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Patterns of local R&D cooperation of foreign subsidiaries in an intermediate country: innovative and structural factors

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Abstract

We attempt to contribute to a better understanding of cooperative innovation patterns of foreign subsidiaries (FS) in Spain as a representative intermediate country, going deeply into three main aspects: firstly, a sectoral taxonomy which combines international technological dynamism and revealed technological advantage as a way to understand such patterns. Secondly we focus our attention on innovative intensive subsidiaries, assuming they are the most important ones for hosting countries. Thirdly, we combine innovation and structural-competitive variables to explain local cooperation. We found more intense cooperation of FS with local agents in dynamic specialization sectors, as well as the fact that this is mostly carried out in a complementary mode with inner knowledge capabilities of the companies. Cooperative activities are influenced by economic-structural factors of the Spanish economy, particularly in highly innovative companies. Cooperative strategies of domestic firms might also have an influence on those of foreign subsidiaries.

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1. Introduction.

In the last decades, different branches of economic and business sciences have paid growing attention to the role of Multinational Enterprises (MNEs) and the changes in the way they organize innovation internationally. An initial debate took place on the level of internationalisation of innovation (Patel and Pavitt 1991; Archibugi and Michie 1995). At the turn of the century the accent changed towards qualitative and organizational aspects: the importance of the innovation strategy of the firms, the role of subsidiaries, differences between sectors or the importance of local firms and institutions (Cantwell and Molero, 2003, Cantwell, 1995).

In this paper we deal with several aspects regarding the way subsidiaries behave in host countries which are not at the frontier of international technological change, as is the case of Spain. In fact, the literature on the so called "intermediate countries" (ICs) is not very abundant. In this paper we understand as ICs economies which combine relative economic development with a clear backwardness in terms of technological competences; the concept will be developed later on (ETAN, 1998; Molero, 1995; Molero, 2002; Manolopoulus et al, 2005; Garcia, Molero and Rama, 2015).

To tackle this challenge we shall introduce significant methodological novelties regarding data and indicators, as will be explained in section 3; it is particularly important to combine innovative and structural factors in the explanatory variables of local R&D cooperation of foreign subsidiaries (FS) in Spain. A number of those structural factors are included in the obstacles to innovation declared by firms.

Therefore, the aim of this paper is to contribute to a better understanding of patterns of local R&D cooperation in ICs, going deeply into three main aspects: a sectoral taxonomy which combines international technological dynamism and revealed technological advantage (RTA). Secondly we focus our attention on innovative intensive subsidiaries, the most interesting ones from the point of view of host countries. The interest of the literature for these types of companies is growing; see, for example, Blomkvist, K., Kappen, P., Zander, I (2014) and Cozza and Zanfei, (2015). Thirdly, in the econometric analysis we combine innovation and structural-competitive explanatory variables.

Furthermore, we incorporate some significant methodological novelties: a deeply debugged data micropanel, the unifications and simplification of variables through factor analysis and the calculation of a synthetic innovation index for companies.

The development of this paper is the following: in section 2 we summarize the theoretical and empirical background which informs our research questions. Section 3 includes detailed information of data sources, variables and econometric strategy. Results are shown in section 4, while section 5 is reserved to synthesize the main conclusions and some policy implications.

2. Review fo the literature and research questions.

In spite of some antecedents of studies about the technological activity of MNEs (Dunning, 1958) it was at the end of the 1980s when a new topic emerged within innovation studies: the internationalization of innovatory activities and the role played by MNEs. An important number of contributions tried to determine the appropriate limits of what some authors called a "suitable case of non-globalization" (Patel and Pavitt,1991; Cantwell, 1995; Patel, 1995). Also the analysis incorporated aspects such as sectoral trends or the geographical distribution of the phenomenon. From the point of view of IB literature, the emphasis was put on the strategies of MNES´ headquarters and the importance of driving and retarding factors (Granstrand et al, 1993, Cantwell, 1995; Patel and Pavitt, 1991a).

One outstanding contribution was the differentiation of levels. Archibugi and Michie (1995) differentiated three: a) global exploitation of technology locally created; b) International technological collaboration and c) the international decentralization of innovatory activity by large MNEs. In the first level they included all forms of international valorisation of technology: foreign trade, patents, licenses and FDI; in the second, all forms of collaboration for innovation were considered, giving particular relevance to international technological alliances of firms; the third focused on the new role MNEs played in carrying out a growing number of innovative activities in third countries (Cantwell and Molero, 2003). MNEs are actively present in the three levels, although in the third their prominence is absolute.

A noticeable advance had to do with the differentiation of two basic strategies: on the one hand, the "classic" international technological deployment referring to the necessity of following the process of FDI in foreign countries (Blanc and Sierra 1999). In fact, the establishment of new subsidiaries in different countries involves necessarily a process of technological adaptation to local conditions. That strategy has been called Home Base Exploiting (HBE), Market Seeking (Kuemmerle, 1999: Cantwell and Jane. 1999) or Competence Exploiting (Narula, 2001; Cantwell and Molero, 2003; Cantwell andPiscitello, 2014).

A different strategy was identified when MNE´s foreign implantation is oriented to take advantage of local knowledge in order to upgrade the overall technological level of the multinational group. It has been called Home Base Augmenting (HBA), Asset Seeking or Competence Creating strategy (same references). As existing evidence points out, the higher the innovative engagement of FS, the more complementary is the interaction between competition and embeddedness (Santangelo, 2012). The significance of market and technological factors differs between those two strategies; as a general approach we could assert that market ones are more likely to be determinant in HBE cases, while technological ones will have a more dominant role in HBA examples.

The last differentiation gave way to a more intensive focus on the role of subsidiaries: an important part of the literature draws our attention to the fact that the increasing internationalization of innovatory activities was accompanied by remarkable changes in the organization of MNEs (Zander, 2002; Blomkvist, K., Kappen, P., Zander, I. 2014a; Narula, 2014). The traditional structure based on a central role of the motherhouse with direct relationships with each of the subsidiaries gave way to a more networking structure which incorporated a more decentralized decision making process and with subsidiaries developed playing a more active role.

The current situation of MNE´s international innovatory activity is based on the co-evolution of two complementary networks: internal and external (Cozza and Zanfei, 2015, Cantwell, 2015, Narula, 2014). The internal one consists of the relations between the headquarters and subsidiaries in different places; this networking structure responds to a new more interactive way of organizing work. The external network is rather complex insofar as each subsidiary and the motherhouse build their particular cluster of relationships with firms and institutions of hosting countries. For us, the role of cooperative R&D activities has to be understood as part of those domestic networks. Of course, the network includes many other ways of interacting, either formally or informally (Manolopoulos, Papanastassiou and Pearce, 2005; Holl and Rama 2014). Those linkages tend to grow and become more heterogeneous with time (Pearce, 1999). In the process of facilitating the embedding of the FSs in the domestic networks of knowledge, it is critical to have an increasing independence of the subsidiary in order to create new competences different from those of the headquarters (Cantwell and Piscitello, 2014, Manolopoulus et al, 2005). A central element is their capacities to obtain good economic results (Blomkvist, Kappen, andZander,2014).

Nevertheless, a number of insufficiencies remain. One quite remarkable is the consideration that the externalization process is not linear or without contradictions; therefore the existence of contradictions both between countries and sectors needs to be assumed (Narula, 2014). Another one has to do with the insufficient attention paid to the role of local actors; there is an abundance of references to factors and variables regarding the FS (size, sector, R&D effort, patenting, age and so on), albeit we know little about factors concerning local collaborators' behaviour and motivations. However, the literature on networks suggests that the point of view of prospective partners deserves some consideration. Well-endowed firms, either technologically or commercially, are more likely to be accepted in partnerships; the opposite is also true (Ahuja 2000); more generally, the capacity of domestic companies is a determining factor of their absorptive capacity from foreign subsidiaries (Sanchez-Sellero, Rosell-Martinez and Garcia-Vazquez, 2014, Garcia, Molero and Rama, 2015).

Therefore, the theoretical approach ought to combine a threefold perspective as shown in figure 1. Although in a modest dimension, we shall consider the third part in order to better understand the actual cooperation process.

Another important aspect recently addressed has to do with the different types of FS (Ho, 2006; Holl and Rama, 2014). In the analysis of the contribution of FS R&D cooperation to the national innovation system (NIS), we understand that innovation -intensive subsidiaries must occupy a central place. The international competition of many countries to attract those firms is based on the belief they may produce more intense technological spillovers, precisely due to their superior innovative activity (Guimón 2011). Although not all intensive subsidiaries cooperate in the same way, there are antecedents which justify the selection of a sample of innovation-intensive companies and their comparison with non-innovation-intensive enterprises (Garcia, Molero and Rama, 2015). Once again, with the necessary caveats, we believe this exercise can help to throw some light on the factors affecting the possibility of positive spillovers on the host structure.

A final aspect of this review deals with the necessity for more research on the cases of countries which neither belong to the group of in-

Figure nº 1: Model to understand FS R&D cooperation

novative leading economies nor are members of the laggard cluster. As established in other places (Molero, 1995; ETAN, 1998) the label of intermediate countries (ICs) tries to highlight the existence of a serious imbalance between technological and economic conditions. Just as a proxy of what we have in mind, let us mention that the EU includes among other countries the so called "moderate innovators" (European Commission, 2014), highlighting a twofold feature: on the one hand, they show a clear backwardness with respect to innovatory activity performance which is combined, on the other, with uneven development of the innovation system. Highly innovative countries, on the contrary, show a much more balanced set of economic, technological and institutional structure. A pan-European study on open innovation finds that foreign subsidiaries adopt a different cooperative behaviour in different host countries; for instance, in technology leader countries, such as the Scandinavian countries, and in high-income, low R&D countries, such as Spain (Ebersberger, Herstad et al. 2011). Hence the interest of studying ICs.

The guideline of our research starts from the idea that the particular situation of ICs makes it more difficult to see how factors affect the cooperative activity of MNEs. So, the distribution of local innovative firms between types of sectors differs from those of more advanced countries: the weak presence in a number of international dynamic sectors is particularly important; inversely, there is a kind of agglomeration in less dynamic sectors. 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, given the rapid rhythm of technology creation at the global scale and their privileged access to international sources of new technology.

Therefore, we formulate the following research questions:

RQ1: Is the local cooperation of FS mainly oriented in a complementary or substitutive way with firms´ endogenous knowledge

RQ 2: Do foreign subsidiaries (FS) especially tend to cooperate locally in these sectors in which the host country has Revealed Technological Advantages?

RQ3: Are the local cooperative activities of FS mainly driven by technological factors, by structural-competitive factors (SCF) or by both?

$RQ_{3.1}$ Is the relative importance of these factors the same across types of sectors?

$RQ_{3.2:}$ In the subsample of highly innovatory companies, is the relative weight of SCF as a determinant of local cooperation for innovation higher than in the total sample of firms?

3. Data, Variables and Methodology.

We combine the analysis of patents and survey results, a methodology that has been rarely utilised in studies on R&D cooperation (an exception is Cantwell, 1989).

Patent data are used to identify priority sectors, i.e. highly dynamic sectors where worldwide technological evolution is particularly rapid, and sectors in which Spain displays RTA. In this way, we can construct a sectoral taxonomy (Molero and García 2008) that enables us to cut the survey data into four subsamples and to analyse the existence (or not) of differences in further data-panel estimations between subsamples.

This information is combined with data on actual local R&D cooperation obtained from the PITEC database: anonymised micro-data at firm-level, both domestic and foreign, from the Spanish Innovation Survey elaborated by the Spanish Institute of Statistics. We analyse 2,145 observations pertaining to 429 foreign subsidiaries of manufacturing firms operating in Spain between 2004 and 2008 which have provided data for every year (balanced panel)[1].

[1] Although recently we have got data until 2010-12,, we decided to stop in 2008 in order to avoid the possible consequences of the crisis on the decision process of the firms

Non-innovators are not included in our sample since PITEC poses questions about R&D cooperation only to firms defined by the questionnaire as "innovative", i.e. companies which have ongoing innovative activities or have abandoned them during the two years prior to the survey. Other CIS-type surveys display the same feature (Ebersberger et al. 2011); 92.2% of the manufacturing firms surveyed by PITEC are innovative in this sense.

A complete description of the variables used in our study is in Appendix 1, nevertheless it is important to highlight below some of the especially relevant ones.

Firms. Foreign subsidiaries are companies which have ≥ 50% of foreign capital.

Local cooperation for innovation. There are cooperative activities if two separate organisations join forces to share and develop knowledge in order to enhance their innovative performance, not including the acquisition of R&D services via the market or R&D subcontracting. As in most studies on this R&D cooperation (Srholec 2011; Holl and Rama 2014; Veugelers and Cassiman 2004), we use a dummy variable, (*domCoopInnov*), indicating whether the company has cooperated for innovation with external partners (own business group excluded) located in Spain in the last two years prior to the survey.

Innovation intensity. With some exceptions (Ebersberger et al. 2011), most previous analyses on cooperation for innovation analyse a single R&D variable, usually internal R&D expenditures. However, certain empirical studies on this question suggest the need to approximate innovation from a variety of angles (Vega-Jurado et al. 2009). In host countries, FS may concentrate their technological effort on aspects other than developing internal R&D capabilities (Franco and Quadros 2003; Schmidt and Sofka 2009; Cantwell, 2015; Narula, 2001). This suggests that the approach to R&D needs to be comprehensive. To approximate to the innovation intensity of the focal firm, we construct an aggregated index (see Appendix 1), which includes seven types of innovation expenditures in accordance with the criteria of the Oslo Manual: a) 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; b) we aggregate the seven dummy variables and we calculate the two-digit industry average; c) we construct a dummy variable *(i_innovExpend)* that takes value 1 if our focal firm is above its two-digit average in the aforementioned aggregate variable innovation expenditures.

The comparison with the two-digit industry average enables us to avoid size effect and other industry effects and trends while comparing firms that operate in different industries. In calculating averages, we take the full two-digit industry into account, because innovative domestic firms (both affiliated and non-affiliated) 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. We use a taxonomy (Molero and García 2008) which combines two complementary indicators calculated through patent analysis: 1) the presence of revealed technological advantages (RTA) or disadvantages of the host country in one particular sector and, 2) the dynamic international behaviour of a sector based on whether it gains or loses weight in world technological production. Combining both classifications, the above mentioned study arrives at four types of sectors*: Dynamic Specialization* (the sector is dynamic worldwide and the host country 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), and *Retreat,* (the host-country has technological disadvantages and the sector displays poor technological dynamism worldwide). See Appendix 2 for two-digit industries sectoral breakdown. Notice that sectors characterized by rapid technological change are not necessarily high-tech sectors.

Notice that this taxonomy does not depend on previous qualifications of the sectors; on the contrary each sector is self-classified according to its double score in the two axes. As stated, in a country such as Spain, belonging to the ICs group, the distribution of sectors in the four quadrants reflects the particular uneven distribution of industry and technological innovation; two particular cases are worthy of mention: on the one hand, the weak presence of Spanish industries in some of the most technologically dynamic sectors leads to the situation of a considerable number of Hi-Tech Spanish sectors included in the Lost Opportunities quadrant. On the other, the relative abundance of traditional industries in less dynamic sectors, inflates the importance of the Stationary Specialisation in the Spanish economy[2].

CNAE industries. The database contains information on the two-digit industry in which the company operates. The Spanish CNAE (Clasificación Nacional de Actividades Económicas), similar to the NACE Rev classification in EU statistics, is used here to calculate whether the company is innovation intensive above the average level in its two-digit industry.

Finally, our work strategy is an iterative approach, both for intensity and taxonomy: 1) we start with an overall estimation (equation 1) for all sectors (without taxonomy cut out of our sample) and for all the firms (without an innovation intensive filter); this estimation is complemented with others made only for innovation intensive firms (we filter our sample with the aforementioned dummy for innovation intensive firms); 2) we repeat both estimations (without and with an innovation intensity filter) for four subsamples segmented by previously described sectoral taxonomy (see Appendix 2).

$$P(domCoopInov) = 1 \left| X_i^T, \beta^T, \alpha_i \right) = \Lambda(\alpha_i + \beta^T X_i^T) \quad [1]$$

Appendix 3 shows the correlation matrix.

4. Results.

In what follows we comment on the results of the estimation of logistic regressions of the cooperation-non-cooperation dependent variable versus a number of independent variables discussed in previous sections. In subsection 4.1 we will pay attention to the global analysis of all companies, without sectoral differentiation. We shall go first to all companies and secondly just to innovative intensive companies.

Some variables, such as the value of internal information, are associated with domestic cooperation in all models or in most of them. Nevertheless, it should be noted that models differ, suggesting that the variables which are likely to explain local R&D cooperation in different taxonomy sector are likely to differ as well.

4.1 General analysis.

a) All firms and sectors.

The model is strong and has an important explanatory power. As was postulated, within the significant variables we find both innovation and structural-competitive (SCF) ones (Table 1).

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[2] Previous studies using this taxonomy have already proved its usefulness: Molero and Garcia, 2008; García, Molero and Rama, 2015.

Table 1. Logistic regression: drivers of local cooperation for innovation. All sectors

domCoopInnov	All firms	Innovation intensive firms
i_innoexp	0.59782***	
	(0.20645)	
i_RDpers(L1)	1.59438***	1.58263***
	(0.30658)	(0.47416)
i_ownfund	0.60474**	
	(0.28883)	
i_size		1.211104**
		(0.52138)
i_new (L1)	0.52861**	
	(0.25092)	
i_interinfo	1.20002***	1.11825**
	(0.25959)	(0.46199)
i_competobst(L1)	-0.464001*	
	(0.238104)	
i_econobst		1.04133**
		(0.43931)
Nb. of observations	1716	746
Prob X2	0.000	0.000
Rho	0.78154	0.82693

Coefficients of Random-effects logistic regression (Standard errors in parentheses).
***, **, * = statistically significant at 99%, 95% and 90% respectively
Variables are described in Appendix 1,
Source: Own elaboration, with data from PITEC database

Starting with those measuring innovation activities, the two variables with the heaviest weight are R&D personnel *(i_RDpers)* and the importance given to own sources of knowledge *(i_interinfo).* R&D personnel has a period of delay which indicates that human capital is a necessary condition for being able to carry out cooperative activities; the search for local partners and the type of projects which can be implemented (and with what kind of partners) demand the existence of qualified R&D personnel who can explore the way by themselves.

The second significant variable is the importance given by the firms to their inner sources of knowledge to innovate. According to the positive sign, we are faced with a clear indication that the cooperation with local partners is a strategy which complements the own core knowledge of MNE subsidiaries (FS) and their group.

We also find the intensity of the FS's innovative effort *(i_innoexp).* The positive sign of its coefficient points to the argument that FS which display intensive innovation activities are more likely to cooperate with local partners. The significance and signs of the variable measuring the importance of new product *(i_new)* in the FS's supply of goods and services point in the same direction.

Finally, we have to take into account the availability of own R&D funds *(i_ownfund)*.From our perspective this is a twofold signal. From the point of view of the FS, this result can indicate the necessity of having a minimum of funds devoted to R&D; on the other hand, the potential local partners see in this circumstance an incentive to establish more cooperation with the FS. It should be noted that the variable includes reimbursable credit provided by Spanish public sources, as part of the support provided to corporate innovation (Huergo Orejas et al., 2014).

Among those variables referring to SCF, a quite interesting one is obstacles to innovating coming from competitive factors *(i_competobst)*: the market is already dominated by others, and uncertainty of the demand. First, the one period delay of its effect shows that the presence of these obstacles induces changes in the propensity to cooperate in the next period. Moreover, the negative sign of the coefficient means that those obstacles make the FS less likely to cooperate with local partners.

b) Analysis of innovation-intensive FS; all sectors.

Now, we analyse the results obtained when we take into account just FS which display innovation efforts over their industry average.

From the comparison of these results with the former ones, a number of highlighting facts arise. Two variables which continue to have statistical significance: the existence of R&D personnel *(i_RDpers)* and the importance firms give to their inner sources of knowledge *(i_interinfo)*. with similar interpretation. However, there are two new significant variables which belong to the SCF cluster: the volume of production *(i_size)* and obstacles to innovating deriving from economic factors *(i_econobst)*. The former bring to the first place the critical factor of companies' size as a facilitator of cooperative strategies, since this characteristic is highly correlated with a number of management capabilities.

According to the PITEC questionnaire, obstacles stemming from economic elements include the cost of innovation and the availability of internal and/or external financial sources to innovate. The positive sign means the higher these obstacles the more probable is cooperation of FS with local partners. A reasonable interpretation is that cooperation may be, at least partially, a way used by the FS for solving those obstacles.

A general comment arises from these first comparisons: in the case of innovation-intensive FS, the presence of SCF has a stronger power, notwithstanding the permanence of the two important variables referring to R&D personnel and the importance of inner sources of knowledge.

4.2. Differences according to the sectoral taxonomy.

Following the methodology previously explained we now show and discuss the results for each of the four kinds of sectors into which we divide manufacturing industry: Dynamic Specialisation (DS), Stationary Specialisation (SS), Lost Opportunities (LO) and Retreat (R). We have estimated similar models for the four, including the general one as well as another for innovative intensive enterprises.

After analysing the results of tables 2 to 5 we conclude it is advisable to discuss the findings by grouping the four sectors into two categories; one which includes the two types of sectors characterized by the existence of a Relative Technological Advantage (RTA > 1) of Spain and the other which puts together sectors with disadvantages (RTA < 1).

Table 2. Logistic regression: drivers of local cooperation for innovation. Dynamic Spacialisation (DS) sectors

domCoopInnov	All firms	Innovation intensive firms
i_RDpers (L1)	2.26887*** (0.61049)	2.79461*** (0.82949)
i_size	1.42702** 0.70799	
i_export(L1)	1.23893*** (0.44043)	1.59080** (0.65682)
i_interinfo	1.70586*** (0.55945)	
i_competobst	0.95211* (0.51034)	1.22461* (0.70503)
i_marketobst	-0.94843* (0.53144)	-1.38609* (0.75413)
Nb. of observations	432	208
Prob X2	0.0000	0.0024
Rho	0.79981	0.75354

Coefficients of Random-effects logistic regression (Standard errors in parentheses).
***, **, * = statistically significant at 99%, 95% and 90% respectively
Variables are described in Appendix 1, sectors in Appendix 2.
Source: Own elaboration, with data from PITEC database.

Table 3. Logistic regression: drivers of local cooperation for innovation. Stationary Specialisation (SS) sectors

domCoopInnov	All firms	Innovation intensive firms
i_innovexp	0.60124** (0.30626)	
i_RDpers (L1)	0.89960** (0.42593)	1.80883** (0.89361)
i_size		2.50288*** (0.95609)
i_Interinfo	1.60306*** (0.40479)	2.23265** (0.94800)
i_new(L1)	0.81905** (0.367322)	1.1667* (0.68976)
i_econobst		1.76303** (0.76342)
Nb. of observations	808	357
Prob X2	0.0000	0.0018
Rho	0.77965	0.90175

Coefficients of Random-effects logistic regression (Standard errors in parentheses).
***, **, * = statistically significant at 99%, 95% and 90% respectively
Variables are described in Appendix 1, sectors in Appendix 2.
Source: Own elaboration, with data from PITEC database.

Table 4. Logistic regression: drivers of local cooperation for innovation. Lost Opportunity (LO) sectors

domCoopInnov	All firms	Innovation intensive firms
i_RDpers (L1)	3.12468*** (0.79997)	
i_size	-1.48659** (0.74591)	
i_interinfo	1.26444** (0.56407)	4.71928** (2.07293)
i_marketobst		2.69595* (1.49393)
i_knowlobst		-4.17862** (1.80734)
Nb. of observations	368	131
Prob X2	0.0002	0.0170
Rho	0.73661	0.96478

Coefficients of Random-effects logistic regression (Standard errors in parentheses).
***, **, * = statistically significant at 99%, 95% and 90% respectively
Variables are described in Appendix 1, sectors in Appendix 2.
Source: Own elaboration, with data from PITEC database.

Table 5. Logistic regression: drivers of local cooperation for innovation. Retreat (R) sectors

domCoopInnov	All firms	Innovation intensive firms
i_innovexp	3.10715* (1.60613)	
i_size		
i_interinfo	-2.02811* (1.18756)	-9.80164*** (1.33155)
i_competobst (L1)	-3.153734** (1.55022)	-8.97892*** (1.65954)
i_marketobst	-2.24342* (1.28197)	
i_knowlobst	4.79242* (1.99349)	
Nb. of observations	104	46
Prob X2	0.0580	0.000
Rho	0.88449	0.92902

Coefficients of Random-effects logistic regression (Standard errors in parentheses).
***, **, * = statistically significant at 99%, 95% and 90% respectively
Variables are described in Appendix 1, sectors in Appendix 2.
Source: Own elaboration, with data from PITEC database.

Table 6. Association of *i_interinfo* and local cooperation for innovation (*domCoopInov*)

		Dynamic Specialization	**Stationary Specialization**
RTA >1	**All firms**	FS use cooperation as a complement of internal knowledge	FS use cooperation as a complement of internal knowledge
	Innovation intensive firms	Coefficient of *(i_interinfo)* is not significant	FS use cooperation as a complement of internal knowledge
		Lost Opportunities	**Retreat**
RTA< 1	**All firms**	FS use cooperation as a complement of internal knowledge	FS use cooperation as a substitute for internal knowledge
	Innovation intensive firms	FS use cooperation as a complement of internal knowledge	FS use cooperation as a substitute for internal knowledge

Source: Own elaboration, with data from PITEC database

We start by analysing the association of the importance of inner sources of knowledge to innovate *(i_interinfo)* in the four sectors. Table 6 shows an interpretation of our findings concerning the association of (*i_interinfo)* and local cooperation for innovation*,* when other factors are controlled for.

In our view, a positive and statistically significant coefficient of *(i_interinfo)* suggests that FS combine internal and external knowledge; In this case, FS which highly value their own internal resources are more likely to search for local innovative partnerships (for statistical details, see tables 2-5). In contrast, a negative and statistically significant coefficient for *(i_interinfo)* means FS use external knowledge as a substitute for internal knowledge; in this case, FS which scarcely value their own internal innovative resources are those tending to search for local innovative partners. Table 6 suggests that in most cases, FS use local cooperation as a complement of their internal resources. Exceptions are FS operating in the Retreat sector, which includes industries where the host country has no RTA and technological change is slow worldwide. In this specific case, the FS which are engaged in local cooperation tend to be those that attribute little value to their own resources.

4.2.1. Sectors with RTA > 1

The sectors with RTA > 1 are DS, (table 2), and SS (table 3). In both cases the models are better than those in which RTA < 1, particularly when the estimation is reduced to the innovatory firm's sample. This consideration is based on two elements: the higher adjustment of the models and the higher number of variables arising as significant. This general finding is coherent with most of the available literature which indicates FS carry out more innovative activities in sectors in which the host economy has a higher technological level., -this is, according to some authors, due to the possibility of benefiting from reverse spillovers(Singh 2002). Furthermore, those technological capabilities of the host country may also explain, a more dynamic strategy of local companies and institutions in this category of sectors with regard to cooperation with FS which perform above the sectoral average.

a) All firms estimation.

In the model for all firms we find some similarities and differences across the two sectors (tables 2 and 3). There are two common variables: R&D personnel *(i_RDpers)* and the importance given by the firms to their inner sources of knowledge to innovate *(i_interinfo)*. Again, the first one arises as the critical facilitator, while the second allows us to argue once again the complementary character of internal and external sources.

Nevertheless, there are some noticeable differences between the two cases. In the DS sectors, R&D personnel is the most important variable; in other words in these clearly strategic sectors the availability of qualified R&D personnel is more indispensable than in the SS.

Another two important variables for this sector are: size, measured by sales *(i_size)*, and exportation *(i_export)*. On the one hand, for many cooperative activities, a minimum size is required insofar as it conditions many other aspects of company capacities. On the other, a presence in international markets demands a more intense innovative effort on the part of the FS and the combination of more types of knowledge; cooperation is a way of accessing many local, sometimes sticky, modes of knowledge. It is not the case of SS; here in many "traditional sectors", Spain has remarkable domestic markets and therefore, exports are less important.

Also exclusive to this sector are two variables summarising different types of obstacles to innovation: factors grouped as competitiveness obstacles *(i_competobst)* and as market obstacles *(i_marketobst)*. In the last case, the negative sign of the coefficient indicates that this kind of obstacle reduces the probability of an FS carrying out cooperative innovation with local partners. On the contrary, the existence of competitiveness obstacles increases the FS's tendency to cooperate as a way of compensating those obstacles.

Results for SS show two other significant variables, which are not present in the DS cluster. The first one has to do with innovation results, as expressed by the percentage of new product in their overall layout *(i_new)*; the time lag of the variable suggests that former innovative results of the firm positively influence its subsequent cooperation activity. The second shows the significance of the variable which measures the general innovation effort of companies *(i_innoexp)*; so, in this sector, firms which display greater innovative efforts are more likely to establish cooperative actions for innovation with local partners. If we have in mind the non-significance of the same variable in the model for the DS cluster, we can conclude that it is in activities characterised by relative slow technological dynamism worldwide where the higher technological effort of the FS increases its probability of cooperating for innovation with local partners.

A final word: the comparison of the two kinds of sectors casts light over the fact that, in SS, some technological variables encourage local cooperation whereas, in DS, the presence of SCF is more powerful to predict local cooperation.

b) Estimation for innovation-intensive FS.

We see first that only one variable is significantly associated with FS local cooperation in the two sector clusters: the existence of specialised R&D personnel *(i_RDpers)*. So, also in these cases, the importance of this strategic variable is corroborated.

Nevertheless, there are noticeable differences between the two groups. In the case of DS, three SCFs should be highlighted. First, the presence of the company in international markets *(i_export)* in one moment of time fosters subsequent local cooperation. Second, competitive obstacles to innovation *(i_competobst)* may induce the firm to consider local cooperation as a mechanism to overcome them. Thirdly, the negative sign of the variable denoting market obstacles *(i_marketobst)* suggests that their presence makes FS reduce or abstain from local cooperative activities.

The case of SS is different because the weight of innovative and SCF is more balanced. Thus, together with R&D personnel, another two innovative variables have a positive influence in encouraging local cooperation: the importance given by firms to their internal knowledge source for innovation *(i_interinfor)* and the weight of new products in the global sales of the company *(i_new)*. Also two more SCFs are significant: on the one hand, the size of the firm (total sales, *i_size*) and obstacles to innovating coming from economic difficulties *(i_econobst)*; again as a general factor facilitating cooperation, whereas the result concerning economic obstacles suggests that cooperation may be playing a compensatory role to overcome them.

Summarizing part of the comparison between

DS and SS, we arrive at the conclusion that, effectively, in the first case, the presence of SCFs is more a determinant for local cooperation while in SS there is a more balanced situation with regard to technology-innovation variables. As this goes in the same direction as results for all firms, we could assert that FS operating in DS tend to display similar technology-innovation capacities and this is why SCFs, such as the presence in foreign markets or the necessity of overcoming specific obstacles to innovation, play a more significant role. On the contrary, in SS, as they usually belong to the traditional category and technology has a lower weight worldwide, a better technological capability of individual firms is a critical driver to carry out cooperation activities with external local partners.

4.2.2. Sectors with RTA < 1.

The starting point is the relatively lesser robustness of the models (tables 4 and 5). In fact, although they are sufficiently well adjusted, both the general level measured by the global probability and the capacity for explaining the behaviour of the dependent variable (to cooperate locally or not) through the selected independent ones show lower levels in RTA <1 than in RTA> 1 sectors. Moreover, the number of significant variables is also smaller in RTA <1 sectors, particularly if we take into account just those significant at the 95% confidence level.

a) All firms estimations.

There is only one variable which is significant both for LO and R types of sectors: the importance of inner knowledge sources for firms´ cooperative activity *(i_interinfo)*. Nevertheless the meaning of the variable is the opposite for each case (Table 6).

If we consider LO sectors, there are three other statistically significant variables. Two of them point in the same direction discussed in our previous analysis: R&D personnel *(i_RDpers)* and the importance given to inner knowledge sources *(i_interinfo)*. The third significant variable is quite surprising: it is the size of the firms (*i_size)* but the sign of the coefficient is negative, meaning that in LO sectors, the propensity to cooperate with local partners is greater the smaller the size of the FS. Here again we can understand this result better if we adopt the point of view of potential local partners. An important proportion of foreign companies operating in LO sectors belong to ICT or other high-tech activities where the power of very large MNEs is remarkable; therefore, it is reasonable to propose that potential local partners may prefer to choose smaller FS in order to make cooperation easier and more manageable.

The cluster of R sectors shows some important features. First of all, the variable measuring the relative innovative intensity of the firms *(i_innoexp)* is significant. As mentioned for the SS case, these sectors are characterised by a low international technological dynamism, so the relatively more intensive innovation effort on the part of the FS may appear to prospective local partners as a stimulating factor for cooperation. The perspective of local firms can also cast some light in this case. As general externalities from actors in those sectors are not expected to be abundant, we can argue that those companies will see cooperation with particular innovative FS as a more strategic way to upgrade their own technological level than in cases where technological dynamism is faster and hence the existence of "spontaneous" spillovers. The importance of inner sources shows a significant and negative sign, so it seems to be more oriented to substitute for firms´ own sources of knowledge than to complement them. Then, we note that practically all kinds of obstacles to innovation display significant coefficients. Both competitive elements *(i_compobst)* and market structure ones *(i_marketobst)* have negative signs (market structure displays a lower level of significance). The conclusion is very important: the higher the importance firms assign to those obstacles the lower their probability of cooperating locally. Obstacles stemming from knowledge scarcity operate in the opposite direction: cooperation with local partners is seen now as a way of overcoming those types of restrictions.

b) Estimation for innovation-intensive FS.

In both sectors the number of significant variables is reduced to only two (three in LO if we consider coefficients with 10% of probability). The only common variable is the importance given to own sources of knowledge to innovate *(i_interinfo)*, but its sign goes in different directions in each case. Thus, while in LO the positive sign of the coefficient suggests that cooperation is complementary to own resources; in R the negative sign of the coefficient indicates that the stronger the inner source of knowledge the less likely is the FS to cooperate with local partners.

In LO, the importance of obstacles from market structure *(i_marketobst)* is significant at 90% of confidence level; FS are likely to foster cooperation as a compensatory way to solve those difficulties. In LO, obstacles derived from knowledge scarcities *(i_knowlobst)* are significant and their negative sign indicates that the existence of these type of obstacles tend to block cooperation with local partners. Obstacles deriving from competitive aspects *(i_comptobst)* are not statistically significant.

5. Conclusions.

As far as RQ_1 is concerned, we can observe that the most frequent pattern of cooperation is oriented in a complementary way. In fact the most extended pattern is that FSs with high consideration of inner sources of knowledge are more likely to cooperate with local domestic companies in order to carry out more (or more intensive) innovatory tasks. This reinforces RQ_1 insofar as this complementary strategy is significantly performed in sectors in which Spain shows relative technological strength. These results help to confirm the importance of the external and internal networks in which MNEs carry out their technological activities (Cantwell and Molero 2003). Therefore we can derive an important suggestion for policy makers: any effort oriented to upgrading the embedding of FS in domestic local systems produces mutual benefits both for foreign and local companies and institutions. In this regard, there is a critical need for increasing the attraction capacities of intermediate countries to host innovative-intensive FDI (ETAN, 1998; Reguer, 2003).

Regarding RQ2, we can reassert that FS establish more cooperative linkages with local actors in sectors in which Spain has RTA. The interpretation of this finding can be found in both FS and local domestic partners´ firms' strategies. From the point of view of FS the results back the view that they follow a classical pattern: to take advantage of higher technological capabilities of the hosting economy (Singh, 2002).

Moreover, through this greater insertion they can be in a better position for gaining access to the flows of knowledge local domestic actors can provide (Cantwell and Piscitello, 2014). However, we can also interpret the data from the perspective of the local economy: in sectors in which Spain has RTA, local agents are better positioned to look for technological cooperation with FS because they are likely to have higher absorptive capacity (Cohen and Levinthal, 1989).

Generally speaking, as FS perform similarly in all categories of sectors, some differences arising in sectors with RTA>1 are partially a consequence of the more intensive cooperation of Spanish firms (Garcia, Molero and Rama, 2015). In other parts of the paper we argue about the importance of innovative- intensive Spanish firms to understand the actual FS cooperation; sometimes it may be the Spanish partner who perhaps may decide to find smaller international partners (and so the size of FS may have a negative impact). On other occasions the necessity of financial sourcing for Spanish industries may also explain the importance assigned by prospective local partners to their own financial R&D sources of the FS.

Our contribution concerning RQ3 is especially important. The first and general finding in this respect is that it is the combination of both aspects that incentivises/disincentivises cooperation. Although with some caveats, technological factors may be seen as necessary conditions while economic/structural ones operate as sufficient ones. In other words, the effectiveness of the FS's technological capabilities in fostering local R&D cooperation is filtered by existing competitive or structural conditions. This relative prominence of SCF has significant consequences for policy actions: the attraction capacity has to be promoted not just with technological-innovation actions but, very importantly, with structural measures which facilitates the access and positive development of those innovative FSs. Questions such as the competitive conditions (regulation or market structures), access to sufficient and flexible financial sources or the development of a more active demand for innovation, including public procurement, are issues that presumably will have an impact even greater than other classical actions linked to R&D&i.

Considering all firms and sectors we arrive at a couple of remarkable conclusions:

1. The combination of innovation and SCF factors does exist and it is particularly important to underline the presence of variables measuring the importance of obstacles to innovation.

2. If we take into account only innovative firms and considering that R&D personnel is a sort of precondition in most cases, we find that the probability of cooperating depends on two SCFs (size and economic obstacles to innovation) and just one innovative variable (the combination with inner sources of knowledge).

The richness of the findings increases on breaking down the analysis by sectoral taxonomy. Starting with all firms, we can assert that innovative variables have a higher presence. However, this is particularly true in sectors we can define as "badly adapted" to international trends, because either Spain has RTA in cases where international dynamism is slow (Stationary Specialisation) or it has disadvantages in highly dynamic sectors (Lost Opportunities) (RQ 3.1.). Thus, in SS cases only innovation-related variables are significant while in LO there is just one SCF and two innovative ones.

The panorama changes when we reduce the focus to highly innovative firms (RQ3.2.). Generally speaking, innovation-related variables lose strength, while SCF ones gain presence. This can be explained by the fact that in these subsample levels of innovation capabilities tend to be more homogeneous, and so factors other than innovation arise as more significant.

Now, the similarities we can establish across sectors depend more on the feature of belonging to internationally dynamic sectors, irrespective of the existence or not of RTA in the host country. Thus, for dynamic sectors, SCFs are always better predictors of local cooperation versus innovative ones. On the contrary, in a retarded type of sector, both kinds of variables are quite balanced (SS) or only innovative variables influence local cooperation (R). These findings give more support to the crucial role taxonomy work plays in the scientific analysis of the innovation process (Pavitt, 1984). Another important guide for policy action arises: through the necessity to differentiate measures and instruments according to the substantial differences existing among economic sectors.

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Appendix 1. Description of variables

Name (1)	Description	Values
Cooperation variable (dependent variable)		
Domestic R&D cooperation ***domRDcoop***	Have you cooperated for innovation with local partners in the last two years?	Y/N
R&D and innovation related variables		
Own resources ***i_ownfund***	Share of own resources of the focal company (including credits) in total resources used to finance internal R&D Share as compared to industry average	% 1= above industry average 0 =below industry average
R&D personnel **i_*RDpers***	No. of employees involved in internal R&D , including researchers, technicians and auxiliary personnel No. of R&D employees as compared to industry average	Employment 1= above industry average 0 =below industry average
Internal information ***i_interinfo***	Importance of internal sources of information for innovation; sources include the company and its business group The firm attributes more importance to internal sources than the average food and beverages company	1-4 Likert scale 1= Very important 4 Not used this source of information (Y/N)
Internal R&D expenditures (*i_intRDexp*)	Internal expenditure in R&D over industry average. Includes personnel, equipment, acquisition of software, etc. in year previous to survey	1= above industry average 0 =below industry average
External R&D expenditures (*i_extRDexp*)	External expenditure in R&D over industry average. Includes personnel, equipment, acquisition of software, etc. in year previous to survey	1= above industry average 0 =below industry average
External knowledge acquisitions for innovation (*i_extknowlexp*)	Expenditures in acquisitions of services and licences related to the use of patents and to non patentable technical knowledge over industry average	1= above industry average 0 =below industry average
Expenditures in technology acquisition (*i_machexp*)	Expenditures in acquisition of machinery, equipment, advanced hardware or software over industry average	1= above industry average 0 =below industry average

Training expenditures (*i_trainingexp)*	Internal or external training of the workforce with the specific aim of developing or introducing new or significantly improved products or industrial processes over industry average	1= above industry average 0 =below industry average
Introduction of innovation expenditures (*i_marketexp*)	Introduction of new or significantly improved goods and services into the market, including market research and advertisement over industry average	1= above industry average 0 =below industry average
Expenditures for preparing and distributing innovations (*i_prepexp*)	Design and other expenditures for producing and distributing innovation that are not included in R&D expenditures over industry average	1= above industry average 0 =below industry average
Aggregate index of innovation intensity ***i_innovExp***	The 7 previous dummy variables are aggregated by summing up the "Yes" responses over industry average	1= above industry average 0 =below industry average
Factors hampering innovation		
Obstacles to innovation Knowledge obstacles Economic obstacles Market obstacles Competition obstacles	11 different obstacles to innovation faced by the firm in the last two years. • Insufficient availability of qualified personnel • insufficient technological information • insufficient market information • difficulties in accessing knowledge • insufficient internal funding • insufficient external funding • high innovation costs • availability of previous innovations • insufficient demand for innovation • market dominated by other firms • demand uncertainties	1-4 Likert scale 1= Highly important obstacle 4 = Has not found this obstacle
Aggregated obstacles data	The 11 obstacles data were aggregated and re-codified through factor analysis into four categories: technological, economic, market and competition obstacles	1-4 Likert scale 1= Highly important obstacle 4 = Has never faced this obstacle

i_knowlobst ***i_econobst*** ***i_marketobst*** ***i_competobst***	Importance of obstacles to innovate as compared to those encountered by the average firm	1 = the FS faces higher obstacles than the average firm 0 = otherwise
	Control variables	
Exports ***i_export***	• Share of sales in foreign countries in total sales of firm • Share of sales in foreign countries over industry average	% 1= above industry average 0 =below industry average
Size ***i_size***	• Sales • Sales over industry average	In € 1= above industry average 0 =below industry average
New products ***i_new***	Percentage of products new to the company in total sales as compared to industry average	% 1= above industry average 0 =below industry average

Appendix 2: Sectoral Taxonomy

		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 agrochemicals, pharmaceutical, medicinal chemical and botanic products; paints, varnishes, printing ink and similar; soap, detergents, cleaning and polishing; manmade fiber, rubber and plastics; manufacture of weapons and ammunition	**Dynamic Specialization:** Textile, wearing apparel; dressing; dyeing of fur; basic metals;machinery for the 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)
Note. RTA>1 indicates sectors in which Spain has Revealed Technological Advantages.
RTA<1 indicates sectors in which Spain has no Revealed Technological Advantages

Annex 3. Correlation Matrix

	i_size	i_new	i_export	i_RDpers	i_ownfund	i_intRDexp	i_innoexp	i_interinfo	i_econobst	i_knowlobst	i_competobst	i_marketobst
i_size	1.0000											
i_new	0.0181	1.0000										
i_export	-0.0347	-0.0007	1.0000									
i_RDpers	**0.2993**	**0.0942**	-0.0189	1.0000								
i_ownfund	-0.0014	0.0452	0.0576	**0.3466**	1.000							
i_intRDexp	-0.0311	0.0594	0.0229	**0.3236**	**0.5124**	1.0000						
i_innoexp	**0.0834**	**0.0843***	0.0443	**0.1978**	**0.0830**	**0.0799**	1.0000					
i_interinfo	**0.0726**	**0.0770***	-0.0086	**0.1565**	**0.1246**	**0.0736**	**0.0742**	1.0000				
i_econobst	**-0.0842**	0.0562	0.0466	0.0560	0.0559	0.0554	-0.0055	-0.0323	1.0000			
i_knowlobst	**-0.1022**	0.0029	0.0593	0.0251	**0.1220**	0.0629	0.0366	-0.0519	**0.2735**	1.0000		
i_competobst	**-0.1044**	0.0482	0.0343	**0.0839**	**0.1170**	**0.1023**	0.0315	-0.0652	**0.3084**	**0.2948**	1.0000	
i_marketobst	0.0052	-0.0381	-0.0226	**-0.1086**	-0.0554	-0.0386	**-0.1150**	**-0.0764**	**0.1074**	**0.0939**	**0.2078**	1.0000

Annex 4. Descriptive statistics (percentage of firms over NACE industry average)

	Sectoral Taxonomy				
	Dynamic Specialisation	Stationary Specialisation	Lost Opportunities	Retreat	All the Foreign Subsidiaries
domCoopInov	37,78%	31,78%	36,52%	37,04%	34,64%
i_size	66,85%	59,50%	45,43%	68,15%	58,88%
i_new	23,89%	22,28%	29,35%	1,63%	23,82%
i_export	25,56%	19,70%	26,09%	22,96%	22,75%
i_RDpers	44,81%	43,96%	47,61%	63,70%	46,20%
i_ownfund	71,85%	68,12%	65,65%	73,33%	68,12%
i_intRDexp	61,67%	57,72%	53,26%	67,41%	58,37%
i_innoexp	42,04%	39,11%	33,48%	39,26%	38,65%
i_interinfo	65,37%	70,20%	72,17%	60,00%	68,76%
i_econobst	33,89%	34,75%	45,65%	31,11%	36,64%
i_knowlobst	39,44%	36,93%	32,61%	38,52%	36,74%
i_competobst	40,00%	41,09%	39,78%	54,07%	41,35%
i_marketobst	41,11%	37,92%	41,09%	40,00%	39,53%

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