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Additional Information

# Motives for international cooperation on R&D and innovation: empirical evidence from Argentinean and Spanish firms

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**Abstract:** This paper focuses on the strategic motives and firm characteristics that influence cooperation for R&D and innovation among Argentinean and Spanish firms. On the basis of a review of different theoretical perspectives we propose and apply a taxonomy of motives for inter-firm technological cooperation. We combined quantitative and qualitative methodologies, developing a database of 540 innovative firms and conducting a survey that obtained evidence from 104 of these firms, supplemented by information gathered from 19 in-depth interviews. Our results show that technological cooperation is not easy to achieve and determined by a complex interplay of intentions and practical opportunities. The lack of convergence in the motives for cooperation creates un-favourable conditions and affects negatively the initiation of the cooperation processes. These differences together with asymmetries in access to funding are important obstacles to cooperation with implications in the administration of national policy incentives and its regulation mechanisms.

**Keywords:** innovation; R&D; inter-firm cooperation; funding programme; technological development; cost reduction; firms; Argentinean firms; Spanish firms; technological cooperation; international cooperation; motives.

## 1 Introduction

Since the last four decades an ample literature has shown the growth of strategic alliances for technological purposes, accompanying the emergence of globalisation of R&D and innovation patterns (Porter and Fuller, 1986; Granstrand et al., 1993; Niosi, 1999; Archibugi and Iammarino, 2002; Hagedoorn, 1996; Hagedoorn and Van Kranenburg, 2003; Narula and Duysters, 2004). International cooperation is driven by partnering firms' strengths and weaknesses in helping them counter with this environment of global competitiveness and greater R&D complexity (Vonortas, 1997; OECD, 2008, 2010).

Motives and selection of partners are critical aspects together with the environment of the partnerships, which encompass both the external environment such as markets, competitors, governments, and the internal environment (strategic context of the

partnership) (Doz, 1996). Understanding alliances requires an understanding of the motives and incentives to collaborate, taking into account how goals can influence the choice of mode of cooperation and the initial conditions in collaboration process (Kogut, 1988; Hagedoorn, 1993; Doz, 1996). In opinion of Arvanitis (2012) firms pursue different goals and incentives when getting engaged in R&D collaborations, often more than one goal at the same time. Can the lack of convergence in the firms' motives undermine or negatively affect the cooperation relationships?

Such aspects are the starting point for this paper, together with the analysis of several firms' characteristics which could influence the underlying motives of their decision to cooperate. Although a considerable amount of literature deals with these issues, international technological cooperation varies widely among the world and remains relatively un-investigated in numerous developing countries (Hagedoorn and Lundan, 2001; Teixeira et al., 2008). Among firms in Europe, for example, the share of collaboration involving partners in a different country ranges from less than 2% in Italy, Romania and Spain to over 12% in Denmark, Finland and Belgium (EUROSTAT, 2010).

According to Ernst (2005) developing country firms are only marginally involved in international technological collaborations. Studies have been conducted by Bayona et al.(2001), López Sebastián (2008) and Trigo and Vence (2012) for Spain, and Albornoz and Estébanez (1998) for Argentina, but these are focused mostly on cooperation at the national level. This is one of the first contributions specifically to target inter-firm cooperation between these two countries. It explores the 'two sides' of technological

collaboration (Lawton Smith et al., 1991), investigating: a the strategic motives underlying Spanish and Argentinean firms' engagement in cooperation for R&D and innovation and how motives affect the initial interactions among partners b the factors and firm characteristics suggested by the theory that influence cooperation on R&D and innovation between firms located in Argentina and Spain.

The paper is organized as follows. Section 2 presents a short description of the context related to innovation and technological cooperation in both countries, followed by the definition of cooperation on R&D and innovation. Section 3 provides an overview of the literature and formulates the analytical framework for our study. Section 4 describes the methodology applied. Section 5 presents and discusses our results and Section 6 concludes.

## **2 Context and conceptual background**

### *2.1 Cooperation in weak innovation systems*

Previously to explore the existence of technological cooperation activities between Spanish and Argentinean firms, it is interesting to take into account an overall picture about innovation – as part of the firms' external environment – in each country. In both cases the productive system comprises few large firms and a majority of small and medium enterprises (SMEs) within a context of a weak national innovation system (Katz and Bercovich, 1993; INE, 2011; IUS, 2012). In the Innovation Union Scoreboard (IUS) Spain is considered as moderately innovative, below the European average and ranked 19 of 27 European states [IUS, (2012), p.33]. Among the root causes of this poor performance is the small percentage of SMEs that collaborate on innovation, reduced total costs under development innovation and venture capital, but no doubt the Spanish

productive structure (in which the high-tech sectors account for less than 8% of total gross value added) is the factor which contributes to the low values of effort on R&D and innovation (Celikel-Esser et al., 2007; EUROSTAT, 2006, 2010; Trigo and Vence, 2012). The amount of R&D expenditures as part of GDP is around 1.3% in Spain (lower than those of most European countries) and 0.5% in Argentina; R&D industrial funding is around 30% in Argentina and 55% in Spain (INDEC, 2008; EUROSTAT, 2010; OECD, 2010). On other hand cooperation is not considered as a relevant innovation strategy in both countries: in Argentina, the dominant innovation strategy is the external knowledge acquisition while in Spanish companies prevail in-house R&D activities.

## *2.2 Definition of cooperation on R&D and innovation*

An inconvenience and other limitation for our study, described in the literature as the problem of multidimensionality, is the generic use of the terms ‘technological collaboration’, ‘technological alliance’ and ‘cooperation on innovation’ to cover a wide scope of inter-firm relationships (Hagedoorn, 1990; Narula and Hagedoorn, 1999; Osborn and Baughn, 1990). In this paper we consider technological cooperation as the relations between different organisations, based on innovation with a R&D content that imply the sharing of resources and assets by two firms (Hagedoorn et al., 2000). These alliances can more or less formal and are set up for sharing, developing, and scanning new technologies with partners (Hagedoorn, 1990; Hagedoorn et al., 2011). Also following to Hagedoorn (1993) R&D alliances are inter-firm cooperative agreements aimed at joint research and development relating to new technologies, products and processes. This definition comprises equity sharing, in particular joint ventures and equity investment, and contractual agreements without equity sharing such as cooperation licensing, manufacturing agreement and formal and informal R&D agreements (Porter, 1985; Contractor and Lorange, 2002; Narula, 2004).

## **3 Overview of the literature**

### *3.1 Motives for international inter-firm cooperation on R&D and innovation*

Theoretical and empirical research has approached motives for cooperation on R&D and innovation from different perspectives, and the stock of literature is quite ample but fragmented and heterogeneous (Archibugi and Iammarino, 2002; Tether, 2002). In this study we particularly considered the extensive contribution of Hagedoorn focused on the firms’ motives for technological cooperation. Hagedoorn (1993, p.373) elaborates a categorisation for cooperative R&D based on three complementary theoretical strands:

transaction cost theory, related to the sharing of costs and risk for developing innovation (also considered by Teece, 1986; Das and Teng, 1996); strategic management theory, which focuses on the relation between technological cooperation and corporate strategy (Dodgson, 1992a; Arvanitis, 2012); and industrial organisation theory, which studies firms’ strategic behaviour to the structure of markets and the generation of spillovers (Gassmann and von Zedtwitz, 1998; Hagedoorn et al., 2000). The joint use of multiple perspectives reflects that R&D alliances are multifaceted entities and it is unlikely that one perspective alone explains their inner workings and performance. Other theoretical perspectives include classical market-power theory (Porter, 1980; Child and Faulkner, 1998); resource-based theory (Conner and Prahalad, 1996; Combs and Ketchen, 1999; Tsang, 1998), and social exchange theory (Das and Teng, 2002). Starting from these theoretical contributions we establish five categories of firms’ motives for cooperation

on R&D and innovation (Table 1). This taxonomy was also obtained from the previous empirical analysis of our sample. We applied a principal components analysis with a varimax rotation (with Kaiser normalisation) of the factor dimensions to group the different motivations (Hair et al., 1998) determining the five dimensions detailed in Table 1 (total explained variance: 66.6%). To assess the degree of consistency (reliability) we use Cronbach's alpha, accepting values equal to or above 0.6 as valid (see details in Annex I).

**Table 1** Categorisation of firms' motives for cooperation on R&D and innovation

Description	Authors
<b>Motive 1: Access to new knowledge and joint technological development</b>	
<p>Based on the need for even the most diversified enterprises to cooperate in order to respond to technological challenges, achieve economies of scale and respond rapidly to demand in the market place despite technological uncertainty. This motive is related to innovation processes, cooperation to reduce innovation time span and time from investment to introduction in the market and technological leapfrogging.</p> <p>This includes:</p> <ul style="list-style-type: none"> <li>• access to complex or specialised new technology</li> <li>• product market complementarities</li> <li>• development of products new to the firm and/or to the market</li> <li>• switching to new technologies promising for the firm</li> </ul>	<p>Hladik (1985), D'Aspremont and Jacquemin (1988), Link and Bauer (1989), De Bondt et al. (1988), Kogut and Zander (1992), Teece (1992), Hagedoorn (1993), Häusler et al. (1994), Wang (1994), Hagedoorn and Narula (1996), Katz and Martin (1997), Tidd (1997), Robertson and Gatignon (1998), Bayona et al. (2001), Cassiman and Veugelers (2002), Hagedoorn (2002), Miotti and Sachwald (2003), Belderbos et al. (2004) and Arvanitis (2012)</p>
<b>Motive 2: Access to new markets</b>	
<p>This is linked to commercial concerns, such as market access, exploitation of new market opportunities, monitoring of technological changes and opportunities for internationalisation, entry of new products to foreign markets, expansion of improved product range, shaping the competitive environment in which partners operate.</p> <p>It includes:</p> <ul style="list-style-type: none"> <li>• access to new market and/or faster market entry</li> <li>• access to resources</li> <li>• innovation for commercialisation</li> </ul>	<p>Hladik (1988), Link and Bauer (1989), Dodgson (1992a, 1992b), Sakakibara (1997), Katz and Martin (1997), Hagedoorn (2002), Miotti and Sachwald (2003) and Dachs et al. (2008)</p>
<b>Motive 3: Sharing risks and reducing costs</b>	

<p>This motive is related to reducing and sharing uncertainties associated with R&amp;D activity. The risks related to innovation are expected results not being realised, or taking too long to emerge, and the need for more financial or technological resources than originally anticipated.</p> <p>It includes:</p> <ul style="list-style-type: none"> <li>• sharing the technological risks involved in the development of new technologies and learning processes</li> <li>• product rationalisation and cost reductions based on economies of scale, while avoiding the risks of full-scale merger</li> <li>• appropriate management of absorption of spillovers.</li> <li>• Increasing the effectiveness of R&amp;D investments at firm level by reducing duplication of effort</li> </ul>	<p>Porter and Fuller (1986), Hladik (1988), Kogut (1988), Pisano (1990), Dodgson (1992a), Teece (1992), Pisano (1990), Hagedoorn (1993), Das and Teng (1996), Tsang (1998), Bayona et al. (2001), Cassiman and Veugelers (2002), Contractor and Lorange (2002) and Arvanitis (2012)</p>
<p>Motive 4: Search for R&amp;D complementarities and technical assistance (capacity complementarity)</p>	
<p>This motive emphasises resources and capability building derived from the resource-based view of the firm proposed by Penrose (1959) and further elaborated by Teece (1992) in his dynamic capabilities approach. Firms need to access complementary external resources in order fully to exploit their internal resources and R&amp;D alliances serve as embedded mechanisms in which human capital intervenes to transfer technological knowledge.</p> <p>It includes:</p> <ul style="list-style-type: none"> <li>• search for technological complementarities based on the increased complexity and intersectoral nature of new technologies</li> <li>• complementarities in basic and joint applied research, technology transfer and reinforcement of technological synergies</li> <li>• access to complementary technology, technological problem solving, joint R&amp;D and technical assistance.</li> </ul>	<p>Penrose (1959), Teece (1986), Kogut (1988), Barney (1991), Teece (1992), Mowery et al. (1998), Hagedoorn et al. (2000), Tsang (2000), Cantner and Meder (2007), Quintana-García and Benavides Velasco (2010) and Arvanitis (2012)</p>
<p>Motive 5: Improvements to technological and innovation competency (learning)</p>	
<p>The organisational literature argues that</p>	<p>Porter and Fuller (1986), Hladik (1988),</p>

<p>one of the reasons for technological cooperation is the possibility of acquiring and internalising the abilities and competences of partners in order to create/reinforce the firm's existing competences, related to search for improvements in productivity through 'capture' of know-how and tacit knowledge. In this sense cooperation can be an effective mechanism for transferring tacit and firm specific knowledge through the establishment of close linkages between organisations. Here the emphasis is on competences and technological change. Companies that seek to innovate through flexible production, standardization and standardised products, achieve high quality products often at lower costs which increases the technological opportunities in the market. It includes:</p> <ul style="list-style-type: none"> <li>• learning and extracting skills from external sources</li> <li>• capturing and absorbing know-how and tacit knowledge</li> <li>• improvements to distribution chains and logistics.</li> </ul>	<p>Hamel (1991), Rothwell and Dodgson (1991), Dodgson (1992a), Hagedoorn (1993), Steensma (1996), Sakakibara (1997) and Tsang (2000)</p>
<p>Source: adapted from Hagedoorn's taxonomy (1993, p.373)</p>	

### 3.2 Determinants of technological cooperation

The positive influence of firm size on the likelihood of cooperating over R&D is supported by many empirical studies (Link and Bauer, 1989; Bayona et al., 2001; Cassiman and Veugelers, 2002; Miotti and Sachwald, 2003; Bönte and Keilbach, 2005).

In an in depth literature review, Dachs et al. (2008) argue that large firms are more likely to have the resources required to search for partners and thus are more likely to cooperate than small firms. Similarly, Fritsch and Lukas (2001) highlight the impact of lower levels of economic activity among small firms. Bayona et al. (2001) in an analysis of Spanish firms, find that large and more technologically intensive firms are more likely to cooperate. However, the focus in this study is domestic cooperation. In relation to exporting activity, although Dachs et al. (2008) argue that the export orientation of firms matters for R&D cooperation, Busom and Vicente Blanes (2004) find no supporting empirical evidence for this. At the industry level, Dodgson (1994) and Tether (2002) show that high-tech industries are more likely to cooperate over R&D.

According the literature R&D and innovation policies can improve the motivation to engage in international collaboration through initiatives and instruments that provide financial support, and ease the regulatory conditions that hinder cooperation (Narula and Dunning, 1998; Lundin et al., 2004; Czarnitzki et al., 2007; Bérubé and Mohnen, 2009;

Kang and Park, 2012). Arvanitis (2012) highlights cases where the existence of a cooperation project is a pre-condition for the utilisation of public promotion grants.

Several studies find a positive effect of participation in national R&D programmes on the likelihood to cooperate (Negassi, 2004; Busom and Fernandez-Ribas, 2004; Abramovsky et al., 2009). The conditions of real financing differ widely among countries and can be obstacles to cooperation. In this sense, Argentina seems to be in a less favourable situation due to macroeconomic instability and the need for firms to finance their innovation activities (Anlló et al., 2007; Kosacoff, 2007; INDEC, 2008). In our study we consider the IBEROEKA programme, which is a political instrument that was introduced in 1991 with the aim of reinforcing the industrial competitiveness of 21 Ibero-American countries. The IBEROEKA collaborative projects are focused on market-oriented R&D through scientific and technological cooperation among enterprises, universities and other research institutions. In each project companies choose their partners and the collaboration agreement with them, the risk share, the costs taken on by each partner and how the profits from the project will be distributed in the operation stage. Between 1991 and 2012, IBEROEKA approved 627 projects, representing Argentinean cooperation participation of 19.2%. However, studies performed by Hidalgo Nuchera and Albors Garrigós (2004), Hidalgo Nuchera et al. (2006) and Pérez (2008) put in evidence that the projects approval does not guarantee successful cooperation and this programme has had a limited impact in Latin America.

#### **4 Data sources and methodology**

The strategy followed in this study has been two-fold: to generate a basic frame for understanding the concrete empirical issue to be tackle and to design an ad hoc survey.

The objective of this research is not one to produce generalisable results but rather to deepen knowledge of the study theme by combining quantitative and qualitative methodological approaches. As mentioned earlier, one relevant limitation is the absence of data and scarce information on technological cooperation in both countries and particularly in the case of the Argentinean firms. For this reason we developed a database containing 540 innovative firms with a selection criterion based on an assumption that they may have been involved in cooperation activities on R&D and innovation. The dataset (a total of  $N = 264$  firms from Spain and  $N = 276$  firms from Argentina) was generated using information from the IBEROEKA programme. Specifically we gather information about IBEROEKA certified projects which included the participation of Spanish and Argentinean firms between 1991 and 2010, excluding cases in which other agents, such as universities and technological institutes, also participated. We also consider a database of exporter firms provided by the Spanish Institute for Foreign Trade (Instituto Español de Comercio Exterior, ICEX). A survey questionnaire delivered by post and online was distributed and achieved a response rate of 19.3% ( $N = 104$  enterprises, 56 Spanish firms and 48 Argentinean firms). We detected several cases of firms that began cooperation projects within the IBEROEKA programme but did not complete the process and cooperation was not successful. Thus, in order to obtain a deeper understanding of the initial cooperation process we conducted 19 personal in-depth interviews with R&D managers and key participants in the cooperation relationships.



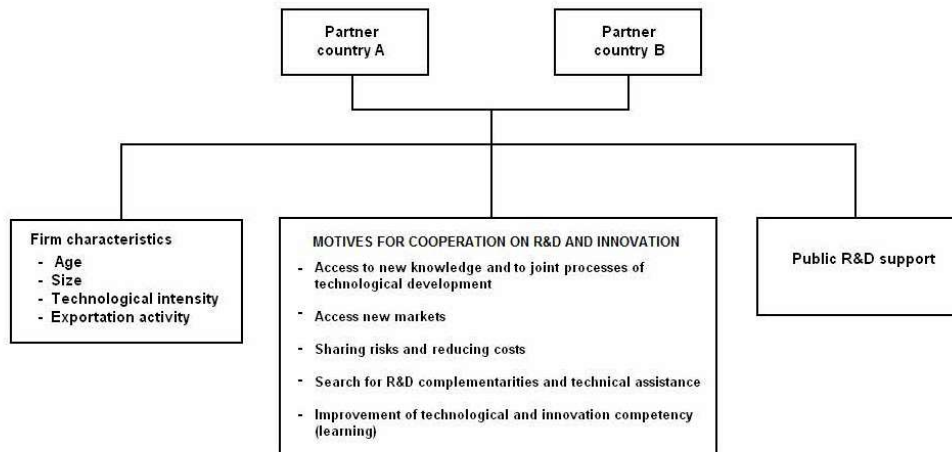
#### *4.1 Definition of the variables*

The empirical analysis involved estimating alliance scope, based on the relationship between the decision to cooperate and the location of the respective firms. We start by considering the total sample ( $N = 104$ ), and model cooperation choice in order to investigate the factors that lead companies to cooperate with other agents given their geographic locations (Spain and Argentina). Because the objective of this work is the analysis of underlying motives for R&D cooperation, the main variable (COOPERATION) is dichotomous and takes the value 1 if the firm has cooperated and 0 otherwise.

For the variables ‘motives for cooperation’ (MOTx) we use the taxonomy with the categories as described previously, defining five new dichotomous variables based on the results of the factor analysis: access to new knowledge and joint technological development (MOT1); access to new markets (MOT2); sharing risks and reducing costs (MOT3); R&D complementarities and technical assistance –capacity complementarities– (MOT4); and improvements to technological and innovation competency – learning – (MOT5). These dichotomous variables take the value 1 if the firm indicates that this motive is relevant and 0 otherwise.

While motives for inter-firm cooperation is at the core of our investigation and firms are the unit of analysis, we take account of firm’s general characteristics (size, age, technological intensity, export activities) and participation in the IBEROEKA programme to control for their possible influence on the analysis (see Figure 1). For firm size, we classified firms into four categories based on number of employees: up to 100 employees, 101 to 250 employees, 251 to 1,000 employees, and over 1,000 employees. Based on the R&D intensity of manufacturing industries, we grouped the firms into two categories corresponding to a dichotomous variable that takes the value 1 if the firm is classed as high or medium-high technological intensity and 0 if the firm is classed as low or medium-low technological intensity (OECD, 2011). For the variable age, measured as the number of years since the firm began its activity until 2012, we checked normality using the Kolmogorov-Smirnov test. Given a significant result ( $p$ -value  $< 0.05$ ), we explored the variable normalisation applying a QQ-plot graph and decided to use the transformed variable [ln\_age] in our analysis. In order to show the differences in the motives to cooperate on R&D and innovation between Spanish and Argentinean firms, we include a dummy variable with the origin of the firm (ORIGIN), that is, if the firm is located in Spain (ORIGIN = 1) or Argentina (ORIGIN = 0).

**Figure 1** Analytical framework



#### 4.2 Quantitative methodological approach

In the first place we developed a descriptive analysis of the motives for R&D cooperation in our sample. Second, a multivariate analysis was done in order to control for specific characteristics of firms that can influence the probability of cooperation. Results obtained provide evidence of general motives for R&D cooperation and specific motives for firms located in each country. As the effective cooperation percentage was less than we expected, we decided to analyse the differences in motivations when the cooperation was successfully performed. In both cases, we use the comparison of proportions test [Fleiss, (1981), p.54] excluding the Yates correction for continuity.

Third, we conducted a multivariate analysis to compare the motives for international technological cooperation for the most important results from the previous analysis. Here our dependent variable is cooperation and firm features and motives for cooperation are independent variables. As cooperation is a dichotomous variable, we conducted a logistic regression analysis. We develop two models, the first with only the main variables and the second one with the interaction terms between motives and the origin of the firm.

This second model allows us to determine the differences in the motives between Spanish and Argentinean firms.

## 5 Results

### 5.1 Descriptive statistics

Just over half of the sample firms (52%) cooperated successfully: 35.6% of Spanish firms cooperated with Argentinean companies and 16.3% Argentinean firms established links with firms in Spain. Table 2 presents some firm characteristics: 41.1% of companies are SMEs and just over one-third of the sample (35.7%) corresponds to large firms (more than 1,000 employees).

**Table 2** Description of firms' characteristics

		<i>Technological cooperation with Spain</i>	<i>Technological cooperation with Argentina</i>	<i>Total</i>
SIZE (number of employees)	0–100	23.5%	29.7%	32.7%
	101–250	17.6%	21.6%	15.4%
	251–1000	23.5%	18.9%	14.4%
	>1000	35.3%	29.7%	37.5%
IBEROEKA (yes)		35.3%	73.0%	46.2%
EXPORT (yes)		70.6%	83.8%	76.0%
TECHINT	Low and medium-low	11.8%	29.7%	33.7%
	High and medium-high	88.2%	70.3%	66.3%
Age (in years)	Mean	12	38	26
	s.d.	9	72	47
	Minimum	1	3	1
	Median	10	22	18
	Maximum	35	450	450
Total		17	37	104

The majority of the sample firms are exporters (76.0%) and around half of the surveyed firms participated in the IBEROEKA programme, with participation among Spanish firms being double that of Argentinean firms. For technological intensity, 66.3% of the firms are high and medium-high intensive, with similar percentages in each country. Information and communication technology (ICT) is the most strongly represented sector in the sample (42.9%) and also one of the main sectors in the IBEROEKA programme. Other sectors, in order of importance in the programme are chemistry, biotechnology, metal-mechanics industry and electronics (interviews were conducted in all these sectors).

In terms of the age of firms, we found that average firm age is 26 years, and that Spanish companies tended to be older than Argentinean companies (38 and 12 years old respectively). Half of Argentinean firms (50.0%) are very young – less than 10 years since their establishment while Spanish firms are slightly older (22 years on average).

### 5.2 Motives for cooperation on R&D and innovation

In Table 3 we can observe that the main motives for technological cooperation in both countries are similar and related to access to new knowledge and joint processes of technological development (MOT1) and access to new market (MOT2) (47.12% and 44.23% respectively). All the motives present significant differences between Argentinean and Spanish firms, except improving technological and innovation competency (MOT5) which is the less chosen option. Sharing risks and reducing costs (MOT3) and R&D complementarities and technical assistance (MOT4) are much more important for Spanish enterprises than for Argentinean ones.

**Table 3** Motives for R&D cooperation

	<i>Total</i>		<i>Origin of the firm</i>				<i>Comparison proportions (p-value)</i>
			<i>Argentina (%)</i>		<i>Spain (%)</i>		
MOT1: Access to new knowledge and joint processes of technological development	49	47.1%	14	29.1%	35	62.5%	0.000***
MOT2: Access to new market	46	44.2%	13	27.1%	33	58.9%	0.001***
MOT3: Sharing risks and reducing costs	31	29.8%	4	8.3%	27	48.2%	0.003***
MOT4: R&D complementarities and technical assistance (capacity complementarities)	28	26.9%	5	10.4%	23	41.1%	0.018**
MOT5: Improving technological and innovation competency (learning)	11	10.6%	2	4.2%	9	16.1%	0.156
Total	104		48	100%	56	100%	

Notes: \*\*p-value<0.05;\*\*\*p-value<0.001

**Table 4** Motives for R&D cooperation in firms with successful cooperation

	<i>Total</i>		<i>Origin of the cooperating firms</i>				<i>Comparison proportions (p-value)</i>
			<i>Argentina (%)</i>		<i>Spain (%)</i>		
MOT1: Access to new knowledge and joint processes of technological development	36	66.7%	11	64.7%	25	67.6%	0.418
MOT2: Access to new market	35	64.8%	11	64.7%	24	64.9%	0.495
MOT3: Sharing risks and reducing costs	27	50.0%	4	23.5%	23	62.2%	0.004***
MOT4: R&D complementarities and technical assistance (capacity complementarities)	26	48.1%	5	29.4%	21	56.8%	0.031**
MOT5: Improving technological and innovation competency (learning)	10	18.5%	2	11.8%	8	21.6%	0.193
Total firms	54		17	100%	37	100%	

Notes: \*\*p-value<0.05;\*\*\*p-value<0.001

Table 4 shows differences in motives when firms have cooperated (52% of our sample had cooperated, 35% of Argentinean and 66% of Spanish firms). As in the previous table, MOT1 and MOT2 are the most frequent options, although the differences are reduced.

Only 18.5% of the cooperating firms choose improving technological and innovation competency (MOT5) as a motive for cooperation. Among Argentinean companies that cooperate with Spanish firms, 64.7% indicated access to new knowledge (MOT1) and search for new markets (MOT2) as motivations. Only 11.8% of these companies cooperate to improve their skills and/or develop competences (MOT5). For companies

that cooperate with Argentina, 67.6% and 64.9% of them do so to access new knowledge (MOT1) and to seek new markets and opportunities (MOT2) respectively. Unlike the previous case, the third strongest reported motive is to reduce risks and innovation costs (MOT3, 62.2%). It is important to note that access to new knowledge and to markets are important in both cases and with practically the same percentage, while MOT3 (sharing risks and costs) and MOT4 (search of complementarities and technical assistance) are more relevant for the firms that cooperate with Argentinean companies, with statistically significant differences.

### *5.3 Multivariate analysis*

The results of the logistic regression are presented in Table 5 showing that goodness of fit of the model reflects the adequacy of the model for the explanation of the data. In addition, the correlation matrix for all the independent variables used in our regression is shown in the Annex III. The majority of the coefficients are weak (below 0.3), showing that the estimation of the model parameters is not affected by multi-collinearity problems. Model 1 includes the main variables and model 2 adds the interaction terms. For multivariate analysis we only use the principal motivations for technological cooperation. In this case, both models comprise access to new knowledge and joint processes of technological development (MOT1) and access to new market (MOT2).<sup>1</sup>

In both models we observe that the probability for technological collaboration increases with the firm size, except for the biggest firms, and decreases with firm age, that is, larger and younger companies are more likely to cooperate. Although firms with more than 1000 employees do not maintain this trend, this result is not significant and agrees with previous findings on the positive relationship between size and cooperation (Link and Bauer, 1989; Hagedoorn and Schakenraad, 1994; Cassiman and Veugelers, 2002; Dachs et al., 2008; Bönnte and Kellbach, 2005). This positive effect is explained by the firm's internal R&D capacity and absorptive capacity, both of which are a characteristic of large firms together with R&D and human resources availability. However, other authors such as Pisano (1990) and Robertson and Gatignon (1998) found contrasting results.

Technological intensity is a non-significant variable but presents a positive sign, implying that high and medium-high technological intensity firms are more likely to engage in these activities. This result is in accordance with the study by Bayona et al. (2001) which found that large and more technologically intensive Spanish firms are more likely to cooperate. Participation in the IBEROEKA programme shows a positive influence on technological cooperation, while exports influence negatively cooperation on R&D and innovation, although this variable is not significant.

Focusing on the motives for R&D cooperation, Model 1 shows the positive influence of access to new knowledge and joint processes of technological development (MOT1) and access to new market (MOT2) to increase the probability of cooperation, although greater for MOT1. Model 2 include the interactive terms between the origin of the firm and the motive variables, which enable the differentiation between the countries. In this case, when firms' characteristics are controlled for, the access to new markets appears as the most relevant motive for R&D cooperation and is the only one with significant differences between firms in both countries. Argentinean firms give more importance to the access to new markets as a motive for establishing cooperation links with Spanish firms.

**Table 5** Logistic regression for motives for R&D cooperation

	<i>Model 1</i>	<i>Model 2</i>
Firm characteristics		
SIZE <sup>a</sup>		
101–250	1.232 (0.805)	1,796** (0,863)
250–1,000	1.058 (0.840)	2,142** (1,004)
>1,000	0.244 (0.603)	0,681 (0,657)
LNANT	–0.320 (0.297)	–0.305 (0.329)
IBEROEKA (yes)	1.146** (0.543)	1.568*** (0.585)
EXPORT (yes)	–0.002 (0.631)	–0.302 (0.705)
TECHINT (high, medium-high)	0.156 (0.563)	0.537 (0.626)
ORIGIN (Spain)	0.628 (0.541)	2.673*** (0.904)
Motives for cooperation		
MOT1: Access to new knowledge and joint processes of technological development	1.192** (0.522)	1.459 (1.052)
MOT2: Access to new market	1.043* (0.555)	3.324*** (1.164)
Interaction terms		
Origin*MOT1		–0.964 (1.229)
Origin*MOT2		–3.829*** (1.436)
Intersection	–1.411 (1.057)	–2.884** (1.281)
Observations (number)	104	104
Likelihood ratio test <sup>b</sup>	106.700***	94.624***
Goodness of fit: $\chi^2$ (d.f.)	17.562 (8)	10.729 (8)
Pseudo R <sup>2</sup>	0.402	0.504

Notes: \*\*\*p-value<0.01; \*\*p-value<0.05; \*p-value<0.1

<sup>a</sup>reference category: size < 100 employees

<sup>b</sup>likelihood ratio test (–2Log-likelihood) for  $H_0: \beta_i = 0 \forall i$ .

Interviews provided further information about diverging motives and how they can play a role in initial interactions among partners and can act as barriers for technological cooperation.

Analysis of the interview data shows that motives and the strategic context of a part of the alliance may become the dominant context, which can be perceived as inappropriate by the other partner in the relationship. In the case of the Argentinean firms, the majority of the interviewees affirmed that motives depend on the activity sector and can be very different for each party involved at the beginning of cooperation. In the initial cooperation process situations involve a mixture of specific motives to further self-interest with the general motivation to cooperate for mutual benefits. In this sense motives are ‘negotiated’ from a ‘mixed’ motive exchange (see examples selected in Table 6).

Interviewees from both countries felt that international cooperation seemed an opportunity for Argentinean SMEs in sectors of high and medium-high technological intensity (e.g., ITC and biotechnology). In the case of Spanish managers, different backgrounds and experiences in cooperation, added to the unfavourable financing and regulation conditions and less stable macroeconomic context in Argentina, constitute relevant barriers to cooperation. Some interviewees commented that poor intra- and inter-organisational coordination in project management in IBEROKA programme projects was a major barrier to the implementation of innovation activities. In general the interviewees’ perceptions about the external environment regarding access to finance and macroeconomic instability, lack of government support and distance, are consistent with empirical evidence obtained in other countries (Heijs and Buesa, 2006).

**Table 6** Some examples of interviewees' perceptions on motives and barriers for technological cooperation (continued)

<i>Firm data</i>	<i>Comments about motives and barriers to cooperate</i>
<p><i>Firm:</i> CONEXUS consultores (Argentinean firm)  <i>Interviewee:</i> Director  <i>Sector:</i> ITC  <i>Size:</i> SME (50 employees)  <i>Age:</i> 12 years  <i>Participation in IBEROEKA programme:</i> Yes (project not finalized)</p>	<p>“The contact was initiated by the Spanish company... 5 years ago through the website. They travelled to Spain to meet the firm face to face ... <i>the Spanish firm is similar to ours and we embarked on a joint development (MOTI)</i> ... Our first attempt to obtain financing and start the project failed due to ... time mismanagement, the bureaucracy of the IBEROEKA programme and its deadlines which were not aligned to the initiative, so that halfway through, lack of finance led them to abort the project”            ... “after knowing better how the programme [IBEROEKA] works we decided to present a new project led by us. Currently this project is going well and we expect to develop a new product for the firm next year. So far, the experience has been extremely helpful, although we have not begun commercialization. In principle, we are ready to continue cooperating, but for now do not dare to make another proposal because the resources available in our company ... both human and financial, are not enough to become involved on more than one project”            ... “The main obstacles we face to cooperate were the disinterest and uncertainty about IBEROEKA ... also our lack of experience. We were at a disadvantage in working with them because they had experience of working with other partners in other European countries and more experience of operate within funding programmes ...”</p>
<p><i>Firm:</i> INDRA (Argentina branch)  <i>Interviewee:</i> R&amp;D responsible  <i>Sector:</i> ITC  <i>Age:</i> 14 years  <i>Size:</i> large firm (&gt;1000 employees)  <i>Participation in IBEROEKA programme:</i> Yes (project not finalized)</p>	<p>... “INDRA invests [in R&amp;D] globally. At the local level [in Argentina] it has only tried to cooperate with the National University of Cordoba (Universidad Nacional de Córdoba) for local software development”            ... “(INDRA) has 1,200 software professionals with 80% of production for the exterior, to Cordoba and Buenos Aires. in Buenos Aires there are 90 developers and also `subcontract staff to service their customers (telephone, Endesa, Iberia, Banco BBV            ... “the company usually establishes joint ventures (JV) to win bids, not only at home but at regional level”            “such joint working is not common in technology cooperation but we entered an alliance in which each participating company brings its expertise to provide a concrete service but not to develop a new product or technology ...” (MOT4)            ... “we have different motivations and different work cultures, INDRA follows the pattern of quick solutions and some small and medium firms are similar in this sense to research institutions ... we are working in different chronological dimensions” ... “even with the same interests coordination is very difficult”</p>

**Table 6** Some examples of interviewees' perceptions on motives and barriers for technological cooperation

Firm data	Comments about motives and barriers to cooperate
<p>Firm: ALTER SA (Spanish MNC)                      Interviewee: R&amp;D director (PHD)                      Sector: pharmaceutical and chemical industry                      Size: large firm                      Age: 71 years                      Participation in IBEROEKA programme: yes (project not finalized)</p>	<p>"Currently there are no cooperative relations with Argentinian companies, although there were some attempts in the last years in the IBEROEKA programme ... but in Argentina firms works at a different pace, firms do not meet commitments and sometimes it seem that <i>their motives are different from ours</i>" ... "many projects are never completed..."                      ... "<i>We were interested in joint research for generic drugs developments (MOT1) ... but I think that they are more interested in the possibility of capturing knowledge and learning from us ...</i>" (MOT3)                      ... "Firm Y produces some medicaments that are protected by patents in Spain, and they sell them freely in the market, so quality requirements are not the same and there is no possibility of reaching agreements about making products"</p>
<p>Firm: AGROCINEGÉTICA MODELO SL, (Spanish firm)                      Interviewee: R&amp;D responsible (engineer)                      Sector: agro food                      Size: medium-low                      Age: 52 years                      Participation in IBEROEKA programme: Yes</p>	<p>"The main obstacle to cooperation on the development of generic drugs is not related to the motives for cooperation but due the different regulatory systems in the two countries, particularly in relation to quality certification ... We offered firm X the possibility of auditing and quality certification according to European regulation but this firm was not willing to assume the costs ... under these conditions (we think) well, they manufacture for their own market"                      "It is important to harmonize regulation and quality control to support technological collaboration beyond technology transfer. We need to create a culture of quality and standards that satisfy the US, Europe and Argentina ... but it is difficult in Argentina because firms are not prepared to take on the costs ..."                      "<i>We had experience with Argentina in R&amp;D to introduce a new product (MOT1). But the experience was not very good, although it was useful from the point of view of staff exchange ... I think that it was more positive for them due the technology transferred from Spain to Argentina, this was their principal motivation to cooperate with us</i>" (MOT4).                      ... "The policy instability of the country, the legal uncertainty, the extreme bureaucracy applied to any procedure there, the excessive length of time for exporting the developed product ... in these conditions it is very difficult to cooperate ..."                      "Overall this is a generalized contextual problem in Argentina ... lack of support from their government"</p>

## 6 Conclusions

International cooperation for R&D and innovation is considered an efficient mechanism for the organisation of complex R&D processes and competitiveness in industry. Our aim in this paper was to provide information to enable a better understanding of motives and explore several determinants of inter-firm cooperation on R&D and innovation in Argentina and Spain. The principal findings show that the dynamics of cooperation on



R&D and innovation at firm level is determined by a complex interplay of motives, economic constraints, and practical opportunities. We also found that patterns of interaction between firms are strongly influenced by the general characteristics of the national innovation systems and sectoral activity, and the different modes of governance of cooperation partnering among organisations. The innovation environment and rates of technological cooperation are weaker in Argentina than in Spain. These weaknesses have been made evident in our study in the number of successful collaborations: of the 104 firms that responded to our survey and which we considered the most likely to have been involved in technological cooperation activities, only 54 had cooperated, and not all successfully. The IBEROEKA programme is an initiative launched to foster science and technology cooperation in Latin America and has infused the beginnings of a technology cooperation culture. In this sense, our results illustrate that effective performance evaluation of the IBEROEKA programme is not adequate. Several projects in its database were certified but this certification procedure does not represent the real outcomes or successful cooperation results.

In general, and with the limitation of our sample size, the information gleaned shows that cooperation is complex and difficult to sustain, and confirms that the lack of convergence in the motives for cooperation and the potential barriers to cooperation affect negatively the initiation of collaboration processes. Obstacles to cooperation mentioned by a majority of respondents are, in order of importance, the different culture of cooperation partners, extensive administrative procedures and bureaucracy (especially in Argentinean), lack of experience in working collaboratively and applying for funding and subsidies, difficulties related to specific industry and economic sectors, poor and uncoordinated decision making mechanisms. The IBEROEKA programme, and other policies to support inter-firm cooperation over R&D and innovation, needs to consider the differences in sectoral and firm characteristics that affect cooperation and the financing conditions of the countries involved, recognising that fuelling cooperation relationships is a policy target that has to be tailored to the specific features of a given economic and innovation system. The principal originality in our study lies in offering insights into a contemporary phenomenon of interest to both practitioners and academics and provides detail on the motives and determinants of technological cooperation in two countries where research is practically non-existent. However this study is only a first stage in the characterisation of the formation of R&D firms' partnerships and in the evaluation of their determinants in Spain and Argentina. This paper has some limitations.

First the study focuses on a limited sample. Second, we may have excluded additional factors that are even more important concerning firms' cooperation performance than the ones we chose. More comparative studies are needed to understand the dynamic relationships between motives, determinants and cooperation processes and to gain more in-depth findings. Another relevant question for further research is the impact and the inter-organisational arrangements effect of inter-national technological cooperation on firms' innovation capability.

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## Notes

1 We consider only the principal motives MOT1 and MOT2 because Argentine firms rarely choose MOT3, MOT4 and MOT5 (see Table 4), taking into account the limitation of the Argentine sample and avoiding methodological problems in the regression results.

## Annex I

### *Test of unidimensionality and reliability coefficients*

<i>Variables</i>	<i>Commonalities</i>	<i>Cronbach's alpha</i>
Motive 1 (MOT1, access to new knowledge and jointly processes of technological development)		0.7
Development of products new to the firm	0.781	
Development of products new to the market	0.572	
Development of technology new to the firm	0.600	
Motive 2 (MOT2, search of new market)		0.6
Commercialisation improvement	0.72	
Access to new market	0.606	
Access to resources	0.716	
Motive 3 (MOT3, sharing risks and reducing costs)		
Motive 4 [(MOT4, R&D complementarities and technical assistance (capacity complementarities)]		0.6
Technological problem solving	0.682	
Joint research	0.657	
Technical assistance	0.646	
Motive 5 [(MOT5, improvements to technological and innovation competency (learning)]		0.6
Improvements to the distribution chain	0.679	
Logistics improvement	0.666	

Note: Total variance explained: 66.6%.



## Annex II

*Correlations matrix of dependent and independent variables*

	1	2	3	4	5	6	7	8	9	10
1 SIZE	1	-0.191	0.155	0.213*	-0.066	0.185	0.219*	-0.004	-0.049	0.014
2 LNANT		1	-0.173	-0.320***	-0.260***	-0.200**	-0.106	-0.141	-0.096	-0.06
3 IBEROEKA			1	-0.066	-0.047	0.208*	0.224*	0.198*	0.264***	-0.068
4 EXPORT				1	-0.123	0.17	0.184	0.121	-0.115	0.047
5 TECHINT					1	-0.183	-0.388***	-0.197*	-0.065	-0.046
6 MOT1						1	0.439***	0.185	0.252***	0.114
7 MOT2							1	0.520***	0.201*	0.197*
8 MOT3								1	0.173	0.254***
9 MOT4									1	0.285***
10 MOT5										1

Note: \*significant correlation at 5%. \*\*significant correlation at 1%.