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ABSTRACT

An Empirical Evaluation Of The Determinants Of Research Joint Venture Formation*

This Paper empirically analyses the determinants of firm participation in Research Joint Ventures (RJVs). A review of the theoretical literature highlights the difficulty of identifying a set of testable hypotheses. Using a large database of European RJVs, we estimate two participation equations at the firm level using the logit procedure. We find that sectoral R&D intensity positively influences the probability of forming an RJV. The presence of technological spillovers has a positive effect on RJV formation, but this is restricted to R&D intensive industries. A minimum level of industry concentration is needed for RJVs to be formed. Last, firm size and past experience with research cooperation increases the likelihood of RJV formation.

JEL Classification: C25, L13, O31
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NON-TECHNICAL SUMMARY

Technological competition features prominently amongst the issues addressed by industrial and business economists. Research joint ventures (RJVs) represent an interesting hybrid form between technological cooperation and market competition. RJVs are agreements whereby firms decide to share technological knowledge while, in principle, continue to compete against each other in the product market. Depending on the characteristics of participants in each RJV, the link between R&D cooperation and product market competition can be weak or strong. Firms joining an RJV must perceive participation as being superior to non-participation. The questions thus arise as to why RJVs predominantly attract firms from some specific industries and why, within an industry, *some* firms participate in RJVs, while others do not. The aim of this Paper is to identify the determinants of RJV formation, that is to identify what firm and industry characteristics influence the decision to form an RJV.

Recent theoretical contributions have highlighted the complex mechanisms that underlie RJV participation. In this Paper we make a contribution to fill the gap between theory and empirical testing by making use of a large firm level data set. The data pertains to RJVs formed under the umbrella of the Eureka and EU Framework Programmes, which are both pan-European initiatives aimed at enhancing inter-firm research cooperation. We apply a two step methodology. We first consider the entire population of firms that could potentially participate in an RJV. We are thus able to measure the effect of the relevant firm and industry characteristics that influence RJV formation. In the second estimation, we focus on firms that are known to have a higher probability of forming RJVs. We use the logit estimation procedure, as we can observe if the firms under analysis decide whether or not to form an RJV in a given period, but not their profits under these two alternative scenarios. We find that sectoral R&D intensity positively influences the probability of forming an RJV. The presence of technological spillovers has a positive effect on RJV formation, but this is restricted to R&D intensive industries. Also, a minimum level of industry concentration is needed in order to observe RJV formation. Last, firm size and past experience with research cooperation increase the likelihood of RJV formation. Taken together, these results allow us to derive several policy implications.

1. Introduction

Technological competition features prominently amongst the issues addressed by industrial and business economists. A wide variety of theoretical models have been put forward to analyse firms' R&D decisions. In particular, the importance of technological spillovers is now recognized as an important factor in determining entry, product characteristics, and competition decisions. Within this context, research joint ventures (RJVs) represent an interesting hybrid form between technological cooperation and market competition.

RJVs are agreements whereby firms decide to share technological knowledge while, in principle, continue to compete against each other in the product market. Depending on the characteristics of participants in each RJV, the link between R&D cooperation and product market competition can be weak or strong. For instance, the welfare effect of an RJV will differ depending on whether participants produce market substitutes or complements. In addition, it must be borne in mind that RJVs must fullfil individual participation constraints. That is, firms joining an RJV must perceive participation as being superior to non-participation. The questions thus arise as to why RJVs attract predominantly firms from some specific industries and why, within an industry, *some* firms participate in RJVs, while others do not (Kogut 1989). The aim of this paper is to identify the determinants of RJV formation, that is to identify what firm and industry characteristics influence the decision to form an RJV.

Recent theoretical contributions (Kamien, Mueller, and Zang 1992, Poyago-Theotoky 1995, Katsoulacos and Ulph 1998, Röller, Tombak, and Siebert 1998, Petit and Towlinsky 1999) have highlighted the complex mechanisms that underlie RJV participation. First, these models show that strategic interactions in the product market affect the decision to participate in RJVs. This effect may be direct (depending on the degree of product market complementarity) or indirect (e.g. when RJVs are simply used as a vehicle to enhance the feasibility of product market collusion). Second, RJVs involve the internalisation of technological spillovers, R&D cost-sharing, and the assimilation of knowledge that may be of strategic importance. Third, the degree of size-related asymmetries between firms influences participation decisions. Finally, the research paths (complementary versus substitute R&D) affect the incentives to form an RJV.

To complicate things further, specific public policies towards RJVs have been developed. On the one side, competition law determines the nature of inter-firm cooperation that is legally accepted. On the other side, subsidies are sometimes granted to encourage RJV creation, as these arrangements are believed to have some socially beneficial characteristics, such as the reduction in the duplication of R&D costs.

Given the complexity of the problem, empirical research has been hampered by a two-fold constraint: lack of micro data, and the unobservability of a key number of parameters highlighted by theoretical models (such as the level of technological spillovers or differences in absorptive capacity across firms). As a result, the empirical literature using a structural approach is scarce. To the best of our knowledge, the only contribution that overcomes some of these problems is that of Röller *et al.* (1998). They develop a duopoly model that contains four key indgredients: spillovers, R&D cost sharing, firm asymmetries, and product market complementarities. The effect of the latter two represent an extension of the existing literature.. They show that asymmetries between firms decreases the likelihood of RJVs being formed. Further, complementarity on the product market enhances the likelihood of RJV formation. Note that their analysis focuses on the formation of pairs between firms that are known to have created an RJV. Thus, the question they ask is the following: given that firms have decided positively on participation, which partners do they choose? Using a dataset pertaining to RJVs formed by US firms, they test their model and find empirical validation of their theoretical results. However, they do not address the issue of which firms are more likely to decide on embarking in an RJV in the first place. In addition, their model is framed in the standard duopoly case, in which RJVs are formed between two firms. This implies full spillover internalisation, as the RJV (if it is formed) encompasses the entire industry. Last, the way their control group is constructed blurs the interpretation of some results.

In this paper we make an additional contribution to fill the gap between theory and empirical testing by making use of a large firm level data-set. The data pertains to RJVs formed under the umbrella of the Eureka and EU Framework Programmes, that are both pan-European initiatives aimed at enhancing inter-firm research cooperation. We apply a two step methodology. We first consider the entire population of firms that could potentially participate in an RJV. We are thus able to measure the effect of the relevant firm and industry characteristics that influence RJV formation. In the second estimation, we focus on firms that are known to have a higher probability of forming RJVs. We use the logit estimation procedure as we can observe if the firms under analysis decide or not to form an RJV in a given period but not their profits under these two alternative scenarios. We find that sectoral R&D intensity positively influences the probability of forming an RJV. The presence of technological spillovers has a positive effect on RJV formation, but this is restricted to R&D intensive industries. Also, a minimum level of industry concentration is needed in order to observe RJV formation. Last, firm size and past experience with research cooperation increase the likelihood of RJV formation. Taken together, these results allow us to derive several policy implications.

The remainder of the paper is organised as follows. Section 2 reviews existing theoretical findings, while section 3 describes the econometric specification. Section 4 describes the data and explains how the variables were constructed. Section 5 discusses the empirical results and section 6 draws some policy implications and concludes.

2. Theoretical findings

Most of the theoretical literature on RJVs has been developed recently. Kamien, Müller and Zang (1992), building on an initial contribution by d'Aspremont and Jacquemin (1988), identify two incentives for RJV formation. In their symmetric oligopoly model, R&D cost sharing and spillover internalisation are the drivers behind RJV formation.[1] Vonortas (1994) and Röller, Tombak, and Siebert (1998) extend the model of Kamien *et al.* to cater for cost asymmetries between firms. The general result is that firms of similar size are more likely to form RJVs amongst themselves. In addition, Röller *et al.* (1998) explicitly consider the degree of product market complementarity. They show that firms in complementary industries are more likely to form RJVs. Katsoulacos and Ulph (1998) have extended and refined these contributions by explicitly considering complementarities in *research trajectories* and by analysing duplication in R&D costs. All of these models require contractibility of R&D investment.[2]

It is possible to identify a set of common features that characterise most of these models. Firms' behaviour is normally represented by a three stage game.

[1] See Suzumura (1992) for a refinement of d'Aspremont and Jacquemin (1988).
[2] See Perez-Castrillo and Sandonis (1996) for a detailed analysis of this assumption.

First, firms decide on whether to participate in an RJV. Second, firms realize their R&D investments and, finally, they compete in the product market. The models are solved backwards, which permits identification of the relevant structural parameters that determine RJV participation. The main characteristics of these papers are outlined below.

First, R&D does not lead to drastic innovations that result in the introduction of new products or production processes that shake-out the existing market structure.[3] On the contrary, R&D expenditures lead to smooth and continuous reductions in costs, i.e., there is process innovation. In particular, current variable costs in a given period are a decreasing and continuous function of R&D expenditures in the previous period.[4] This choice precludes the existence of genuine vertical product differentiation in the industry. This is unfortunate as R&D intensive products are typically vertically differentiated.[5] In addition, process innovation takes place in an environment characterised by the absence of uncertainty.[6]

Second, there is imperfect appropriability of own innovations and a fraction of them spills over to rival firms. The latter result in costs reductions for firms that have not paid the cost of the R&D investment. Clearly, the presence of spillovers generates a free-rider problem. Firms face diminished incentives to undertake

[3] For instance, this rules out monitoring technological developments within the industry (technology watch) as a possible motivation for joining an RJV.

[4] The average cost function can be written as:

$$AC = c - F(X)$$

where AC stands for average cost, c is a constant term, and $F(X)$ is an increasing function of own and rivals' R&D expenditures. All models impose decreasing returns in R&D expenditures in order to properly characterise the equilibrium strategies.

[5] Motta (1992) is the only exception. He presents a model of product innovation and vertical product differentiation in an oligopoly. The gains associated with RJV formation imply that a larger number of firms may be sustained in equilibrium. This implies that some of the central results obtain, such as the improvement in profitability and welfare when RJVs are formed.

[6] This hypothesis stands in contrast to the findings of the business literature, where RJVs appear as a mechanism to diversify and insure against the intrinsic uncertainty and riskiness that characterise research activities (Kogut 1991).

R&D, as it will benefit product market competitors. An RJV alleviates this problem, as spillovers are internalized by the consortium. If an RJV encompassing the entire industry is formed, spillovers will be *fully* internalised.[7]

Third, in most models, there is no duplication of costs *neither before nor* after the RJV is formed.[8] Katsoulacos and Ulph (1998) are the exception, as they explicitly treat cost duplication. One of the clear advantages of cooperative ventures is that R&D costs are shared. Cost sharing reduces the amount of R&D that each participating firm must undertake to achieve a given cost reduction, thus enhancing the attractiveness of forming an RJV.

Fourth, symmetry is imposed when there are more than two firms in the industry. One key result derived from this assumption is that in equilibrium, RJVs are undertaken either by all or by none of the firms in the industry. The reasons for this are obvious in the symmetric case of n firms: if one wants to join, all of the industry will behave in the same manner. By definition, this is also the case in a duopoly: if an RJV is formed, it will encompass the entire industry.

Asymmetries are only treated in the context of duopoly models. Röller *et al.* (1998) show that asymmetries are an important determinant of RJV participation. Assuming that size reflects relative efficiency, larger firms may be more reluctant to share economic knowledge with smaller (and less efficient) rivals. By the same token, small firms ought to be particularly eager to enter into RJVs. The idea is simple: small firms have a limited technological capital to share (i.e., little to

[7] Katsoulacos and Ulph (1998) endogenise the size of spillovers within the RJV, reflecting the fact that firms maintain a degree of control on information flows after the RJV is formed.

[8] This is due to the fact that costs reductions resulting from R&D *add* to each other. That is:

$$F_i(X) = x_i + \beta_i \sum_{\forall j \neq i} x_j$$

where x denotes firms' individual R&D expenditures, β is the spillover parameter, and indices denote firms.

lose), and will find participation with large firms attractive as they are potential recipients of spillovers from their larger partners.[9] However, it should be borne in mind that these results obtain because we have a duopolistic market structure to start with. In addition, these findings are not as clear cut as they may seem at first sight. Indeed, size-related incentives to participate in an RJV depend on the *change* in the spillover parameter following the formation of the venture.[10]

Most real world industries are made-up of a large number of asymmetric firms, and RJV formation are rare events relative to the number of firms participating in the industry. The models whereby only a subset of firms within the industry join the RJV, while the remainder stay out and continue to benefit from spillovers, do not provide closed forms solutions. Greenlee and Cassiman (1999) report the simulations of a model in which coalitions are formed. Ex-ante, there are n symmetric firms producing a homogeneous good and facing a linear demand. The authors then analyse how coalitions are formed in that industry. An important ex-post result is that even in the presence of symmetric firms, one seldomly observes a grand coalition, with all firms in the industry joining the RJV, although the latter would maximise overall industry profits.

Last, the nature of product market competition plays a crucial role in determining firms' incentives to participate in RJVs. Most theoretical models assume a certain degree of substitution between firms' outputs.[11] When firms compete in the product market, the cost sharing element and/or spillover internalisation play an important role when determining firms' participation in an RJV. By contrast,

[9] Of course, the way costs are shared could be used to compensate the firm that provides access to a larger pool of knowledge. See Petit and Towlinski (1999) for a formal treatment.

[10] Kesteloot and Veugelers (1997) obtain results in sharp contrast to those of Röller *et al.* (1998) in the context of a dynamic model where they impose no change in the spillover following the formation of the RJV.

[11] Röller *et al.* (1998) and Katsoulacos and Ulph (1998) are an exception, as they also consider complementary products.

firms not competing in the final market ought to have fewer qualms regarding the sharing of technological knowledge. In the extreme case of perfect complementarity, firms have a strong incentive to maximize inter-firm knowledge flows (Katsoulacos and Ulph 1998).

The literature and results reviewed above are conditional on the implicit assumption that firms do not join RJVs for strategic reasons. For instance, an RJV could be used to soften competition, strengthen a dominant position, gather strategic information, or as a vehicle to coordinate behaviour.[12] It may also be the case that a firm enjoying a dominant position on its market participates in an RJV in order to consolidate its position and/or pre-empt the development of technology that could displace it from its leadership position.[13]

The business literature provides additional and useful information regarding RJV formation. It stresses that firms have different absorptive capacities of research results, which in turn determine their willingness to form RJVs. The absorptive capacity of each firm is determined by factors such as size, past experience with research cooperation, corporate culture and business line of activity.

Summing up, theoretical models identify a set of relevant variables that may influence RJV formation such as spillover internalisation, cost sharing, firms asymmetries, and product complementarities. Unfortunately, some of these variables are not directly observable, and most of the theoretical findings depend on the underlying market structure and/or parameter constellation. In short, there are no clear cut results that can be drawn from the theory. Still, these models provide some guidance and useful insights for constructing our empirical model and

[12] Both in Europe and the US, the legal framework applicable to RJVs recognises that these agreements might be used as a vehicle for collusion. For instance, in EU law, a distinction is established between "concentrative" and "cooperative" joint ventures. See Neven *et al.* (1998) for a thorough economic and legal analysis.

[13] This would be an instance of RJV participation aimed at generating a "technological foreclosure" effect.

interpret the results.

3. Econometric specification

A firm will join an RJV if its expected profits are larger than those it would obtain staying out of the RJV, given the behaviour of industry rivals. In asymmetric contexts, this should lead to an equilibrium in which some firms opt for RJV participation, while others decide to stay out, which is what is observed empirically.

The economics and business literature reviewed in the previous section identify a set of variables, represented by the vector $z_{i,j,t}$, that affect firms profits and how they may change following the creation of an RJV. Accordingly, a firm will join an RJV if:

$$\Pi(z)^{in}_{i,j,t} - \Pi(z)^{out}_{i,j,t} > 0 \tag{1}$$

where $\Pi^{in}_{i,j,t}(z)$ and $\Pi(z)^{out}_{i,j,t}$ represent the expected flow of discounted profits associated with each strategy for firm i in industry j at time t, given the strategy profile of its rivals. The first hurdle that we face is that the theoretical models reviewed above can provide limited information for interpreting our results since most of their variables are not directly observable and in many cases they lead to contradictory predictions.

Firms for which (1) does not hold will decide against RJV participation. Profits associated with each strategy (joining an RJV or staying out) are not simultaneously observable. Thus, the only information we have is whether firm i has joined an RJV at time t. Nevertheless, assuming rational behaviour on the part of firm i, we have

$$\Pr(RJV_{i,j,t} = 1) = \Pr(\Pi(z)^{in}_{i,j,t} - \Pi(z)^{out}_{i,j,t} > 0) = \Pr(\beta z_{i,j,t} + u_{i,j,t} > 0) \quad (2)$$

where $RJV_{i,j,t} = 1$ signifies that firm i joins the RJV, $RJV_{i,j,t} = 0$ that it does not, and β is a vector of parameters. The $\Pr(RJV_{i,j,t})$ can be estimated as a univariate logit or probit model.[14]

Practically, we need to construct a set of variables that measure or proxy the theoretical determinants identified in the models, and explicitly spell out testable hypotheses. More precisely, we need a measure pertaining to firm size, an index of market concentration, measures of industry R&D intensity, and industry specific proxies for the extent of spillovers, all of which form the elements of $z_{i,j,t}$. In addition, for some firms, willingness to join an RJV may be influenced by past experience with RJVs. This may reflect the success or failure of past ventures, the existence of once-for-all fixed costs associated with RJV formation, as well as a learning process in achieving successful cooperation. Last, the origin of firms may introduce a country specific effect. Indeed, it seems that national idiosyncracies influence the attitude of firms towards formal cooperation (Nelson 1993).

The variables that we include in the regressions are as follows:

To control for differences in the extent and magnitude of potential cost reductions across industries, we include R&D intensity at the level of the industry. All else equal, costs reductions resulting from a successful RJV will be more important in R&D intensive industries, thus affecting firms' incentives to join in the first place. This cost reduction effects positively influence firms willingness to form an RJV.

[14] Provided that some firms join more than one project in a given period, an alternative approach is to estimate a multinomial logit, which control for the number of projects joined by the firm in that period. We have carried on such exercise and the results obtained are highly consistent with those presented here.

To measure differences in the importance of spillovers across industries, we constructed a proxy based on data taken from Mansfield (1985) which measures the speed at which innovations -unwillingly- diffuse within an industry. This variable acts as a proxy for the "spillover lag". Another concurrent interpretation pertaining to this variable is that it reflects the importance of lead time in R&D intensive industries.

In the case of an asymmetric oligopoly, internalisation of spillovers via RJV formation is greater the smaller the number of rivals in that industry segment. We therefore constructed the Hirshman Herfindhäl index (*HHI*) for each industry, and expect this variable to appear with a positive sign. Note that this variable also generates information as to whether firms join RJV to reduce the toughness of actual or potential competition.[15] Both the spillover and market power motives go in the same direction. Given that we are attempting to explain firms' decisions with respect to hypothetical RJVs, this variable pertains to concentration in the industry in which the firm operates, not to the RJV project itself.

To represent asymmetries across firms, we introduce a measure of firm size.[16] According to most oligopoly models for homogeneous products, size differences within an industry reflect differential efficiency.[17] Also, if there are fixed costs

[15] In the previous section we mentioned that RJV formation may be driven by motives that have little to do with innovation as such. While not treated formally, anecdotal evidence of firms joining RJVs to pre-empt entry or block the development of a rival technology suggest that this does occur in practice. All else equal, this will tend to happen more often in concentrated industries.

[16] Instead of absolute size, we experimented with market share. The essence of the results was the same. We opted for absolute size for the following reasons: market share is correlated with our measure of concentration (an *HHI* index), and absolute size generates information of its own. If there are important fixed costs, size will matter irrespective of the industry. In addition, given that the theory does not provide clear cut results on whether large firms will team with other large firms (as opposed to joining smaller partners), the market share variable may pose difficulties of interpretation.

[17] Most RJV models represent competition in the third stage of the game as quantity Cournot competition. One of the basic results of this model is that firms' market share within the industry are inversely related to their marginal costs, i.e., directly related to their efficiency.

associated with forming RJVs (such as paper work and/or the establishment of specific facilities), large firms may be more willing to join, as they can spread these costs across a larger volume of sales. In addition, size is likely to be highly correlated with "absorptive capacity", thus increasing the likelihood to join. It may also be the case that size may influence the public authority responsible for these programmes. This may possibly result from exogenous preferences "for" or "against" big business, or a process of regulatory capture.

Last, we include a set of control variables such as the country of origin of the firm, and a variable indicating the number of times the firm had participated RJV projects in the past.[18]

Accordingly, the expression to be estimated (that is expression (2)) can be written as:

$$\begin{aligned}\Pr(RJV_{i,j,t}) &= \beta_0 + \beta_1 \; R\&D \; Intensity_{j,t-2} + \beta_2 \; Spillover \; lag_j (3) \\ &\quad + \beta_3 HHI_{j,t-2} + \beta_4 \ln Firm \; size_{i,t-2} + \beta_5 Experience_{i,t} \\ &\quad + \gamma_k \sum_{k=1}^{K} Country_{k,i} + u_{i,j,t}\end{aligned}$$

the sub-indices i, j and t, denote firm, sector, and time respectively. We have lagged our independent variables by two periods in order to eliminate endogeneity problems from our estimation. The variable *Firm size* is included in log form in order to account for non linear effects. The probability $\Pr(RJV_{i,j,t})$ can be estimated using a logit or probit model.

We estimate two different versions of (3). First, we construct a database containing the population of firms joining at least an RJV in period t, and a control group of similar size made-up of firms that did not join any RJV in period t. This

[18] See next section for a description of how these dummies were constructed, and an explanation for their inclusion.

control group is randomly selected from the total population of firms. Clearly, the proportion of firms joining an RJV in our constructed database is much higher than its true population counterpart. This introduces biases in the estimation process. In order to solve this problem, and given that we know the population proportions, we use a weighting variable during the estimation to scale down the proportion of $RJV_{i,j,t} = 1$. This procedure also involves a correction to obtain the correct asymptotic covariance matrix.[19] In short, our results are estimated in a manner that explicitly corrects for the difference between the characteristics of our sample on the one hand, and those of the true population on the other.[20] This exercise is particularly demanding, since the firms forming RJV are very few with respect to the total population, which itself contains very heterogeneous firms.

In our second exercise, we restrict our population to those firms that have a high probability of forming an RJV. The objective of this exercise is to better identify the determinants of RJV formation by focusing on a sub-set of firms that have a higher propensity to form RJVs. We define these firms as those that had joined at least an RJV any time before period t. Thus, we analyse the probability that one of these firms joins a new project in period t. In this case, we can work with the whole population which includes only 1,042 firms. We estimate the $\Pr(RJV_{i,j,t} = 1 \mid RJV_{i,j,t-k} = 1)$, $\forall k > 0$ and interpret the results accordingly. Notice that firms that joined an RJV at period t but did not joined any before are excluded from this regression. The advantage of this twin track approach is that it allows us to check the robustness of our results. Moreover, it permits a more accurate interpretation of the effects unearthed by the two separate estimations.

[19] See Manski and McFadden (1981) for a detailed explanation of this procedure.

[20] There are two more alternative solutions to the small population size of firms actually joining an RJV. First, we could use the whole population (more than 200,000 firms). Second, we could sample the true population maintaining the relative size of the two groups of firms. The first is unfeasible because of tractability problems associated with such a large data set. The second would imply losing relevant information on characteristics of the firms that join an RJV.

4. Data and construction of the variables

4.1. The data

The set of RJVs which are analysed in this paper are retrieved from the "STEP to RJV" database, constructed as part of an EU financed TSER project. These RJVs have been formed under the umbrella of either the Eureka Programme or the EU Framework Programme for Science and Technology (EU-FP in the remainder of the paper). Eureka was launched in the mid-eighties as a pan-European initiative aimed at enhancing cross-border technological cooperation. Obtaining the Eureka label does not entitle firms to European subsidies (it should also be noted that Eureka is not an EU programme). However, obtaining the Eureka "seal of approval" enhances firms' ability to receive subsidies from their respective national authorities. RJVs formed under EU-FP programmes are eligible for a subsidy, which varies according to the nature of the project. Information on these projects has been retrieved from CORDIS (an EU database which centralises information on all EU financed projects in a raw format).

Table 1 depicts the total number of projects involving a firm from a given country, the geographical origin of firms participating in RJVs, and the average number of firms of the same nationality participating in a given project. The data pertains to projects for the period 1986-1996.

< Insert Table 1 about here >

There is a high correlation between number of projects, average number of participants of the same nationality, and country size. This should come as no surprise; nonetheless, some interesting patterns emerge. For instance, while German and French firms appear keen to participate in EU-FP projects, most of these cooperations involve compatriot firms. This tendency is even more marked for Eureka, since the figure is larger for Eureka than EU-FP for almost all countries. This may be taken as an indication that despite the programmes' declared objective of fostering pan-European cooperation, many of the projects are still national. Firms of non-EU origin tend to be keener to participate in Eureka. This is the case of Norway, Switzerland, Poland, Sweden, and Finland (the latter two countries were still not part of the EU). Last, the average size of EU-FP projects is larger (7.15 firms per project) compared to Eureka projects (5.8 firms).

Our data set is constructed using three separate sources. First, we use data on individual Eureka and EU-FP RJVs. In both cases, we have a brief description of the project, a sectoral acronym, and the name of the participating firms. Some projects were launched in the mid eighties, but the bulk of them were initiated in the nineties. We have data on RJVs till 1996.[21] Table 2 presents the number of projects initiated during six two-year sub-periods. The figures are increasing with time for both EU-FP and Eureka projects. Notice that the EU-FP involves a much larger number of projects for all the years during which the two programmes co-exist.

< Insert Table 2 about here >

Throughout the construction of the sample, we used a four-digit sectoral breakdown. It would have been preferable to work at eight digits, but some of the data were not available at such a fine level of aggregation.[22] The nomenclature used is that of the British Central Statistical Office (CSO). A word is in order on the

[21] Our data does not contain all RJVs, as some of them may take place outside the framework of the EU programmes or Eureka. We are nonetheless confident that our sample contains the bulk of cross-border RJVs. The reason is the following: Once the costs of establishing a cross-border cooperation have been incurred, the additional outlays associated with gaining an EU subsidy, or the Eureka seal, are minimal. By contrast, the gains are important, as they may involve substantial subsidies.

[22] Since we are using three different sources of information, the same nomenclature must be available from the three sources.

composition of these RJVs. While some RJVs in our sample a clearly vertical (involving business units in different sectors), most of them involve at least two firms operating in the same market segment. Table 3 provides the sectoral affiliation of participating firms. As can be readily seen, firms belonging to the information technology and aerospace clusters represent the most important contingent. This is followed by environmental and energy technologies.

< *Insert Table 3 about here* >

Table 4 presents the distribution of the projects' duration; it emerges that the two sub-samples differ substantially along this dimension. About a third of Eureka projects have a duration of four years or more. By contrast more than three quarters of EU financed projects last between one and three years.

< *Insert Table 4 about here* >

Table 5 provides information on the number of participants by project. In the case of EU-FP projects, the distribution is fairly even, with a peak for projects containing four to seven participants. By contrast, Eureka projects involve, on average, fewer participants.

< *Insert Table 5 about here* >

The second source of information pertains to participating firms. We retrieved this data from Amadeus, a database produced by Bureau Van Dijk, a specialist provider of firm-level data based on balance sheet information. The total number of entries exceeds 200,000 firms, with detailed information on ownership structure, and a fine sectoral affiliation (up to 8 digits). Geographical coverage pertains to Europe (including Central and Eastern Europe). To our knowledge, Amadeus is the most comprehensive source of firm level data in Europe. We retrieved the relevant information on firms that appear both in Amadeus and in our RJV database, and dropped firms which had formed EU-FP or Eureka RJVs, but for which no data was available in Amadeus. We retrieved unconsolidated balance sheets in order to make use of data pertaining to the relevant business establishment. We have been extremely careful in identifying the relevant business unit, as many conglomerates participate in these RJVs.[23] The final sample consists of 1,042 firms that had participated at least once in a project.

These firms are those that have decided to join an RJV during the period 1986-96. Given that information on firms and industry characteristics only span the period 1991-1996, and some of the independent variables may be endogenous to the model, we construct our dependent variable for the period 1995-96.[24] This allows us to deal with possible issues of endogeneity by using lagged values for the independent variables (i.e., pre 1995 values).

As mentioned above, for our first econometric exercise, it is necessary to form a control group with firms that have not joined an RJV during the period under study. We assumed that Amadeus, with more than 200,000 European firms, was a fair representation of the true universe. Accordingly, once we knew the number of firms joining an RJV during the period 1995-96, we randomly selected a sample of a similar size from Amadeus. The sectoral and geographical distribution of these firms replicates that of the assumed universe. For the second econometric

[23] The presence of large, multi-product firms, poses a problem. Suppose that ABB participates in an RJV in semi-conductors. The relevant business units are the ABB subsidiaries that appear with this product as their main business line at the four-digit level. Taking the consolidated, worldwide accounts of the ABB group would make no sense, as the associated data for ABB's participation in that joint venture would include data (e.g., on employees, sales, etc...) which have nothing to do with the project. This proved to be more than a minor problem as many large multi-product firms participate in RJVs. We thus had to be very careful in retrieving unconsolidated data for the relevant subsidiaries of these large groups.

[24] Throughout the remainder of the text, one period refers to two years.

exercise, it is not necessary to construct a control group, given that the population is made-up of firms that had joined an RJV before 1995.

The third source of information we use is the Worldscope database. The latter provides R&D expenditures for about 1,500 large firms. The data is available for the period 1991-1996 at the SIC four digit level of aggregation, which we converted into their CSO equivalent using detailed conversion tables.

4.2. The variables

To construct the variables, we take four digit sectors and Europe as representing the relevant market. Our independent variables were constructed as follows:

R&D intensity or *R&D expenditures/Sales:* for each industry, we take the weighted R&D intensity, calculated as total R&D expenditures over total sales, reported by firms belonging to that four-digit sector.[25] We retrieved this data from Worldscope.

Spillover lag: this variable is taken from Mansfield (1985). It measures the speed at which knowledge about an innovation diffuses within an industry. It refers to both product and process innovation and is measured as the average number of months before the diffusion of an innovation in the industry.[26] The information is available at two to four digits, depending on the industry. We

[25] In addition to sectoral R&D, we would have liked to use firm level R&D intensities. However, Worldscope only contains a few matches with the firms found in our RJV database, thus greatly limiting sample size.

[26] Mansfield (1985) provides survey information for R&D intensive industries. Our sample also contains firms belonging to sectors which undertake little or no R&D. For the sectors for which no data is provided by Mansfield (1985), we assumed that diffusion is immediate, i.e. we gave value zero to this variable for these sectors. The logic behind this choice is the following: when R&D intensity is low, this implies that there are few opportunities for technological improvement, and/or that appropriability is extremely weak. From a formal perspective, this is equivalent to assuming that diffusion is immediate, thus eliminating incentives to undertake R&D. Nonetheless, as this choice may appear as arbitrary, we re-ran all our estimations limiting ourselves to observations for which information on spillovers was available. We also estimated our equations excluding the spillover variable. The results are identical for the spillover as well as the remaining variables, indicating that none of them was driven by this coding choice.

assigned values for this variable accordingly (for instance, in some sectors, we have a perfect correspondence; in others, we assigned the value associated to the higher level of aggregation for which the spillover variable was available).

Market concentration: we constructed the Hirschman-Herfindhäl index (HHI) for each four-digit sector present in our sample. The *HHI* is defined as:

$$HHI_j = \sum_{i=1}^{n} (Market\ Share_{i,j})^2$$

Where n is the number of firms in that four digit sector.[27] The value taken by the *HHI* is the average for the 1991-94 period. Recall that the database is formed by firms, not RJV projects.

Firm size: we use the natural logarithm[28] of the number of employees for each firm in our sample. This measure is fairly stable over time. We have taken firm level averages for the 1991-94 period.

Experience or *past participation:* Practitioners and the business literature stress that some firms are keener to cooperate than others as a result of differences such as corporate culture. It is also stressed that past cooperation with other firms may make it easier to repeat the experience (with the same group of firms, or new partners). We have thus constructed a "quantitative" variable that takes into account the cumulated number of past participations for the period 1986-92. This variable also provides information on the success of these programmes (in terms of firms' willingness to take part in them).

Given that accepted projects receive a "seal of approval" by public authorities in the case of Eureka, and a subsidy for EU-FP projects, we constructed country-of-origin dummies for each firm.[29] The data will itself reveal whether geographic

[27] The sectoral HHIs are defined over the entire Amadeus database.

[28] Taking the log reflects the fact that the effect of firm size on participation is non-linear, as it decreases as firm size increases.

[29] Once the Eureka label has been granted participants may turn to their national authorities for funding. Evidence shows that most projects end up receiving subsidies.

origin is an important determinant behind the decision to approve a project. Last, the dependent variable takes value 1 if the firm has participated in an RJV initiated during the period 1995-96 and 0 otherwise.

We feel that our specification and definition of variables present a twin advantage. On the one hand, the variables that we include have a link with the theory, and thus shed some light on the issues raised by formal models. Second, the empirical model is parsimonious, thus permitting a straightforward interpretation of the results.

5. Econometric results

Table 6 presents the results of estimating (3) using the logit estimation technique. We recall that our estimation techniques adjusts for the differences between the characteristics of the true and sample populations. The estimation contains industry variables (R&D intensity, the spillover lag and concentration), and firms specific variables (size and past participation in Eureka and EU-FP projects). The industry variables are defined at the four digit level of the CSO nomenclature. Last, we included country dummies, with Denmark as the reference country.

< Insert Table 6 about here >

The overall fit of the regression is quite good, with a log-likelihood ratio that is significant at less than the 1% level. The success index measures the proportion of outcomes that the estimation would predict correctly if the population was split evenly between the firms joining an RJV and those staying out. In this sense, this index measures the improvement over chance, that is the results that would be obtained with a random procedure. The success index for this first exercise stands at 70%, which is quite satisfactory. It should be noted that this exercise is quite demanding, since we work with a representation of the entire universe, of which less than 0.5% of firms join RJVs. This is shown in the small size of the marginal effects. As mentioned above, we tried alternative specifications. The results appear very robust to the choice of specification (for instance, introducing country dummies does not affect the estimates of the other coefficients).

As expected, sectoral R&D intensity appears with a positive sign, and it is significant at less than the 1% level. This reflects the fact that an RJV is an attractive option for projects involving large R&D outlays because of the cost sharing element.

The point estimate associated with the spillover lag is negligible, and nowhere near being significant. This may imply that this variable is irrelevant with respect to RJV formation. An alternative explanation is that, since our control group contains many observations belonging to sectors which undertake no R&D, pure noise prevents this variable from revealing its significance.

An industry's *HHI* reflects the degree of concentration, or conversely, the extent of fragmentation. The less fragmented is an industry, the easier it is to identify the appropriate partners to form an RJV. In addition, a more concentrated industry offers greater scope for effective internalisation of spillovers. The coefficient is positive and significant at the 10% level, lending support to the arguments presented above. Note that while the variable spillover lag acts as a proxy for the presence of spillovers at the industry level, concentration captures the potential for internalising them within an RJV.[30]

Before turning to firm specific variables, a comment is in order. Given that our control group has the same composition as the population, it is not clear whether

[30] We also attempted to identify a possible multiplicative effect by introducing the product of these two variables. This interaction effect did not prove significant, nor did it affect the other coefficients. Thus, it was dropped from the final specification.

industry R&D intensity and concentration represent the existence of threshold rather than continuous effects. For instance, it could be the case that some minimum level of industry R&D intensity must be reached before RJVs become attractive options, and for values above that threshold, R&D intensity becomes irrelevant. The same applies to concentration. As will be seen below, the second estimation sheds some light on these issues.

The coefficient associated with firm size is positive and highly significant. There is a number of (non-exclusive) explanations for this finding. First, it may reflects the fact that, given the degree of concentration, large firms prefer to form RJVs with other large firms to maximise spillover internalisation. Röller *et al.* (1998) provide theoretical results pointing in that direction. Second, this may be an indication of significant fixed costs associated with RJV formation, such as the establishment of specific facilities (e.g. a new R&D lab), or the administrative and negotiation efforts necessary to reach agreement with partners and/or the sponsoring organisation. *Ceteris paribus*, large firms in an industry will have a strong incentive to participate in many RJVs in order to monitor innovative activity in their segment (a sophisticated form of "technology watch").[31] Third, for inter-industry RJVs (that is RJVs which involve technological complementarity), firms will be keen to cooperate with the largest -and more efficient- firms in the complementary industry. Fourth, the positive coefficient associated with firm size may reflect an exogenous preference for "big business" on the part of the sponsoring organisation, or a process of regulatory capture.[32]

The coefficient capturing past participations in Eureka or EU-FP projects is significant at less than the 1% level in both cases. There are two non-exclusive

[31] By definition, the largest firms -which are also the technology leaders- have most to lose from the emergence of new, technologically advanced, rivals.

[32] As it is necessary expand resources (e.g. lobbying) to achieve effective capture, large firms are typically in a better position to achieve these ends.

explanations for this finding. First, it may reflect the fact that a large part of the fixed costs associated with RJV formation have to be paid only once. Thus, having already paid these costs, firms' marginal cost of launching a new venture may very well be negligible. Second, the positive sign may be an indication that there is an important learning process in achieving successful cooperation.

In this first exercise none of our country effects proved to be significant. Thus, while we have kept the dummies in the estimation presented in Table 6, we do not report the point estimates.

In our second estimation, our control group is made of firms that had participated in at least one project before period t. We are thus restricting ourselves to a subset of firms and sectors for which RJV formation is more likely to be observed. Carrying out this second estimation provides some indication of the consistency and robustness of the results across the two specifications. In addition, comparison of the two sets of results may shed further light on the interpretation of the coefficients. The exogenous variables are the same as those in the previous exercise. The results are presented in Table 7.

As before, the overall fit of the regression is good, with a log-likelihood ratio that is significant at less than the 1% level. Moreover, the success index stands at a respectable 71%. Overall, the results are consistent and robust across the two specifications.

< *Insert Table 7 about here* >

Industry R&D intensity remains positive and significant, indicating that this variable picks up more than simply a threshold effect. It is also more significant than in the previous exercise.

The spillover lag variable is now significant and of the expected sign. This confirms our prior that spillovers are important, but only in R&D intensive industries (which make-up the bulk of sectors present in this second exercise).

By contrast, the *HHI* index appears with a positive sign, but is no longer significantly different from zero. There are two alternative explanations for this. The first is that there is only a threshold effect: above a minimum degree of concentration, this variable becomes irrelevant in influencing RJV formation. Alternatively, there may exist a non linear relationship in the form of an inverted U-shaped curve. For instance, increases in concentration may facilitate internalisation of spillovers up to a point. Thereafter, increasing concentration may start having a negative effect on RJV formation because of acute rivalry amongst firms, or because anti-trust authorities start objecting to their formation.[33] To test this hypothesis, we re-ran our regressions using a specification aimed at identifying this effect. However, the results did not prove conclusive.

As previously, past experience has a strong, positive, and significant effect on the probability of forming an RJV. The interpretation is the same as before.

In this second exercise, the information provided by marginal effects is as follows. For each of our variables, going from the 10th to the 90th percentile increases the probability of joining by 25% for R&D intensity, by 1% for the HHI, by 45% for firm size, and falls by 13% for spillovers. In addition, one extra past experience in EU-FP increases the probability of joining by 26%, and one in Eureka by 6%.

In this second exercise, the country dummies for France, Germany and Italy proved to be significant, and the dummy for the UK is "almost" significant[34] (with

[33] In the extreme case of a monopoly, there no room for an RJV. In less extreme cases of oligopolistic dominance by a few firms, the EU Commission is likely to block any agreement (even research ones) that may have an adverse impact on product market competition. There are indeed a few cases were firms had to modify their proposed agreements to abide with competition rules. Anticipating this, firms are less likely to attempt the formation of an RJV in highly concentrated industries.

[34] It is significant at the 15%, but not at the 10% level.

Denmark as the reference country). The fact that three significantly negative dummies refer to large countries should not come as a surprise. Firms in these countries find it easier to find partners within their borders.

6. Conclusions and policy implications

This paper identifies the characteristics of firms that tend to form RJVs. To this end, we identified a set of relevant variables from existing theoretical models. Both our industry and firm specific variables appeared with the expected sign, and in most cases, are significant. More importantly, both regressions proved to have substantial predictive power, and the results are robust and consistent across the two specifications. The first finding is that -not surprisingly- RJVs are found in R&D intensive industries. The effect of this variable is not a threshold one. Second, spillovers are an important determinant, but their impact only emerges once the we restrict ourselves to intensive R&D industries. Third, concentration has a positive effect on the probability of RJV formation, possibly because it facilitates spillover internalisation and reduces the intensity of competition. For this variable, there may be a threshold effect or a non-linear relationship after a critical point. Firm size appears as very significant in all specifications suggesting that RJV formation is primarily a large firm phenomenon. Last, past experience in research cooperation greatly enhances the probability of forming a cooperative venture.

The policy implications of these findings can be summarised as follows. From our estimations, it emerges that RJVs are the domain of large firms. While it may partially reflect exogenous preferences and/or capture, the finding is robust enough to suggest that absolute size facilitates RJV formation. This is consistent with some theoretical results (Röller *et al.* 1998), and is intuitively appealing as

RJVs probably involve large fixed costs. In addition, large firms have been identified as having a greater capability to successfully absorb technology. From that perspective, attempts to increase the proportion of small firms in EU sponsored RJVs seem justified.[35] It also appears questionable whether large firms need a subsidy to be induced into forming RJVs.

It also seems that competition authorities do well to monitor cooperative agreements in research activities, as those are found in more concentrated industries. As long as RJVs are formed to internalise spillovers and share costs, this should not be too much of a concern. However, the fact that RJVs may be used as a device to reduce actual or potential competition warrants attention, given that they are found in concentrated activities.

The sign and significance of the "past experience" variable indicates that firms appear as satisfied with the RJVs, as they show a clear willingness to repeat the experience. It also reflects that there are strong fixed costs and learning effects associated with an RJV. Combining this finding with that on absolute firm size suggest that a possible avenue to enhance small firm participation is to cover a substantial part of the fixed costs for small first-time participants.

The picture that emerges from country effects is encouraging as there seems little bias associated with the origin of firms. When the latter is present, it works against firms originating in large and rich countries, which have often been perceived as receiving a disproportionate part of EU funds. Of course, this conclusion may only apply to the topic of this paper, namely RJVs. In addition, EU authorities have adopted a stance of "positive discrimination" in favour of firms from the "periphery" (Greece, Ireland, Portugal, and Spain). This policy has been criticised at times as unnecessary or even counter-productive. Our results suggest

[35] The European Parliament has repeatedly asked the EU Commission to increase the participation of small firms.

that, in the best of cases, the policy has achieved its aim of generating a "level playing field" with regard to RJV formation, as the country dummies for the periphery do not appear with negative and significant signs.

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Table 1. RJV participation by country.

Country	EU-Framework Programme					Eureka				
	Projects		Firms		Average no. of local firms per project	Projects		Firms		Average no. of local firms per project
	No.	%	No.	%		No.	%	No.	%	
Austria	265	6.8%	167	1.7%	1.25[1]	122	11.7%	154	3.7%	1.80
Belgium	872	22.5%	482	4.9%	1.48	128	12.3%	141	3.4%	1.46
Czech Republic	5	0.1%	5	0.1%	1.00	25	2.4%	27	0.7%	1.52
Denmark	632	16.3%	335	3.4%	1.43	129	12.4%	128	3.1%	1.49
Finland	393	10.1%	190	1.9%	1.35	121	11.6%	160	3.9%	2.13
France	2,196	56.7%	1,490	15.3%	2.05	367	35.3%	653	15.8%	2.78
Germany	2,313	59.7%	1,694	17.4%	2.02	373	35.9%	604	14.6%	2.48
Greece	840	21.7%	367	3.8%	1.49	33	3.2%	38	0.9%	1.76
Hungary	9	0.2%	9	0.1%	1.22	39	3.8%	41	1.0%	1.44
Iceland	12	0.3%	20	0.2%	1.08	4	0.4%	19	0.5%	1.00
Ireland	487	12.6%	207	2.1%	1.27	18	1.7%	17	0.4%	1.06
Italy	1,653	42.7%	1,025	10.5%	1.78	188	18.1%	279	6.7%	2.29
Luxembourg	37	1.0%	28	0.3%	1.11	8	0.8%	10	0.2%	1.25
Netherlands	1,217	31.4%	631	6.5%	1.54	284	27.3%	366	8.8%	1.76
Norway	288	7.4%	155	1.6%	1.33	130	12.5%	176	4.3%	2.02
Poland	12	0.3%	15	0.2%	1.33	17	1.6%	23	0.6%	1.65
Portugal	558	14.4%	292	3.0%	1.38	64	6.2%	80	1.9%	1.91
Spain	1,170	30.2%	773	7.9%	1.61	222	21.4%	307	7.4%	1.81
Sweden	656	16.9%	313	3.2%	1.38	179	17.2%	206	5.0%	1.53
Switzerland	373	9.6%	165	1.7%	1.23	176	16.9%	261	6.3%	2.39
United Kingdom	2,316	59.8%	1,381	14.2%	1.84	266	25.6%	448	10.8%	2.35
EUROPE	3,874	100.0%	9,744	100.0%	7.15[2]	1,039	100.0%	4,138	100.0%	*5.82

[1] This average figure is based on projects where at least one firm from this country is involved.

[2] In this case, local means European. Accordingly, this figure represents average number of firms per project.

Table 2. Distribution of projects started in each two-year period.

Period	E.U. Framework Programme		Eureka		Total	
85/86	-	-	43	4%	43	1%
87/88	-	-	105	10%	105	2%
89/90	-	-	141	14%	141	3%
91/92	699	19%	176	17%	875	18%
93/94	1,226	33%	270	26%	1,496	31%
95/96	1,839	49%	295	29%	2,134	45%
TOTAL	3,765	100%	1,030	100%	4,795	100%

Table 3. Distribution of projects by technological area.

Technological area	No. of RJVs	%
Information	1229	26%
Aerospace	892	19%
Energy	511	11%
Environment	436	9%
Agriculture	387	8%
Education/Training	282	6%
Medical and Biotechnology	263	6%
Robotics/Production automation	172	4%
Measurement methods	142	3%
Transport	141	3%
Electronics/Microelectronics	118	2%
New materials	112	2%
Communications	43	1%
Lasers	26	1%
TOTAL	4,754	100%

Table 4. Distribution of projects by duration.

Duration	E.U. Framework Programme		Eureka		TOTAL	
1 year or less	173	5%	21	2%	194	4%
Between 1 and 2 years	1,053	28%	147	14%	1,200	25%
Between 2 and 3 years	2,099	55%	273	27%	2,372	49%
Between 3 and 4 years	471	12%	225	22%	696	14%
More than 4 years	13	0%	365	35%	378	8%
TOTAL	3,809	100%	1,031	100%	4,840	100%

Table 5. Distribution of projects by number of participants.

No. of participants	E.U. Framework Programme		Eureka		TOTAL	
3 or less	546	14%	439	43%	985	20%
4 or 5	1,048	27%	249	24%	1,297	26%
6 or 7	977	25%	151	15%	1,128	23%
8 to 10	732	19%	78	8%	810	17%
11 to 15	391	10%	64	6%	455	9%
16 or more	180	5%	50	5%	230	5%
Total	3,874	100%	1,031	100%	4,905	100%

Table 6. Unconditional participation equation: Binomial Logit model.

Dependent variable: Prob(RJV_t = 1)		
Variable	**Coefficients**	**Marginal effects**
Constant	-6.97 (8.24)	$-2.35 \cdot 10^{-4}$ (8.24)
R&D Intensity$_j$	0.16 (2.76)	$0.05 \cdot 10^{-4}$ (2.76)
Spillover lag$_j$	0.00 (0.01)	0.00 (0.01)
HHI$_i$	4.95 (1.82)	$1.66 \cdot 10^{-4}$ (1.82)
Log (Firm size)$_i$	0.65 (4.37)	$0.22 \cdot 10^{-4}$ (4.37)
Experience$_{i,EU\text{-}FP}$	15.20 (24.09)	$5.11 \cdot 10^{-4}$ (24.06)
Experience$_{i,Eureka}$	15.71 (12.60)	$5.28 \cdot 10^{-4}$ (12.60)
Log-likelihood ratio - $\chi^2_{(16)}$	203.79	
Success Index	70%	
No. of observations	1,283	

Notes: *t*-statistics in absolute values in parenthesis.
Country dummies are not shown. None of them is significant at the 10% level.

Table 7. Conditional participation equation: Binomial Logit model.

Dependent variable: Prob($RJV_t = 1 / RJV_{t-k} = 1$)		
Variable	**Coefficients**	**Marginal effects**
Constant	-4.03 (9.97)	-1.01 (6.05)
R&D Intensity$_j$	0.10 (3.78)	0.03 (3.48)
Spillover lag$_j$	-0.05 (3.39)	-0.01 (3.20)
HHI$_i$	0.30 (0.26)	0.07 (0.26)
Log (Firm size)$_i$	0.40 (6.63)	0.10 (5.32)
Experience$_{i,EU\text{-}FP}$	1.04 (9.74)	0.26 (4.54)
Experience$_{i,Eureka}$	0.24 (2.56)	0.06 (2.20)
Country dummies:		
France	-0.57 (2.15)	-0.14 (2.10)
Germany	-1.04 (3.33)	-0.26 (3.04)
Italy	-0.86 (2.93)	-0.21 (2.74)
Log-likelihood ratio - $\chi^2_{(16)}$	433.63	
Success Index	71 %	
No. of observations	1,042	

Notes: *t*-statistics in absolute values in parenthesis.
The table only shows those country dummies significant at the 10% level.