism worldwide)
- *Retreat* (the host country has technological disadvantages and the sector displays poor technological dynamism worldwide)

Each sector may include several two-digit industries (see Table 1). Sectors characterised by rapid technological change are not necessarily high-tech sectors.

Our research strategy is an iterative approach, for both innovation intensity and taxonomy. We start with an overall estimation for all sectors and for all the firms (no distinction by taxonomy sector or innovation intensity). This estimation is replicated for a subsample of advanced firms. We use the *i_innovExpend* variable to split our sample into two subsamples. The above-mentioned estimations (full sample and advanced firms subsample) are repeated for the four subsamples of firms segmented by sectoral taxonomy.

4. Results

4.1 Descriptive statistics

Table 2 shows descriptive statistics for FS and SFG. The share of FS that cooperate locally for innovation is larger than that of SFG. As compared to SFG, the shares of FS with above-average size or above-average propensity to export are larger. In contrast, SFG tend to be higher above the two-digit industry average with regard to the four variables measuring technological level than are the FS.

We found a significant positive association between *Foreign ownership* and whether or not the company operates in sectors in which Spain has RTA (see Table 3). Nearly 70% of the sample FS operate in those sectors (i.e. Dynamic specialization and Stationary specialization (see Table 3)). In contrast, there was no significant statistical association between *Foreign ownership* and whether or not the firm operates in fast changing sectors (i.e. Lost opportunity and Dynamic (see Table 4)).

4.2 Multivariate tests: Foreign status and domestic cooperation for innovation

Table 5 displays five multivariate models that test for statistical associations between *Foreign ownership* and *domCoopInnov*, when above-average size and other characteristics of firms are controlled for. Column 1 refers to all the sample firms and columns 2–5 to subsamples of firms operating in each of our four taxonomy sectors (Dynamic, Stationary, Lost opportunities and Retreat). For all firms, the coefficient of the independent variable of interest, *Foreign ownership*, is positive and statistically significant. Foreign status and local cooperation for innovation are therefore associated. The coefficient of *Foreign ownership* is also positive and significant in three of the four taxonomy sectors (columns 3–5). An exception is the Dynamic sector (column 2), since, in this case, the coefficient of the *Foreign ownership* variable is not statistically significant: no association between foreign status and local collaboration for innovation was found. Apparently, FS operating in one of the two sectors characterised by rapid technological growth are not necessarily prone to engage in domestic cooperation for innovation. It should be noted that this is also a sector in which the host country displays RTA (we return to this question in Section XXX).

Next we explore whether *Foreign ownership* is associated with *domCoopInnov* in a subsample of advanced firms, both domestic and foreign (see Table 6). Column 1 displays a model for all advanced firms, independently of the taxonomy sector in which they operate. We now find that the coefficient of the independent variable of interest is not statistically significant: *Foreign ownership* and *domCoopInnov* are not associated. Looking at sectors (columns 2–5), we observe that the coefficient of *Foreign ownership* is positive for advanced firms operating in the Lost opportunity sector (column 4) but now it is only tangentially significant (at 90% level). Again, the coefficient of *Foreign ownership* is not statistically significant in the Dynamic sector (column 2).

i_RDpers_1 displays a positive and statistically significant coefficient for all firms as well as for the four taxonomy sectors in the full sample (see Table 5) and in the subsample of advanced companies (see Table 6). With the exception of advanced firms operating in the Lost opportunity sector, firms hiring more R&D personnel than the average company in their respective two-digit industries are more likely to embark on local cooperation for innovation. The association of *i_size* and *domCoopInnov* is also positive and statistically significant in the full sample as well as in the subsample of advanced firms.

We replicate the models presented in Table 6 with a more restrictive definition of advanced firms, which are now characterised as those companies with internal R&D expenditure above the average in their respective two-digit industry. In doing so, we use *i_intRDExpend* to split our sample. When this limited definition of advanced firms is used, the coefficient for *Foreign_ownership* becomes positive and

Table 1. Sectoral typology

		International technological dynamism	
		Slow	Fast
Revealed technological advantage (RTA)	**RTA > 1**	Stationary specialization: Food and drinks; paper products; publishing, printing and reproduction; basic chemical, pesticides and other agro-chemicals, pharmaceutical, medicinal chemical and botanic products; paints, varnishes, printing ink and similar; soap, detergents, cleaning and polishing; man-made fibres, rubber and plastics; manufacture of weapons and ammunition	Dynamic specialization: Textiles, wearing apparel; dressing; dyeing of fur; basic metals; machinery for production and use of mechanical power (except aircraft, vehicle and cycle engines), agricultural machinery and other purposes machinery; machine-tool; domestic appliances; manufacture of insulated wire and cable
	RTA < 1	Retreat: Tobacco; wood and cork products (except furniture), straw and plaiting materials; non-metallic mineral products; medical and surgical equipment and orthopedic appliances; instruments and appliances for measuring, checking, testing, navigating and other purposes (except industrial process control equipment)	Lost opportunities: Office machinery and computers; electric motors, generators and transformers, accumulators, primary cells and primary batteries, lighting equipment and electric lamps and electrical equipment; electronic valves and tubes and other electronic components and other electronic components; television and radio transmitters, apparatus for line telephony and line telegraphy, television and radio receivers, sound or video recording or reproducing apparatus and associated goods; optical instruments, photographic equipment, watches and clocks; motor vehicles, trailers and semi-trailers and other transport equipment; fabricated metal products, except machinery and equipment; industrial process control equipment; furniture; luggage

Source: Adapted from Molero and García (2008)
RTA > 1 indicates sectors in which Spain has revealed technological advantages
RTA < 1 indicates sectors in which Spain has no revealed technological advantages

statistically significant for the full sample and for each of the taxonomy sectors: FS seem clearly more prone to cooperate with local partners than SFG. Our results suggest that analyses which only take into consideration internal R&D expenditures (and omit other innovation expenditures) to define advanced firms may be too optimistic concerning the contribution of FDI to the NIS of host countries.

4.3 Patterns of local cooperation for innovation across sectors

Bonferroni tests are performed to identify statistically significant differences concerning cooperative strategies within the two groups of firms, FS and SFG (see Table 7). Our aim is to understand whether FS engaged in fast changing sectors are significantly more prone to cooperate locally for innovation than FS engaged in slow changing sectors (RQ 3a and RQ 3b). SFG are used as a control group. In addition, this *post hoc* test may help us to gain further insight into the results of the previous multivariate tests.

We start by cross-tabulating *domCoopInnov* and *Sector* (see Table 7). The results suggest that SFG operating in sectors with fast changing technology are particularly interested in cooperating locally for innovation, much more so than SFG operating in sectors with slow changing technology (significant results in bold face). In contrast, the share of FS that cooperate locally for innovation in each of the taxonomy sectors is quite similar. In our sample, cooperative FS oscillate between 29.8% of the FS in the Stationary sector and 33.4% of the FS in the Lost opportunity sector but, according to the Bonferroni tests, the differences are not statistically significant. No preference for cooperation in fast changing sectors or for cooperation in sectors where Spain displays RTA was detected. We conclude that the distribution of cooperative FS tends to be even across sectors (see Table 7, rows 1–3, columns 1–3). This result was confirmed for advanced FS. When we focus on the latter, we observe that the share of cooperative FS oscillates between 45.8% in the Retreat sector and 39.5% in the Stationary sector. Again, differences across sectors are not statistically significant (see Table 7, rows 1–3, columns 4–6). We conclude that the distribution of advanced FS is also even across taxonomy sectors.

In contrast, the share of cooperative SFG varies significantly across taxonomy sectors, oscillating between 25.1% in the Dynamic sector and 18.4% in the Retreat sector. This time, differences are statistically significant (see Table 7, row 5, column 2). In the subsample of advanced SFG, the percentage of cooperative firms fluctuates between 24.6% in the Retreat sector and 33.5% in the Lost opportunity sector. Again, the differences are statistically significant (see Table 7, row 4, column 4). SFG that operate in sectors with fast technological change (Dynamic and Lost opportunities) tend to look for local R&D partnerships to a greater extent than SFG operating in a slow changing sector (Retreat).

We use the Bonferroni tests as *post hoc* tests that will help us to interpret the relationship between foreign status and local cooperation for innovation. According to the multivariate tests, the strength of the association between both variables is relatively greater in the Retreat sector, a slow changing sector in which Spain has no RTA (see Table 5, column 5 and Table 6, column 5). This is precisely a sector in which, according to the *post hoc* tests, SFG display less interest in cooperation for innovation. Secondly, the association of foreign status and local cooperation for innovation is relatively weaker in the two fast changing sectors, Dynamic and Lost opportunity. The Bonferroni tests suggest that SFG that operate

Table 2. Descriptive statistics. Percentages (%) of firms, by type of ownership

	Variable								
Foreign-ownership	*domCoopInnov*	*i_size*	*i_new*	*i_export*	*i_RDpers*	*i_int RDExpend*	*i_innovExpend*	*EU_market*	*Local_market*
Spanish firms belonging to a group	22.6	41.3	27.3	16.1	41.9	60.5	41.1	81.3	94.1
Foreign subsidiaries	31.3	58.5	23.3	20.5	40.9	56.7	36.3	92.5	89.4
Total	25.7	47.5	25.8	17.7	41.5	59.1	39.4	85.3	92.4

Variables are defined in Appendix 2

domCoopInnov: Percentage of firms which cooperate locally for innovation

Other variables: Percentage of firms above average in their respective two-digit industries. For instance, *i_RDpers* reports percentage of firms with R&D employment above average in their respective two-digit industries

Table 3. Cross-tabulation of *Foreign ownership* and RTA (% of firms)

Foreign	Revealed technological		
ownership	advantage		
	No (1)	Yes (2)	Total
Spanish firms	34.47 (a)	65.53 (a)	100.00 (a)
belonging to a group	67.02 (b)	62.63 (b)	64.08 (b)
Foreign	30.25 (a)	69.75 (a)	100.00 (a)
subsidiaries	32.98 (b)	37.37 (b)	35.92 (b)
Total	32.95 (a)	67.05 (a)	100.00 (a)
	100.00 (b)	100.00 (b)	100.00 (b)

Pearson $\chi^2(1) = 17.8399$ Pr = 0.000
Cramer's V = 0.0430

(1) Includes Lost opportunities and Retreat sectors.

(2) Includes Dynamic specialization and Stationary specialization sectors

(3) Includes Lost opportunities and Dynamic specialization sectors

(4) Includes Retreat and Stationary specialization sectors

(a) Percentage of firms operating in sectors with or without RTA, by ownership

(b) Percentage of each type of ownership by sectors with or without RTA

(c) Percentage of firms operating in sectors displaying or not international technological dynamism

(d) Percentage of each type of ownership by sectors displaying or not international technological dynamism

Foreign ownership and *sector* are defined in Appendix 2. RTA and international dynamism are defined in Section 3.2

Source: Authors' own elaboration based on PITEC data and Molero and García (2008) taxonomy

Table 4. Cross-tabulation of *Foreign ownership* and international technological dynamism (% of firms)

Foreign	International technological		
ownership	dynamism		
	No (3)	Yes (4)	Total
Spanish firms	51.25 (c)	48.75 (c)	100.00 (c)
belonging to a group	64.21 (d)	64.60 (d)	64.40 (d)
Foreign	51.68 (c)	48.32 (c)	100.00 (c)
subsidiaries	35.79 (d)	35.40 (d)	35.60 (d)
Total	51.40 (c)	48.60 (c)	100.00 (c)
	100.00 (d)	100.00 (d)	100.00 (d)

Pearson $\chi^2(1) = 0.1589$ Pr = 0.690
Cramer's V = −0.0040

See notes and source of Table 3

in these sectors seem especially interested in cooperation for innovation. In our opinion, the parallel developments suggested by the multivariate tests and the Bonferroni tests are not coincidental. It should be noted that FS show a similar interest in local cooperation for innovation across sectors, a finding confirmed for advanced FS.

As stated, we are especially interested in FS that are able to build complex networks of innovation in the host country. These firms are referred to here as multi-cooperative FS. We attempt to assess whether their presence is greater in fast changing sectors than in slow changing sectors (RQ 4a). Again, we more specifically focus on advanced FS (RQ 4b). We cross-tabulate *Breadth* and *Sector* for, respectively, the subsample of FS and the subsample of SFG. We perform Bonferroni tests to assess whether the respective distribution of multi-cooperative companies, domestic or foreign, is even across sectors (results available upon request). For FS, we find that *Breadth* and *Sector* are associated ($\chi^2 = 12.6923$, Pr = 0.048, Cramer's V = 0.0497). The share of multi-cooperative SFG was higher in the Dynamic sector than in the Stationary sector, and differences were statistically significant ($\chi^2 = -0120549$, Pr = 0.012). In contrast, in the subsample of advanced FS, multi-cooperative FS were evenly distributed across sectors. *Breadth* and *Sector* were not statistically associated ($\chi^2 = 9.4714$, Pr = 0.149, Cramer's V = 0.0693).

In the subsample of SFG, *Breadth* and *Sector* were significantly associated ($\chi^2 = 19.7030$, Pr = 0.003, Cramer's V = 0.0472) and the distribution of multi-cooperative SFG was uneven across sectors. Their presence was greater in the Dynamic sector than in the Retreat sector ($\chi^2 = 0.108133$, Pr = 0.004) or the Stationary sector ($\chi^2 = -080818$, Pr = 0.003). Focusing on the subsample of advanced SFG, we observed that the variables were, again, significantly associated ($\chi^2 = 10.9402$, Pr = 0.090, Cramer's V = 0.0526). There was a significantly greater presence of multi-cooperative SFG in the Lost opportunity sector than in the Retreat sector ($\chi^2 = 14.9961$, Pr = 0.045). To summarize, SFG tend to build complex networks in fast changing sectors rather than in slow changing sectors. This is not necessarily the case for FS.

5. Discussion

In our sample, FS do not seem to be especially attracted by sectors with rapid technological change. This circumstance may limit the contribution of these firms to the diffusion of state-of-the-art technology in the host country. FS operate mainly in sectors in which the host country has RTA (i.e. Dynamic and Stationary). This is similar to findings for other European countries (Cantwell et al. 2004; Schmidt and Sofka 2009). The importance of Spain's technological advantages, together with the magnitude and depth of the domestic market, explain, in our view, the concentration of FS in those sectors. More specifically, the Stationary specialization sector

Table 5. Logistic regression: Drivers of local cooperation for innovation, by sector. All sample firms

domCoopInnov	All firms (1)	Dynamic (2)	Stationary (3)	Lost_opportunities (4)	Retreat (5)
Foreign_ownership	0.6079163 ***	0.1286202	0.5797879 **	0.8766468 **	1.458749**
	(0.1719707)	(0.345373)	(0.2602688)	(0.3553419)	(0.6246404)
i_size	0.7161015 ***	0.9957868 ***	0.9282108 ***	0.3252988	0.4949278
	(0.1628764)	(3247712)	(0.261254)	(0.3351379)	(5079197)
i_export	−0.0646088	−0.0270932	−0.0077776	−0.0301668	−6041828
	(0.14455757)	(0.2661661)	(0.2427815)	(0.2900723)	(0.4904184)
i_ RDpers_1	0.9334996 ***	0.9353212 ***	1.102217 ***	0.5240373 *	1.157084 ***
	(0.1403177)	(02657852)	(0.2204845)	(0.3134114)	(4465613)
i_new	0.7054484 ***	0.3699716	0.7441382 ***	0.7800019 ***	1.096668 ***
	(0.1310478)	(0.2608829)	(0.2125848)	(0.2599997)	(0.4226999)
EU_market	0.8201276 ***	1.527201 ***	−0.2142137	2.193419 ***	1.27891 **
	(0.2225317)	(4584971)	(0.347708)	(0.5892285)	(0.6115767)
Local_market	−0.5573181 **	−0.2482676	−0.9844191 **	−0.1134344	−1.595363 **
	(0.2377583)	(0.4287662)	(0.438771)	(0.7704611)	(0.7847822)
Number of observations	7422	1921	988	1657	766
Wald χ^2	148.77	43.86	41.98	37.35	26.71
Prob > χ^2	0.0000	0.0000	0.0000	0.0000	0.0004

Standard errors in parentheses

***, **, *=statistically significant at 99%, 95% and 90% levels, respectively

Variables are described in Appendix 2, sectors in Table 1 and Appendix 2

Table 6. Logistic regression: Drivers of local cooperation for innovation, by sector. Advanced firms

domCoopInnov	All firms (1)	Dynamic (2)	Stationary (3)	Lost Opportunities (4)	Retreat (5)
Foreign_ownership	0.1056535	0.4779007	0.9051644 **	0.8516883 *	2.9979 **
	(0.1995306)	(0.4393946)	(0.4334043)	(0.5002528)	(1.095817)
i_size	0.5787808 ***	1.15125 ***	0.888766 **	−0.1659677	0.2049123
	(0.1917918	(0.4217729)	(0.4140887)	(0.4765432)	(0.7908074)
i_export	−0.1967225	−04849642	−0.2620878	−0.3789608	−1.658811 **
	(0.1692497)	(0.3561278)	(0.3855493)	(0.4316385)	(0.7795469)
i_ RDpers_1	1.021067 ***	0.5998865 *	1.663762 ***	−0.1619407	1.210559
	(0.1692497)	(0.3530195)	(0.3769949)	(0.44255077)	(0.7877121)
i_new	0.5716566 ***	0.1330825	0.5678728 *	0.6354076 *	1.30961 *
	(0.1596513)	(0.3428876)	(0.3438324)	(0.3851655)	(0.7115788)
EU_market	0.6673502 **	0.56888439	−0.0281258	2.374628 **	0.6750812
	(0.2845821)	(0.5592812)	(0.6244)	(0.8757895)	(0.9315043)
Local_market	−0.4931969 *	0.2505441	−1.775633 **	−0.4777679	−1.913357
	(0.2805547)	(0.5876974)	(0.851109)	(0.6566776)	(1.183334)
Number of observations	4867	953	1353	678	318
Wald χ^2	79.67	19.56	39.56	14.74	15.82
Prob > χ^2	0.0000	0.0066	0.0000	0.0395	0.0268

Standard errors in parentheses

***, **, * = statistically significant at 99%, 95% and 90% levels, respectively

Variables are decsribed in Appendix 2, sectors in Table 1 and Appendix 2. Advanced firms: *i_innovExpend* = 1

comprises a quite substantial number of so-called traditional industries that have strongly attracted FDI. Interestingly, this does not imply that FS operating in those sectors are more likely than other FS to source local knowledge via cooperation for innovation.

FS are significantly more prone to be engaged in local cooperation for innovation than SFG, even when the size and other characteristics of companies are controlled for (RQ 1a). With one exception, results seem to support the idea that FS encourage cooperation for innovation in all the Spanish manufacturing industries (RQ 1b). This is not unimportant in that, in general, Spanish firms cooperate less than firms located in other European countries. In the case of Spain, we do not find a branch plant syndrome, in contrast to FS operating in comparable European countries (Ebersberger et al. 2011). This intriguing result supports the findings of Holl and Rama (2014) on service and manufacturing FS in Spain. An analysis of reasons for the specificity of Spain is clearly beyond the scope of this paper. Such a study would have to include data for several countries. Nonetheless, we make a few preliminary arguments here. The reason offered by Holl and Rama (2014) for the greater embeddedness of FS as compared to their much more limited embeddedness in similar European countries was the substantial involvement of FS in production subcontracting networks in Spain. It was claimed that these arrangements provided a framework for collaborations for innovation between contractors and local suppliers, thus reducing transaction costs. A study based on in-depth interviews with a small group of MNEs performing R&D in Spain seems to confirm this opinion (Miravitlles et al. 2013). The companies declared that the availability of qualified suppliers had been a key consideration for establishing their respective R&D centres in the host country. Furthermore, early FDI policy often imposed the incorporation of a

Table 7. Bonferroni tests: Differences in distribution of cooperative firms across sectors

	Foreign subsidiaries (1)			Advanced foreign subsidiaries (2)		
	Lost opp	Retreat	Dynamic	Lost opp	Retreat	Dynamic
Retreat	−0.001829			0.031976		
	1.000			1.000		
Dynamic	−0.017832	−0.016003		−0.015457	−0.047427	
	1.000	1.000		1.000	1.000	
Stationary	−0.035611	−0.33782	−0.07779	−0.030465	−0.062441	0.015015
	0.458	1.000	1.000	1.000	1.000	1.000
	Spanish firms belonging to a group (3)			Advanced Spanish firms belonging to a group (4)		
	Lost opp	Retreat	Dynamic	Lost opp	Retreat	Dynamic
Retreat	−0.03971			**−0.089665**		
	0.216			**0.050**		
Dynamic	0.021751	**0.061461**		−0.14411	0.75254	
	0.935	**0.005**		1.000	0.117	
Stationary	−0.008846	0.030863	−0.030598	−0.041339	0.048326	−0.026928
	1.000	0.459	0.135	0.573	0.724	1.000

Source: Authors' own elaboration based on PITEC. Definitions of *Sector*, *Foreign ownership* and *domCoopInnov* in Appendix 2. Advanced firms: *i_innovExpend* = 1

Results of cross-tabulations of *domCoopInnov* and *Sector*: (1) Pearson $\chi^2 = 3.6443$, Pr = 0.303, Cramer's V = 0.0324. (2) Pearson $\chi^2 = 1.5562$, Pr = 0.669, Cramer's V = 0.0352. (3) Pearson $\chi^2 = 12.0527$, Pr = 0.007, Cramer's V = 0.0442. (4) Pearson $\chi^2 = 8.4206$, Pr = 0.038, Cramer's V = 0.0576

Statistically significant differences are given in bold face

quite important percentage of local content on manufacturing FS. This circumstance, coupled with the rapid development of a non-negligible domestic manufacturing network, may have stimulated production subcontracting and, consequently, cooperation for innovation between FS and local suppliers. More recently, Spain's innovation policy may have also played a role. In 2007, Spain was the OECD country that offered the most generous tax incentives to business R&D (Guimón 2011). Spain was also the first country to use the European Technology Fund (2007–13) in order to stimulate the R&D activities of FS. Both explanations may be complementary. As noted by an UNCTAD (2005) report, specific government incentives are rarely effective in attracting FDI in R&D when other conditions are not met in the host country.

Though FS seem more prone to cooperate locally for innovation than SFG, this is not necessarily specifically the case of 'the best' FS. FS displaying newness of technology are not necessarily more prone to cooperate locally than similar SFG. FS operating in the Dynamic sector, a fast changing sector, were not more prone than their domestic counterparts to cooperate with local partners. This is a counter-intuitive finding since IB theory suggests that FS attempt to source local knowledge precisely from those sectors in which the host country is relatively strong, as is the case of the Dynamic sector. At least two possible explanations may help to account for our results. In this sector, FS may be absorbing local knowledge via methods not explored in our paper. Secondly, FS operating in sectors in which the host country displays RTA may experience some difficulties when attempting to launch local innovative networks, since technologically leading domestic firms may be able to secure the most suitable local partners for R&D collaboration. Previous studies (Álvarez and Cantwell 2011; Cantwell and Mudambi 2011) validate this interpretation.

Also, advanced FS are not necessarily more likely than advanced SFG to engage in local collaboration for innovation (RQ 2a). In this subsample, moreover, *Foreign ownership* and *domCoopInnov* are not associated, or are only weakly associated, in fast changing sectors (i.e. Lost opportunities and Dynamic specialization sectors). In one of them (Dynamic specialization), Spain shows technological advantages (see Table 1). However, in the other (Lost opportunities), Spain has technological disadvantages. In the face of fast technological change, a greater contribution of advanced FS to the upgrading of the latter sector would have been especially desirable since Lost opportunities includes: the electronics industries, which are essential to the development of modern economies and societies; and vehicles, one of the Spanish export industries. In contrast, the coefficient of *Foreign ownership* is positive and significant in slow changing sectors (Stationary and Retreat). Regarding advanced firms, the association between foreign status and domestic collaboration for innovation seems to be relatively stronger in those sectors (see Table 4, columns 3 and 5) (RQ 2b). FS are more embedded than SFG in sectors where their presence seems less useful for facilitating catching-up processes in Spain.

We now discuss results concerning the cooperative behaviour of FS operating in different taxonomy sectors. We attempted to understand whether the presence of cooperative FS was greater in fast changing sectors than in slow changing sectors and found that the cooperative behaviour of these companies was even across sectors (RQ 3a). Similar results were found for advanced FS (RQ 3b). Though the majority of FS seem to be attracted to sectors in which the host country has RTA, this does not imply that FS operating in those sectors are more likely than other FS to source local knowledge via cooperation for innovation. The stable cooperative behaviour of FS across sectors involving very different technologies suggests that these companies look for general capabilities in local partnerships, rather than for specific expertise in areas in which the host country has RTA. For instance, training with a focus on recruitment is actually an important driver of R&D collaboration between FS and Spanish universities (Guimón and Salazar 2014). This confirms the idea that FS may expect a wide base of expertise from universities rather than immediate commercial applications in a specific industry (Cantwell 1995). This may contribute to explaining the stable presence of cooperative FS

across sectors. The distribution of cooperative SFG is uneven across sectors and this contrasts with the distribution of FS. SFG, and particularly advanced SFG, display a greater interest in cooperation in fast changing sectors than in slow changing sectors. In countries that are not technology leaders, SFG operating in fast changing sectors need to update their technology continuously in order to catch up, incurring in high R&D costs. Our results are in line with those of a study on the linkages of Brazilian universities (do Couto e Silva Neto et al. 2013): the decision to cooperate locally may follow different motives in FS and in domestic firms.

The results of Bonferroni tests imply that some caution is necessary in attributing the results of the multivariate tests (see Tables 3 and 4) to proactive strategies of FS. First, the *post hoc* tests suggest that the lack of association between *Foreign ownership* and *domCoopInnov* in the Dynamic sector (see Tables 4 and 5, columns 2) may be explained by a greater interest in local cooperation for innovation on the part of SFG rather than by a lesser interest on the part of FS. As revealed now by the Bonferroni tests, patterns of local cooperation for innovation among FS do not significantly vary across sectors. Secondly, *Foreign ownership* has the largest positive coefficient in the econometric models concerning the Retreat sector. However, this does not necessarily mean that FS in this sector are especially interested in local cooperation. Again, reasons may be sought in the behaviour of SFG operating in the Retreat sector, which seems to be relatively less interested in local cooperation for innovation than SFG operating in sectors with fast technological change. In addition to these merely statistical considerations, another possibility is that FS find more difficulties in securing suitable partners in host industries endowed with RTA (Schmidt and Sofka 2009), as is the case of the Dynamic sector in Spain. This occurs because in those industries, domestic firms may recruit the best local partners. The literature has mostly assumed, without further study, that the statistical association between foreign status and local cooperation for innovation is an effect of the strategies of FS. Our results suggest, however, that these strategies are only part of the picture. *Post hoc* tests may help researchers to gain further insight into the results of multivariate tests. This is a methodological contribution of our paper.

SFG (and advanced SFG) tend to build complex local networks in the two fast changing sectors (Dynamic and Lost opportunities), rather than in the two slow changing sectors. FS prefer to build such networks in the Dynamic sector (as opposed to the Stationary sector) but results are not confirmed for advanced FS (RQ 4a). Therefore, we cannot provide a conclusive answer for RQ 4b.

6. Conclusions

We studied the association of foreign status and local cooperation for innovation in the Spanish manufacturing industry. We were especially interested in FS that, in our view, could make a greater contribution to the technological upgrading of the host country owing to: intensity of innovation, newness of technology or ability to build complex local networks of innovators. The general comparison of FS with affiliated domestic firms shows the higher level of local cooperative activities of the former. However, when we focus on the FS that are more likely to make a greater technological contribution to the host country, foreign status does not necessarily increase the probability of local cooperation for innovation. Although Spain has been successful in attracting cooperative FS, our findings point to the need for more targeted policies that enable the host country to fully benefit from the internationalisation of R&D. Linkage facilitation policies should focus, more specifically, on FS that are well endowed with state-of-the-art technology, innovativeness or organisation skills. The capacity of domestic affiliated firms, notably innovation-intensive firms, to promote local cooperation for innovation is not far behind that of foreign investors. Moreover, domestic affiliated companies tend to cooperate locally and to even establish complex innovation networks in fast changing sectors rather than in slow changing sectors. As argued by Erken and Gilsing (2005), the evaluation of the respective merits of domestic R&D and foreign R&D is an important avenue for future research.

In providing one of the infrequent case studies of an intermediate country, our paper suggests that no general rules towards FDI in R&D can be recommended, given the heterogeneity of situations. More specifically, concerning the policies of intermediate countries, the capacity to discriminate across categories of sectors is essential. In sectors in which the host country enjoys technological know-how and a large domestic market (sometimes strengthened by the substantial presence of domestic exporters or investors in foreign markets), FDI in R&D may contribute to deepening the internationalisation of domestic firms. However, policies need to consider a balance between inward and outward spillovers. These are sectors in which the interactions between agencies in charge of attracting FDI and agencies in charge of promoting the internationalisation of domestic companies have an important role to play. The situation is different in sectors where, in the face of rapid technological change, the host country is far from the technological frontier. In this case, FS are likely to display limited interest in cooperating with local innovators. Domestic technological upgrading needs to be fostered through the development of local networks of highly qualified suppliers (here, the positive experience of Spain may be a reference), encouragement of clustering, and strengthening of education and R&D institutions. These measures may contribute to expanding domestic resources as well as attracting high quality FDI. When the host country is an export platform for the MNE, policies in these sectors need to stimulate high value-added contents through collaboration with local manufacturing suppliers and service firms. This is likely to promote innovative domestic SMEs and indirect exporters. The cases of, respectively, the Stationary specialization and the Lost opportunity sectors in Spain illustrate these two types of sectors.

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Notes

1. Also referred to in the literature and in this paper as R&D cooperation or as collaboration for innovation.
2. OECD Globalisation statistics <http://stats.oecd.org/index.aspx> accessed Jan 2014. 2007 was the last year for which data was available.

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Appendix

Appendix 1. Correlation matrix

	Foreign ownership	i_size	i_export	i_ RDpers_1	i_new	EU_market	Local_market
Foreign ownership	1.0000						
i_size	0.1646	1.0000					
i_export	0.0542	0.0586	1.0000				
i_ RDpers_1	−0.0094	0.3160	0.0265	1.0000			
i_new	−0.0439	− 0.0110	0.0129	0.0936	1.0000		
EU_market	0.1526	0.1097	0.1768	0.0881	0.0140	1.0000	
Local_market	−0.0860	−0.0227	−0.0319	−0.0061	−0.0150	0.0578	1.000

Appendix 2. Definition of variables

Name	Description	Values
Foreign ownership	Dummy variable	1 = FS (foreign subsidiary) 0 = SFG (Spanish firm belonging to a group)
Industry	CNAE classification of economic activities	26 two-digit industries. Calculations of averages include domestic firms (affiliated or not) and foreign subsidiaries
i_size	No. of employees	Dummy variable = 1 if firm's employment is above average company in its two-digit industry
i_export	Exports, as % of turnover, are above two-digit industry	Y/N
i_new	New or improved products, as % of turnover, are above two-digit industry	Y/N
EU_market	• company markets its products in EU market	Y/N
Local_market	• Company markets its products in a Spanish regional market	Y/N
Sector	Taxonomy sector	*Dynamic specialization*: sector is dynamic worldwide and host country displays technological advantages *Lost opportunities:* sector is dynamic worldwide but host-country shows technological disadvantages. *Stationary Specialization:* host country shows technological advantages but sector shows scarce technological dynamism worldwide. *Retreat:* host country has technological disadvantages and sector displays poor technological dynamism worldwide
	Innovation related variables	
i_RDpers_1	No. of employees involved in internal R&D	Dummy variable = 1 if firm is above average company in its two-digit industry
i_int RDExpend	Internal expenditures in R&D, including personnel, equipment, acquisition of software, etc. in previous year (in €)	Dummy variable = 1 if firm is above average company in its two-digit industry
External R&D expenditures	External expenditures in R&D, including personnel, equipment, acquisition of software, etc. in previous year (in €)	Dummy variable = 1 if firm is above average company in its two-digit industry
External knowledge acquisitions for innovation	Expenditures with acquisitions of services and licences related to use of patents and to non patentable technical knowledge (in €)	Dummy variable = 1 if firm is above average company in its two-digit industry
Expenditures in technology acquisition	Expenditures in acquisition of machinery, equipment, advanced hardware or software (in €)	Dummy variable = 1 if firm is above average company in its two-digit industry
Training expenditures	Internal or external training of workforce with specific aim of developing or introducing new or significantly improved products or industrial processes (in €)	Dummy variable = 1 if firm is above average company in its two-digit industry
Innovation expenditures	Introduction of new or significantly improved goods and services into market, including market research and advertising (in €)	Dummy variable = 1 if firm is above average company in its two-digit industry

(*continued*)

Appendix 2. Continued

Name	Description	Values
Expenditures for preparing and distributing innovations	Design and other expenditures for producing and distributing innovation that are not included in R&D expenditures (in €)	Dummy variable = 1 if firm is above average company in its two-digit industry
Aggregate index of R&D intensity	7 previous dummy variables are aggregated by summing up 'Yes' responses	0–7
i_innovExpend	Dummy variable that indicates whether, with regard to total innovation expenditures, focal company is above or below average in its two-digit industry	1 = above industry average (advanced firms) 0 = below industry average
	Cooperation variables	
domCoopInnov	Cooperated for innovation with external partners located in Spain in two years prior to survey	Y/N
Breadth	Breadth of local cooperation for innovation with external partners	0 = did not cooperate; 1 = cooperated with one type of partner; 2 = cooperated at least with two types of partners