Obstacles of innovation and institutional support in the cooperation agreements: the Spanish case

Abstract

The objective of this paper is to analyse the effects of obstacles and institutional factors on the cooperation for innovation. The collaboration between different types of organizations has been seen as a strategy that allows the firms to obtain reciprocal benefits, and that incentivises innovation. However, following D'Este et al. (2012) and Antonioli et al (2017), we assume that the decision to cooperate is perceived as a strategy to overcome the obstacles and barriers of the innovation process. We analyse these questions in the frame of the PITEC-2013 data that covers the period 2012-2013 and includes 5,461 Spanish innovative companies. Our results support that an important drive for the firm's cooperation is to overcome the obstacles of the innovation process. Moreover, the type of partner for cooperation is influenced by the different perception that those companies have on the obstacles to innovation. Additionally, our results contribute to the regional literature with new empirical evidence to characterize regions in terms of innovation. Such factors shed new light about the intensity of regional innovation and variables of the cooperation pattern.

Keywords: Cooperation agreements; Obstacles of Innovation; Incentives; Spanish firms.

Introduction

Cooperation for innovation between firms and institutions is becoming increasingly important because this can create reciprocal benefits for all parties involved and for society in general. Defined as the union of two or more parties, institutions or individuals, which jointly pursue innovation objectives (Doz et al., 2000; Serrano-Bedia et al., 2010; Milesi et al., 2017), cooperation for innovation has attracted considerable attention from academics, entrepreneurs, and policy-makers since the pioneering work of Hagedoorn (1993). In addition, from the 1990s, scientific and technological policy in Europe, the United States or Japan has advanced decisively towards the promotion of cooperation in R&D and innovation projects between companies, universities and other research institutes (Takayama et al., 2002; Archibugi and Coco 2004; Lopez, 2008; Abramovsky et al., 2009; Poutanen et al., 2016).

The collaboration between different types of organizations has been seen from different theoretical perspectives, as a strategy that allows the firms and the universities to obtain reciprocal benefits, providing resources, learning and knowledge spillovers, from other

companies and institutions (Hagedoorn et al., 2000; Vuola and Hameri, 2006; Lavie, 2006; Bayona-Sáez and García-Marco, 2010). In general, these theoretical approaches assume cooperation as an incentive for innovation. However, Lopez (2008) and Barge-Gil (2010) have pointed out that cooperation can be considered as a way to minimize a loss or to overcome the barriers and obstacles of the innovation process. From this perspective, D'Este et al. (2012) pointed out that innovation obstacles not only affect the propensity to cooperate but also the choice of partners. Additionally, Antonioli et al. (2017) introduce the heterogeneity of companies, considering the different perception that companies have on the obstacles of the innovation process. Through this perspective, not only it can be explained why companies cooperate, but also why they follow different cooperation strategies. Despite this promising perspective to clarify why companies cooperate and explain the variability in the decision to cooperate, there are few works that have addressed this issue (Antonioli et al., 2017), and exists surprisingly little empirical evidence on how cooperation for innovation might be affected by the obstacles faced by firms.

Taking this gap as the starting point, the objective of this paper is to contribute to the cooperation of the firm, analysing three research questions. Firstly, following the approach of D'Este et al. (2012), we assume on the one hand, that the decision to cooperate is perceived as a strategy to overcome the obstacles and barriers of the innovation process. Thus, the company in the development of the innovation process faces a series of obstacles such as the uncertainty, either from the market (in the acceptance of innovation) or from the innovation process itself (for example, in terms of the cost of innovation), and the lack of knowledge and capabilities in developing this process. On the other hand, following Antonioli et al. (2017) we assume the heterogeneity of companies in terms of the perception of innovation obstacles, differences in experience, knowledge, managerial skills, etc. in innovation processes. Therefore, the first question that we raise is: *Do the obstacles of innovation affect the decision to cooperate in the firms?* Secondly, we consider that the diversity of cooperation agreements that companies can reach, either by type of partners (competitors, clients, universities and research centres, for example), or by the geographical scope of the agreements, (national, EU, USA, among others), are influenced by the innovation obstacles. Thus, we assume that companies look for the type of partner and/or the most appropriate geographical scope to face the obstacles and barriers of the innovation process. Therefore, the second question we analyse is: *Do the innovation obstacles affect the typology and geographical scope of the agreements to be developed by firms?* Finally, companies take part in cooperation agreements as a way to overcome the difficulties in the development of the

innovation process, but through the technological policy, companies are exposed to institutional resources that may encourage the development of such agreements. Thus, public financing and informational support are institutional resources that might incentive cooperation for innovation. Therefore, we raise the question: *Do institutional resources encourage cooperation agreements for innovation*?

We analyse these questions in the frame of the PITEC-2013 data that covers the period 2012-2013 and includes 5,461 Spanish innovative companies. According to Eurostat (CIS-2012), Spanish companies are below the European average both in the number of companies that innovate and in cooperation agreements, which also have a limited international component[1]. Therefore, analysing the cooperation patterns of Spanish companies and their impact on innovation might be a key issue to improve these results.

In the next section, we present a concise overview of relevant literature on cooperation agreements and the obstacles for innovation in order to frame our research questions. The following section describes the research methodology, including data collection and measures. Afterwards, our data analysis and results are provided. Then, we present the discussion and managerial implications of the findings.

Literature review

Cooperation agreements and the obstacles for innovation

A large proportion of the literature on R&D cooperation has focused on why firms cooperate and with whom (e.g., Miotti and Sachwald, 2003; Arranz and Fernandez de Arroyabe, 2008; Cassiman et al., 2010). There is also considerable empirical evidence with respect to the performance of partners involved in R&D cooperation (e.g., Belderbos et al., 2006). From the resource-based perspective, the rationale for partnerships is the value-creation potential of combining the resources of the partners by exploiting complementarities (Eisenhardt and Schoonhoven, 1996; Tether, 2002; Miotti and Sachwald, 2003; Lavie, 2006; Arranz and Fernandez de Arroyabe, 2008). Eisenhardt and Schoonhoven (1996) and Lavie (2006) point out that cooperation improves the strategic position of companies, providing resources from other companies and institutions that allow them to share costs and risks

[1] Spanish innovative companies represent 34% of the total number of companies, considering that the European average represents 49% (EU-28) or 54% (EU-15). Likewise, we have a significant deficit in terms of the international dimension of the agreements. Thus, while in Spain 27% of the agreements are within the EU, the average in the case of European companies is 42% (EU-28). This deficit increases, if we consider the case of cooperation with China/India or with the USA.

(Grant and Baden-Fuller, 2004; Lavie, 2006; Poutanen et al., 2016). This strategic advantage derives from the specific assets that companies dedicate to cooperative relations and the complementarity between their resources and the resources of their partners. Eisenhardt and Schoonhoven (1996) have pointed out that the cooperation agreements are a way to obtain critical resources for most companies. In short, a key aspect is that the firm's competitive advantage arises not only from the owned resources but also from the possibility of accessing other resources through cooperation.

In addition to this point of view, in which cooperation is an incentive for the innovation process, D'Este et al. (2012) have pointed out that cooperation can be considered as a strategy to solve the problems of the innovation development. Thus, the innovation development process has been characterized as a complex process in its management (Rothaermel and Lundwall, 2007; Arranz and Fernandez de Arroyabe, 2009). The uncertainty related with the process itself and the market, as well as the management of costs and resources for the development of innovation are the main difficulties that companies must overcome and explain the complexity of the process (Arranz and Arroyabe, 2009; Lundwall, 2007; Das et al., 2018). Moreover, several investigations have highlighted the difficulties that internalization of innovation activities implies for the company (Hagedoorn, 1993, Archibugi and Coco, 2004), either due to their size (need to generate economies of scale) or due to the uncertainty of technological processes in terms of results and time. In this context, Hagedoorn et al. (2000), Tether (2002), and Verspagen and Duysters (2004) stated that entry into unknown technological markets may be facilitated by cooperation. Additionaly, Hagedoorn (1993) and Miotti and Sachwald (2003) note that cooperation agreements constitute an innovation facilitator that brings economies of scale and scope, reduces uncertainty and provides firms to access complementary knowledge. These arguments have made cooperation a common strategy in the innovation development of companies that helps to compensate for the lack of resources and/or capacities (Hagedoorn, 1993; Tether, 2002; Miotti and Sachwald, 2003).

Antonioli et al. (2017) point out that it is important to introduce the company's perception of innovation obstacles to understand the variability in the decision to cooperate. Thus, based on psychological and strategic approaches, the literature suggests that firms' decision are the result of the reflection of managers in the organization, and their choice of action is based on their idiosyncratic experiences, motives, and influences of people in their social environment (Carpenter et al., 2004). It is expected that firms have a different perception of the obstacles to innovation. Cooperation between companies emerges to mitigate innovation obstacles (Lopez,

2008, D'Este et al., 2012), and the perception of innovation obstacles by companies will determine the decision to cooperate. Therefore, we raise the following question:

RQ1. *Do the obstacles of innovation affect the decision to cooperate in the firms?*

Typology of partners and geographical scope of agreements as an answer to innovation obstacles

Empirical evidence shows that companies establish agreements with different partners and in different geographical areas. One of the most important cooperation agreement is vertical cooperation or cooperation in the supply chain, in which the company collaborates with its customers and/or suppliers (Tether, 2002; Miotti and Sachwald, 2003; Arranz and Fernandez de Arroyabe, 2008). These agreements play an important role in mitigating the obstacles of the innovation process, contributing with crucial information about technologies, user needs and/or markets. Thus, when the firms cooperate with suppliers tends to complement internal R&D efforts. This is the case for example of firms, which need to have an R&D capacity that does not reach by itself, either because of its size or because of lack of investment. In the case of clients' cooperation, the obstacle to overcome is the uncertainty of the market. Thus, the establishment of agreements with clients allows mitigating this obstacle, helping to define innovations, with the consequent reduction of the associated risks with their introduction into the market (Tether, 2002; Chesbrough, 2006). Arranz and Fernandez de Arroyabe (2008) summarizes the importance of cooperation with clients in that it provides necessary knowledge and helps to find the right balance between performance and price; provides an understanding of user behaviour that may be important for the refinement of innovation; and it improves the possibilities for innovation to be accepted and adopted by other companies. Another type of agreement is that made with partners such as universities and public research institutions as the way to access scientific and technological knowledge (Archibugi and Coco, 2004; Milesi et al., 2017). The lack of technological and research knowledge, as well as the lack of technological infrastructures, are the main motivation to cooperate with these partners. Finally, cooperation with competitors is perceived by companies as a way to mitigate problems of size, experience and those associated with risk in the development of innovation processes. It is well known how competitors come together when they need to achieve economies of scale, the acquisition of experience and the diversification of risks while increasing the power of the associated companies within the sector (Mytelka, 1991, Fritsch and Lukas, 2001). However, this type of cooperation is potentially dangerous because

competitors sell in similar markets and can access the technology resources of the own company through cooperation (Hagedoon et al., 2000; Miotti and Sachwald, 2003)[2].

Regarding the geographical scope of the agreement, Serrano-Bedia et al. (2010) point out that cooperation is not only limited to the region or country of companies but that resources can be acquired outside these areas. In this sense, companies establish international cooperation agreements, seeking access to new technological markets, among other reasons. For example, Arranz and Fernandez de Arroyabe (2008) have stressed that Spanish companies in high-tech sectors establish agreements with American companies with the aim of integrating into high-tech networks. Thus, Following D'Este et al. (2012), companies in the development of innovation processes establish agreements with the partner and the geographical area most appropriate, pursuing the objective of mitigating the obstacles and barriers of innovation.

Therefore, we raise the following question:

RQ2. *Do the innovation obstacles affect the typology and geographical scope of the agreements to be developed by firms?*

Institutional resources as incentives of cooperation for innovation

The literature has identified a series of institutional resources that promote technological cooperation. As pointed out by Gutiérrez-Garcia et al. (2010), these institutional factors are not a cause per se but are aspects that encourage cooperation agreements as an innovation strategy.

A first factor considered in the literature has been public financing, both loans and subsidies (for example, see Bayona-Sáez and García-Marco, 2010). Thus, the various public institutions support the development of collaborative projects between companies and public research organizations (Gutiérrez-Garcia et al., 2010), through financing the initial stages of selection and negotiation of agreements (Miyata, 1996), and later, during the development of the agreement itself (Mytelka, 1991; Busom and Fernández-Ribas, 2008; Barajas, et al., 2016).

[2] Various researchers have point out that cooperation between competitors should be limited to two cases (Hagedoorn, 1993; Hagedoorn et al., 2000; Fritsh and Lukas, 2001): when an area of common interest has been identified (for example, when there are strengths that are complementary to the development of a new range of products or services); and when cooperation affects distant markets and joint R&D&I leads to generic results (for example, when collaboration can influence the nature of the regulatory environment).

A second institutional factor that promotes technological cooperation is the use of external sources of information for innovative development (Miotti and Sachwald, 2003; Arroyabe and Fernandez de Arroyabe, 2008). This information can come from the market, different institutions, fairs, seminars and congress among others (PITEC, 2013). As a result, companies obtain information about the existence of innovation possibilities, markets and partners that, through contact with agents and institutions, may lead to establishing an agreement for cooperation. (Miotti and Sachwald, 2003; Lopez, 2008). It can be assumed that information sources have a positive influence on the adoption of cooperation agreements for innovation (Arranz and Fernandez de Arroyabe, 2008). Therefore, we raise the following question:

RQ3. *Do institutional resources encourage cooperation agreements for innovation*?

Empirical study

The unit of analysis in this research is the firm, and the data come from the PITEC. This survey has been conducted bi-annually by National Statistics Institute since 2001 and replicates for Spain the questionnaire used by the Community Innovation Survey, following the guidelines of the Frascati Manual and Oslo Manual (OECD, 2005) for using a standardised questionnaire. PITEC contains firm-level data and provides information about the company (e.g., employment, sales, geographic market, industry sector) as well as detailed information about its innovation activity (e.g., innovation expenditures, kinds of innovation output, cooperation between firms, public financial support, barriers to innovation, and so on).

The reference period for our research is from 2012 to 2013. After a filtering process, our final sample contains 5,461 firms that conducted some sort of innovation during the period of study.

Measures

The PITEC (2013) defines five dummy variables to measure the different *partners* for cooperation. The value taken by the variable for cooperation is 0 if cooperation for innovation has not occurred during the research reference period, and 1, if the firm establishes a cooperation agreement with this partner. The five types of partners considered are: i) Group companies; ii) Suppliers; iii) Clients; iv) Competitors; and v) Universities and Research Centres. In reference to the geographical area in which the partners are located, the questionnaire includes five items: i) National; ii) EU; iii) the USA; iv) China-India; and v) Other countries.

The second group of variables are related to the *obstacles* that hinder innovation activities. The PITEC (2013) measures the importance of cooperation obstacles on a 4-point Likert scale, where 1 is assigned if the objective is not important, 2 if its importance is reduced, 3 if it is intermediate, and 4 if it is high. The obstacles to innovation are grouped into three sets. The first is *cost obstacles*, measured by three items: i) Lack of funds in the company or group of companies; ii) Lack of funding from sources outside the company; and iii) Innovation is too expensive (Cronbach Alpha: 0.837). The second group is *knowledge obstacles*, measured by four items: i) Lack of qualified personnel; ii) Lack of information on technology; iii) Lack of information about the markets; and iv) Difficulties for finding cooperation partners for innovation (Cronbach Alpha: 0.845). Finally, *market obstacles* are measured by two items: i) Market dominated by established companies; and ii) Uncertainty regarding the demand for innovative goods and services (Cronbach Alpha: 0.771).

Following PITEC (2013), the third variable is *public funding*. The questionnaire includes three sources of public funding: i) local or regional; ii) national; and iii) EU. With these three items, we have created an index that shows the use of external financing, being 1 if the company uses only one source of financing; 2 if the company uses two sources of financing, and 3 if the company uses the three sources of financing (Cronbach Alpha: 0.702).

The fourth variable used refers to external *information sources*. PITEC (2013) identifies ten dummy variables as sources of external information: i) suppliers; ii) customers; iii) competitors, iv) consultants and commercial laboratories; v) universities; vi) public research organizations; vii) technology centres; viii) conferences; ix) scientific and professional journals and l; and, x) sectoral associations. (Cronbach Alpha: 0.967).

Control variables

Technological Intensity. We control for the impact of the level of technological intensity of the companies included in the sample. Following (Miotti and Sachwald, 2003; Arranz and Fernandez de Arroyabe, 2008), this variable was measured as the ratio between internal R&D expenditure and the number of employees in the company.

Manufacturing/Services. To control whether the company belongs to the manufacturing or services sector, we create a dummy variable whose value is 0 if the company belongs to the manufacturing sector, and 1 if belongs to the services sector.

Internationalisation. We control for the relevance of international operations of the firm. The PITEC questionnaire distinguishes four different geographical markets: (1) local; (2) national; (3) European Union; and (4) other countries. We created a variable to control

whether the firm operates abroad or not, whose value is 0 if the company operates in the local or national market, 1 if the company operates in the EU market, and 2 if it operates in international markets (the USA, China and India and other countries).

Group. Following PITEC (2013) questionnaire, to control whether the firm belongs to a group, we included a dummy variable whose value is 0 if the company does not belong to a group and 1 if it does.

Firm Size. Previous empirical studies have found the firm size to be a determining factor in the development of technological innovations (Miotti and Sachwald, 2003; Triguero et al., 2013). This variable is measured, as is standard in the literature, with the log of the total number of employees.

Econometric Model

To test the first research question, which establishes the differences in the perception of obstacles to innovation among companies cooperating and not cooperating, we use an ANOVA analysis, being the cooperation the control variable (see Table 3).

To analyse the second and third questions, about whether the obstacles of the innovation process and institutional factors affect the development of cooperation agreements for innovation, we have used an Ordinal Logit Regression Model (see Tables 4 and 5)[3]. In Model 1 in Table 4, the dependent variable is a dummy variable that determines whether companies cooperate or not. In Models 2 to 6 (Table 4), the dependent variable is the type of partner (group companies, suppliers, clients, competitors, universities and research centres). In Table 5 (Models 7 to 11), the dependent variable is the geographical area to which the partner belongs (national, EU, USA, China-India, other countries). For all Models (Table 4 and 5), the independent variables are Public Funding, Information Sources, the Obstacles (Costs, Knowledge, Market), and the five control variables.

Our econometric model is (Models 1 to 6, Table 4):

$$y = constant + \beta_1(Public\ Funding) + \beta_2(Information\ Sources) + \beta_3(Costs\ Obstacles) + \beta_4(Knowledge\ Obstacles) + \beta_5(Market\ Obstacles) + \beta_6(Technological\ Intensity) + \beta_7(Manufacturing/Services) + \beta_8(Internationalisation\ Level) + \beta_9(Group) + \beta_4(Size) + e$$

being:

y: dependent variable (type of partner)

e: error term.

[3] In order to consider the robustness of the analysis, we have included in the Ordinal Logit Regression Model, the VIF factor and Durbin-Watson test to consider the correlation level of variables.

Our econometric model is (Models 7 to 11, Table 5):

$y=constant + \beta_1(Public\ Funding) + \beta_2(Information\ Sources) + \beta_3(Costs\ Obstacles) + \beta_4(Knowledge\ Obstacles) + \beta_5(Market\ Obstacles) + \beta_6(Technological\ Intensity) + \beta_7(Manufacturing/Services) + \beta_8(Internationalisation\ Level) + \beta_9(Group) + \beta_4(Size) + e$

being:

y: dependent variable (geographical area)

e: error term.

Results and Discussion

In accordance with PITEC, 43.1% of 5,461 innovative companies have established cooperation agreements. From a descriptive point of view, Table 1 shows the percentage of companies that cooperate in product, process, organizational and marketing innovations. In general, approximately 50% of the innovative developments were made through cooperation agreements. These results confirm that cooperation agreements are a key element of innovative developments, as noted in previous studies (Hagedoorn, 1993; Lopez, 2008).

Regarding the type of partner chosen in cooperation agreements and the geographical area to which the partner belongs, Table 2 shows these values. Our results highlight as the previous research suggests, that the preferred partners for innovation are suppliers, group companies and customers and that cooperation with competitors is less important (Tether, 2002, Arranz and Arroyabe, 2008). It is worth noting the importance that universities and research centres have as partners for innovation, whose relevance has been emphasised in numerous studies on the economic competitiveness of countries (Archibugi and Coco, 2004, Gutiérrez et al., 2010). Our results show that about one in four agreements involves universities and research centres. This collaboration involves a real transfer of knowledge from these institutions to the company, being especially important for small and medium-sized companies since it allows them access to technological resources they do not have (Hagedoorn et al., 2000, Fritsch and Lukas, 2001; Gutiérrez et al., 2010). From a geographical point of view, it is observed that mostly the agreements are established with national partners and to a lesser extent with the EU, being scantily relevant the agreements in which North American or Chinese and Indian companies participate. This reality corroborates the results shown in other studies that reveal the important deficit of Spanish companies in relation to international collaboration (Garcia Canal, 1995, Arranz and Fernandez de Arroyabe, 2008, Lopez, 2008). This can be explained in part by the fact that Spanish

companies operated for a long time in a closed and protected market, which has resulted in less international experience (Fernández and Nieto, 2006, Arranz and Fernandez de Arroyabe, 2008). The other explanatory argument is the small size of Spanish companies and that their activity focuses on traditional sectors when compared with companies in the economies of northern Europe (Arranz and Fernandez de Arroyabe, 2008; Lopez, 2008).

Regarding the first research question, *whether the obstacles of innovation affect the decision to cooperate*, the results of ANOVA analysis are shown in Table 3. We have separated the perception of obstacles for the case of companies that cooperate and those that do not cooperate. It is observed that in the three types of obstacles (costs, knowledge and market), significant differences are obtained between cooperating companies and those that do not cooperate. In general, companies that do not cooperate perceive the cooperation obstacles to a lesser important degree than those that cooperate. Our results corroborate the hypothesis of Antonioli et al. (2017) and provide empirical evidence that the perception of obstacles constitutes an important factor in the decision to cooperate. Moreover, following D'Este et al. (2012) and López (2008), our results confirm that companies cooperate as a mechanism to overcome the barriers and obstacles of the innovation process. Specifically, our results show that the greatest difficulty lies in the search for partners to cooperate (F: 204,986), followed by the cost of innovation (F: 189,067) and the lack of external financing (F: 183,991). However, the obstacles that are perceived as less relevant are the lack of qualified personnel and the lack of technological information.

Regarding the second research question, *whether the innovation obstacles affect the typology and the geographical scope of the agreements,* the results are shown in Table 4 for the case of the typology of partners and in Table 5 for the geographical scope of the cooperation agreements. Regarding the typology of the partners, Table 4 shows the effect of the obstacles to innovation in cooperation with the different types of partners (Models 2 to 6). More in detail, in the cooperation with companies of the same group (Model 2), it is observed that the cost obstacles are not significant, while the lack of technological and market knowledge are significant. These results corroborate previous literature and provide empirical evidence on the drivers of cooperation with companies in the same group in which the firm seeks support to access information on new technological developments or to enter new markets (Arranz and Fernandez de Arroyabe, 2008). In the case of cooperation with suppliers (Model 3), it is observed that the only significant obstacle is the lack of market knowledge. This finding contradicts the results of the previous literature on cooperation in which it is indicated that the cooperation with suppliers has as main objective the search of technological

knowledge (Miotti and Sachwald, 2003). In the case studied, the explanation could be that most of the Spanish companies are small and medium-sized, so in collaboration with suppliers, the company seeks to grow through market development strategies and diversification in new markets, being the supplier the support for such strategies. Regarding cooperation with clients (Model 4), our results are corroborated in the previous literature that states that the client has active participation in the innovation processes, both to inform about the technological needs of the market and the development of the product (Rothaermel and Deeds, 2004). In terms of cooperation with competitors (Model 5), the results indicate that it is mainly carried out in cases where there are cost and market obstacles. This finding is in line with the results emerging in the cooperation literature which has consistently found that cooperation with competitors is carried out in two cases: when economies of scale are required (for example to develop a large project) or when new opportunities exist in the market (Miotti and Sachwald, 2003; Arranz and Fernandez de Arroyabe, 2008). Finally, cooperation with universities and research centres (Model 6) is driven by companies when they perceive the three obstacles (costs, knowledge and market). In this case, the university serves the needs of companies for the lack of technological background and infrastructures, which is reflected in cost objectives as well. In fact, this type of cooperation is perceived by companies as a source of specialized low cost and low-risk knowledge, focused mainly on basic or more generic R&D and long-term strategic research (Bayona-Sáez and García-Marco, 2010).

In the second research question, we also set out to analyse if the obstacles condition the geographical scope of the cooperation. In general, it is observed that the obstacles are less significant in the decision to cooperate from the point of the partner's country. Perhaps this minor significance is explained by the low level of internationalization of the cooperation agreements of Spanish companies (Arranz and Fernandez de Arroyabe, 2008; Lopez, 2008), being only significant the cooperation in the international scope when the company seeks to overcome the market obstacles (Models 8, 10 and 11). These results are emphasized in the literature as driving factors for establishing cooperation agreements for innovation since they represent a strategic decision that mitigates uncertainty and transaction costs (Hagedoorn et al., 2000; Tether, 2002). However, in the case of cooperation with national partners, it is observed that the three types of obstacles are determinants for the establishment of cooperation agreements. Therefore, it can be concluded that cooperation with national partners, seeks to overcome obstacles of market, knowledge and cost, while international agreements, exclusively pursue mitigate market problems.

Regarding the third research question, *whether the institutional factors encourage cooperation agreements for innovation*, the results are shown in Tables 4 and 5 both in the case of the type of partners for cooperation and their geographical scope. It should be noted that both the existence of external public financing and sources of information exhibit positive and significant values in all types of cooperation agreements. Thus, in Table 4, it is observed that, unlike in the case of innovation obstacles, institutional support through financing and information sources has a significant impact on all cooperation agreements, being more prominent in the case of cooperation with Universities and research centres and in cooperation with clients. These results provide further empirical evidence on the importance of external financing as an incentive to the establishment of agreements for innovation (Busom and Fernández-Ribas, 2008; Barajas et al., 2016). In respect of cooperation from the geographical point of view (Table 5), the results confirm that there is no significant difference in the effect of institutional factors on the diverse geographical areas of agreements, although it is slightly more important in the case of cooperation in the scope of the European Union. Just as in previous research, our results confirm the importance of public support (by funding and information) for the development of any type of collaboration agreement. Moreover, they support the conclusion from Lundvall (2007) when pointing out that in the frame of innovation systems, the continuous flow of information, resources and knowledge among the participants allow reducing the development time of innovations, and increasing access to new knowledge, technologies and markets.

With regards to the characteristics of firms that take part in partnerships, our results show that the size of firms is an important variable in the tendency to cooperate. Additionally, the variables related to the internationalization degree of the company show that, in absolute value, most agreements are carried out at the local/regional and national level. The results also underline that, in percentage, the use of cooperation agreements is greater in the international environment. These findings are in line with the results emerging in prior research which highlight that cooperation agreements serve to mitigate situations of uncertainty and high transaction costs (Hagedoorn, 1993; Hagedoorn et al., 2000). Regarding the technological intensity, there is a greater presence of cooperation agreements in the sectors of high and medium-high technological intensity, and in the manufacturing sector companies. The empirical evidence indicates that companies with high technological intensity are much more dynamic and prone to develop this type of collaboration agreements (Arranz and Fernandez de Arroyabe, 2008).

Conclusion

The objective of this paper has been to analyse the effects of obstacles and institutional factors in the cooperation for innovation. These aspects have important implications both from a theoretical point of view and from a managerial perspective.

Although our results are specific to our study context, they contribute to extending the current literature on cooperation for innovation and improve our understanding of it. The cooperation and innovation literature suggests that cooperation is an incentive for the development of innovations (Hagedoorn et al., 2000; Vuola and Hameri, 2006; Lavie, 2006; Bayona-Sáez and García-Marco, 2010). However, in line with previous works of D'Este et al. (2012), Lopez (2008) and Antonioli et al. (2017), our results support that an important driver of firm's cooperation is overcoming the obstacles of the innovation process. Moreover, the type of partner for cooperation is influenced by the different perception that companies have of the obstacles to innovation. This outcome complements previous studies that point out the experience and managerial skills of firms as the factors that lead to cooperation.

Second, our results contribute to the regional literature (see, for example, Cooke et al., 2011), with new empirical evidence to characterize regions in terms of innovation (Rodríguez-Pose and Crescenzi, 2008; Cresceni and Rodriquez-Pose, 2011). In general, regional classifications are based on technological indexes that allow determining the proactivity or reactivity of regions with respect to the innovation (Cooke et al., 2011). Our work complements previous research providing empirical evidence about the intensity of innovation in a region and the decision of firms to cooperate. García-Aracil and Fernández De Lucio (2008), and Polenske (2004) have indicated that in regions with greater technological intensity, the decision to cooperate has a strategic nature and its objective is the increase of regional development. In the case studied, Spain is a country that in terms of innovation and cooperation is below the European average, and our results show that the incentive that drives cooperation agreements is to solve problems and obstacles, having, therefore, an operative rather than strategic character (Lopez, 2008). Hence, a relationship can be established between the intensity of regional innovation and the nature of the cooperation agreement.

From a managerial point of view, our results point to some relevant issues for both policy-makers involved in the management of innovation programmes, and managers of firms and organizations that participate in these programmes. The first reality is that small and medium enterprises are reluctant to cooperate. Cooperation agreements for innovation involve sharing authority, creating communication channels between partners, setting common objectives,

and assessing the contribution of each partner, among other aspects (Arranz and Fernandez de Arroyabe, 2008). Consequently, policy-makers should define rules and mechanisms to participate in innovation programmes focusing on firms' and organizations' prior experience, and on the obstacles they perceive, since this dimensions are determining factors on the programme's success. Secondly, cooperation for innovation can be a fundamental mechanism for the internationalization of companies compared to other types of strategic internationalization decisions. It has been pointed out the low international profile of Spanish companies and more specifically, the low percentage of partnerships outside the EU (Segarra and Teruel, 2014; Arranz and Fernandez de Arroyabe, 2008). In this sense, researches coincide in stating that cooperation is an important mechanism to mitigate transaction costs, especially in situations of high uncertainty as a consequence both the lack of information on the market and the difficulties for finding innovation partners. These issues are fundamental in the case of the USA or emerging countries such as China and India. Besides this, although various activities have been carried out from the regional, national and international institutions to facilitate the search for innovation partners, the results of this study suggest that there is still a long way to go. While it is worth highlighting the active role of the Chambers of Commerce in the search for partners and from an institutional point of view, the creation of databases at national and EU level, it would be necessary for the whole set of actions to be oriented to facilitate the managerial practices that minimize the obstacles and optimize the exploitation of innovation opportunities through cooperation.

Finally, like any other, our study is not free from limitations. We have studied the Spanish case. In the context of Europe, Spain is a country that in terms of innovation and cooperation is below the European average, and in which the presence of SMEs is comparatively more important in the productive structure than in other northern European countries. These factors could introduce biases in our analysis, for which further efforts are required to expand the analysis to other countries.

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Table 1. Percentage of companies that cooperate for innovative developments

	Cooperation	
	N	**%**
Product innovation:		
• Product innovation	1603	50.2
• Innovative goods	1326	50.7
• Innovative services	756	58.2
Process innovation:		
• Process innovation	1532	47.9
• Manufacturing innovation	1161	52.8
• Logistics innovation	411	55.8
• Support for innovation	882	49.5
Organizational innovation:		
• Innovation in the company's procedures	1124	51.9
• Innovation in methods and organization of work	1086	52.0
• New management methods for external relations	608	61.8
Marketing innovation		
• Design innovation	633	51.1
• Promotional innovation	665	54.2
• Positioning innovation	562	54.0
• Prices innovation	418	55.1

Table 2. Type of partner and geographic area in cooperation agreements for innovation

	Cooperation	
	N	**%**
Partner:		
• Group companies	891	16.3
• Suppliers	1043	19.1
• Clients	907	16.6
• Competitors	618	11.3
• Universities and Research Centres	1515	27.7
•		
Geographic area:		
• Own country	1985	22.0
• EU	787	9.2
• USA	222	2.5
• China-India	117	1.4
• Other countries	89	1.0

Table 3. Obstacles in the innovation process and cooperation agreements

	Cooperation	Mean	F	Sig.
Cost obstacles:				
• Lack of funds in the company or group of companies	1	2.34	124.250	,000
	0	1.92		
• Lack of funding from sources outside the company	1	2.45	183.991	,000
	0	1.90		
• Innovation is too expensive	1	3.25	189.067	.146
	0	2,87		
Knowledge obstacles:				
• Lack of qualified personnel	1	2.95	53.042	.000
	0	2.58		
• Lack of information on technologies	1	3.24	34.551	.000
	0	2.39		
• Lack of information about the market	1	3.11	112.090	.000
	0	2.75		
• Difficulties for finding cooperation partners for innovation	1	3.01	204.986	.000
	0	2.50		
Market obstacles:				
• Market dominated by established companies	1	2.25	109.262	.005
	0	1.99		
• Uncertainty regarding the demand for innovative goods and services	1	2.82	166.527	.001
	0	2.10		

Table 4. Impact of institutional resources and innovation obstacles in the cooperation agreement (type of partner)

	Model 1 Cooperation	**Model 2** Group Cooperation	**Model 3** Supplier Cooperation	**Model 4** Client Cooperation	**Model 5** Competitor Cooperation	**Model 6** University/Research Centre Cooperation	**VIF**
Public Funding	.572***	.048***	.117***	.272***	.125***	.406***	1.263
Information Sources	.668***	.083***	.115***	.156***	.078***	.263***	1.217
Cost obstacles	.009	.005	.010	.019	.013*	.060***	1.372
Knowledge obstacles	.259***	.019*	.013	.038**	.003	.047**	1.633
Market obstacles	.135***	.018*	.035**	.077***	.039***	.072***	1.559
Technological Intensity	-.008	-.001	-.004**	-.001	-.003**	-.002	1.072
Manufacturing/ Services	.090	-.031	-.024	.141***	.062***	.072**	1.279
Internationalisation level	.080**	.012	.005	.079***	-.005	.014	1.289
Group	210***	.408***	.126***	.078***	.001	.071**	1.073
Size	1.651E-5***	2.507E-5***	4.513E-5***	1.517E-5**	1.312E-5***	3.866E-5***	1.038
-2 Log Likelihood	6755.471	4109.811	4394.183	3302.199	1896.112	7070.801	
Chi-Square	2221.338	1270.120	1161.702	672.103	440.373	2384.790	
df	10	10	10	10	10	10	
Sig.	.000	.000	.000	.000	.000	.000	
Cox and Snell	.200	.282	.217	.279	.165	.295	
Nagelkerke	.269	.325	.383	.290	.287	.381	
McFadden	.164	.201	.220	.195	.260	.330	

*p<0.05, **p<0.01, *** p<0.001
Robustness analysis: VIF and Durbin-Watson test.

Table 5. Impact of institutional resources and cooperation obstacles in the cooperation agreement (geographical scope).

	Model 7 National Cooperation	**Model 8 EU Cooperation**	**Model 9 USA Cooperation**	**Model 10 China and India Cooperation**	**Model 11 Other Countries**	**VIF**
Public Funding	.348***	.365***	.067***	.076***	.105***	1.263
Information Sources	.299***	.143***	.085***	.051**	.096***	1.217
Cost obstacles	.044**	.024	.014	.007	.005	1.372
Knowledge obstacles	.064***	.024	.010	.025	.023	1.633
Market obstacles	.096***	.059***	.022	.049**	.052**	1.559
Technological Intensity	-.004*	-.004*	-.004	-.002	-.001	1.072
Manufacturing/ Services	.094***	.110***	.030	.034	.064*	1.279
Internationalisation level	-.009	.061***	.018	.057**	.055**	1.289
Group	.213***	.053*	.095**	.053	.087**	1.073
Size	4.478E-5***	4.413E-5***	4.559E-5**	2.375E-6	2.502E-5**	1.038
-2 Log Likelihood	3190.345	1125.452	1067.230	878.009	633.152	
Chi-Square	1025.092	531.733	634.625	225.110	193.182	
df	10	10	10	10	10	
Sig.	.000	.000	.000	.000	.000	
Cox and Snell	.338	.225	.078	.056	.039	
Nagelkerke	.425	.275	.190	.152	.101	
McFadden	.311	.189	.152	.109	.099	

*p<0.05, **p<0.01, *** p<0.001
Robustness analysis: VIF and Durbin-Watson test.