# Foreign Ownership and Domestic Cooperation for Innovation During Good or Harsh Economic Times

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***Abstract***. *We analyse a sample of firms active in the Spanish Information and Communication Technology sector during 2003-2014 to assess whether foreign subsidiaries are likely to make a technological contribution to domestic innovative capabilities during expansive phases of the business cycle and recessions. Domestic firms are used as a control group. An econometric analysis shows that foreign subsidiaries are better than unaffiliated domestic firms at cooperating for innovation with local partners, but not than domestic business groups. Innovative foreign subsidiaries are more likely than non-innovative foreign subsidiaries to cooperate for innovation with local partners. However, the most advanced foreign subsidiaries seem reluctant to engage in local cooperation for innovation. Foreign subsidiaries have shown greater capability than domestic firms to increase their collaborations with local partners during the 2008 crisis.*

## Introduction

Multinational enterprises (MNEs) perform R&D abroad for a variety of reasons, such as adapting their products to local tastes and regulations; and benefitting from local expertise and funding (Rama, 2009). Is the current world expansion of foreign direct investment (FDI) in R&D (Dunning & Lundan, 2009; OECD, 2008) likely to contribute to linking host-countries to international sources of upgraded technology? The inquiry is most timely since competition between countries to attract R&D-intensive foreign direct investment (FDI) has increased in recent years (Guimón, 2009). Most academics and policy-makers believe that foreign firms may be a source of up-to-date technology for host-countries. The need for transfers of technology is especially acute in those that are not at the forefront of sciences and techniques, such as many European peripheral countries and emerging economies. Reviews of the empirical literature suggest that technology transfers are facilitated when foreign subsidiaries (FSubs) build local linkages (UNCTAD 2001)(Rama, 2009). One such linkage is cooperation for innovation with local partners.

However, many different circumstances may limit the local embeddedness of the foreign subsidiary. Recessions may put the brakes on the decision of the foreign firm to cooperate locally for innovation since local innovators not burdened by financial constraints may be difficult to find. Even during expansive phases of the business cycle foreign MNEs may operate as enclaves, with little impact on the host national innovation system (NIS) (Ebersberger & Herstad, 2012 . High transaction costs may check their local embeddedness and, hence, limit their collaborations with local innovators. Cooperative behaviour in the host country is also influenced by characteristics of the foreign firm, such as its technological level or its line of business (Dachs et al., 2008; Guimón & Salazar-Elena, 2015; Holl & Rama, 2014 ; Jaklič et al., 2014; Manolopoulos et al., 2005; Santangelo, 2009; Zhang et al., 2018).

The possible association between foreign ownership and local cooperation for innovation represents a complex and incompletely understood question. Mostly based on the empirical evidence provided by the Community Innovation Survey (CIS) of the European Union (EU), previous studies have offered important insights on this relationship. However, research results are not conclusive and certain aspects of the question deserve further analysis. Firstly, although there are exceptions (Ebersberger et al. 2011; Holl and Rama 2014 ; Knell and Srholec 2006; Molero and Heijs 2002)(do Couto e Silva Neto et al., 2013; Srholec, 2009), most analyses on the possible impact of foreign ownership on local cooperation for innovation focus

on highly industrialized countries. More inquiries on European peripheral countries and emerging economies are necessary to complete the picture since the risk of branch *plant syndrome* is greater in countries that are not technology leaders (Ebersberger et al., 2011; Srholec, 2009). The *branch plant syndrome* has been characterized by the poor integration of FSubs in the local milieu (Phelps, 1993). Secondly, most previous studies are based on cross-sectional analyses. Quantitative sectoral studies are rare. Yet, the heterogeneity of patterns of innovation across sectors has been clearly established (Malerba, 2005) and, within the same host country, the cooperative arrangements of FSubs may differ by sector (Ebersberger et al., 2011; García Sánchez et al., 2016a, 2016b; Guimón & Salazar-Elena, 2015). Quantitative sectoral studies may help us to understand more precisely the role of foreign ownership since, in this case, the problem of unobserved heterogeneity is reduced. Thirdly, the question of the possible contributions of FSubs in terms of updated technology remains elusive in the literature.

Finally, the relationship between foreign ownership and the probability of domestic cooperation for innovation has been tested during "normal" phases of the business cycle. To our knowledge, no studies have yet tackled this relationship during harsh economic times. Since open innovation may contribute to mitigate the difficulties and risks involved in a global financial crisis (D'Agostino & Moreno, 2017; Zouaghi et al., 2018), it would be important to ascertain whether FS may help the host economy to cope with the effects, often devastating, of a global crisis on innovation. Williams and Ecken (2011) note that the embeddedness of R&D subsidiaries should not be considered static and advise researchers to take into account longitudinal elements since, for instance, the resources available to the domestic partners of the multinational may change. This article attempts to contribute to a better understanding of these under researched questions.

For our study, we selected the Spanish Information and Communication Technology (ICT) sector owing to the following reasons. A major one is the broad applicability of ICT. Since the 1990s, evolutionary theories of technological change have identified ICT as a cornerstone of the current technological paradigm. Information and communication technology is at the origin of many general purpose technologies, such as photonics, micro and nanoelectronics, semiconductors and advanced technology manufacturing, which may contribute to transforming the face of economies and societies. ICT is a key area that underpins major ongoing industrial transformations. The Digital Agenda is one of the pillars of the Europe 2020 strategy for growth (Mas et al., 2018). Industry 4.0 may contribute to the competitiveness of national industries by improving connections between different segments of the value-chain, facilitating quality controls and reducing factory costs. Worldwide, the automobile industry is currently undergoing a major technological shift, which is related to the increased importance of ICT. A study claims that "*the traditional automakers need to stop thinking about cars as they were when Henry Ford build the first Model T and begin thinking about them as a smartphone with wheels*" (Butler & Martin, 2016, p.33). The emergence of electric vehicles, autonomous vehicles, connected cars, sharing services platforms and new battery technologies have posed new challenges as well as opportunities. These developments are causing an upheaval in markets and companies, and they very much regard Spain, the second largest EU producer of cars after Germany and the primary producer of industrial vehicles. Moreover, 85% of the Spanish production of cars is exported, as well as 60% of that of electronics components for automobiles. The Spanish machine tool industry, another important client of the national ICT sector, is the third largest producer and exporter of machine tools in the EU. However, according to patent analysis, Spain has no Revealed Technological Advantages (RTA) in ICT (Molero & Garcia, 2008) and there is a fear that the country could not adapt to the new developements in these key export industries. Logically enough, the "value" of a potential international transfer of technology is greater for host industries that enjoy no RTA

since such transfer may facilitate the acquisition of state-of the art technology that is not available at the national level. Also, Spain has recently become an exporter of capital in electronics and, especially, telecommunications (Fernández-Otheo & Myro, 2014; Rama & Ferguson, 2007; Valdaliso et al., 2011).

We start by asking whether, in the ICT Spanish sector, FSubs are more prone than domestic firms to engage in cooperation for innovation with local partners. Secondly, we investigate whether innovative FSubs are more likely to cooperate locally for innovation than non innovative FSubs (definitions below). This is a crucial inquiry from the point of view of host countries since non innovative FSubs contribute little to the host country in term of state-of-the-art knowledge and may, instead, crowd out domestic companies (Buckley et al., 2007). Thirdly, we ask if the local cooperative behaviour of FS has been affected by the 2008 financial crisis. Spain is a good choice for analysis since it is one of the European countries worst hit by the 2008 financial crisis. During the crisis, Spanish enterprises often abandoned R&D (Holl & Rama, 2016; Zouaghi & Sánchez, 2016). As many other countries, Spain suffered a credit crunch and cuts of public finance devoted to innovation (Cruz-Castro et al., 2018). We aim at assessing whether FSubs maintained their local collaborations for innovation during the crisis or if, alternatively, they preferred to stop these collaborations. In attempting to respond to these inquiries, we use domestic firms as a control group since we aim at identifying the specificities of FSubs. Ultimately, we aim at understanding whether FSubs are likely to make a technological contribution to domestic innovative capabilities in the ICT sector. The analysis of the Spanish case may be of interest to other host countries that strive at upgrading this key sector.

Section 2 deals with the literature review and proposes our research questions. Section 3 presents the contextual setting; section 4 the data and methodology; and section 5 the results and discussion. The last section concludes.

## 2. Review of the literature and research questions

The reviews of the literature draws from several strands of theory: the literature on cooperation for innovation; International Business theory; network theory, and theories of technological change.

Foreign subsidiaries use different strategies for sourcing local technology (Holl & Rama, 2014 ; Zhang et al., 2018) but cooperation for innovation seems to have a greater potential than the subcontracting of R&D services or the purchase of R&D services via the market for diffusing new knowledge. Cooperating with a partner to develop a technology or a product implies frequent interactions between the agents involved in the arrangement, while companies use the subcontracting of R&D services for performing mere standardized tasks (Beneito, 2006; Dhont-Peltrault & Pfister, 2011). According to the Resource Based View of the firm, R&D cooperation is a solution to problems the company cannot solve by itself (Miotti & Sachwald, 2003) and certain empirical studies seem to confirm this point of view for electronics industries (Huang & Holden, 2016). The product life cycle of certain ICT is especially rapid (Douglas B Fuller et al., 2017) but producing innovations in this field involves very long-term horizons and requires tight cooperation for innovation between companies, universities and research centres (Aschhoff et al., 2010). Therefore, cooperation for innovation is not only a necessity for generating new technology, but also displays a potential for transferring it.

2.1. Foreign subsidiaries and domestic firms

Appendix 1, section *a*, shows a list of selected studies dealing with the association of foreign ownership and local cooperation for innovation (LCI). The majority find that foreign

ownership has a negative or, at best, a neutral effect on the probability that a company cooperates for innovation with local partners (column 5). An explanation frequently offered is that high transaction costs in the host country impede the FSub to launch local linkages similar to those of domestic firms or, specifically, those of domestic business groups (DomGs). The International Business literature maintains that FSubs often incur a *liability of foreignness* due to the social and cultural barriers that these companies need to overcome in a host country (Zaheer, 1995). According to this theory, FSubs may face high transaction costs (Williamson, 1985) since their social capital in the host-country is often limited. This circumstance, in turn, is likely to reduce their possibilities to cooperate with innovative domestic projects since trust between partners is an essential ingredient of open innovation (Love & Roper, 2004). However, certain studies point to settings that may ease the embeddedness of FSubs in the milieu and, hence, facilitate their participation in local networks of innovation. Previous contractual relationships, it is argued, may reduce the transaction costs incurred by the FSub and, consequently, encourage its engagement in domestic partnerships for innovation (Holl & Rama, 2014; García Sánchez et al, 2016a). In a sample of top European and US MNEs active in the electronics industry, previous experience of the market has similarly a positive effect on local cooperation (Castellani & Zanfei, 2002).

## 2.2. Foreign subsidiaries in high tech sectors

According to the network literature, firms in high tech sectors, such as ICT, are more prone to cooperate for innovation since they face more risky and costly innovation processes. Therefore, the argument runs, cooperation may allow them to share costs and enter new technological fields (Miotti & Sachwald, 2003). This point of view is corroborated by certain empirical studies on European countries (Carboni, 2013; Ebersberger et al., 2011; Holl & Rama, 2019). The software, electronics and telecom industries have actually pioneered the adoption of open innovation; multinationals such as Philips, Xerox, Siemens and British Telecom are good examples (Gassmann et al., 2010).

Foreign subsidiaries engaged in different types of business seem to display different patterns of LCI (García Sánchez et al., 2016a; Molero & Garcia, 2008; Schmidt & Sofka, 2009)(Guimón & Salazar-Elena, 2015). Appendix 1, section *b*, shows a list of selected studies that focus, specifically, on the local cooperative behaviour of FSubs active in high-tech sectors, ICT included. Research results suggest that foreign ownership is unlikely to predict local cooperation for innovation in ICT, at least when FSubs are compared to similar domestic firms, that is to DomGs. More than ten years ago, Arita & McCann (2006) already observed that the most important MNEs with investments in the US and Europe semiconductor industry tend to remain only vertically integrated. Therefore, we formulate the following research questions:

RQ1 a: Are FS better than unaffiliated domestic firms at cooperating locally for innovation?

RQ1 b: Are they better than domestic groups?

## 2.3. Highly innovative foreign subsidiaries

As stated, a particularly important objective of host countries resides nowadays in attracting R&D-intensive foreign firms (Guimón, 2009). A crucial question is whether innovative FSubs are more likely to collaborate for innovation with local partners than non-innovative FSubs. The evidence is mixed in this respect. In a sample of manufacturing FSubs operating in Spain, those that are more prone to cooperate locally for innovation display: *i)* higher innovative intensity than the average firm in their two-digit host industry; *ii)* or a larger share of new products in turnover*; iii)* or a greater number of R&D employees and *iv)* greater

ability than average to combine internal and external sources of knowledge (García Sánchez et al., 2017). Holl & Rama (2014 ), in another sample of Spanish firms, observe that FSubs engaged in basic research are especially prone to cooperate for innovation with local partners. In a sample of non-European MNEs operating in Spain, Álvarez & Cantwell (2011) detect that those defined as "innovators" in their study, that is, exporters that had introduced products new to the market, are likely to engage in local R&D cooperation. In a sample of FSubs operating in Greece, it was similarly found that creative subsidiaries are more prone to collaborate intensely with local partners (Manolopoulos et al., 2005).

In contrast, other authors observe that FSubs may fear spillovers of knowledge, limiting their outer flows of knowledge in the host country. A study on the semiconductor industry observes that MNEs have been wary of improving the technical capabilities of their own FSubs in China or of outsourcing R&D to local firms, their objective being to keep design activities in the headquarters of the company (Fuller, 2014). In a set of Spanish manufacturing industries characterized by rapid worldwide technological change, electronics industries included, FSubs are more prone than DomGs to engage in LCI; however, the association between foreign ownership and LCI is weakened in a subsample of highly innovative firms (García Sánchez et al., 2016a). In a study on European and Asian subsidiaries active in the US semiconductor industry, Perri and Andersson (2014) observe that *the most advanced subsidiaries, which own highly valuable knowledge and superior technology, are the ones contributing less to the local knowledge network*" (p.73). Analysing the Spanish food and drinks industry, another study detects similarly that innovation-intensive FSubs are reluctant to engage in LCI (García Sánchez et al., 2016b). The discussion suggests that innovative FSubs are not necessarily more likely than non-innovative FSubs to engage in LCI.

Therefore, we ask:

RQ2: Are innovative FSubs more prone than non-innovative FSubs to cooperate for innovation with local partners?

(Definitions below).

2.4. Local cooperation for innovation during harsh economic times.

The emerging field of MNEs resilience has mainly focused on the financial performance of these companies during a downturn, not on their innovative performance (Fainshmidt et al., 2017; Manolopoulos, 2018). However, a few studies in the field of innovative resilience take into account the specific technological strategy of MNEs during the 2008 crisis. In a sample of European firms that operate in innovation intensive sectors, Archibugi et al (2013) find that companies with investments abroad, a proxy for MNEs in their study, were less likely than uninational companies to increase their R&D investments during the recent crisis. On analyzing Spanish data, Holl and Rama (2016) observe that foreign ownership had a neutral effect on the probability that a company adopted a countercyclical strategy during the 2008 crisis, even when size, technological leadership and other features of firms were checked. A countercyclical strategy means that the firm maintains or increases its investment in innovation during a downturn. Evaluating the probability that a firm generates radical innovations during the crisis, another study on Spain also suggests that foreign ownership had a neutral effect (D'Agostino & Moreno, 2017). From the discussion, one can conjecture that MNEs were not likely to adopt a countercyclical technological strategy during the 2008 global crisis.

To our knowledge, no previous study has yet focused on the specific cooperative behaviour of FSubs during a downturn. As stated, the relationship between foreign ownership

and the probability of LCI has been tested during "normal" phases of the business cycle. However, evolutionary theories of International Business, which maintain that multinationals co evolve with their environment, may provide some guidance (Cantwell et al., 2010). As a response to uncertainty in the host country, the argument runs, MNEs may shift towards networked forms of organization that provide more flexibility. In our view, this theory would predict a greater involvement of the MNE in a networked form of organization of innovation, such as LCI, during a shock since this form would help the multinational to share the costs and risks of innovation with local partners. Nevertheless, the scarce available evidence is far from suggesting this expected organizational shift during the 2008 crisis. Two studies on, respectively, Italy and eight Latin American countries suggest that, during the crisis, FSubs and leaders of GVC have maintained or even augmented their innovative activities, while their local suppliers have been likely to reduce or stop theirs (Brancati et al., 2017; Paunov, 2012). A speculative interpretation of the above-mentioned findings is that FSubs may have reduced their involvement in local R&D cooperation during the crisis, while going on with their own projects *"intra-muros"*. Consequently, we formulate the following question:

RQ3: Have FSubs reduced their local collaborations for innovation during the 2008 crisis?

## 3. Context Setting

In 2015, the Spanish ICT sector ranked fifth in the EU in terms of value-added, after those of Germany, the UK, France and Italy (Mas et al., 2018). The number of Spanish ICT firms increased from 29.838 in 2011 to 33.176 in 2016, the most dynamic subsectors in this regard being informatics and the media. Total ICT turnover increased from 89,203 M€ in 2013 to 105,868 M€ in 2016. In 2017, employment amounted to around half a million people and value added, to 4.2% of the Spanish GDP.

The subcontracting of production plays a very important role in this Spanish sector (Cámaras de Comercio, 2008; Holl & Rama, 2009; Lopez-Bayon & Gonzalez-Diaz, 2010) and many firms operate exclusively in *"business-to-business"* markets. As stated, the ICT sector is a substantial supplier of two important national export industries: automobiles and machines tools. ICT subcontractors display significant links with the national aeronautic industry (Díaz-Mora, 2008). Large domestic groups specialising in defence electronics and cyberdefence (Calvo, 2019) have been involved in European projects, such as the Airbus and the European Fighter.

In 2015, Spanish outward stock of FDI in ICT amounted to 47,261 M€. Telefonica, a very large native multinational, is key in the internationalization of telecommunication services, while the protagonists of the internationalisation of the computing and electronics industries are companies of all sizes (Esteve & Rodríguez, 2014; Rama & Ferguson, 2007; Valdaliso et al., 2011). Foreign direct Investment is also substantial; in 2015, the inward stock position of FDI in the Spanish ICT industries was 31,583 M€.

## 4. Data

We use data on actual LCI obtained from the PITEC database, which provides anonymised micro-data for both domestic and foreign companies. PITEC is the Spanish Technological Innovation Panel collected by the Spanish National Statistics Institute as a contribution to the CIS of the EU. Compared to other CIS-type surveys, PITEC has the advantage of providing data collected every year (CIS has a two-year periodicity). It should be noted that non innovators are not included in our sample, as PITEC poses questions about cooperation for innovation only to firms broadly defined by the questionnaire as "innovative":

companies that have launched new products into the market, introduced new industrial processes, abandoned them during the two years prior to the survey, or have ongoing innovative activities. Other CIS-type surveys display the same feature (Srholec, 2009; Veugelers & Cassiman, 2004). Our sample is statistically representative of ICT firms located in Spain in 2003 - 2014.

We perform an econometric analysis in order to study factors influencing significantly the probability that a firm cooperates locally for innovation. Our research strategy consists of an iterative estimation of logit models with panel data. First, we perform an overall estimation using a categorical independent variable identifying whether a firm is an UDF, a DomG or a FSub, with UDF as base class. Second, we repeat the analysis for a subsample that excludes DomGs, in order to compare UDFs and FSubs. Third, we repeat the test for a subsample of business groups, either national or foreign. Finally, in order to capture technological differences between cooperative and non-cooperative companies within each class of firms (UDF, DomG and FSub) we segment our sample into three subsamples and we estimate for each of them a logit model similar to the aforementioned model:

$$P(domRDcoop = 1 \,|X_i^T, \beta^T, \alpha_i) = \Lambda(\alpha_i + \ \beta^T X_i^T)$$

Variables

Appendix 2 displays the definitions of the variables and Appendix 3 the correlation matrix.

*Dependent variable*

***LocCoopInn*** (Local cooperation for innovation). As in most studies on cooperation for innovation (Holl & Rama, 2014 ; Srholec, 2014; Veugelers & Cassiman, 2004), our dependent variable is a dummy that indicates whether the focal company cooperated for innovation with external partners located in the host country. "External" refers here to partners located in Spain that are not part of the company and/or the business group; for instance, local universities. Cooperative activities are defined here as two separate organisations joining forces to share and develop knowledge in order to enhance their technological performance. Cooperation for innovation includes R&D cooperation but not the acquisition of R&D services via the market or via R&D subcontracting.

*Independent variables*

***fsub***. This dummy variable indicates whether the company is a foreign subsidiary. It is our variable of interest concerning RQ1a and RQ1b. PITEC 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 FSub. If not, the company is classified as a DomG, while companies not belonging to a group are classified as UDF.

***domGroup.*** This dummy variable indicates whether the company pertains to a domestic business group. We take into account the nature of domestic firms (affiliated or unaffiliated) since group membership seems to influence the propensity to cooperate (Annique Un & Romero-Martínez, 2009; Ebersberger et al., 2011; Holl & Rama, 2014 ; Molero & Heijs, 2002).

PITEC and other CIS-type surveys do not permit the identification of native MNEs (Holl & Rama, 2014; Cozza et all, 2018)

The following independent variables denote intensity as as compared to the two-digit host industry, domestic and foreign firms included; for instance, above average R&D internal expenditures. This methodology aims at asserting the traits and capabilities of the host industry. Our objective is to understand the degree of embeddedness of the FSub when characteristics of the host industry are checked. Intensity is indicated by an "*i_*" before the name of the variable. Innovation-related variables are used to assess whether quality ICT foreign investment is likely to be involved in LCI (RQ2). Following previous studies and the criteria of the Oslo Manual we adopt a comprehensive approach to innovation (Ebersberger et al., 2011; García Sánchez et al., 2016a; Holl & Rama, 2014 ). The use of several innovation variables may provide a nuanced picture of the possible contributions of FSubs to the NIS. The following variables are dummies that indicate whether the focal firm is more innovation-intensive than the average firm that operates in its two-digit industry. When the variables display a positive, statistically significant coefficient, the focal firm would be more innovation-intensive than average. In this set of innovation variables, our variables of interest are:

*i_intRDexp:* Internal R&D expenditures. This variable reflects a high commitment to R&D on the part of the firm and is the sole innovation variable taken into account in certain studies to characterize the technological strength of a firm.

*i_newmar:* Share of products new to the market in turnover. Certain studies consider this variable essential to define innovators or, specifically, radical innovators (Zouaghi et al, 2018; Álvarez & Cantwell, 2011) since it points to the ability of the firm to introduce first novelties into the market.

As a complement, we analyse other variables that also denote innovative intensity:

*i_extRDexp*: External R&D expenditures.

 *i_other InnExp*): Other innovation expenditures.

*i_RDpers* : Number of employees involved in internal R&D. Following Cohen and Levinthal (1989), the variable indicates whether the focal firm enjoys more absorptive capacity than the average company -- a crucial consideration for a firm attempting to benefit from cooperation for innovation.

*i_newent* : Share of products new to the enterprise in turnover. Following Zouaghi et al (2018) we use this variable to assess the capacity of the firm to produce incremental innovations.

*i_interinfo:* This variable denotes the perception of the firm regarding the usefulness of internal information coming from both the company itself and its group. Combining internal and external information inputs can improve the productivity of in-house R&D (Di Guardo & Harrigan, 2012). MNEs are likely to value their own sources more than domestic firms value theirs (Dachs et al., 2008; Molero & Heijs, 2002). Certain studies suggest that external knowledge seems only to supplement their internal sources (García Sánchez et al., 2017; Manolopoulos et al., 2005).

*i_ownfund* : Share of own resources in the total resources used by the focal company to finance R&D. Cross-sectional studies are not conclusive as to whether credit rationed firms or firms facing high costs of innovation are more likely to become involved in cooperative

arrangements (Carboni, 2013; López, 2008; Miotti & Satchwald, 2003). In a study on the Spanish food and beverage industry, FSubs that display a larger than average share of own funding for innovation are more likely to cooperate locally for innovation than FSubs that display a smaller-than-average share (García Sánchez et al., 2016b).

*Obstacles*. We take into account 11 obstacles to innovation. Obstacles were aggregated through factor analysis and re-codified into four categories: knowledge, economic, market and competitive obstacles. Our independent variables for obstacles are: ***i_knowobst***, ***i_econobst,*** ***i_marketobst*** and ***i_competobst***. Negative, statistically significant coefficients would indicate that the focal firm faces *fewer* obstacles to innovate than the average company in its two-digit industry. In this set, ***i_knowobst*** is our variable of interest since it indicates key characteristics of the firm such as fewer difficulties than average in accessing knowledge, and in finding qualified employees or technological/ market information.

As stated, an "i_" before the name of the variable indicates that we are comparing the focal firm with the average company in its two-digit industry.

*crisis*. This is our variable of interest concerning RQ3. The 2008-2014 period is used here to signals the in-crisis cooperative performance of firms. We take 2014 as the final year of the crisis since it is the first year displaying an increase of the Spanish GDP after its inception (Zouaghi et al., 2018).

Following previous studies (Ebersberger et al., 2011; Holl & Rama, 2014; Miotti & Satchwald, 2003)(Belderbos et al., 2014), we control for the size, export activities and previous cooperative experience of the company.

***i_size*** : size of the firm as measured by employment.

***L_size*** Logarithm of employment

***mdoue*** . Indicates whether the focal firm exports goods or services to the EU market.

***previousLocCoop*** Belderbos et al (2014) find that persistence is the most common pattern of collaboration in a sample of Spanish manufacturing and service firms. Firms that cooperated previously may have acquired some experience concerning the identification of suitable partners and of joint innovative projects. Thus, they are probably more likely to engage in LCI than those that have not a recent cooperation experience. Also, previous experience in the host-country may have reduced the *liability of foreignness* faced by FSubs. On the other hand, an increase in cooperative activities may be attributable to this cumulative effect, not to the crisis; hence the need to control for previous cooperative experience. Following Belderbos et al, (2014), the variable takes the value 1 when the focal firm was engaged in LCI in the two previous consecutive years, 0 otherwise. As observed by the above-mentioned authors, there is little scope for longer survey lags, given the limited panel structure of the PITEC data.

## 5. Results and Discussion

Our sample includes nearly 14,000 observations for 2003-2014. UDFs account for 53% of the sample firms; DomGs for 35%; and FSubs for 12%. Most of the sample companies operate in the subsector of programming and consulting (53%) and informatics products (22.3%); the rest are in other informatics services, telecommunications, etc. FSubs are overrepresented in telecommunications and other informatics services. DomG spend more

money in innovation than the two other types of firm, while FSubs stand out for their large size rather than for their R&D intensity (Table 1). At first sight FSubs seem to engage more frequently in LCI than do DomGs or UDFs; however, a multivariate analysis is needed to clarify this question.

Table 1. Descriptive statistics

**A. Turnover (€)**

| | Mean | Std. Dev. | Obs. |
|---|---|---|---|
| UDFs | 4769553.7 | 23983745 | 8,555 |
| DomGs | 1.093e+08 | 5.495e+08 | 4,100 |
| FSubs | 1.964e+08 | 7.449e+08 | 1,267 |
| Total | 52982618 | 3.794e+08 | 13,922 |

**Total expenditures in innovation (€)**

| | Mean | Std. Dev. |
|---|---|---|
| UDFs | 416412.84 | 3743335.4 |
| DomGs | 5013271.1 | 2977389 |
| FSubs | 8567730 | 40241381 |

**Source: PITEC**

Predictors of LCS for the entire sample are shown on Table 2, column 1.

*domGroup* and *fsub* have both positive, statistically significant coefficients. Belonging either to a DomG or to a foreign multinational increases the probability that a company engages in LCI, even when other factors that may influence the propensity to cooperate, such as the size of the firm, are controlled for. Firms belonging to business groups, either national or multinational, enjoy more organizational and technical capabilities to link with external partners since they have access to the resources of the corporation (Cozza et al., 2018; Tamayo & Huergo, 2017; Un & Rodríguez, 2018). In column 3, we compare FSubs and UDFs. The *fsub* variable has a positive, statistically significant coefficient, suggesting that FSubs are better than UDFs at cooperating for innovation with local partners (RQ1a). In column 5 we repeat

the estimation on a subsample comprising only firms belonging to a business group, either domestic or foreign. The *fsub* variabl*e* has a positive, non-significant coefficient, suggesting that FSubs are not necessarily better than DomGs at cooperating for innovation with local partners (RQ1b). This result is in accordance with most previous studies (section 2) in that foreign ownership is unlikely to predict local cooperation for innovation in ICT, at least when FSubs are compared to similar domestic firms, that is to DomGs. The coefficient of the *crisis* variable is not statistically significant.

We repeat now the estimation for three subsamples of, respectively, UDFs, DomG and FSubs (Table 3). Columns 1 and 3 focus on, respectively, UDFs and DomGs, and column 5 on FSubs. We attempt to detect whether cooperative companies are more innovation intensive than non-cooperative companies.

Column 5 shows the distinctive characteristics of, specifically, FS engaged in LCI. Compared to noncooperative FSubs, cooperative FSubs display higher than average R&D employment and a higher share of improved products in turnover (*i_RDpers* and *i_newent* have both positive, statistically significant coefficients). Higher than average R&D employment increases the probability that a FSubs engages in LCI by 17%; a large share of incremental innovation in turnover increases it by 11% (column 6). Compared to non-cooperative FSubs, cooperative FSubs highly value their internal sources of information (*i_interinfo* displays a positive, statistically significant coefficient). At first sight, these results suggest that innovative FSubs are more prone than non-innovative FSubs to cooperate for innovation with local partners.

Turning now to our variables of interest, we note that *i_newmar* and *i__intRDexp* display negative, statistically significant coefficients; and *i_knowobst* a positive, tangentially significant coefficient. These results suggest that the non-cooperative FSubs of the sample are more likely than average to: *i)* display a higher share of radically new products in turnover; *ii)* invest in internal R&D and *iii)* face *fewer* knowledge obstacles to innovation. A higher than average share of radical innovations in turnover *reduces* by more than 8% the probability that a FSub engages in LCI; a higher than average expenditure in internal R&D, by 11% (column 6). Experiencing fewer knowledge obstacles than average *reduce*s this probability by 6%. These results introduce an interesting nuance in the analysis. As stated in the above paragraph, innovation-intensive FSubs are inclined, generally speaking, to cooperate with local partners. However, the most advanced FSubs, given their significant commitment to internal R&D, their ability to be first to introduce novelties into the market or their outstanding level of knowledge, propend to avoid LCI.

Table 2. Local Cooperation for Innovation.  Foreign Subsidiaries versus Domestic Firms

| | All ICT firms | | UDF/ Foreign subsidiaries | | Only ICT Groups | |
|---|---|---|---|---|---|---|
| | Coef./se | dydx | Coef./se | dydx | Coef./se | dydx |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *LocCoopInn* | | | | | | |
| *previousLocCoop* | 1.79124*** | 0.14505 | 1.72736*** | 0.12175 | 1.94985*** | 0.20304 |
| | (0.132) | | (0.170) | | (0.184) | |
| *i_intRDexp* | -0.18579+ | -0.01505 | -0.11337 | -0.00799 | -0.47212** | -0.04916 |
| | (0.106) | | (0.134) | | (0.162) | |
| *i_extRDexp* | 0.57914*** | 0.04690 | 0.81737*** | 0.05761 | 0.15788 | 0.01644 |
| | (0.139) | | (0.176) | | (0.215) | |
| | | | | | | |
| *i_RDpers* | 0.46343*** | 0.03753 | 0.28513 | 0.02010 | 0.81815*** | 0.08519 |
| | (0.136) | | (0.194) | | (0.179) | |
| *l_size* | 0.25562*** | 0.02070 | 0.21322*** | 0.01503 | 0.27601*** | 0.02874 |
| | (0.040) | | (0.054) | | (0.056) | |
| *i_newmar* | 0.37987*** | 0.03076 | 0.24853+ | 0.01752 | 0.33504* | 0.03489 |
| | (0.111) | | (0.147) | | (0.162) | |

| | | | | | | |
|---|---|---|---|---|---|---|
| *i_newenter* | 0.50762*** | 0.04111 | 0.31062* | 0.02189 | 0.84371*** | 0.08786 |
| | (0.109) | | (0.142) | | (0.161) | |
| *i_interinfo* | 0.32347*** | 0.02619 | 0.48074*** | 0.03388 | 0.30977* | 0.03226 |
| | (0.098) | | (0.125) | | (0.145) | |
| *i_knowobst* | 0.28871** | 0.02338 | 0.27698* | 0.01952 | 0.35493* | 0.03696 |
| | (0.098) | | (0.124) | | (0.147) | |
| *i_competobst* | 0.18799+ | 0.01522 | 0.15745 | 0.01110 | 0.35150* | 0.03660 |
| | (0.099) | | (0.128) | | (0.147) | |
| *i_marketobst* | -0.24970** | -0.02022 | -0.25410* | -0.01791 | -0.15241 | -0.01587 |
| | (0.095) | | (0.121) | | (0.143) | |
| *DomGroup* | 0.34610** | 0.02843 | | | | |
| | (0.133) | | | | | |
| igm_multinational | 0.53853* | 0.04595 | | | | |
| | (0.214) | | | | | |
| *Fsub* | | | 0.90770*** | 0.06398 | 0.15422 | 0.01606 |
| | | | (0.256) | | (0.207) | |
| Constant | -7.58027*** | | -7.25067*** | | -7.58996*** | |
| | (0.612) | | (0.797) | | (0.912) | |

| lnsig2u | | | |
|---|---|---|---|
| Constant | 1.14571*** | 1.28781*** | 1.11308*** |
| | (0.112) | (0.138) | (0.171) |
| Prob > chi2 | 0.000 | 0.000 | 0.000 |
| N. of cases | 9663 | 6831 | 3595 |
| sigma_u | 1.77333 | 1.90390 | 1.74462 |
| rho | 0.48872 | 0.52422 | 0.48057 |

ource: Authors' elaboration based on PITEC.

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: Includes only the variables with statistically significant coefficients.

Table 3. Predictors of local cooperation for innovation by types of firm

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| | Unaffiliated domestic firms | | Domestic Groups | | Foreign subsidiaries | |
| | coef/se | dydx | coef/se | dydx | coef/se | dydx |
| | (1) | (2) | (3) | (4) | (5) | 6) |
| *locCoopInn* | | | | | | |
| *previousLocCoop* | 1.74510*** | 0.11128 | 2.21393*** | 0.22680 | 1.86618*** | 0.20680 |
| | (0.198) | | (0.222) | | (0.353) | |
| *crisis* | -0.10894 | -0.00695 | -0.12644 | -0.01295 | 0.77382* | 0.08575 |
| | (0.121) | | (0.148) | | (0.303) | |
| *i_intRDExp* | 0.03084 | 0.00197 | -0.34345+ | -0.03518 | -0.99580** | -0.11035 |
| | (0.149) | | (0.183) | | (0.356) | |
| *i_extRDexp* | 0.99733*** | 0.06359 | 0.28078 | 0.02876 | -0.23731 | -0.02630 |
| | (0.191) | | (0.234) | | (0.532) | |
| *i_RDpers* | -0.10779 | -0.00687 | 0.62457** | 0.06398 | 1.51424*** | 0.16780 |
| | (0.236) | | (0.196) | | (0.419) | |
| *lsize* | 0.24839*** | 0.01584 | 0.29098*** | 0.02981 | 0.13110 | 0.01453 |
| | (0.062) | | (0.061) | | (0.116) | |
| *i_newmar_* | 0.39853* | 0.02541 | 0.58851*** | 0.06029 | -0.72622+ | -0.08048 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.161) | | (0.178) | | (0.388) | |
| **i_newenter** | 0.22239 | 0.01418 | 0.85647*** | 0.08774 | 0.95358** | 0.10567 |
| | (0.158) | | (0.179) | | (0.369) | |
| **i_interinfo** | 0.34822* | 0.02220 | 0.14783 | 0.01514 | 1.03424** | 0.11461 |
| | (0.138) | | (0.163) | | (0.322) | |
| **i_knowobst** | 0.21971 | 0.01401 | 0.29725+ | 0.03045 | 0.54240+ | 0.06011 |
| | (0.138) | | (0.167) | | (0.304) | |
| **i_competobst** | 0.10179 | 0.00649 | 0.36304* | 0.03719 | 0.35765 | 0.03963 |
| | (0.141) | | (0.163) | | (0.331) | |
| **i_marketobst** | -0.31115* | -0.01984 | -0.23377 | -0.02395 | 0.06304 | 0.00699 |
| | (0.134) | | (0.161) | | (0.309) | |
| Constant | -7.65246*** | | -7.59644*** | | -5.85385** | |
| | (0.919) | | (1.006) | | (1.929) | |
| lnsig2u | | | | | | |
| Constant | 1.31560*** | | 0.91281*** | | 1.21751*** | |
| | (0.151) | | (0.208) | | (0.361) | |
| Prob > chi2 | 0.000 | | 0.000 | | 0.000 | |
| N. of cases | 6068 | | 2832 | | 763 | |
| sigma_u | 1.93054 | | 1.57839 | | 1.83814 | |

| rho | 0.53115 | 0.43094 | 0.50666 |

Source: Authors' elaboration based on PITEC

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Note: Includes only the variables with statistically significant coefficients

In contrast, the UDFs spending more than average in internal R&D are likely to cooperate with local partners (column 1). Moreover, among both UDFs and DomGs, radical innovators are likely to cooperate with local partners (columns 1 and 3). The *i_newent* and *i_newmar* variables have both positive, statistically significant coefficient for UDFs and DomGs. A possible explanation for differences in the behaviour of highly innovative firms is that FSubs may face high transaction costs due to their limited social capital in the host country; hence, their fear of involuntary spillovers of knowledge when innovation is especially valuable. This is the case of new to the market innovation. This interpretation is in accordance with theories of International Business that maintain that MNEs probably internalize their more important innovative activities (Caves, 1996). In contrast, the greater embeddedness of domestic firms in the milieu promotes trust between potential partners and, in turn, may induce these firms to cooperate locally even when radical innovation is involved. Analyses of domestic ICT firms in Spain and elsewhere seem to corroborate this interpretation (Paija, 2001; Rama & Ferguson, 2007; Suárez-Villa & Han, 1990; Valdaliso et al., 2011).

Although FSubs seem less embedded in the milieu than DomG, they are far from behaving as enclaves in the Spanish ICT industry. This crucial difference with the behaviour of FSubs in many other host-countries (section 2) may be explained by a combination of two theoretical approaches to inter-firm relationships: the capabilities approach and the transaction costs approach. As stated, the Spanish electronics suppliers seem highly competitive (section 3). High capabilities of potential suppliers tend to de-motivate the adoption of vertical integration (Argyres, 1996) and may promote, instead, inter-firm linkages. Secondly, subcontracting of production -- as stated, quite widespread in the Spanish ICT sector – may have reduced transaction costs and, in doing so, encouraged LCI (Holl & Rama, 2009a)(Carboni, 2013; Love & Roper, 2004). These combined factors may be less evident in other host-industries. International comparisons would be necessary to clarify this question.

Within Spain, innovative FSubs active in ICT seem more prone to cooperate with local partners than innovative FSubs active in the food and drinks industry (García Sánchez et al., 2016b). Risks of spillovers may be lessened in host-industries not endowed with RTA; this is the case of ICT in Spain (Molero & Garcia, 2008). Also, innovations are relatively difficult to replicate. From the point of view of the innovative FSubs, these circumstances would reduce the risks of spillovers and, probably, encourage local cooperation, at least concerning incremental innovation. More sectoral studies are needed to assert possible differences in the patterns of local cooperation of FSubs across host-industries.

The *crisis* variable displays a positive, statistically significant coefficient for FSubs but not for domestic firms. While the downturn probably encouraged the cooperative activities of FSubs it seems to have had no effect on those of domestic firms. This responds to RQ3. A possible explanation is that FSubs may have endured fewer financial difficulties than domestic firms owing to their easier access to international funding. Also, the different types of partnerships in which firms are engaged may have played some role. Unreported results of a Pearson $X^2$ test and of a Cramer's V test (available upon request) suggest that the sample FSubs are clearly more likely than the sample domestic firms to engage in partnerships with local clients and suppliers. During a crisis, partnerships across the value-chain seem to be preferred by firms, given the need to reduce costs and face the shortage of liquidity (Hoffmann et al., 2017). This may be the case of the sample FSubs. However, this question deserves more attention than attempted here.

Finally, *previousLocCoop* has a positive, statistically significant coefficient in columns 1, 3 and 5, suggesting that previous cooperative experience facilitates cooperation in all types

of firms. In domestic firms, a large size predicts engagement in LCI (i\_\_*size* displays a positive, statistically significant coefficient), but not in FSubs (the coefficient is not statistically significant).

**Conclusions**

Analysing the Spanish ICT sector, we have striven to ascertain whether foreign subsidiaries are likely to make a technological contribution to domestic innovative capabilities. Responses are not monochrome. Foreign subsidiaries are better than unaffiliated domestic firms at cooperating locally for innovation but not better than domestic business groups, even when other factors that may influence cooperation for innovation, such as the size of the company, are taken into account. At first sight, innovative foreign subsidiaries seem more prone than non-innovative foreign subsidiaries to cooperate for innovation with local partners. Nevertheless, the most advanced foreign subsidiaries are reluctant to engage in such collaborations, probably because they fear spillovers of knowledge. Domestic firms seem more likely to transmit sophisticated knowledge. Among them, radical innovators and companies with substantial investments in internal R&D are prone to collaborate with local partners. However, foreign firms have shown greater capability than domestic firms to increase their collaborations with local partners during harsh economic times.

Compared to international results, ours suggest that the competitiveness of local ICT suppliers and the existence of previous subcontracting relationships in host-industries may contribute to encourage foreign subsidiaries to cooperate for innovation with local partners. These may be relevant factors to consider by host countries wishing to fully profit from the internationalization of R&D. At the same time that implementing measures to fully profit from the internationalization of R&D, host-countries may find it useful not to neglect the role of domestic firms since these companies may be able to transmit locally more advanced knowledge than foreign subsidiaries do, owing to their greater embeddedness in the milieu.

As for managers of MNEs, they may find it useful to realize that many host countries have now strong domestic groups that are highly competent in attracting the best local partners for innovation. In this new panorama, subcontracting of production to domestic suppliers could be a step towards reducing the transaction costs faced by the MNE. The propensity of many ICT foreign subsidiaries to subcontract production abroad and to engage in intra-group subcontacting (Holl & Rama, 2009) may, indirectly, hamper their possibilities to engage in local innovative networks in the medium-term.

A limitation of our analysis was the unfeasibility to verify the importance of production subcontracting in the sample since the PITEC database does not provide such information. Also, although cooperation of ICT firms with upstream industries is likely to be relevant, the available data are not suitable for detecting inter-industry collaborations. An avenue for future research is a detailed analysis of the cooperative strategies of foreign subsidiaries in times of crisis, in terms of the types of local partners and the dimensions of innovative networks.

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Annex 1 . Relationship between foreign ownership and local cooperation for innovation.  Selected studies

| Author (s) | Source of data/ sample (1) | Geographical coverage | Control group | Main results |
|---|---|---|---|---|
| a)   All sectors | | | | |
| Veugelers & Cassiman (2004) | CIS 1992. 1,335 manufacturing firms | Belgium | All domestic firms | Foreign ownership has a negative effect on the probability of domestic cooperation |
| Dach et al (2008) | CIS3. CIS-type survey for Norway. National samples could not be pooled | Austria, Denmark, Finland, Norway and Sweden | All domestic firms | In Finland and Sweden, foreign ownership is positively associated to domestic cooperation. In Denmark and Norway, it is neutral.  In Austria, foreign subsidiaries seem to be reluctant to domestic cooperation |
| Srholec (2009) | CIS3. 46,000 firms in industry and market services | 12 EU countries | All domestic firms | Foreign ownership is positively associated to domestic cooperation but the coefficient of the variable denoting it is very small and weakly statistically significant |
| Ebersberger et al. (2011) | CIS, 2004 and 2006. 130, 274 observations | 22 EU countries + Iceland and Norway | All domestic firms. Estimates a separate model for domestic cooperation undertaken by native multinational enterprises | Foreign ownership is negatively associated to domestic cooperation.  However, in technology leader countries no effect can be detected. |
| Ebersberger & Herstad (2012) | Norwegian Innovation Survey 2005 (CIS-Type survey). 863 firms affiliated to a business group active in manufacturing or in knowledge-intensive services | Norway | Compares foreign subsidiaries and Norwegian multinational enterprises | Foreign ownership may cause branch plant syndrome in the host-country |
| Arvanitis & Bolli (2013) | CIS3 for EU member states and Norway.  A comparable survey for Switzerland. Manufacturing and services firms | Belgium, Germany, Portugal, Norway  and Switzerland | All domestic firms (includes group membership as a control variable) | In Norway and Portugal, foreign subsidiaries are less likely to cooperate only at the national level.  In Belgium, Germany and Switzerland no effect of foreign ownership is detected. |

| | | | | |
|---|---|---|---|---|
| Holl & Rama (2014) | PITEC data. 10,209 companies active in manufacturing and services, 2005-2009 | Spain | Distinguishes between unaffiliated domestic firms and domestic groups | Foreign subsidiaries tend to engage in local cooperation for innovation to a greater extent than do unaffiliated domestic firms and domestic groups |
| Srholec (2015) | CIS4. 28, 674 firms | 15 EU countries | All domestic firms | Foreign ownership tends to be negatively associated to domestic cooperation |
| Guimón & Salazar-Elena (2015) | PITEC data. 9,614 firms, 2005-2011 | Spain | Distinguishes between unaffiliated domestic firms and domestic groups | Differences between the propensity to cooperate with Spanish universities between foreign subsidiaries and domestic groups are not statistically significant. However, both foreign subsidiaries and domestic groups are more likely to cooperate with Spanish universities than unaffiliated domestic firms do. |
| Cozza & Zanfei (2016) | Italian Bureau of Statistics,. 13,675 firms performing R&D, 2001-2010 | Italy | Distinguishes between unaffiliated firms and domestic groups. Compares foreign subsidiaries and Italian groups with international R&D | Foreign subsidiaries and domestic groups are more prone to cooperate with Italian universities than unaffiliated domestic firms but differences are not very large. Italian groups with international R&D outperform foreign subsidiaries. |
| García Sánchez et al, 2016 | PITEC data. 1,965 manufacturing companies , 2004-2008 | Spain | Domestic groups. | Foreign subsidiaries tend to engage in local cooperation for innovation to a greater extent than do domestic groups. However, the advantage held by foreign subsidiaries in this respect disappears in a subsample of highly innovative companies. |
| Cozza et al. (2018) | Italian Business R&D Survey and Bureau Van Dijk. 13,675 firms, 2001-2010. | Italy | All domestic firms. Also distinguishes between foreign and Italian MNEs | Foreign subsidiaries are less prone than domestic firms to set up domestic cooperation. They are also less prone than, specifically, Italian MNEs. |
| | | **b)   High tech sectors** | | |
| Ebersberger et al. (2011) | CIS, firms engaged in high tech manufacturing and knowledge intensive services, 2004- 2006. | 22 EU countries + Iceland and Norway | All domestic firms in these sectors. Estimates a separate model for domestic cooperation | The effect of foreign ownership on the probability of the firm engaging in LCI tends to be either negative or not statistically significant |

| | | | | undertaken by native multinational enterprises | |
| --- | --- | --- | --- | --- | --- |
| Binh & Linh (2013) | Case studies. Three major foreign MNE and three Vietnamese suppliers pertaining to electronics industries | Vietnam | --- | | Foreign firms collaborate for innovation with research centres but transfers of technology to local firms are limited |
| García-Sánchez & Rama (2015) | PITEC data. 2,000 firms engaged in manufacturing electronics , 2004-2008. | Spain | Distinguishes between unaffiliated firms and domestic groups. | | Foreign subsidiaries are more likely than UDF to cooperate for innovation with local partners, but not necessarily more than DG. |
| Guimón & Salazar- Elena (2015) | PITEC data for 2005-2011. Firms active in: computer programming and consultancy; and in manufacture of computers, electronics and optical products. | Spain | Distinguishes between unaffiliated firms and domestic groups. | | Foreign subsidiaries are more likely than UDF to cooperate for innovation with local universities, but not necessarily more than DG. |
| Chi & Sun (2018) | 189 firms active in: electronics, electric power and manufacturing equipment | China | Domestic firms | | The effect of foreign ownership on the probability that a firm will obtain a patent from its cooperative activities is not statistically significant |
| Holl & Rama (2019) | PITEC data. 9,790 firms engaged in TIC during 2004-2013 | Spain | Unaffiliated domestic firms, domestic groups with and without international cooperation for innovation | | Foreign subsidiaries show fewer propensities to cooperate locally for innovation than domestic groups with international cooperation for innovation do. However, they are more likely to cooperate than UDF and other domestic groups. |

Appendix 2.  Description of variables

| Name (1) | Description | Values |
|---|---|---|
| *LocCoopInn*<br><br>(dependent variable) | Cooperation for innovation with local partners external to the focal firm in the two previous years | Y/N |
| **Innovation -related variables** | | |
| *i_ownfund* | Share of own resources of the focal company (including credits) in total resources used to finance internal R&D, as compared to industry average (€) | If the firm scores 1, it means that it is more able than average to fund its innovative projects with its own resources; 0 otherwise |
| *i_ RDpers* | No. of R&D employees as compared to industry average. | If the focal firm scores 1, it means that it hires more R&D personnel than average; 0 otherwise. |
| *i_newemp* (incremental innovation) | % of products new to the company in total sales as compared to industry average | If the focal firm scores 1, it means that its share of improved new products in turnover is above average; 0 otherwise. |
| *i_newmar* (radical innovation) | % of products new to the market in total sales as compared to industry average | If the focal firm scores 1, it means that its share of radically new products in turnover is above average; 0 otherwise. |
| *i_interinfo* | Importance of internal sources of information for innovation, including the focal firm and its business group | 1-4 Likert scale; 1= Highly important<br><br>4 =Not used this source of information<br><br>(Y/N) |

| | | |
|---|---|---|
| | The firm attributes more importance to internal sources than the average food and beverage company | |
| *i_intRDexp* | Internal expenditure in R&D over industry average. Includes personnel, equipment, acquisition of software, etc. in year previous to survey | If the firm scores 1, it means that it invests more resources than average in internal R&D; 0 otherwise. |
| *i_extRDexp* | External expenditures in R&D over industry average. | If the firm scores 1, it means that it invests more resources than average in external R&D; 0 otherwise. |
| *i_otherInnExp* | Other innovation expenditures over industry average. | If the firm scores 1, it means that it invests more resources than average in other innovation expenditures; 0 otherwise. |
| *i_knowlobst* (knowledge obstacles) *i_econobst* (economic obstacles) *i_marketobst* (market obstacles) *i_competobst* (competition obstacles) | Importance of obstacles to innovation as compared to those encountered by the average firm | If the focal firm scores 1, it means that it faces higher obstacles than the average firm; 0 otherwise. |
| *Crisis* | 2008-2014 signals the in-crisis period | |
| *i_size* | Size as measured by employment | If the focal firm scores 1, it means that it is larger than the average firm; 0 otherwise. |
| *L_size* | Logarithm of employment | |
| *Mdoue* | Indicates whether the firm exports goods or services to the EU | Y/N |
| *previousLocCoop* | Indicates whether the firm reported local cooperation for innovation in the two previous years | Y/N |