

Measuring the impact of international R&D cooperation: the case of Spanish firms participating in the EU Framework Programme

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Abstract

The objective of this paper is to analyse the effects of international R&D cooperation on firms' economic performance. Our empirical analysis, based on Spanish firms' participation in the Framework Programme (FP) between 1995 and 2005, has confirmed that: (1) cooperation within the FP has a positive impact on the technological capacity of firms, captured throughout intangible fixed assets and (2) the technological capacity of firms is positive related to their economic performance, measured by labour productivity.

Keywords: international R&D cooperation, Framework Programme, impact assessment

J.E.L. Classification: H81, L2, O3

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1. Introduction

The objective of this paper is to analyse the effects of R&D cooperation, exploring the relationship between cooperation, knowledge generation and economic results. Empirical analysis is focused on consortia supported by the R&D Framework Programme (FP) of the European Union and, more specifically, our sample refers to those Spanish firms participating during the period 1995-2005.

Consortia shaped under the FP have been considered in the literature as a clear example of international R&D cooperation, since they involve partners from different nationalities which invest their own resources in R&D activities, in order to obtain appropriable results. Prior studies concluded that the FP has contributed to build and consolidate R&D networks within the European area (Roediger-Schluga and Barber, 2006; Breschi and Cusmano, 2006). Nevertheless, empirical evidence about the effect of the FP on firms' economic performance is scarce.

The main obstacles that authors must face when trying to measure the impact of the participation in the FP are two: 1) how to avoid the self-selection effect and 2) how to joint data on participation and on economic performance for a period long enough to capture the long-term effect of the FP R&D projects.

Following Barajas and Huergo (2009), our empirical approach takes into account that the cooperation into this program is the result of two decisions. Firstly, the firms have to decide if they engage or not into de consortia. Secondly, the agency decides to approve or to reject the project after the evaluation. In this second stage, we are considering a selection equation in order to avoid the self-selection effect that can produce bias when the information considered is only referred to firms with accepted projects. Afterwards, we analyze the effect of participating in the FP on technological and economic results.

The second obstacle has been overcome joining two complementary databases. The first one, provided by the CDTI (the public organism in charge of monitoring the participation of Spanish firms within the FP), contains much relevant information about the FP projects and the participants and allows us to discriminate between the decision to apply and the agency selection. Additionally, we use data provided by the SABI database, that consists of company accounts for over 1,000,000 Spanish firms. This allows us to build a control

sample with information on economic variables. Thus, we compile homogeneous samples containing information about more than 50,000 firms and for a long-term period.

In contrast to other impact studies of the FP, the features of our database allow us to carry out the empirical analysis from a more in-deep and precise approach. Previous literature on the economic impact of the FP has confirmed the positive effect on firms' technological capabilities, but has not provided evidence about any significant effect on economic performance. Our approach, based on the work by Crepón *et al.* (1998), considers that technological capabilities have a direct effect on productivity and thus, the participation in the FP could have also an indirect effect on this performance measure.

Moreover, our database contains information for a period large enough to capture the long-term impact of the participation in FP consortia. Thus, we consider a time lag of five years from the application year of each project. Other works are not able to establish the same time lag for all the projects or consider a short-term horizon¹. Finally, previous literature does not take into account the existing differences among FP instruments. In order to guarantee the homogeneity of the sample, only Specific Targeted Research Projects (STREPs) and Integrated Projects are considered by the present work.

Following this introduction, section 2 summarizes prior literature focused on R&D cooperation impact and, more specifically, on the FP. In section 3 we present the database and the model used to carry out the empirical analysis contained in section 4. Finally, in section 5 some conclusions are drawn from the results, pointing out also key policy implications.

¹ Benfratello and Sembenelli (2002) consider a sample of firms participating during 1992-1994, indistinctly, and analyze their economic results for the period 1995-1996. Dekker and Kleinknecht (2008) use information for firms supported in FP4 and FP5, but they have no information about the concrete year of participation. Impact is measured considering sales of new products introduced in the market during 2002-2004 for the whole sample.

2. Previous empirical evidence on R&D cooperation impact

The origin of cooperation impact studies must be explained in the framework of the literature on R&D impact. Following the seminal works by Solow (1957) and other authors which incorporated R&D as an endogenous factor in the production function (Romer, 1990; Grossman and Helpman, 1991), many studies have tried to quantify the contribution of technology to the economic growth of a country, industry branch or enterprise, concluding that the private return of R&D investments is lower than the social one. Griliches (1992), Mohnen (1996) and Nadiri (1993) confirmed that, on average, the social rate of return is higher by 50% to 100% than the private one. Griliches and Mairesse (1984), Jaffe (1986) and Verspagen (1995) demonstrated that those spillover effects associated to R&D activities are responsible for the increasing rate of returns when knowledge flows from one firm or institution to others.

In the 90s, available data on firms' innovative activities open new research paths and new approaches are proposed. One of the most relevant works is the paper by Crepon *et al.* (1998). Using data from the French Innovation Survey, these authors build a model (CDM model) which considers that the effect of R&D on firms' productivity is the result of the innovation outputs and not directly of the R&D activity. Their empirical analysis concludes that technological results are favoured by the R&D intensity and the innovative dynamic of the activity branch. Moreover, productivity is positive influenced by the introduction of innovations in the market, controlling by human resources' qualification and physical capital.

The basic CDM model includes variables measuring the internal effort in R&D, but does not take into account the effect of external spillovers. At this respect, cooperation has been considered by some authors a valid proxy to explain knowledge generation associated to those knowledge spillovers. Cincera *et al.* (2003) argue that cooperation is an alternative to measure the voluntary access to external knowledge and also to control the involuntary outgoing spillovers. In fact, a considerable amount of empirical works corroborates the relationship between the propensity to cooperate and the relevance of spillovers for the innovation process.

Cassiman and Veugelers (2002) find, for the case of Belgian firms, that cooperation seems to be a suitable strategy for internalising spillovers within formal consortia, since those firms which consider incoming spillovers as more important, have a greater probability to cooperate. Using data from the Community Innovation Survey and based on the previous work, several studies have been carried out, stressing the relevance of spillovers as explaining factor for R&D cooperation (Abramovsky *et al.* 2009). For the case of Spanish firms, López (2008) confirms that the probability to cooperate is positively influenced by the increasing relevance of incoming spillovers (measured as publicly available information useful for the firms' innovation activity) and by the higher effectiveness of intellectual rights property protection.

Previous literature analyzing the effect of cooperation on firms' performance is characterized by the heterogeneity of models, due, in part, to the relative novelty of this research area. Most papers are focused on measuring the cooperation effect on innovation output and economic results. Moreover, some works also explore the relationship between cooperation effects and the type of partner selected by the company.

One of the first works analyzing the effect of cooperation on economic results is carried out by Siebert (1996). This author uses a sample of 314 US research joint ventures registered from 1985 to 1992 in the NCRA-JRV databases (National Cooperative Research Act) and confirms that the effect of R&D intensity on profit margin is higher for cooperating firms than for non-cooperating. Nevertheless, cooperation does not affect profit margin.

Thanks to the improvement and international harmonisation of innovation statistics in the 90s (mainly throughout the CIS initiative), researchers were able to measure the impact of R&D cooperation on new output indicators, closer to the firms' innovative activity. This information source also allows distinguishing different kinds of cooperation, according to the type of organisation selected by the company to carry out joint R&D projects. Researchers use to introduce in empirical models explanatory variables capturing the type of cooperation (related to the type of partner) and measure their impact on some innovation output indicators. Most of the works find a positive relationship between cooperation with universities/research centers and innovation output, measured by the volume of sales due to new products (Löf and Heshmati, 2002; Faems *et al.*, 2004; Löf and Broström, 2008).

Nevertheless, due to the interest to know the real impact of cooperation on economic performance, and not only on innovation results, some works try to go beyond carrying out more exhaustive research. One of the most cited papers is the work by Belderbos *et al.* (2004). These authors measure the effect of different types of cooperation on Dutch firms' performance, captured by two indicators: the growth of value added per employee (as indicator of labour productivity) and the growth of sales per employee from products new to the market (as indicator of "innovative sales productivity"). Available data for the period 1996-1998 allow them to reach information on innovative activity (from the CIS) and financial indicators for more than 2,000 enterprises. They cannot confirm that cooperation with universities has an effect on labour productivity, but find a significant impact on innovative sales growth. Aschhoff and Schmidt (2008) reinforce the positive relationship between cooperation with universities and the new-to-the-market product innovation. In the same study, these authors confirm also the effect of cooperation in process innovation, capturing throughout this indicator the cost-reduction factor associated to collaborative R&D.

Other remarkable attempt to demonstrate the economic effects of R&D cooperation is the paper by Cincera *et al.* (2003). These authors analyze the effect of international R&D cooperation by including in a classical productive growth function not only R&D expenditure, but also R&D cooperation. This last indicator is a proxy of available external know-how (knowledge spillovers) and complements the internal innovation effort. Empirical results confirm the positive impact of R&D intensity on sales growth. However, only cooperation with more applied objectives (with customers, suppliers or other companies) has a positive impact on sales growth.

In general, the literature confirms the existence of a positive relationship between R&D cooperation and innovative results, but the effect on economic performance is not so evident. Taking into account different types of cooperation processes, empirical evidence seems to corroborate that the more market-oriented the cooperation is, the higher is the probability to find positive economic effects (Benfratello and Sembenelli, 2002; Cincera *et al.*, 2003; Belderbos *et al.*, 2004).

The impact of cooperation taking place within the FP

The Framework Programme (FP) is the main political instrument supporting cooperative R&D within the European Union. It was born in 1984 with the aim of coordinating dispersed R&D activities funded by the European Commission. Since then, seven editions of the FP have been launched, evolving towards increasing budgets, new participation models and wider research priorities.

Over the seven editions the operative scheme of the FP has been characterized by several key aspects. Roediger-Schula and Barber (2006) remark that all projects are promoted by self-organised consortia, shaped by different kinds of partners and located in different nations (usually, consortia are integrated by firms, public research centres, universities and users). Moreover, supported projects have a limited duration and their R&D activity is co-financed by grants coming from the European Commission and private funds coming from consortia partners. Evaluation and selection processes have been traditionally based on scientific excellence and relevant socio-economic aspects, being carried out by independent experts in each technological area.

R&D cooperation within the FP is characterized by some specific features, such as the participation of universities and research institutes in consortia and the relevance of pre-competitive research. Thus, we can consider that FP projects are close to the public-private or institutional cooperation model. In fact, as we will expose following, literature on FP impact remarks that the main contribution of this programme is the improvement of innovation capacities and most of the empirical studies do not find a direct effect on economic results.

Impact studies carried out in several European countries (UK, Austria, Finland, Germany, and Ireland) have reported the same general conclusions regarding firms' performance: low levels of commercialisation, significant generation of new scientific knowledge, significant acquisition of technical knowledge and capabilities; improved access to technical networks (DTI-Office of Science and Technology, 2004). In the same line, Georghiou et al. (1992) find that the main benefit for industry is the improvement of skills. Also Luukkonen (1998) observes that the promotion of 'infrastructural' matters (such as

skills and training of personnel) can be considered the primary impact of EU research programmes.

The specifics of the FP regarding economic impact are reinforced by Benfratello and Sembenelli (2002). Matching data on 411 participants in Eureka and in the FP and balance sheet information from the AMADEUS database, these authors compare the effect of cooperation taking place in the two different programmes. They corroborate the positive influence of Eureka cooperation on some economic variables (labour productivity and price cost margins), but they cannot find any effect for the case of FP participants. Authors explain these results by the differences between the two programmes: Eureka is more market oriented and the FP is more focused on pre-competitive projects.

Some works have found different effects regarding firms' characteristics. Thus, Luukkonen (2000) suggests that commercial and short term objectives are much more relevant for small firms, since these companies are not able to maintain a large project portfolio and their innovation activity is based in short return periods, allowing them to finance consecutive R&D projects (European Commission, 2009). For the case of the Swedish industry, Arnold *et al.* (2008) report that the FP impact largely depends on the activity branch. They analyze four industries and confirm that, when the objectives of the FP consortia are closer to the market and the participation of big companies is more important, like in ICT or vehicles, the economic impact is higher. On the contrary, in live sciences or energy, the most relevant impact of the FP is related to the increasing technological capabilities of SMEs.

Similar results were obtained by Polt *et al.* (2008). They analyze the relationship between the participation in the FP and the innovative activity of enterprises using data from the Community Innovation Survey and a wide database on participation in FP5 and FP6. They remark that industrial participants are characterized by higher R&D intensity and better network advantages. They are more oriented to international markets and have a greater propensity to patent. Compared with projects financed by other sources, FP projects are less market-oriented, have longer development periods and are focused on non-core technologies of participants, being related to basic research activities. From the organisation perspective, these authors find that FP projects must face a lower degree of flexibility and higher administrative burdens. According to this empirical evidence, authors

conclude that the participation of non-entrepreneurial organisations is increasing and, consequently, the proportion of results that could lead directly to industrial innovation has declined.

Introducing a new perspective, Dekker and Kleinknecht (2008) take into account the self-selection of applicants and analyze whether the FP participants from the Netherlands, Germany and France have better performance indicators due to the fact of participating or because they are more innovative. They confirm the existence of the self-selection bias associated to the participation in the FP and estimate the impact equation correcting this aspect. Concerning the FP impact, they consider firms participating indistinctly in FP4 and FP5 and analyze the effect on innovative output, measured as logs of sales of innovative products per employee. These authors cannot corroborate a positive effect on innovative results, but they find a positive influence on R&D intensity for companies with less than 100 employees.

Summarizing, empirical evidence on the FP impact seems to indicate that the main contribution of this programme to the industry participants is related to the improvement of scientific and technological capabilities and not directly to the firms' economic performance.

3. Empirical model and data

When analyzing the impact of any public aid, the implicit question to answer is what would have been the behaviour of a supported firm if it would not have received this public aid. The problem is that each firm can only be observed either in the status of receiving the public support or not, that is, we cannot observe directly the additional effect. As it is well-known, if aids were granted randomly to firms (or consortia), we could estimate the effect of public aid on (for instance) performance as the difference between the average one in supported and non-supported firms. However, the evidence shows that aids are not granted randomly. Therefore, to measure the effect of public aids, we need to estimate or approximate the counterfactual. That is, we have to take into account that the awarding decision by the public agency probably depends on the same firm (or consortia) characteristics that determine performance. The econometric literature has developed

several methods in order to solve these difficulties². One of the most used alternatives, and the one we are going to follow here, is the Heckman selection model, which involves estimating what determines the receipt of the aid (the “selection equation”).

Nevertheless, the application of this method is not free of difficulties. Most of the empirical studies that try to explain the impact of national or international aid programmes have information only about financed projects, and therefore are not able to distinguish between the firm’s decision to apply for the aid and the agency selection among the proposals (see, for example, Blanes and Busom (2004), who refer to participation in R&D subsidy programmes). The main disadvantage of this lack of information is that the selectivity problem is not fully considered.

However, in our database, we also have data about rejected applications. Taking this into account, we can express the probability of participation in a financed cooperative R&D project as the following joint probability:

$$\begin{aligned} \Pr(\text{participation} = 1) &= \Pr(\text{application} = 1, \text{award} = 1 | x) = \\ &= \Pr(\text{award} = 1 | \text{application} = 1, x) \cdot \Pr(\text{application} = 1, x) \end{aligned}$$

Following a previous paper by Barajas and Huergo (2009), to estimate both probabilities, the empirical model includes two equations. The first describes the decision of applying for a FP cooperation project involving at least one Spanish firm. The second equation refers to the awarding by the European Commission.

Formally we can write our model as follows. Let $i = 1, \dots, N$ index firms. The equation which describes the decision of applying for a FP cooperation project (involving at least one Spanish firm) takes the form:

$$y_{li} = \begin{cases} 1 & \text{if } y_{li}^* = x_{li}\beta_1 + u_{li} > 0 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

where y_{li}^* is a latent dependent variable, x_{li} is the set of explanatory variables, β_1 is the vector of coefficients and u_{li} is the error term. The firm i applies within the FP if y_{li}^* is positive.

² See a detailed discussion of the different methods in the survey by Aerts, Czarnitzki and Fier (2007).

Conditional on firm i applying, the agency can award or reject the proposal. Again, the probability of being awarded is formalised in terms of a binary model:

$$y_{2i} = \begin{cases} 1 & \text{if } y_{2i}^* = x_{2i}\beta_2 + u_{2i} > 0 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

where y_{2i}^* is the latent dependent variable, β_2 is the vector of coefficients, u_{2i} is the error term, and x_{2i} is the set of explanatory variables, that are assumed to be strictly exogenous or predetermined longer in advance. The proposal in which the Spanish firm i participates is approved if y_{2i}^* is positive.³

Assuming than the error terms of both equations can be correlated (with correlation coefficient equal to ρ), we estimate the system of equations (1) and (2) as a probit model with sample selection by maximum likelihood (using the Heckman procedure for binary response variable in Stata).

After the joint estimation of both equations, we proceed to estimate the impact of the supported cooperative project in terms of output. Given the R&D projects supported through the FP are generally long term projects (the average duration of a project is around 24 months and before starting the project, the negation phase with the European Commission could take also several months), it seems reasonable to analyse its impact once the project has formally finished. To do so, the measures of output that we include in our analysis refer to the period t+5 respect to the awarding year.

We consider two alternative measures of output. The first one is the proportion of intangible fixed assets over employment, which constitutes an indirect measure of innovation output, given that the knowledge generated in the R&D project usually will be reflected by the volume of intangibles inside the firm (especially in the case of patents and R&D investments). Therefore, the next equation in our model is:

$$k_i = p_i^* \gamma + x_i' \delta + e_i \quad (3)$$

³ Notice that more than one Spanish firm can participate in the same proposal, and the same Spanish firm can participate in more than one proposal every year. To establish a clear correspondence between firms and projects, in our sample we have only included one project by firm and year.

, where k_i stands for firm's intangible fixed assets, and p_i^* denotes the predicted value for the probability to participate within the FP. We include the prediction instead of the dummy for observed participation to take care of the selectivity problem. x_i is a vector of other control variables in equation (3).

The second one is firm's labour productivity, as an indicator of economic success. Notice that firm's productivity is supposed to be associated also with knowledge capital. Therefore, if we find that intangibles are affected by the participation within the FP, and that these intangibles increase productivity, the economic impact of the cooperative project we will be also supported by the evidence. As a consequence, the last equation in our model takes the form,

$$g_i = \pi_1 k_i + z_i' \pi_2 + v_i \quad (4)$$

, where g_i is labour productivity, k_i is knowledge capital (represented by intangible assets) and z_i stands for other additional controls in equation (4). We take care of the endogeneity of k_i in this equation by using in the estimation the predicted values from equation (3).

In equations (3) and (4) dependent variables refer to period t+5 respect to the awarding year. As we have explained previously, the R&D projects supported by the FP are generally long term, and it seems reasonable to analyse its impact once they have formally finished and firms have obtained economic returns.

Summarizing, in this paper we apply a structural model which has the following basic structure: (i) firms decide to apply or not for a FP cooperation project; (ii) the proposal is awarded or rejected by the European Commission; (iii) the innovation activities involved in the cooperative R&D project succeed through the generation of new knowledge (represented by intangibles); (iv) the addition of this new knowledge to the production process causes productivity growth. Since we assume a recursive model structure and do not allow for feedback effects, we follow a three-step estimation procedure. In the first step we estimate a maximum likelihood probit model with sample selection (equations 1 and 2). In the second step the knowledge production function (proxied by the stock of intangible fixed assets) is estimated (equation 3) using the predicted value of the probability to participate within the FP to take care of the selectivity problem. In the last step we estimate

the productivity equation using the proportion of intangible fixed assets as an indicator of knowledge generation.

We choose this structural model because it captures the main features of the phenomenon we want to analyze, but is parsimonious and empirically tractable with the data we have available. This recursive structure is, to a certain extent, similar to the proposed in the well-known CDM model (Crepon *et al.*, 1998).

3.1 Database

The database used here is provided by the Centre for the Development of Industrial Technology (CDTI), which is the public organisation in charge of monitoring the participation of Spanish firms within the FP. Since FP6 went into effect, the CDTI has been the organisation in charge of the maintenance and management of the information related to Spanish participation in the FP. As a consequence, the CDTI-PM database includes information about all the proposals,⁴ eventually granted or not, in which at least one Spanish firm participated between 1995 and 2005. This period covers part of FP4 (1994-1998), all of FP5 (1999-2002) and part of FP6 (2002-2006).

This information from the CDTI-PM database has been complemented with the SABI database that contains the company accounts of more than 1,000,000 Spanish firms between 1995 and 2007. The merger of the CDTI-PM and SABI databases has been possible because Spanish firms are identified both in the CDTI-PM and the SABI databases through their company tax codes.

From the SABI database, we have selected a control sample that takes into account the availability of data about the relevant variables for each firm. Given that Spanish firm size is smaller than the European average (European Commission, 2003), we have designed the sample selection considering that a firm is large when its number of workers exceeds 200, although the threshold in international statistics is usually set at 250. We have chosen all companies employing more than 200 employees. Firms employing between 10 and 200

⁴ To guarantee the homogeneity of the sample, only Specific Targeted Research Projects (STREPs) and Integrated Projects are considered.

employees are selected by a random sampling scheme for each NACE class (two-digit) level, and represent around 4% of the Spanish Central Companies Directory (CCD), which comprises all Spanish companies and their local units. This makes our control sample representative of the Spanish economy.⁵ Although we have information since 1995, the sample used in the empirical analysis of participation refers only to the period 1999 to 2005, given that FP5 started in 1999 and we want to take into account the experience, if any, in the previous programme. In addition, as we use the forward values of output measures to capture long term relationships, in some estimates the number of years with complete information is reduced to 4.

Since our objective is to analyze the impact of collaboration within the FM program on performance variables, our unity of analysis is the firm. In this sense, although some firms have applied in more than one proposal every year, we only consider one project by firm and year. We have given priority to those supported projects with bigger subsidies. After that, 1,555 observations have been eliminated, where 142 observations refer to supported projects. We have also excluded observations of the extreme values of employment and sales growth rates. Specifically, we have eliminated values in the extreme percentiles (1 and 99%). In addition, we dropped negative values for productivity, tangibles and intangibles fixed assets. Overall, the final sample consists of an unbalanced panel of 56,945 observations, 11,435 companies, and 2,536 proposals.

The CDTI-PM database allows us to analyze specifically those factors related to agency selection⁶, while the information from the joint database is used mainly to estimate the firm's decision to engage in a cooperative project, and the impact of participation on firm's output.

4. Results

In this section we present the results of the estimation of the model depicted in section 3. As equations (1) to (4) point out, we assume a recursive model where feedback from

⁵ Coverage of the data is basically restricted to firms that have at least 10 employees (annual average), but we have also included 615 micro-companies (0.5% of the CCD, chosen again by means of a random sampling scheme), given that 219 applicants of cooperative FP projects belong to this category.

⁶ Proposals are evaluated by independent experts according to some common criteria. However, such information is absent from our database.

performance variables to the decision of applying for a FP cooperation project is not allowed. Taking this into account, we follow a three stages estimation procedure. In the first stage, a probit model with sample selection including the participation decision in a cooperative R&D project within the FP and the decision of awarding by the EC are jointly estimated consistently by maximum likelihood. In the second stage, we estimate the generation of new knowledge (equation (3)) approaching the innovation output by the intangible fixed asset and introducing the predicted value of the probability to participate within the FP as explanatory variable. In the last stage, the productivity growth equation (4) is estimated including as explanatory variable a proxy of the new knowledge; specifically we introduce the predicted value of intangible fixed assets.

Cooperation within the FP

Tables 1 and 2 show the results of the Heckman probit estimation associated with the probability of participation within the FP. The first one exhibits the coefficients of the probit model for the firm's decision to apply for a FP cooperation project (equation (1)), while the second one corresponds to the probability of being awarded by the EC (equation (2)). We report also marginal effects in square brackets. Notice that the correlation term ρ in Table 2 is significant, pointing out the necessity of estimating a selection model for the awarding decision⁷.

The explanatory variables included in equations (1) and (2) follow the selection made by Barajas and Huergo (2009) for a quite similar sample⁸. The results basically confirm the evidence obtained in that paper. In what refers to the applying equation, as can be seen in Table 1, most coefficients are statistically significant, although marginal effects are small except for those variables measuring the FP experience in the previous year. In general, explanatory variables increase the probability of applying for a FP cooperation project, with the exception of the liquidity ratio, that has a negative impact, which is consistent with the idea that cooperation can be considered a strategy for avoiding financial obstacles associated with R&D projects for firms with financial constraints.

⁷ The Heckman procedure for binary response variable in STATA does not take into account the panel structure of the data and the information is treated as a pool. However, in Barajas and Huergo (2009), the decision to apply has been estimated as a random-effects probit model taking into account the panel structure of the data and the results are basically the same.

⁸ Find the exact definitions of the variables in Appendix 1.

Table 1: Probability of applying within the FP. Probit estimates.

	Coefficient		Std. E.
Time dummies			
Year 2000	-0.054	[-0.003]	0.038
Year 2001	-0.040	[-0.002]	0.037
Year 2002	-0.280 ***	[-0.012]	0.041
Year 2003	0.055	[0.003]	0.036
Year 2004	-0.258 ***	[-0.011]	0.040
Year 2005	-0.233 ***	[-0.010]	0.041
Prior experience in FP proposals	0.564 ***	[0.047]	0.029
Granted project in previous year	1.545 ***	[0.289]	0.045
Rejected proposal in previous year	1.650 ***	[0.315]	0.030
Exporter	0.125 ***	[0.006]	0.023
Liquidity ratio	-0.048 **	[-0.002]	0.020
Intangible fixed assets over employment	0.033 ***	[0.002]	0.008
EBITDA margin	0.232 ***	[0.012]	0.087
Stock market	0.322 ***	[0.023]	0.067
Firm's size dummies (no. of workers)			
From 10 to 49	-0.239 ***	[-0.011]	0.041
From 50 to 99	-0.351 ***	[-0.014]	0.044
From 100 to 199	-0.395 ***	[-0.016]	0.045
More than 200	-0.385 ***	[-0.018]	0.040
Region			
Basque Country	0.300 ***	[0.020]	0.037
Catalonia	0.113 ***	[0.006]	0.030
Madrid	0.119 ***	[0.006]	0.030
Valencia	0.112 ***	[0.006]	0.042
High-tech services			
Post and telecommunications	0.603 ***	[0.055]	0.068
Computer and related activities	0.459 ***	[0.036]	0.039
Research and development	0.583 ***	[0.053]	0.072
High and medium-tech manufacturing			
Chemicals and chemical products	0.020	[0.001]	0.049
Machinery and equipment n.e.c.	0.020	[0.001]	0.051
Office machinery and computers	0.495 ***	[0.041]	0.144
Electrical machinery and apparatus n.e.c.	0.052	[0.003]	0.076
Radio, television and communication	0.257 ***	[0.017]	0.076
Medical, precision and optical instruments	0.156	[0.009]	0.096
Motor vehicles, trailers and semi-trailers	0.072	[0.004]	0.073
Other transport equipment	0.432 ***	[0.034]	0.079
Log of likelihood function			-8,190.55
Number of observations			56,945

Marginal effects in square brackets. Std. E.: Estimated standard error. Coefficients significant at: 1%***, 5%***, 10%*. All regressions include the constant. Dummies excluded for firms with fewer than 10 employees and the year 1999. Marginal effects are computed at sample means. For dummy variables, the marginal effect corresponds to the change from 0 to 1.

Table 2: Probability of being awarded. Probit estimates.

	Coefficient		Std. E.
Year of the application			
Year 2000	0.064	[0.007]	0.114
Year 2001	0.241 **	[0.029]	0.109
Year 2002	0.149	[0.017]	0.126
Year 2003	-0.251	[-0.023]	0.219
Year 2004	0.001	[0.000]	0.217
Year 2005	0.016	[0.002]	0.200
Participation of organisms	-0.470 ***	[-0.050]	0.168
Size (of consortium)	0.707 ***	[0.075]	0.071
FP budget for the specific programme	-0.009	[-0.001]	0.018
Leader nationality			
British	-0.032	[-0.003]	0.122
Dutch	0.345 *	[0.048]	0.188
French	0.220 *	[0.028]	0.127
German	0.361 ***	[0.051]	0.113
Italian	-0.104	[-0.010]	0.130
Spanish	0.312 ***	[0.042]	0.087
Technological area			
Aeronautic and aerospace	0.259	[0.034]	0.246
Agro-food	0.261	[0.034]	0.269
Environment and energy	0.024	[0.003]	0.230
ICT	0.129	[0.015]	0.217
Innovation programmes	0.385	[0.055]	0.335
New materials	0.247	[0.032]	0.195
Transports	0.311 **	[0.042]	0.130
Geographical distance	-1.079 ***	[-0.114]	0.107
Prior experience in granted FP projects	0.143 *	[0.017]	0.080
Granted project in previous year	-0.031	[-0.003]	0.109
Rho	0.089 *		0.046
Log of likelihood function	-8,190.55		
Number of censored / uncensored obs.	54,409 / 2,536		

Marginal effects in square brackets. Std. E.: Estimated standard error. Coefficients significant at: 1%***, 5%***, 10%*. All regressions include the constant. Dummy excluded for the year 1999. Marginal effects are computed at sample means. For dummy variables, the marginal effect corresponds to the change from 0 to 1.

When we analyze the coefficients of the time variables, we observe that firms applied in smaller proportion in 2002, 2004 and 2005. The first one corresponds to the last year of the edition of the FP4 and confirms that firms tend to submit a smaller percentage of proposals when the current programme edition is finishing, probably due to the lower number of calls for proposals. The other two dummies variables correspond to the FP6 and allow us to compare both FP5 and FP6. The results are consistent with the fact that, in comparison with FP5, FP6 were less favourable to the technological objectives of Spanish firms, which consequently applied in smaller proportions.

As expected, previous experience in FP proposals increases the probability of applying in the future editions and especially when the prior experience took place during the previous year. Since the application process within the FP is very costly, companies in consortia that have been rejected will try to profit from the accumulated knowledge applying to the following calls. The probability of engaging in a FP project increases about 30 points for firms with experience in the last year, while it increases in almost five points for firms with experience in previous editions of the FP.

With respect to the rest of explanatory variables, exporters, firms that are on the stock market, and companies that present a higher ratio between intangible fixed assets and employment, are also more likely to apply. The earnings in terms of sales (approached by EBITDA), as a measure of ex-ante firm's market power, also present a positive effect. This result is coherent with the Schumpeterian hypothesis that the less competitive the markets are, the more incentives for firms to innovate (and to participate in R&D consortia) since they are more able to capture innovation benefits.

The coefficients of the set of size dummies indicate a negative impact of size on the probability of applying. This unexpected result can be affected by the fact that our control sample is biased towards large firms, which are chosen on the basis of a census, while firms employing between 10 and 200 employees are selected by a random sampling scheme. Additional work would be necessary to study this result more deeply⁹.

With respect to the geographical indicators, firms located in the Basque Country, Catalonia, Madrid and Valencia show higher probabilities of submitting an application, which is consistent with the major concentration of technological firms in these regions. The last rows of Table 1 present the coefficients of industry dummies¹⁰. Firms that carry out high-tech activities are also more prone to become proponents. The probability of engaging in an FP project increases more than 5 points for companies in the Post and telecommunications service sector and R&D sector. Also, affiliation to Computer and

⁹ Barajas and Huergo (2009) present complementary estimations for two sub-samples: small and medium size enterprises (SME), and large firms. They found a non-linear effect of size which is negative for the SME and positive for large firms.

¹⁰ We include also some other industry dummies with statistically significant effects. Specifically, Education, Wearing apparel and footwear and Other business activities, that include architectural and engineering activities and related technical consultancy, should be noted. An opposite case is the Hotels and restaurants industry, with a lower probability to participate in technological projects. In reference to the Energy sector, both FP4 and FP5 had specific programmes for the development of sustainable energies, which increased the occasions for firms to present proposals. The results are available from the authors upon request.

related activities, Office machinery and computers, and the transport equipment industry increases the probability of applying in about 4 points.

Table 2 shows the coefficients corresponding to the estimation of the equation for the probability of being awarded by the EC. Again the results confirm the evidence provided by Barajas and Huergo (2009): Firstly, the presence of public organisations within a consortium and the distance among the partners affect negatively the viability of the proposal. Both variables can be reflecting the existence of coordination costs. With respect to the participation of non-entrepreneurial organizations, these costs could be associated to the differences in private and public cooperation routines, especially concerning the protection of innovation results.

Secondly, the inclusion of a new member in the consortium increases the probability of being supported by 7.5 points. In this case, the required technological diversity of the research equipment seems to exceed the coordination cost associated with each additional partner.

Thirdly, the probability of being supported increases when the project belongs to the Transport area¹¹, and especially when the proposal is led by a German organisation. Probably, Spanish firms that participate in consortia led by companies or organizations from Germany – a very active country within the FP-, earn greater experience, enjoy better coordination routines, and therefore have higher probability of being awarded by the EC.

The previous experience in FP projects has less impact on the probability of being supported than on the probability of applying. It seems clear that “learning-by-doing” is a more relevant factor in explaining the decision to participate due the complexity of the FP procedures and the need to exploit scope economies once the effort to apply was made and the consortium is shaped.

Finally, although the temporal dummies which indicate the year in which the firm applied are jointly significant, do not present significant coefficient any year. That is, according to

¹¹ The greater part of the total budget of the FPs is allocated to information and communication technologies. Therefore, it seems that EU give priority to these technological areas. Our result that only firms which carry out FP programs in Transport present bigger probability to be awarded can be consequence of the criteria followed to eliminate the firms which have more than one project. Most of the dropped observations are projects belonging to ICT, Transport and Aeronautical technologies areas.

these results, there are not specific differences in the probability of being supported in both FP5 and FP6.

Impact on knowledge accumulation

We next proceed to estimate equation (3). As already stated, to capture the impact of supported cooperative projects, our measure of output is the proportion of intangible fixed assets over employment. We assume that this constitutes an indirect measure of innovation output, given that the knowledge generated in the R&D project usually will be reflected by the volume of intangibles inside the firm, especially if the new knowledge is protected through patents¹². In Table 3, we describe the variables used in the following econometric analysis.

The firms' technological capabilities are represented by their intangible fixed assets, given the intangible character of R&D¹³. The difference of means test confirms that the average of this variable in the sample is higher for participants within the FP than for non-participants. The proportion of intangibles over employment is slightly lower for participants. On the contrary, the percentage of tangible fixed assets per employee is higher for supported firms. Participants seem to be more productive, although the difference is small.

In addition, we consider a set of geographical dummies to be explanatory variables, as the more technological Spanish firms tend to locate in specific regions. As we can see, for participants, the percentage of companies located in Madrid, Catalonia and Basque Country (regions with R&D intensities above the national average), is higher than for non-participants.

We also take into account whether the firm's activity corresponds to a high-tech service sector or a high or medium-tech manufacturing sector according to the OCDE classification. The frequencies in Table 3 reflect a high presence of these activities among participants, especially in high-tech services.

¹² Most previous empirical evidence approaches the new knowledge by other technological outputs as product and process innovations, or sales generated by new products. However, this information is not available in our data base.

¹³ Spanish accounting rules allow to capitalize R&D expenditures under certain conditions (mainly when there exists reasonable expectations of marketable results).

Table 3: Features of the participants. Descriptive statistics

Means of quantitative variables:	Total sample	Participants	Non-participants
Intangible Fixed Assets (€)	3,120.05	7,362.01	3,091.83
Intangible Fixed Assets over Employment (€)	13.93	11.91	13.94
Tangible Fixed Assets (€)	22,272.04	108,593.5	21,697.33
Tangible Fixed Assets over Employment (€)	76.49	127.38	76.15
Productivity (sales over employment) (€)	247.17	268.77	247.02
Firm's size (n° of employees)	355.41	877.41	351.93
Frequencies of binary variables:	Total sample	Participants	Non-participants
Stock-market	1.25	6.87	1.21
Exporter	49.81	66.76	49.70
Basque Country	7.51	15.93	7.45
Catalonia	24.62	27.20	24.61
Madrid	23.56	32.42	23.50
Valencia	9.67	6.87	9.69
High and medium-tech manufacturing	17.07	25.55	17.01
High-tech services	5.88	15.66	5.82

Firm's export activity is captured through a binary variable that takes the value one if the firm is an exporter during the period. As we can see in Table 3, the percentage of exporters among participants is 16 points higher than among non-applicants.

As an additional control variable, we include a dichotomy variable that reflects whether the firm is listed on the stock-market. This kind of company is usually financially more consolidated and international funds could be less attractive to it. However, firms on the stock-market tend to show more formalised quality procedures and therefore could have more systematic collaboration routines. In our sample, stock market companies are more frequent among participants.

The empirical results are reported in Table 4. We assume that all explanatory variables are strictly exogenous and the estimation is carried out by OLS using a random effect model for panel data. We have included in the specification some control variables as time, size,

export activity, industries (to capture some sector specific effects as technological opportunities) and regional (to control for the concentration effect in some Spanish area) dummies.

The coefficients reported in this table are semi-elasticities because the dependent variable is measured in logarithms. Specifically, as all explanatory variables are dummies, they show the variation rate in unitary terms of intangible fixed assets per employee when the explanatory variable change from 0 to 1.

Due to the pre-competitive orientation of FP projects, we assume that their results will have effects on long term. In this sense, our dependent variable is referred to the period $t+5$, where t is the awarding year¹⁴.

Table 4: Intangible fixed assets per employee (t+5)

	(1)		(2)	
	Coefficient	Std. E.	Coefficient	Std. E.
FP participant (observed)	0.083	0.061		
FP participant (estimated)			0.394 **	0.172
Stock-market	1.174 ***	0.182	1.169 ***	0.181
Exporter	0.156 ***	0.030	0.154 ***	0.030
Firm's size dummies (n°. of workers)				
From 10 to 49	-0.104 **	0.048	-0.104 **	0.048
From 50 to 99	-0.201 ***	0.052	-0.201 ***	0.052
From 100 to 199	-0.279 ***	0.053	-0.280 ***	0.053
More than 200	-0.358 ***	0.053	-0.358 ***	0.053
Region				
Basque Country	0.057	0.058	0.052	0.058
Catalonia	0.246 ***	0.039	0.245 ***	0.039
Madrid	0.117 ***	0.039	0.116 ***	0.039
Valencia	0.030	0.049	0.029	0.049
High and medium-tech manufacturing	0.073 ***	0.041	0.072 *	0.041
High-tech services	0.318 ***	0.070	0.314 ***	0.070
Sigma of u	1.210		1.209	
Rho	0.868		0.867	
Number of observations	23,089		23,089	

Std. E.: Estimated standard error. Coefficients significant at: 1%***, 5%***, 10%*. All regressions include the constant and temporal dummies. Dummy excluded for firms with less than 10 workers.

We are interested on comparing the effect of predicted participation versus observed participation. In Table 4, the first column correspond to the model in which we included as explanatory variable the dummy for observed participation (yes /no), while in column (2)

¹⁴ Most empirical evidence also recognizes the need to measure effects using a long term perspective (see Benfratello and Sembenelli, 2002; Dekker et al., 2008).

this variable is substituted by the prediction obtained in the previous step (estimations of equations 1 and 2). It should be remarked that to take into account the selection problem is relevant: whereas the coefficient for observed participation is not significant, the predicted probability of participation affects positively our technological output. Specifically, to be a firm that cooperates in a FP increases the ratio of intangible fixed active over employment in almost a 40%. This result is in concordance with those presented by Dekker *et al* (2008).

With respect to the control variables, industries dummies are highly significant. Firms belonging to high-tech manufacturing and services and medium-tech manufacturing have a higher potential to generate technological outputs. The level of intangible fixed assets per employee increases in 7% in manufacturing and in more than 31% in services. As expected, we find regional differences in terms of technological output. Firms located in Madrid and Catalonia present a bigger intangible assets level.

We obtain a negative effect of the size dummies. Most empirical previous evidence for Spanish manufacturing provides a positive relationship between firms' size and the probability of being engaged in technological activities and to obtain product or process innovations, stressing the capacity of large firms to exploit economies of scale. However, a negative relationship is found in terms of innovation intensity: large firms present a lower proportion of resources in R&D with respect to smaller firms. *****REFERENCIA*****

Finally, to be a company listed on the stock market or being exporter also affects positively the generation of new knowledge. Specifically, firms operating in international markets register an increment of 15% in the ratio of intangible fixed assets over employment.

Impact on labor productivity

The variable used to analyze the impact of cooperation on economic performance is labor productivity, measured as the ratio between total sales and number of employees. Estimations of the productivity equation (4) are shown in Table 5. Again, the estimation is carried out by OLS using a random effect model for panel data.

The coefficients reported in Table 5 are elasticities or semi-elasticities, since the dependent variable is the logarithms of sales per employee. In addition to control variables referring to size, industry, year, and firms' location, we have included in the model a proxy of

physical capital intensity, measured throughout the variable “tangible fixed asset per employee”. Finally, to capture the effect of knowledge accumulation on productivity we have included the predicted value of “intangible fixed assets over employment” from equation (3).

By means of these estimations, we analyze whether the participation within the FP has not only an indirect effect but also a direct effect on firms’ economic success. As we have demonstrated in previous section, the predicted probability of being awarded enhances the ratio of intangible fixed assets. If we find a positive relationship between this proxy of technological output and the level of productivity, the indirect economic impact of cooperation on productivity would be confirmed. If we find that FP participation has also a significant effect on productivity, and additional direct effect of cooperation on economic performance would be corroborated.

In the first column of Table 5, we present the obtained results considering as explanatory variables neither the observed, nor the predicted participation. Under these conditions, the impact of the predicted value of “intangible fixed assets per employee” on productivity is clearly significant, reflecting a difference in favor to innovative firms. Specifically, if the ratio of intangible assets duplicates, it generates that the productivity grows up more than 12% (see Table 5). As firms participating in FP present higher technological outputs, this result supports an indirect effect of cooperation on this performance variable.

In column (2) and (3), the specification also includes the dummy for observed and predicted participation, respectively. As can be seen, both of them are not significant. Therefore, it seems that the cooperation in FP does not have a direct effect on performance variables. This result is in concordance with those presented by Benfratello and Sembenelli (2002). Using a different methodology, they do not find significant differences on labour productivity of firms that have participated in FP 3 and FP 4. In a similar way, Dekker *et al* (2008) confirm that innovative output – sales of innovative product per employee- is not enhanced by participation in the EU FP in France, Germany and The Netherlands.

Table 5: Labour productivity (t+5)

	(1)		(2)		(3)	
	Coefficient	Std. E.	Coefficient	Std. E.	Coefficient	Std. E.
FP participant (observed)			0.010	0.032		
FP participant (estimated)					0.044	0.070
Intangible Fixed Assets per employee predicted (t+5)	0.121 ***	0.009	0.120 ***	0.012	0.120 ***	0.012
Tangible Fixed Assets per employee (t+5)	0.336 ***	0.005	0.336 ***	0.014	0.336 ***	0.014
Stock-market	-0.110	0.089	-0.111	0.168	-0.111	0.168
Exporter	0.381 ***	0.022	0.381 ***	0.025	0.381 ***	0.025
Firm's size dummies (n° of workers)						
From 10 to 49	0.079 ***	0.024	0.079 **	0.036	0.079 **	0.036
From 50 to 99	0.097 ***	0.027	0.097 **	0.038	0.097 **	0.038
From 100 to 199	0.122 ***	0.028	0.122 ***	0.039	0.122 ***	0.039
More than 200	0.130 ***	0.028	0.130 ***	0.039	0.130 ***	0.039
Region						
Basque Country	0.176 ***	0.042	0.176 ***	0.039	0.175 ***	0.039
Catalonia	0.195 ***	0.028	0.195 ***	0.030	0.195 ***	0.030
Madrid	0.344 ***	0.028	0.344 ***	0.031	0.344 ***	0.031
Valencia	0.016	0.037	0.016	0.040	0.016	0.040
High and medium-tech manufacturing	0.152 ***	0.029	0.152 ***	0.028	0.152 ***	0.028
High-tech services	-0.094 **	0.047	-0.094 **	0.046	-0.094 **	0.046
Sigma of u	0.889		0.889		0.889	
Rho	0.894		0.894		0.894	
Number of observations	22,985		22,985		22,985	

Std. E.: Estimated standard error. Coefficients significant at: 1%***, 5%***, 10%*. All regressions include the constant and temporal dummies. Dummy excluded for firms with less than 10 workers.

Additionally, there are not changes in the coefficients of the rest of variables. Capital intensive firms – approached by the ratio “tangible fixed assets per employee” – are also more productive. As in previous empirical evidence, exporter firms are also more efficient than non-exporter firms.

With respect to the size dummies, we find a positive lineal relationship between firms' size and productivity. We also obtain geographical differences in terms of productivity. Firms located in Catalonia, Basque Country and Madrid present a bigger productivity than the rest of the firms. As expected, firms from high-tech and medium-tech manufacturing industries present larger levels of productivity. However, the opposite happens with firms on high-tech services.

5. Conclusions

The objective of this paper is to analyse the effects of R&D cooperation on economic performance. Empirical analysis is focused on consortia supported by the R&D Framework Programme (FP) of the European Union and, more specifically, on Spanish firms participating during the period 1995-2005.

In general, literature confirms the existence of a positive relationship between R&D cooperation and innovative results, but the effect on economic performance is not so evident. Taking into account different types of cooperation processes, empirical evidence seems to corroborate that the more market-oriented the cooperation is, the higher is the probability to find positive economic effects (Benfratello and Sembenelli, 2002; Cincera *et al.*, 2003; Belderbos *et al.*, 2004).

Previous empirical analyses agree about the positive effect of the cooperation carried out within the FP on variables related to technological capabilities (Georghiou *et al.*, 1992; Luukkonen, 1998; Arnold *et al.*, 2008; Polt *et al.*, 2008; Dekker and Kleinknecht, 2008), but evidence about the effect on economic performance is scarce. Considering the specific features of the FP (ambitious projects; consortia shaped by different types of organisations located in different countries; long-term periods; pre-competitive orientation in most of the cases), it is obvious that the economic effect of this kind of projects should be analysed from a different perspective.

At this respect, one of the main contributions of the present paper is the application of a recursive model structure to capture the relationship between cooperation, knowledge generation and economic results. The model has the following basic structure: (i) firms decide to apply or not for a FP cooperation project; (ii) the proposal is awarded or rejected by the European Commission; (iii) the innovation activities involved in the cooperative R&D project succeed through the generation of new knowledge (represented by intangibles); (iv) the addition of this new knowledge to the production process causes productivity growth.

With respect to the participation within the FP, the results confirm the evidence obtained in a previous work by Barajas and Huergo (2009) about the determinants of applying in the FP and being awarded by the European Commission. Moreover, we have corroborated that

the self-selection bias exists and, thus, we have estimated the impact equation using alternatively the predicted and the observed probability. Going to a beyond step, we have confirmed that the predicted probability of participating in the FP have a positive impact on firms' technological capabilities. Specifically, five years after awarding the project the ratio of intangible fixed assets over employment increases in almost 40%.

The variable used to analyze the impact of the cooperation on economic performance is the labor productivity, measured as the ratio between sales and employment. The impact of the predicted value of "intangible fixed assets over employment" on productivity is clearly significant. Specifically, if the ratio of "intangible fixed assets over employment" duplicates, it generates that the productivity grows up more than 12% five years after awarding the project. This result supports an indirect effect of participating in the FP on firms' performance, captured throughout labor productivity.

From the above mentioned evidences, we can draw out some conclusions regarding the interest of policy makers. The key idea supported by the study is the existence of a positive relationship between the participation in FP consortia and the firms' economic performance. Nevertheless, this effect is not as direct as in other public programs, such as Eureka (Benfratello and Sembenelli, 2002). At this respect, it is necessary to take into account that the evaluation criteria followed in the FP refers to scientific and technological excellence, coordination abilities of the consortium, European added value (in terms of critical mass of resources mobilised and contribution to Community policies) and potential to disseminate the knowledge and reach innovations¹⁵. Therefore, results must be assessed according to these criteria.

Obviously, the ideal situation is to get all those objectives, but the fact is that the market is not always the immediate receptor of research results, especially if we are talking about border research. Therefore, the direct impact of the FP uses to be an improvement in innovative capabilities that, to a large extent, are intangible assets, difficult to measure. Regarding intangible assets introduced in accounting, our work has demonstrated that the participation in the FP has a positive impact. The matter from the point of view of policy makers is how to capture the impact on the rest of intangible assets, following objective

¹⁵ Rules for Participation in the Sixth FP (Regulation (EC) No 2321/2002, Article 10). These criteria are quite similar to the ones of FP5.

and efficient criteria. Nowadays, surveys and interviews seem to be the best option in order to complement the analysis of financial information, since accounting systems are only valid instruments to value some intangible assets, such as capitalized R&D expenditure, patents and software.

The second conclusion is that the economic impact of the FP should be evaluated from a long term perspective, once the specific project is finished and the market dynamic has allowed firms to introduce innovations. Otherwise, impact assessments could be ignoring a relevant contribution on firms' performance.

Appendix 1: Definitions of variables

EBITDA margin	Earnings Before Interest, Taxes, Depreciation and Amortization divided by sales.
Exporter	Company exports during the period.
Firm size	Firm's number of employees in the current year (<10, 10-49, 50-99, 100-199, 200+)
FP budget for the specific programme	Percentage of the total FP budget allocated to each specific programme.
Geographical distance	Percentage of partners from Northern Europe, Eastern Europe and non-European countries in the total number of partners. The percentage is multiplied by 2 or 3 if the partners are, respectively, from 2 or 3 of the aforementioned geographical areas.
Granted project in the previous year	At least one of the Spanish firms involved in the consortium has participated in a granted project during the previous year.
High-tech services	Company belongs to the high-tech services (NACE2 codes 64, 72, 73).
High and medium-tech manufacturing	Company belongs to any high or medium-tech manufacturing sectors (NACE2 codes 24, 29, 30, 31, 32, 33, 34, 35).
Intangible fixed assets per employee	Ratio between intangible fixed assets and total employment in the current year (in logs.)
Labour productivity	Sales per employee (in logs.)
Leader nationality	The leader of the consortium is (British, Dutch, French, German, Italian, Spanish).
Liquidity ratio	Shareholders' funds in non-current liabilities in the current year
Participation of organisations	Number of non-entrepreneurial organisations in the total number of consortium members in the proposal.
Prior experience in FP proposals	The Spanish firm applied to the FP in the edition previous to the current one.
Prior experience in FP granted projects	At least one of the Spanish firms involved in the consortium has participated in a cooperative project financed during the FP edition previous to the current one.
Region	Firm is located in (the Basque Country, Catalonia, Madrid, Valencia).
Rejected proposal in the previous year	At least one of the Spanish firms involved in the consortium has participated in a rejected project during the previous year.
Size of the consortium	Total number of members (firms, public organisations or other institutions) in the consortium (in logs).
Stock market	Company is listed on the stock market.
Tangible fixed assets per employee	Ratio between tangible fixed assets and total employment in the current year (in logs.)
Technological area	Project is related to (ICT, new materials, environment and energy, transport, agro-food, aeronautic and aerospace, innovation programmes).

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