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RESEARCH JOINT VENTURES: THE ROLE OF PUBLIC RESEARCH INSTITUTES

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In this paper, we identify the main determinants of firms' decision to include public research institutes in their R&D cooperation agreements. To this end, we estimate the probability that they take such a decision by applying a probit model to a dataset on Research Joint Ventures developed under the umbrella of the Eureka initiative, a pan-European programme. These data were gathered from a survey of the main partner companies of individual projects. The results show that the size of the main partner, the search for new relationships, the possibility of sharing costs, the research design and the project's main targets stand out as some of the main explanatory variables in the model.

Keywords: University-industry partnership, Research Joint Ventures, R&D, Eureka.

(*JEL* L31, O31)

1. Introduction

For more than twenty years, governments have acknowledged the importance of innovation and development of new products and processes as one of the key engines of growth. This has led them to authorize, and even promote, R&D agreements among companies, a priori banned by antitrust legislation. As a result, both the United States and the

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European Union have launched programmes aimed at supporting cooperative agreements in R&D, that is Research Joint Ventures (RJV). An RJV is an agreement whereby partners (companies and/or other public or private entities) decide to coordinate their research and development activities in a joint project, and to share, to some degree, the knowledge derived from this common effort, while continuing to compete against each other in the products market.

Several theoretical papers model firms' behavior and their incentives to take part in an RJV. D'Aspremont and Jacquemin (1988) and Kamien, Müller and Zang (1992) show that RJVs facilitate the internalization of technological spillovers and permit R&D cost sharing. Additionally, asymmetries in size (Petit and Towlinsky, 1999) and whether the research paths are complementary or substitute (Katsoulacos and Ulph, 1998) affect firms' decision when forming an RJV.

Finally, the business literature has added some additional insights on the formation of RJVs. In short, firms' incentives to join an RJV are also affected by their individual capabilities to appropriate research results. This absorptive capacity is determined by factors like size and past research behavior, as well as corporate culture (Kogut, 1991).

By contrast to this fairly large theoretical literature, there is a limited number of empirical papers concerning firms' participation in RJVs, mainly due to the generalized lack of data and the unobservable character of some key variables identified in the theoretical literature. Special mention has to be made of Röller, Tombak and Siebert (1999) that analyze the probability that two companies form an RJV, and Cassiman and Veugelers (2002) and Hernán, Marín and Siotis (2003) that analyze a company's decision to participate in an RJV.

There is an interesting aspect of RJVs that has been barely studied, both from the theoretical point of view and at the empirical level, which is the frequently observed joint participation of firms and Public Research Institutes (PRIs)[1] in this type of projects. These public-private partnerships in R&D have been growing in the European Union (Geuna, 1998) as well as in the United States (Hall, Link and Scott, 2003).

Public research institutes are not private firms and do not fit the profile of a conventional economic agent, that is assumed to take decisions

[1] Throughout the whole paper, we will use the term Public Research Institutes to refer to Universities and other public research centers.

according to competitive criteria. This implies that it is particularly difficult to model the objective function of these organizations and, therefore, their participation decision. Existing models focus on firms' decision to include or not PRIs to their projects, without modeling the latter's decision.

So far, the theoretical results with empirical relevance suggest that companies are interested in introducing PRIs in their RJVs for two main reasons. First, PRIs facilitate monitoring tasks and, therefore, reduce monitoring costs within the RJV (Leyden and Link, 1999). Second, they provide access to complementary research, helping companies to incorporate new technological and scientific knowledge (Cohen, Florida, Randazesse and Walsh, 1997, and Beath, Katsoulacos, Poyago-Theotoky and Ulph, 2002). However, the inclusion of a PRI in an RJV may also have negative effects by increasing appropriability problems since PRIs are more inclined to diffuse knowledge (Leyden and Link, 1999).

From an empirical point of view, this implies that the probability of incorporating a PRI increases with RJV size and with the size of the companies in the project. The first is due to the fact that the inclusion of a PRI increases appropriability problems, but reduces monitoring costs. Since the appropriability problems increase with the number of participants in the project, the additional negative effect of incorporating the PRI decreases with the size of the project. By contrast, monitoring problems increase with the size of the project, increasing the value of the PRI's contribution. Thus, given the remaining parameters of the model, for a certain size of the agreement, the positive (monitoring) effect dominates the negative (appropriability) one. The second part is due to the specific role of the PRI, which consists of helping firms to incorporate new knowledge, and to the fact that the largest companies have a higher capacity to assimilate this knowledge (absorptive capacity).

The objective of this paper is to empirically analyze the determinants of firms' decision to include at least one PRI in their RJV. By identifying the common characteristics of the projects and the companies involved, it is possible to infer the characteristics that make of PRIs usual partners in RJVs. Consequently, we estimate a probit model for the probability that the companies will or will not include a PRI in their R&D agreements, using information from different RJVs formed under the umbrella of the European Programme Eureka. This allows

us to identify a set of variables that influence firms' decision process and their potential effects over the probability of cooperating with PRIs. Our results show that the size of the main partner of the project, the search for new relationships, the possibility of sharing costs, the research design and the project's main targets stand out as some the main explanatory variables in the model.

The remaining of the paper is structured as follows. In section 2 we provide a detailed description of the dataset, the variables to be constructed and the econometric specification. In section 3, we present the results while section 4 discusses the main conclusions.

2. Empirical Methodology

2.1 Data

Our analysis focuses on research projects developed under the Eureka programme. Contrary to EU initiatives, Eureka projects do not receive any direct grant from the European Union, but just a seal of approval that facilitates obtaining public financing from the corresponding national governments. In order to be eligible for this official seal, each project must fulfill only four requirements: 1) be collaborative and involve independent organizations from at least two participant countries; 2) be innovative in the corresponding sector, i.e. aimed at developing a new product, process or service with market potential; 3) result in a significant technological advance in its sector and a marketable product or process for civil use, and 4) participants must be appropriately qualified, technically and managerially, to conduct the project, with access to necessary financial resources.

The dataset was constructed from a survey of European firms involved as main partners in at least one European RJV[2]. Firms had to answer to questions related with their project or projects, with a maximum of three projects per firm. As a result, 500 companies provided response pertaining to 634 RJVs initiated between 1990 and 1998. Fifty per cent of the projects were selected following a population approach representativeness. In these cases, a researcher involved in the study personally interviewed the responsible for the project in each firm. In addition, the questionnaire was mailed to all firms in the population involved as main partner in an RJV project, trying in all cases to

[2] This survey was carried out within the project "Step to RJV" supported by the European Commission TSER programme.

identify beforehand the person in charge for the project inside the firm in order to personally send her the questionnaire. The companies that returned the questionnaire, but were not included in the first group, form the remaining fifty per cent of the sample.

Out of the 634 European RJVs from which we obtained information[3], 117 belong to the Eureka programme[4]. This represents 11.3% of the 1,031 RJVs started under Eureka during that period. Hence, our observation unit is the RJV. The information and opinions registered for each RJV are those expressed by the project manager in the main partner or coordinating entity of the RJV, so we assume them to be representative of the opinion of the remaining partners. Accordingly, the firm level data that we use refers to the project's main partner.

TABLE 1
Distribution of projects by number of partners and participation of PRIs

Number of partners	With at least one PRI		Without PRI		Total	
	No.	%	No.	%	No.	%
2 - 3	20	29	31	66	51	44
4 - 7	23	33	13	28	36	31
8 - 10	9	13	1	2	10	9
11 - 15	9	13	2	4	11	9
16 - 20	5	7	0	0	5	4
More than 20	4	5	0	0	4	3
Total	70	100	47	100	117	100

[3]The 634 European RJVs also include projects inscribed within the EU Framework Programme, and other National Programmes, in which participation of PRIs is highly superior to that registered in Eureka. However, the Framework Programme requires that a minimum number of partners form the RJV in order to grant financial aid, which could have persuaded firms to appeal to PRIs. Similarly, some National Programmes require the explicit inclusion of at least one PRI in the RJV. The reduced predictive power of the models estimated for these non-Eureka programmes evidenced the possible distorting effect of the structure of the grants on the decision to include the PRI. In this sense, the decision on the PRI inclusion is free of distortion in the case of Eureka, and this is the reason that explains why the analysis presented here has been restricted to the projects developed under this initiative.

[4]In some regressions, 88 observations were used since some variables were not available for all the companies.

As can be observed in tables 1 through 4, most Eureka projects started in the nineties, registering a duration no greater than 6 years in most cases, and their size oscillates between two to seven partners in 75% of the cases. On average, projects in which at least one PRI participates (60% of the sample) have more partners, indicating that in many cases the companies consider the PRI as a complementary member rather than a substitute for other firms[5]. By technological area, Environment, Medicine and Biotechnology stand out with a combined weight close to 50%. Also, it is worth noting that, with the exception of Transportation Technologies, all the technological areas register the participation of PRIs in more than 45% of the cases.

TABLE 2
Distribution of projects by Technological Area

Technological Area	Number of RJVs (sample)	% RJVs with PRI	Number of RJVs (population)
Communications	5 (5%)	100%	43 (4%)
Information	18 (16%)	61%	172 (17%)
Medicine and Biotech.	24 (22%)	62%	187 (18%)
Robotics	16 (14%)	75%	172 (17%)
New materials	10 (9%)	60%	112 (11%)
Energy	5 (5%)	60%	51 (5%)
Transportation Technologies	5 (5%)	20%	74 (7%)
Environment	27 (24%)	48%	194 (19%)
Lasers	1 (1%)	100%	26 (2%)
Total	111 (100%)	60%	1031 (100%)

Note: This information is not available for six projects in the sample.

TABLE 3
Distribution of projects by starting date

Period	Number of RJVs (sample)	Number of RJVs (population)
1985-86	1 (1%)	45 (4%)
1987-88	3 (3%)	105 (10%)
1989-90	16 (14%)	141 (14%)
1991-92	12 (11%)	170 (16%)
1993-94	32 (28%)	267 (27%)
1995-96	35 (31%)	295 (29%)
1997-98	14 (12%)	n.a.
Total	113 (100%)	1031 (100%)

Note: This information is not available for four projects in the sample.

[5] This is consistent with the data presented by Leyden and Link (1999).

Tables 2, 3 and 4 present the importance of each technological area, the starting date and the project's duration. In our sample (in parentheses in the first column of each table), these characteristics are reasonably similar to those of the population (in parentheses in the last column). This indicates that the sample used is representative, at least along the dimensions analyzed.

TABLE 4
Distribution of projects by duration

Number of Years	Number of RJVs (sample)	Number of RJVs (population)
0 - 1	17 (15%)	21 (2%)
1 - 2	18 (16%)	147 (14%)
2 - 3	36 (32%)	263 (25%)
3 - 4	13 (12%)	225 (22%)
4 or more	28 (25%)	377 (37%)
Total	112 (100%)	1031 (100%)

Note: This information is not available for five projects in the sample.

The information gathered in the survey is mainly qualitative, and refers to the strategic orientation and the R&D activity developed in a specific RJV in which the respondent firm has participated as main partner, as well as to some managerial and financial characteristics of the company. In particular, information on the type of the RJV partners, the cooperation's objectives, the projects' expected benefits and drawbacks, the organization of the cooperation and the learning mechanisms applied are provided. All qualitative answers were ranked according to a 5 points Likert scale measuring the project's main partner expectations regarding the objective, benefit or specific problem related to the question she was answering. This scale is ordered from 1 for low expectations to 5 for very high expectations.

It is clear that the use of survey data necessarily introduces subjective elements that could distort variables measurement. Indeed, each of the agents that answered the questionnaire on behalf of their company may have interpreted the 5 points Likert scale differently. Unfortunately we do not have a panel of data to control for these firm-level fixed effects.

2.2 Variables

Our dependent variable pertains to the inclusion of a PRI in a given RJV. This variable has been constructed for each RJV from the list of

project members reported in the questionnaire[6]. This variable takes value 1 when there is at least one PRI participating in the projects, and 0 otherwise. Sixty per cent of the projects include at least one PRI among the partners[7].

The information obtained from the survey allows us to construct a set of variables that measure RJVs' characteristics[8]. First, we construct the variable RJVSIZE, which is a headcount of the number of non-PRI participants in the RJV. Leyden and Link (1999) assume that the design of the project is carried out in two stages: first the number of participant firms is decided and second, the decision on the inclusion of a PRI is taken[9]. Within this context, they find that a larger number of participants increases the probability of including a PRI in the project, since in this case appropriability problems caused by the PRI's presence are more than outweighed by its beneficial monitoring role[10].

The second variable suggested by theory is FIRMSIZE that measures whether the main partner is a large firm (with 100 or more employees), in which case it takes value 1, or medium or small, in which case it takes value 0. The question requested firms to report the number of their employees. We expect that large firms are better able to assimilate

[6] These figures have been directly compared to the Eureka database (obtained directly from its web page) to check the accuracy of the survey.

[7] Only firms participating in RJVs filled the questionnaire. To restrict the sample to these companies could generate problems of sample selection if one thinks that the participation of the PRI is a key element in the decision to form the RJV. However, this possibility has been discarded since more than 85% of the projects also incorporate another type of partners.

[8] The questions used to construct these variables are detailed in the Appendix.

[9] This assumption is based on the fact that the PRIs cannot substitute a firm as a partner in the project, but complement it. However, this could be questioned since both decisions could be taken simultaneously. In the next section, we explain the econometric approach used to solve this potential problem.

[10] In their paper, Leyden and Link (1999) carry-out a simple empirical analysis in which they show, in the context of a probit model, that there is a positive relationship between these two variables. However our understanding of their analysis is that when they construct the variable that measures the size of the project they include PRI participants. This introduces a serious problem of endogeneity, which puts a serious question mark on their empirical results. To avoid this problem we construct this variable excluding PRIs in the computation of the partners.

knowledge since they are usually endowed with better laboratories and more qualified personnel[11].

Third, we construct a variable called ALONE based on the question pertaining to the form of cooperation. This variable takes value 1 when only one partner carries out research specific to the RJV, and 0 otherwise. This is likely to arise when the main partner fears that competitors (actual or potential) may gain access to its own knowledge. In such a situation, one would expect companies being reluctant to involve PRIs in the project, since the main task of the PRI would consist in performing part of the research[12].

Fourth, we use a question about the expected outcome of the RJV to construct the variable PROD, which takes value 5 for those projects in which product quality improvements are highly likely. In other words, this variable captures the differential characteristics of a project geared toward product innovations. The degree of appropriability is preeminent among these differences. As Mansfield (1985) points out, it is more difficult to appropriate a product improvement than a process improvement, since the information and visibility associated to a product sold in the market is greater than that related to the alteration of a production process within the firm. The evidence presented by Levin, Klevorick, Nelson and Winter (1987) goes in this same direction. They show that the most effective form of appropriation of a product innovation is a patent, whereas trade secrecy is the chosen option for a process innovation. In addition, as Leyden and Link (1999) suggest, companies more concerned with appropriability issues are more reticent to join forces with PRIs, as the latter have a natural tendency to disseminate knowledge. Thus, it is likely that when the RJV is geared toward a process innovation, collaboration with a PRI may endanger the more effective form of protection, secrecy. By contrast, when the purpose is to develop new products, the decision to include a PRI will not affect appropriability as long as patent protection is effective.

[11] This is consistent with the evidence provided by Cassiman and Veugelers (2002). The same assumption is made in the models of Leyden and Link (1999) and Beath *et al.* (2002).

[12] From the point of view of the decision taking process, one might consider that this is an exogenous characteristic of the project or, alternatively, that the decision on the organization of the cooperation is taken simultaneously to that on the inclusion or not of the PRI. In the next section we explain the econometric approach used to solve this potential problem.

Fifth, firms were asked whether R&D cost sharing was an important motive to join the RJV. This allowed us to construct the variable COST. The latter is discrete and takes values between 1 and 5 according to the importance that the company attaches to this dimension. According to the theoretical literature, this is an important variable when forming an RJV. It, thus, acts as a control but we have no priors as regards its effect on the decision to include a PRI. Public research institutes do not have large budgets to share with private sector agents. Consequently, companies for which the costs of the R&D represent an important obstacle are less likely to be interested in a PRI when looking for partners. However, PRIs rely on highly qualified personnel and technologically advanced facilities, which may not otherwise be available to private firms. In addition, the presence of a PRI in the project can facilitate the awarding of public grants, contributing in this way to cover part of the project costs. Last, the incorporation of a PRI may represent a financial attractive form of sub-contracting compared to setting up laboratories that are necessary to carry out a specific project. In this sense, the presence of the PRI can save the company significant amounts. In summary, the sign of this effect is an empirical issue[13].

Finally, we use a question on the search of new relationships to construct the variable NREL, in order to measure the extent to which the company participated in the RJV to obtain new contacts in its technological domain. In this sense, as suggested by Geuna (1998), the inclusion of a PRI can fulfill a positive signaling role, indicating to outsiders that the company is a partner to be considered for future projects.

Some of these variables, such as the size of the project or the search for new relationships, may be associated with basic science projects for which the presence of a PRI is highly desirable. To control for this effect, we construct the variable BASIC from the question regarding the type of R&D carried out in the project, which can be classified as basic research, applied research or development. Finally, we include dummy variables for the country of origin and the activity of the main partner. The data will determine whether the geographical origin or

[13] Leyden and Link (1999) recognize that the presence of the PRI in the RJV can generate as much costs as extra revenues to the project.

the technological area affect the decision regarding the inclusion of a PRI in the project.

TABLE 5
Descriptive Statistics

Variable	Sample projects Mean (Std. Deviation)	With at least one PRI Mean (Std. Deviation)	Without PRI Mean (Std. Deviation)
PRI	0.60 (0.49)	1.00 (0.00)	0.00 (0.00)
BASIC	0.14 (0.35)	0.16 (0.37)	0.11 (0.31)
RJVSIZE	3.32 (3.54)	3.96 (4.15)	2.38 (2.07)
FIRMSIZE	0.31 (0.46)	0.42 (0.50)	0.16 (0.37)
ALONE	0.26 (0.44)	0.16 (0.37)	0.42 (0.50)
PROD	3.40 (1.27)	3.59 (1.23)	3.09 (1.30)
COST	2.54 (1.24)	2.47 (1.17)	2.64 (1.33)
NREL	2.90 (1.42)	3.17 (1.41)	2.52 (1.35)

Table 5 shows the descriptive statistics for all these variables. Almost all of them present significantly different means depending on the inclusion of PRIs in the project. We observe that, on average, the projects including a PRI involve more participants, more basic research is carried out, the main partner is larger and more emphasis is given to the objective of establishing new relationships. On average, in the projects with no PRIs, there is more concern for costs and a tendency to have only one partner undertaking research. Last, there is no significant collinearity among the variables used in the empirical analysis.

Dichotomous variables were built from the aforementioned discrete variables. Given that all these variables present non-degenerate distributions and that the estimation results with the redefined variables did not improve the predictive power of the model, we decided to maintain the original specification for all of them.

2.3 Econometric specification

The econometric specification is applied to a group of RJVs. Our objective is to identify the variables that make the profits associated with the inclusion of at least a PRI in the project greater than those of not including any. Clearly, we cannot observe the profits associated with these two alternative decisions.

We define the variable PRI as a binary variable that takes value 1 if the project includes a PRI and 0 otherwise, and we estimate the

probability that an RJV includes a PRI. The equation we estimate is the following:

$$\Pr(\text{PRI}_i = 1) = F\left(\begin{array}{c}\beta_o + \beta_1\text{BASIC}_i + \beta_2\text{RJVSIZE}_i + \beta_3\text{FIRMSIZE}_i \\ +\beta_4\text{ALONE}_i + \beta_5\text{PROD}_i + \beta_6\text{COST}_i + \beta_7\text{NREL}_i \\ +\sum_{j=1}^{J}\delta_j\text{COUNTRY}_{j,i} + \sum_{k=1}^{K}\alpha_k\text{AREA}_{k,i}\end{array}\right) \quad [1]$$

where $F(.)$ is the Normal distribution function, and the subindexes i, j and k denote, respectively, the project, country and sector of the main partner in the project.

As mentioned previously, the variables RJVSIZE and ALONE can be part of the design of the project and thus represent a simultaneous decision regarding the inclusion of a PRI. In that case we have to control for endogeneity in order to avoid any undesirable bias in the estimates. In order to test for the exogeneity of these variables, we have applied a Hausman test, comparing the univariate model expressed in equation [1] with an alternative model including instruments for RJVSIZE and ALONE. The results of the test lead to accept the null hypothesis of exogeneity of these two variables.

3. Results

Table 6 reports the results obtained for different specifications of the univariate probit model presented above[14]. These results are consistent for all the specifications and satisfactory in terms of goodness of fit and predictive power. As for the quantitative effects that arise from these results, they should be interpreted with caution given the qualitative nature of the variables.

The coefficient of the variable BASIC is not significant in any of the specifications, thus indicating that the PRI's participation in Eureka projects is not associated with basic research[15]. Moreover, the inclusion of this variable does not affect the remaining coefficients. Consequently, we can reject an explanation of the results in terms of the type of research: basic *versus* applied[16].

[14] Similar results are obtained from a logistic distribution.

[15] Bayona Sáez *et al.* (2000) find similar results when analyzing Eureka projects.

[16] We must recall that participation in Eureka requires the project outcome to be a product or process innovation. That is to say, the basic research component, although present in some projects, is never the only declared aim of the project.

TABLE 6
Univariate Probit. Dependent variable *Pr* (PRI_i=1)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.21	-0.75	-0.80	-0.35	-0.64	-0.45
	(1.68)	(1.40)	(1.47)	(0.40)	(0.55)	(0.32)
BASIC	0.28		0.48	0.46	0.36	0.39
	(0.78)		(0.98)	(0.93)	(0.66)	(0.73)
RJVSIZE		0.07	0.08	0.09	0.06	0.08
		(1.40)	(1.51)	(1.74)	(1.12)	(1.59)
FIRMSIZE		0.80	0.78	0.75	0.88	0.78
		(2.26)	(2.18)	(2.02)	(2.11)	(1.83)
ALONE		-0.60	-0.63	-0.63	-0.83	-0.82
		(1.94)	(2.02)	(1.90)	(2.69)	(2.54)
PROD		0.20	0.20	0.18	0.16	0.16
		(1.82)	(1.85)	(1.67)	(1.44)	(1.33)
COST		-0.24	-0.26	-0.25	-0.28	-0.28
		(1.94)	(2.06)	(2.06)	(2.25)	(2.21)
NREL		0.26	0.26	0.26	0.32	0.33
		(2.12)	(2.17)	(1.99)	(2.42)	(2.27)
Country Dummy	NO	NO	NO	YES	NO	YES
Tech. Area Dummy	NO	NO	NO	NO	YES	YES
Pseudo R^2	0.00	0.22	0.23	0.24	0.30	0.31
Wald χ^2 (d.f.)	0.62 (1)	20.24 (6)	21.90 (7)	28.47 (11)	37.20 (14)	45.41 (18)
No. of observations	117	88	88	88	88	88

Note: *t*-statistics in parentheses in absolute values.
In columns (4) and (6), United Kingdom is the reference country. None of the remaining country dummy coefficients is significantly different from zero.
In columns (5) and (6), Communication is the reference sector. None of the remaining sector dummy coefficients is significantly different from zero.

The coefficient of the variable RJVSIZE is significant at the 10% level only for specification (4). The difference between this result and the one obtained by Leyden and Link (1999) could be due to the inclusion of other explanatory variables such as NREL, that could partially explain the size of the RJV, so that once we control for these factors the variable RJVSIZE loses significance. It could also be due to the problems already mentioned about the possible endogeneity of the variable constructed by these authors. Additionally, none of the country and technological area dummy variables is significant.

The coefficient of the variable FIRMSIZE is very significant and presents a positive sign, supporting the idea that projects with large main partners are more likely to include at least one PRI[17]. As argued by Beath

In this sense, our results suggest that the existence or not of basic research in the project is not a determinant for the inclusion or not of one or more PRIs in the RJV.

[17] This result is consistent with Cassiman and Veugelers (2002).

et al. (2002), a possible explanation is that PRIs constitute an important source of complementarities and facilitate the absorption of information by the companies that collaborate with them. This is also consistent with the idea that large firms are characterized by a substantial absorptive capacity.

As for the ALONE variable, its coefficient is very significantly negative indicating that the probability of including a PRI in RJVs where only one partner does the research is low. A project design in which only one partner investigates is usually incompatible with the presence of a PRI as a partner since the latter's main task inside the RJV is to perform part of the research.

The coefficient associated with the variable PROD is significantly positive, indicating that product improvements are a common purpose in projects involving PRIs. In line with the theoretical discussion, this suggests that, in the case of a process innovation, whose most effective form of protection is trade secrecy, appropriability problems are inflated by the presence of a PRI in the project. Consequently, PRIs will only be accepted as research partners in projects focused on product innovations, since the latter can be protected by patents.

Regarding costs sharing, the significant and negative coefficient of the variable COST indicates that PRIs are not appealing partners when firms need to share R&D costs. This suggests that in our sample the aforementioned "grant effect" does not outweigh the limited capacity to share costs with public centers. Cassiman and Veugelers (1999), who use a group of projects developed under other programmes, report the opposite sign for this variable. This confirms the a priori ambiguous effect of this variable, which ultimately depends on the specific characteristics of each programme, such as the quantity of the grant associated with the inclusion of a PRI[18].

Last, the coefficient associated with the variable proxying the desire to establish new relationships, NREL, is positive and highly significant. This confirms the initial idea that companies with the clear intention of establishing new contacts in the R&D domain are more likely to include a PRI in their RJVs.

With regard to the predictive power of the model, 64% of the 'zeros' and 86% of the 'ones' are predicted correctly, which gives a 77% rate

[18] Marín and Siotis (2002) provide further evidence on how the programme's institutional design affects RJV formation.

of correct predictions, much greater than the 60% of 'ones' present in the sample (which could, therefore, be predicted in the absence of our model).

4. Conclusions

In this paper, we have presented an empirical analysis of the firms' decision to include PRIs in their collaborative research agreements or RJVs. We have identified the projects' underlying characteristics that include at least one PRI among the partners. The empirical analysis has been performed using data from a survey on projects undertaken within the Eureka programme. The results are obtained by applying a probit model to the decision to include or not a PRI in the RJV.

Although the qualitative nature of the data requires caution in quantifying the effects captured by the estimated parameters, it is still possible to derive some clear-cut results. Large companies have more incentives to cooperate with PRIs, probably due to their higher capacity to learn from them. The condition that only one partner can carry out the research, be it due to appropriability problems or to minimize the costs of the project, impedes PRIs participation. This participation is also hindered when research is only directed toward process innovations, since the presence of a PRI can endanger effective protection in the form of trade secrecy. In addition, participation of a PRI in the project is more likely when the main partner of the project wishes to establish new technological relationships, suggesting that it acts as a signaling device for other companies. Moreover, PRIs do not seem to be interesting partners when firms need to share the costs of the project, at least in the context of this programme. Finally, neither the size of the project, measured by the number of non-PRI partners, nor the fact that the RJV has a component of basic research appear to be a key determinant of PRI's inclusion in an RJV.

As we have seen, these results provide partial support for some of the theoretical models' results. They also identify some variables whose links with existing theoretical models are less clear. All in all, this paper's results could contribute to open a path for the development of future theories. It is also true that the empirical results obtained do not perfectly coincide with those found by other researchers that have worked with alternative databases. This induces us to think that the design of the programme under which the project is developed can significantly influence firms' decisions.

Appendix. Questionnaire used to construct the variables

PRI AND RJVSIZE:

Please indicate the number of participants of different entities or types of organizations that belong to each of the following categories in this project:

Type of organization	Number of partners
Public Research Institute	
University	
Supplier	
Customer	
Competitor firm in the same geographical market	
Competitor firm in other geographical markets	
Other firms	
Other entities	

FIRMSIZE:

Financial and corporate data:

	1992	1993	1994	1995	1996	1997
Number of employees						

ALONE:

How was the research activity organized in the project?
(Please mark the right answer)

Organization of the Collaborative Research	
1. Research carried out by a single partner	
2. Research carried in one laboratory with participation of personnel from all the partners	
3. Research carried out separately in different partners' laboratories: i. Doing complementary research ii. Doing parallel research iii. Doing secondary activities in the labs of other partners	

PROD:

Please estimate your company's expectations with this project:

Expectations (1: very little ... 5: a lot)

1	2	3	4	5	Benefits of the R&D
					Improvement of existing products

COST:

Please value your business unit's initial expectations regarding the following objective of the research project:

Expectations					(1: very little ... 5: a lot)
1	2	3	4	5	Project Objective
					Sharing R&D costs

NREL:

Please value your business unit's initial expectations regarding the following objective of the research project:

Expectations					(1: very little ... 5: a lot)
1	2	3	4	5	Project Objective
					Establish new relationships

BASIC:

How would you typify the R&D of this project?
(mark all items that your consider applicable)

Basic Research		Applied Research		Development		

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Resumen

En este trabajo se identifican los principales determinantes de la decisión de las empresas de incluir centros públicos de investigación en sus acuerdos de cooperación en I+D. Para ello se estima econométricamente la probabilidad de que tomen tal decisión mediante un modelo probit utilizando información sobre proyectos conjuntos de I+D acogidos al programa europeo Eureka, a partir de una encuesta dirigida a las empresas involucradas en los mismos como socios principales. Los resultados obtenidos muestran que el tamaño del socio principal, la búsqueda de nuevas relaciones, las posibilidades de reparto de costes y la organización y objetivo de la investigación establecida para cada proyecto, se revelan como algunas de las principales variables explicativas del modelo.

Palabras clave: Cooperación Universidad-Empresa, Research Joint Ventures, I+D.

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