THE IMPACT OF INTERNATIONAL RESEARCH JOINT VENTURES ON SMEs PERFORMANCE

Ascension Barajas[a*], Elena Huergo[b**] and Lourdes Moreno [b**]

[a]*Department of Impact Analysis, CDTI, Madrid, Spain;*
[b]*GRIPICO - Department of Economic Analysis, Universidad Complutense de Madrid, Spain*

January 2012

Abstract

The objective of the present study is to analyse the effect of technological cooperation on SMEs performance consideringtwo dimensions: technological and economic results**.** For that purpose, we use a data set containing information about participants in research joint ventures supported by the SME-specific measures of the sixth Framework Programme. Empirical evidence corroborates a direct and positive impact on technological assets of participants. On the part of the economic indicators, EBITDA per employee and sales are positively influenced by the improvement of technological background. The same results are found for productivity. All those effects are effective in the medium term, confirming that SMEs use to be involved in market-oriented R&D projects.

Keywords: research joint ventures, SMEs, impact assessment

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

The authors benefit from presentations at the CONCORD 2011 (Sevilla) and at the Seminar at the Department of Applied Economics II (Universitat de València), and especially from suggestions by Bronwyn Hall and Juan Mañez. All errors are ours. This research has been partially funded by the CICYT project ECO2010-19847.

* Corresponding author: CDTI (Centre for the Development of Industrial Technology). Dpto. de Estudios y Calidad. Dirección de Control de Resultados e Indicadores. C/ Cid 4, 28001. Madrid. España. E-mail: abi@cdti.es.
** GRIPICO (Group for Research in Productivity, Innovation and Competition). Dpto. Fundamentos del Análisis Económico I. Facultad de CC. Económicas y Empresariales. Universidad Complutense de Madrid. Campus de Somosaguas. 28223 Madrid. España. Tel.: +34 913942408. Fax: +34 913942561. E-mail: ehuergo@ccee.ucm.es; lmoreno@ccee.ucm.es.

1. Introduction

In general, empirical literature on R&D cooperation concludes that big companies have a greater probability to cooperate, due to their higher technological capability and the considerable scope of their R&D projects (Bayona et al., 2001; López, 2008). Nevertheless, current trends indicate that cooperation is taking a relevant roll within corporative strategies of innovative firms, regardless of their size. The increasing dynamism of SMEs in intensive industries, such as biotechnology and ICT, cooperating with other companies and with research institutions, illustrates this fact. Although the percentage of firms cooperating on innovation activities is much higher considering large firms, the available data (OCDE, 2009) show a relevant activity of SMEs in some countries such as Finland (28% of all SMEs cooperate), Austria (18%) or France (24%, considering only manufacturing SMEs).

Public policies aiming to encourage cooperation between SMEs and research centers have been implemented by the R&D Framework Programme of the European Union (FP) since its third edition, being strongly reinforced in the fifth and the sixth ones. SMEs can be supported by the classical actions, such as Integrated Projects or Specific Targeted Research Projects, but also through the specific measures for small companies. These measures follow two schemes. The Cooperative research scheme supports European SMEs with a specific research objective or need but without (or limited) technological capacity. Thus, a great part of the technological development will be done by the R&D performers involved in consortia. SMEs own all intellectual property rights resulting from the project but R&D performers may benefit from preferential use of the outcomes. The Collective Research scheme is similar, but specifically oriented to SMEs associations. Both schemes follow a bottom-up approach and there is neither thematic nor technological priority set up by the European Commission. Under the sixth FP, the evaluation criteria stress the business interest of the project and not only its technological novelty.[1]

According to qualitative analysis carried out under the auspices of the European Commission, a high percentage of supported SMEs reach their own goals (European Commission, 2010). Nevertheless, this approach is not able to quantify at what extend R&D cooperation improve firms performance. The objective of the present study is to

[1] For a more detailed description of RJVs taking place under the FP, see Barajas and Huergo (2010) and Barajas et al. (2011).

analyzewhether research joint ventures (RJVs) have a positive impact on SMEs performance considering two dimensions: technological and economic results. With this approach, we study a set of key performance indicators.

The empirical research is divided in two phases. First, through the estimation of a knowledge production function, we measure the impact of the SMEs participation in R&D consortia supported within the FP on technological results, proxied by intangible fixed assets. Second, we analyze whether the participation has also a significant impact on three economic performance indicators: sales, EBITDA and labour productivity.

For this purpose we integrate two data sets. The first one, owned by the Center for the Development for Industrial Technology (CDTI, the public organism in charge of monitoring the participation of Spanish firms within the FP), contains much relevant information about the SME-specific measures of the sixthFP (rejected and supported projects) and the participants. The second one is the SABI database, which consists of company accounts for over 1,000,000 Spanish firms. The resulting database could be considered an original and powerful instrument to measure the impact of the FP on economic performance for a period large enough to capture the medium and long-term effect of the FP R&D projects.

Overall, we compile a homogeneous sample that consists of an unbalanced panel of 41,800 observations, 10,450 companies, and 1,526 proposals. Available data allow us to consider variables related to the characteristics of consortia (leadership, geographical origin of partners, technological area) and the economic performance of SMEs.

Our results corroborate a direct and positive impact of SME-specific measures on technological assets of participants. Labour productivity, sales and EBITDA are also positive influenced by the improvement of technological background. All these effects are effective in the medium term, confirming that SMEs use to be involved in market-oriented R&D projects. From the aforementioned results and complementary evidence obtained in this paper, some conclusions will be drawn regarding the interest of policy makers.

The rest of the paper is organized as follows. Section 2 summarizes previous evidence about the impact of cooperative agreements by SMEs. Section 3 describes the empirical model and the data. In Section 4, we present the results and, finally, section 5 concludes.

2. SMEs and technological agreements

Empirical papers based on the resources-based theory and the absorptive capacity approach corroborate that internal technological competences facilitate the access to resources generated outside the firm (Cohen and Levinthal, 1990). In particular, external knowledge could be internalized by innovative firms throughout technological alliances. As empirical evidence shows, the probability of a firm to be involved is this type of alliances is positively related to its own R&D competences. Although this affirmation is generally confirmed by researchers, there is no clear consensus about how to measure internal capacity. As we will see, this discussion determines our understanding of the core topic of the present paper: the participation of SMEs in RJVs.

Frequently, R&D capacity has been related to firm size, assuming that it is necessary a critical mass of resources to generate and maintain R&D assets. In this regard, empirical evidence confirms that big companies have a higher probability of participating in RJVs (Bayona et al., 2001; Cassiman and Veugelers, 2002; Miotti and Sachwald, 2003; Negassi, 2004; López, 2008).

In line with these evidences, statistics show that SMEs tend to collaborate less than large firms (OCDE, 2009). This fact can be explained by disadvantages related to the setting up of communication channels with R&D organisations (Rothwell and Dodgson, 1991) and by the high risk associated to the partner selection. Therefore, outsourcing could be a suitable alternative for many SMEs (Narula, 2004), although the lack of financial resources negatively affects the probability of gathering external knowledge, wherever its origin is (Bougrain and Haudeville, 2002).

However, other authors stress that, in spite of (or because) their smaller size, cooperation is a core strategy for innovative SMEs aiming to acquire external resources and, doing so, to compete with big companies (Audretsch and Vivarelli, 1996; Rothwell and Dodgson, 1991). Collaboration could be so important that a "*firm's competitiveness may in fact be determined more by its external network than its size*" (Narula, 2004). Therefore, the effect of size on collaboration should be qualified by the positive influence of other factors, such as the existence of an own R&D unit (Kleinknecht and van Reijnen, 1992); the relative importance of R&D personnel (Belderbos et al., 2004); the previous experience in collaboration (Hernán et al., 2003) or the number of registered patents

(Colombo et al., 2009). Taking a step forward, Barge-Gil (2010) considers not only the frequency of collaboration, but also the type of firms for which cooperation is more relevant. Using a sample of firms with internal R&D activities, he concludes that companies outside high-tech sectors and smaller firms with greater needs of external knowledge have a higher probability to be cooperate-based innovators. Thus, the decision to cooperate seems to be influenced by a combination of internal capacity and external needs.

Absorptive capacity has also been considereda key factor to explain the access to international networks. Costs associated to geographical distance could decrease if the cognitive distance between partners is lower. For a sample of high-tech small firms, De Jong and Freel (2010) demonstrate that increasing R&D expenditure is associated with geographically distance collaboration. This research is focused on a specific type of SMEs, characterized by a higher technological capacity. A more extensive analysis of international technological alliances reflects that European SMEs are more focused on intra-EU and intra-country networks than big companies (Belderbos et al., 2004). In this line, Barge-Gil (2010) corroborates that being involved in international partnerships is negatively correlated to the frequency of collaborations. These results reflect that, despite the improvements in communication and information technologies, costs associated with geographical distance still matter, especially for SMEs with a medium or low technological level.

The complex nature of collaboration is present also in the impact assessment literature. Although the theory states clearly that collaboration improves firms' innovativeness, empirical research faces many obstacles to measure the effect of R&D partnerships on firms' performance, mainly because of the lack of suitable and homogeneous indicators.

Following the resource-based theory, cooperative and in-house R&D activities are considered complementary strategies aiming to increase technological capacities of firms. In order to measure this effect, many authors have built objective performance indicators related to technological capabilities (mainly from patents databases) and have concluded that R&D partnerships have the predicted positive effect on internal capacity (Mowery et al., 1998; Branstetter and Sakakibara, 2002; Scott, 2003). Other papers find a positive relationship between cooperation with universities and research centers and innovation output measured by the volume of sales due to new products (Lööf and Heshmati, 2002; Faems et al., 2005; Lööf and Broströn, 2008).

Empirical evidence also seems to corroborate that, taking into account different types of partners and different cooperation objectives, the more market-oriented the project is, the higher the probability of finding positive economic effects (Benfratello and Sembenelli, 2002; Cincera et al., 2003; Belderbos et al., 2004; Bayona-Sáez and García-Marco, 2010).

For the specific case of SMEs, Bougrain and Haudeville (2002) do not find a significant effect of cooperation in innovation success (measuring success as not having incidences in the development of supported projects). Other authors explore new perspectives aiming to measure the theoretically positive effect of cooperation on SMEs. Nieto and Santamaría (2010) draw a comparison with big companies and conclude that technological partnerships could improve the innovativeness of SMEs compared to that of large firms. They also find a significant pushing effect of collaboration on non-innovative SMEs, which decide to start to innovate with partners.

Literature shows a growing interest in analysing the collective of new technology-based firms (NTBFs), since they are a clear example of SMEs with great R&D internal capacity and with high constrains of resources. Colombo et al. (2009) find a positive relationship between the number of partnerships and NBTFs performance (measured by total factor productivity). They remark that this effect increases when industrial partners are located in countries which are in the forefront of knowledge generation.

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. This conclusion is also valid for the case of cooperative projects carried out under the FP scheme. Aiming to measure the effect of this programme on firm performance, many authors have focused their research on technological outputs (Luukkonen, 1998; Polt et al., 2008; Dekker and Kleinknecht; 2008) and on economic indicators (Benfratello and Sembenelli, 2002; Arnold *et al.*, 2008; Aguiar and Gagnepain, 2011). Whereas the effect on innovativeness is demonstrated, no clear evidence is obtained about economic performance. Barajas et al. (2011) go a step forward and corroborate that the impact of cooperation within the FP on firms' productivity is produced through the indirect channel of intangible assets. This result is obtained considering that FP consortia carry out precompetitive projects and their impact should be measuredfrom a long-term perspective.

For the specific case of SMEs, empirical evidence reinforces the existence of a positive technological effect. Thus, Arnold et al. (2008) remark that, in live sciences or energy, the most relevant impact of the FP is related to the increasing technological capabilities of SMEs. Dekker and Kleinknecht (2008) find a positive influence on R&D intensity for companies with fewer than 100 employees. In line with these results, the European Commission (2010) carried out a descriptive analysis of SMEs specific measures and states that, whereas 30% of participants obtained new IPR, the commercial exploitation of results is the least effective factor. On the contrary, the survey undertaken by the EC confirms that SMEs have improved the degree of R&D formalization and their own R&D capabilities, incorporating new scientific and technological knowledge and reinforcing their network abilities.

In line with previous literature, in next sections we analyze the effect of R&D cooperation on SMEs, considering both technological and economic outputs and using a methodology that allows for capturing its direct effect as well as the indirect one. A major difference with respect to the works mentioned above is that our dataset is rich enough to measure medium term effects on relevant and objective performance indicators, such as intangible assets, sales, EBITDA and productivity.

3. Empirical model and data

As we have explained previously, we want to quantify the impact of SME-specific measures financed by the sixth FP on SMEs performance considering two dimensions: technological outputs and economic results. Specifically, in a first step we analyse how the participation of an SME in an FP project affects its generation of new knowledge. This new knowledge is approached by intangible fixed assets reported in firms' accounting, which include, among others, capitalized R&D expenditure, intellectual property and software.

Corrado et al. (2005) distinguish three main categories of intangibles: (1) computerized information; (2) innovative property and (3) economic competencies. The last one, which refers to brand equity, human capital training and organizational management, is beyond the scope of this work due to the lack of data. According to Van

Ark et al. (2009), investments of Spanish firms in computerized information and innovative property represent more than 65% of total intangible private investment.

We suppose that our data on intangible assets constitute an indirect measure of innovation output, given that expenditures generated in the cooperative project related to R&D, software and patenting will be capitalized once the firm recognize that these outlays will generate future benefits. Formally, the equation in our model is:

$$k_i = p_i \gamma + x_{1i}^{'} \beta_1 + e_{1i} \quad [1]$$

, where $i = 1, \cdots, N$ index firms, k_i stands for a firm's intangible fixed assets, p_i denotes the SMEs participation within the FP, and x_{1i} is a vector of other control variables.

After this, in a second step we use alternative measures of economic success g_i as dependent variables: EBITDA, sales and labour productivity. The equation takes the form:

$$g_i = p_i \delta + x_{2i}^{'} \beta_2 + e_{2i} \quad [2]$$

, where x_{2i} stands for other additional controls in the equation. This set of controls also includes intangible assets. Therefore, if we find that intangibles are affected by participation within the FP, and that these intangibles increase the firm's performance, the economic impact of the cooperative project will also be supported by the evidence.[2]

Given that R&D projects supported by the SME-specific measures of the FP are generally medium-term projects[3] and that target recipients are European SMEs with a specific research objective or need but without (or limited) technological capacity, we believe that it is reasonable to analyze their impact once the project has formally finished. For this reason, we will experiment alternatively by including the dependent variables in equations [1] and [2] referred to the periods t+2, t+3 and t+4 relative to the awarding year. This allows us to study the lag required to obtain a positive impact of the FP participation on technological capabilities and labor productivity.

Following Barajas et al. (2011), in this analysis we take into account that the participation in this specific type of cooperative projects implies a selection process that

[2] We take care of the endogeneity of k_i in this equation by using the predicted values from equation [1] in the estimation.
[3] The average duration of a project is around 24 months.

includes both the self-selection by participants to join the consortia and the selection of projects by the European Commission to award the public aid. To face this double-selection problem, instead of the dummy for observed participation, in empirical specifications of [1] and [2] we include the prediction of the probability of participating that we obtain from an auxiliary estimation of two equations for the probability of applying for a cooperative project (involving at least one Spanish SME) and the probability of awarding by the European Commission. Assuming than the error terms of both equations can be correlated (with correlation coefficient equal to rho), we estimate these two equations as a Probit model with sample selection by maximum likelihood.

The database used for the analysis is provided by the CDTI, which is the public organisation in charge of monitoring the participation of Spanish firms within the FP. The CDTI database includes information about all the applications for the SME-specific measures financed by the sixth FP (2002-2006).[4] Granted and rejected proposals in which at least one Spanish firm participated within are considered for the present work.

This information from the CDTI database has been complemented with the SABI database that contains the company accounts of more than 1,000,000 Spanish firms between 1998 and 2009. The merger has been possible because Spanish SMEs are identified through their company tax codes in both databases.

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 a firm to be SME when its number of workers do not exceeds 200, although the threshold in international statistics is usually set at 250. Firms employing between 10 and 200 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] The

[4] Specifically, Cooperative Research projects and Collective Research Projects are considered.

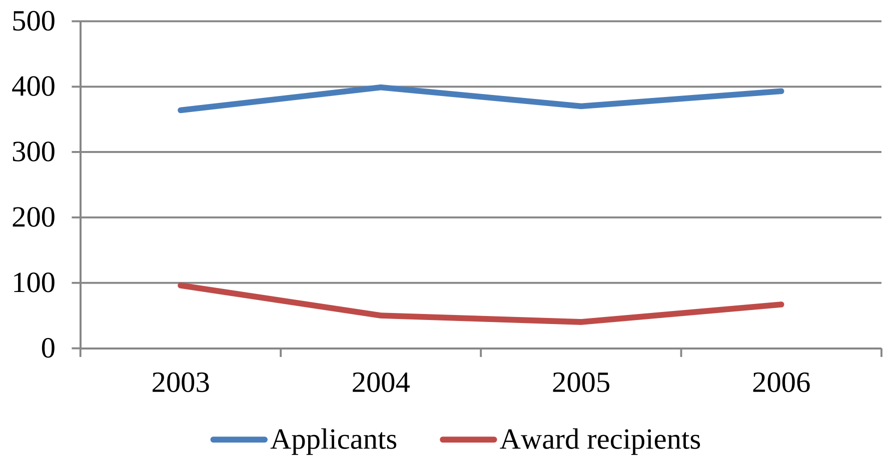
[5] Coverage of the data is basically restricted to firms that have at least 10 employees (annual average), but we have also included 615 micro-companies (0.5% of the CCD, chosen again by means of a random sampling scheme), given that 330 applications for SME-specific measures belong to this category.

sample used in the empirical analysis of participation refers to the period 2003 to 2009[6] given that we use the forward values of output measures to capture long-term relationships.

Since our objective is to analyze the impact of collaboration within the SME-specific measures of the FP 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 per firm and year. We have given priority to those supported projects with bigger subsidies. 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 intangible fixed assets. Overall, the final sample consists of an unbalanced panel of 41,800 observations; 10,450 companies; and 1,526 applications.

The CDTI database allows us for analyzing specifically those aspects determining the firm's decision to engage in a cooperative project, those factors related to agency selection[7], and the impact of participation on the firm's output. Figure 1 shows the number of applicants and awarded firms in this database and Table 1 presents the descriptives of the main variables in our model.

Figure 1: Spanish applicants and awarded firms by year.



Source: CDTI database and own elaboration.

[6] Although the sixth FP was formally launched in 2002, during that year there is no application registered.
[7] Proposals are evaluated by independent experts according to some common criteria. However, such information is absent from our database.

Award recipients seem to have more profits than non participants. On the contrary, the labour productivity of participants is lower, although the difference is small. As expected, the presence of awarded firms is greater among activities corresponding to a high and medium-tech manufacturing sector or a high-tech service sector. Notice, however, that the average of intangible fixed assets, that will be our indirect measure of the firms' technological capabilities, is lower for awarded firms both in terms of volume and when defined relative to size. This is coherent with the evidence provided by the European Commission (2010) that suggests that the SMEs participating in the SME specific measures have less formalised R&D activities compared to the SME participants in the other FP measures.

Table 1: Descriptive statistics of main variables

	Total sample	**Applicants**	**Award recipients**
Age (years)	15.8	17.5	17.1
Construction (%)	3.6	4.1	4.0
EBITDA (€)	587,674	637,762	666,139
EBITDA per employee (€)	19,614	18,470	20,335
Exporter (%)	25.3	44.3	43.5
High and medium-tech manufacturing (%)	11.2	20.5	18.2
High-tech services (%)	4.5	7.3	6.3
Intangible fixed assets (€)	358,293	437,088	314,209
Intangible fixed assets per employee (€)	13,667	12,260	8,832
Labour productivity (sales per employee) (€)	220,394	207,026	207,717
Leverage ratio (%)	66.4	65.5	65.7
Sales (€)	8,087,127	7,593,896	7,542,639
Size (nº of employees)	30.7	42.2	42.1
Tangible Fixed Assets (€)	1,721,069	1,977,829	1,967,115
Tangible Fixed Assets per employee (€)	71,670	58,083	70,186
Number of observations	41,800	1,526	253

In what follows we investigate econometrically the relationships between these variables and the SMEs participation in the sixth FP taking into account that the impact of these cooperative agreements is likely to occur in the medium to long term.

4. Results

In this section, we present the results of estimating the impact of SME-specific measures financed by the sixth FP on some SMEs performance measures. First, we estimate the determinants of the generation of new knowledge (equation [1]), approaching the innovation output by the ratio of intangible fixed asset over employment (in logarithms). Second, we estimate equation [2] using three alternative dependent variables - labour productivity, EBITDA and sales- as measures of a firm's economic performance. In this second stage, to take into account the potential endogeneity of knowledge capital, the predicted value of intangible fixed assets per employee from the equation [1] is included as explanatory variable.

Impact on technology capabilities

Table 2 shows the results of estimating the impact of supported cooperative projects on technological output (equation [1]). As already stated, our measure of new knowledge is the ratio of intangible fixed assets over employment. This measure can be interpreted as an indirect measure of technological output, given that the knowledge generated in R&D projects will usually be reflected by the volume of intangibles inside the firm.[8]

Following the suggestion of most empirical evidence (Benfratello and Sembenelli, 2002; Dekker and Kleinknecht, 2008), we assume that the expected economic results from cooperative FP projects will be generated in the medium-long term. In Barajas et al. (2011) a period t+5 is considered because supported projects present a clear pre-competitive orientation. However, as the European Commission (2010) points out, the nature of R&D activities supported under SME-specific measures of the sixth FP focuses on finding solutions to technical problems that SMEs identify, that mainly constitute applied research. Specifically, the most important objective for SMEs in this kind of projects is the development of a new or improved product. Moreover, Luukkonen (1998) confirms that small firms participating in the FP have shorter-term objectives than big companies.In this sense, we experiment by including alternatively our dependent variable referred to the periods t+2, t+3 and t+4 relative to the awarding year.

To control for the double-selection process in the participation within FP programs (participants self-selection and the selection by the European agency), instead of introducing the observed status of participation, following Barajas et al. (2011) we use the predicted value of the probability of participating obtained from an auxiliary estimation. Specifically, the results of this auxiliary estimation, made by means of a Heckman Probit

[8] Other measures of technological outputs as product and process innovations used in previous empirical evidence are not available in our database.

procedure, are presented in the Table B1 of Appendix B.[9] Finally, the estimation of equation [1] is carried out by OLS using a random effect model for panel data, assuming that all explanatory variables are strictly exogenous.

Table 2: Intangible fixed assets per employee

	t+2			*t*+3			*t*+4		
	Coefficient		Std. E.	Coefficient		Std. E.	Coefficient		Std. E.
SME participant	0.102		0.172	0.538	**	0.198	0.816	***	0.272
Exporter	0.273	***	0.030	0.282	***	0.030	0.280	***	0.032
Size dummies (nº. of workers)									
From 10 to 49	0.119	***	0.021	0.127	***	0.022	0.147	***	0.026
From 50 to 99	0.160	***	0.031	0.195	***	0.034	0.202	***	0.041
From 100 to 200	0.176	***	0.038	0.152	***	0.043	0.197	***	0.052
Age dummies (years)									
From 6 to 10	-0.023		0.023	-0.049	**	0.025	-0.076	**	0.032
From 11 to 20	-0.105	***	0.028	-0.139	***	0.028	-0.126	***	0.033
More than 20	-0. 142	***	0.033	-0.150	***	0.034	-0.139	***	0.040
High & medium-tech manuf.	0.195	***	0.039	0.200	***	0.038	0.205	***	0.040
High-tech services	0.628	***	0.069	0.644	***	0.065	0.665	***	0.077
Construction	-0.075		0.056	-0.055		0.056	-0.054		0.058
Sigma of u	1.096			1.069			0.944		
Rho	0.738			0.712			0.591		
Number of observations	36, 393			26,487			16,527		
Temporal Dummies	2004-2007			2004-2006			2004-2005		

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

As can be seen in Table 2, the predicted probability of participation positively affects our measure of technological output but it is necessary a delay to obtain a positive impact. Only three years after the project has been awarded, the coefficient for the SME participation is significant.[10] In this case, being an SME that cooperates within the FP increases the ratio of intangible fixed assets over employment almost 55%. As we

[9] In Table B1, the first column exhibits the coefficients of the Probit model for the SMEs decision to apply for an FP project, while the second one corresponds to the determinants of the probability of being awarded the subsidy by the EC. The explanatory variables included in this estimate also follow the selection made by Barajas et al. (2011) for a sample of SMEs and large firms which apply for other FP programs. In addition, specific characteristics of Cooperative and Collective Projects and the firms´ age are considered. The results basically confirm the evidence obtained in the previous paper and the empirical evidence about the determinants factors of R&D cooperation for Spanish economy (see, for example, Segarra-Blasco and Arauzo-Carod, 2008, Marin and Siotis, 2008, and Santamaría and Rialp, 2007). Find the exact definition of the variables in Appendix A and their descriptives in Table B2 of Appendix B.

[10] Note that, although the average duration of a project is around 24 months, the phase of negotiation with the European Commission before the awarding could also take several months.

expected, the impact is even higher if the dependent variable is referred to the period $t+4$: the cooperation increases the ratio more than 80%. This result is in concordance with those presented by Dekker and Kleinknecht (2008). In the same line, the post evaluation of the European Commission (2010) establishes that the participation of SMEs within the fifth and sixth FP increased their degree of R&D formalisation (yearly R&D budget, for example).

As for the control variables[11], being an exporter positively affects the generation of new knowledge. Specifically, the ratio of intangible fixed assets per employee of the firms operating in foreign markets is a 28% bigger than the ratio of non-exporters. The size dummies also present a positive effect, although their impact is nonlinear. Most empirical evidence for Spanish manufacturing also provides a positive relationship between firm size and the probability of obtaining product or process innovations.

However, we find a negative effect of the firm's age. This result is in accordance with the prediction of the theoretical model developed by Keppler (1996) that establishes that the number of innovations per firm at a given moment will be higher the younger the cohort is. For Spanish industry, Huergo and Jaumandreu (2004) support this result.

Firms belonging to high-tech manufacturing and services and medium-tech manufacturing have a higher potential of generating technological outputs. The level of intangible fixed assets per employee is almost 20% higher in manufacturing firms and 65% in services.

Impact on economic performance

To analyze the impact of R&D cooperation on economic performance of SMEs we used three alternative measures of economic success: labour productivity, EBITDA over employment and sales. Estimations of equation [2] for these three variables are shown in Table 3. Again, estimations are carried out using random effects models for panel data. In this table, dependent variables refer to the period $t+3$ relative to the awarding year which is the first period where a positive impact of the FP participation on technological output is

[11] The coefficients of the control variables don't differ among the columns.

achieved. We have also tried with dependent variables referred to periods *t*+2 and *t*+4, but the results do not differ substantially[12].

The coefficients reported in Table 3 are elasticities or semi-elasticities, since the dependent variables are expressed in logarithms. As control variables we consider dummy variables referring to size, industry, year, firm age and location. In addition, we include a proxy of physical capital intensity measured throughout the variable "tangible fixed assets per employee".

Finally, to capture the effect of knowledge accumulation, we use the predicted value of "intangible fixed assets per employee" from equation [1] in order to control for potential endogeneity. When the dependent variable is labour productivity, the estimation allows for comparing our results with some previous empirical evidence which relates technological output to productivity. The EBITDA per employee can also capture improvements in the firm's efficiency or market share associated with the generation of new knowledge. When we introduce sales as dependent variable, this equation can be interpreted as a kind of production function; therefore, in addition to the number of employees, as inputs we include the magnitude of tangible and intangible fixed assets (in logarithms) instead of their ratios over employment.[13]

These estimations permit to analyze whether R&D cooperation supported by the FP has not only a direct effect but also an indirect effect on SMEs economic success. Specifically, if we find that FP participation has a significant effect on our measures of economicsuccess, a direct effect of cooperation on economic performance would be corroborated. In addition, if we find a positive relationship between the proxy of technological output and labour productivity, EBITDA per employee or sales, this would suggest the existence of an indirect economic impact of R&D cooperation.

[12] These results are available from the authors upon request.

[13] In this case, the prediction of "intangible fixed assets" (in logs.) is obtained from an estimate where this variable is the dependent variable in equation [1]. The results when the dependent variable refers to period *t*+3 are shown in Table B3 of Appendix B.

Table 3: Labour productivity, ETBIDA per employee and Sales

	Labour productivity (t+3) (1)			ETBIDA per employee (t+3) (2)			Sales (t+3) (3)		
	Coefficient		Std. E.	Coefficient		Std. E.	Coefficient		Std. E.
SME participant	-0.108		0.089	0.000		0.429	-0.142		0.088
Intangible fixed assets per employee (t+3)[(p)]	0.120	***	0.012	0.250	***	0.026			
Intangible fixed assets (t+3)[(p)]							0.111	***	0.006
Tangible fixed assets per employee (t+3)	0.171	***	0.008	0.396	***	0.017			
Tangible fixed assets (t+3)							0.099	***	0.006
Number of employees							0.620	***	0.014
Exporter	0.492	***	0.023	0.423	***	0.056	0.623	***	0.024
Size dummies (nº of workers)									
From 10 to 49	-0.036	**	0.015	0.320	***	0.049	0.051	***	0.018
From 50 to 99	-0.051	**	0.023	0.211	***	0.074	0.111	***	0.030
From 100 to 200	-0.042		0.028	0.094		0.091	0.180	***	0.037
Age dummies (years)									
From 6 to 10	0.026	*	0.014	0.130	**	0.057	0.039	***	0.014
From 11 to 20	0.067	***	0.018	0.123	**	0.061	0.113	***	0.017
More than 20	0.122	***	0.023	0.065		0.072	0.207	***	0.022
High and medium-tech manufacturing	-0.010		0.024	0.123	*	0.071	0.003		0.025
High-tech services	-0.303	***	0.047	0.086		0.113	-0.315	***	0.049
Construction	0.243	***	0.073	0.297	**	0.132	0.263	***	0.077
Sigma of u	0.873			1.815			0.877		
Rho	0.866			0.483			0.884		
Number of observations	26,204			26,407			26,204		

Std. E.: Estimated standard error. Coefficients significant at: 1%***, 5%**, 10%*. All regressions include the constant and temporal and regional dummies. Dummies excluded for firms with fewer than 10 workers and firms less than 5 years old. [(p)]: predicted value from equation [1].

As shown in Table 3, regardless the dependent variable the FP participation is not statistically significant. Therefore, it seems that technological cooperation within FP does not have a direct effect on performance. This result is in concordance with Dekker and Kleinknecht (2008) who obtain that the sales of innovative product per employee –as measure of innovative output- of French, German and Dutch firms are not enhanced by the participation in the FP. In a similar way, Benfratello and Sembenelli (2002) do not find significant differences in labour productivity of firms that have participated in the third and fourth FP, and the European Commission (2010) does not detect any impact of project participation on economic performance of the SME, suggesting that, although in many projects new technologies have been developed, these have not been translated yet into potential commercial products.[14]

However, our results show that the impact of intangible fixed assets per employee (or intangible fixed assets) on economic performance is clearly significant, reflecting a difference in favor of innovative firms. Specifically, if the ratio of intangible assets duplicates, it causes productivity to grow more than 12%. These results are in line with Hao et al. (2008), Van Ark et al. (2009) and Roth and Thum (2010). These works confirm for several countries that a relevant part of the labor productivity growth is explained by investments on intangibles.

The effect on EBITDA per employee is also positive, being its magnitude the double than for productivity. With respect to the sales, the elasticity of sales to intangible fixed assets is 0.1%. As we have shown in the previous section, given that firms participating within the FP present higher technological outputs, this result supports an indirect effect of cooperation on these performance variables.

In addition, the coefficient for tangible fixed assets suggests that capital-intensive firms are also more productive, and present bigger earnings. As in previous empirical evidence, exporting firms are also more efficient than non-exporting firms. Firms operating in international markets also present a higher ETBIDA per employee. This last result is in line with Moreno and Rodríguez (2010), which find that Spanish manufacturing non-exporters have smaller margins than persistent exporters.

With respect to the size dummies, we find a negative non-linear relationship between firm size and productivity. However, larger firms present a greater ETBIDA per employee. The results also reflect a positive effect of firm's age on economic performance. Previous empirical evidence shows that firms entering in the industry experiment high growth rates of productivity. Huergo and Jaumandreu (2004) confirm this result but also show that the growth of surviving firms converge to the one of incumbents.

---

[14] Using a different methodology to control the selection bias, Aguiar and Gagnepain (2011) analyze the impact on productivity labor of the participation on the fifth European FP using the CORDIS and the AMADEUS data bases. They take into account the different instruments from the programme (Key Actions) and they obtain that the instantaneous impact of participation is quite heterogeneous across them but they are rarely significant.

Finally, as expected, firms from high-tech and medium-tech manufacturing industries present larger levels of ETBIDA per employee. However, the earnings of firms from high-tech services do not differ from the other sectors. This result is even clearer when we analyse labour productivity and sales: firms in high-tech services present smaller levels of both variables. However, the results obtained for firms operating in Construction are in accordance with the Spanish cycle behaviour during this period. The participation of this industry in the Spanish economy has strongly increased due to its high growth rate.

5. Conclusions

The objective of the present paper is to analyse the effect of technological cooperation on SMEs performance. For this purpose we use a data set that contains information about Spanish firms participating in consortia supported by the specific SMEs measures of the FP. This type of RJVs is characterized by the low technological capabilities of industrial partners, in such a way that research performers involved in consortia carry out the great part of R&D activity. Through this scheme, the European Commission aims to incentive SMEs to find technological solutions that improve their competitiveness.

Empirical evidence shows that RJVs have a clear positive effect on technological capabilities of firms (Branstetter and Sakakibara, 2002; Scott, 2003), although there is no general accepted conclusion about the economic impact. Economic performance seems to be more influenced by the type of technological partner, the distance to the market of the cooperative project and the type of firm (Benfratello and Sembenelli, 2002; Cincera et al., 2003; Belderbos et al., 2004; Bayona-Sáez and García-Marco, 2010; Colombo et al., 2009). However, Barajas et al. (2011) demonstrate that, five years after the end of the project, cooperation has an indirect and positive effect on productivity thanks to increments in intangible assets.

For the specific case of SMEs, the literature remarks that cooperation could be a suitable strategy to access external knowledge when resources constrains are an obstacle to innovate (Audretsch and Vivarelli, 1996; Rothwell and Dodgson, 1991). In this line, Nieto and Santamaría (2010) find that technological partnerships could improve the innovativeness of SMEs compared to that of large firms.

In the present paper, we confirm the positive impact of R&D cooperation on firms' performance. In particular, we find that: (1) being a cooperative SME increases the ratio of intangible fixed assets over employment almost 55% and (2) the impact of intangible fixed assets on economic performance, measured alternatively by productivity, EBITDA per employee or total sales,is clearly significant. Nevertheless, all effects are significant three years after the end of the project, confirming that SMEs participating in the FP have shorter-term objectives than big companies (Luukkonen, 1998).

These results are in line with previous empirical evidence on cooperation, although our methodology allows us to go a step forward and demonstrate that economic impact of RJVs should be analysed as a consequence of increasing technological capabilities. This evidence could be relevant regarding future impact assessment activities of cooperation programmes, and specifically of the FP.

Considering that those small firms with limited or null technological capability are the target recipients of the SMEs specific measures, we can conclude that this programme has reached one of its main goals: results show that firms obtain significant gains in intangible assets. Under the sixth FP, the evaluation criteria established by the European Commission stress the business interest of the project. However, descriptive analyses (European Commission, 2010) show that firms do not exploit technological results as expected. Probably, SMEs need an additional support for the post-cooperation phase, in order to overcome commercialization barriers. Also, R&D performers should be involved in this phase, to guarantee that the final output of the project meets all the market needs.

However, empirical evidence obtained in this paper indicates that the effect of collaboration on performance indicators is similar for SMEs than for big companies, although the extent of R&D projects, and consequently the time period for their impact, tends to be shorter. Assuming that SMEs with low or almost null technological capabilities are involved in different kind of consortia, it seems appropriate to support these companies with specific measures.

References

Aguiar, L. and P. Gagnepain (2011), "European Cooperative R&D and Firm Performance", paper contributed to the ENTER Jambouree 2011, European Network for Training in Economic Research.

Arnold, E., T. Åström, P. Boekholt, N. Brown, B. Good, R. Holmberg, I. Meijer and G. van der Veen (2008), *Impacts of the Framework Programme in Sweden*. VINNOVA, Stockholm.

Audretsch, D. and M. Vivarelli (1996), "Firm size and R&D spillovers: evidence from Italy", *Small Business Economics* 8, 249–258.

Bayona, C., T. García-Marco and E. Huerta (2001), "Firms' motivation for cooperative R&D: An empirical analysis of Spanish firms", *Research Policy* 31, 1289-1307.

Bayona-Sáez, C. and T. García-Marco (2010), "Assessing the effectiveness of the Eureka Program", *Research Policy* 39, 1375–1386.

Barajas, A. and E. Huergo (2010), "International R&D Cooperation within the EU Framework Programme: Empirical Evidence for Spanish Firms", *Economics of Innovation and New Technology* 19(1–2), 87–111.

Barajas, A., E. Huergo and L. Moreno (2011), "Measuring the economic impact of research joint ventures supported by the EU Framework Programme", *Journal of Technology Transfer*, DOI: 10.1007/s10961-011-9222-y.

Barge-Gil, A. (2010), "Cooperation-based innovators and peripheral cooperators: An empirical analysis of their characteristics and behavior", *Technovation* 30, 195–206.

Benfratello, L. and A. Sembenelli (2002), "Research joint ventures and firm level performance", *Research Policy* 31, 493-507.

Belderbos, R., M. Carree, B. Diederen, B. Lokshin and R. Veugelers (2004), "Heterogeneity in R&D cooperation strategies", *International Journal of Industrial Organization* 22, 1237– 1263.

Bougrain, F. and B. Haudeville (2002), "Innovation, collaboration and SMEs internal research capacities", *Research Policy* 31, 735-747.

Branstetter, L.G. and M. Sakakibara (2002), "When Do Research Consortia Work Well and Why? Evidence from Japanese Panel Data", *American Economic Review* 92(1), 143-159.

Cassiman, B. and R. Veugelers (2002), "R&D Cooperation and Spillovers: Some Empirical Evidence from Belgium", *American Economic Review* 92(4), 1169-1184.

Cincera, M., L. Kempen, B. Van Pottelsberghe, R. Veugelers and C. Villegas (2003), "Productivity growth, R&D and the role of international collaborative agreements: Some evidence for Belgian manufacturing companies", *Brussels Economic Review* 46(3), 107–140.

Cohen, W.M. and D.A. Levinthal (1990), "Absorptive Capacity: A New Perspective on Learning and Innovation", *Administrative Science Quarterly* 35(1), 128-152.

Colombo, M.G., L. Grilli, S. Murtini, L. Piscitello and E. Piva (2009), “Effects of international R&D alliances on performance of high-tech start-ups: a longitudinal analysis”, *Strategic Entrepreneurship Journal* 3, 346-368.

Corrado, C.A., C.R. Hulten and D.E. Sichel (2005), “Measuring Capital and Technology: An Expanded Framework”, NBER Chapters, in: *Measuring Capital in the New Economy*, pages 11-46. National Bureau of Economic Research, Inc.

De Jong, J.P.J. and M. Frell (2010), “Absorptive capacity and the reach of collaboration in high technology small firms”, *Research Policy* 39, 47-54

Dekker, R. and A.H. Kleinknecht (2008), “The EU Framework Programs: Are they worth doing?”, MPRA Paper, 8503. University of Munich.

European Commission (2003), *SMEs in Europe 2003*. The European Observatory for SMEs. Luxembourg: Office for Official Publications of the European Communities.

European Commission (2010), *Impact assessment of the SME-specific measures of the Fifth and Sixth Framework Programmes for Research on their SME target groups outsourcing research*. Brussels: DG Research.

Faems, D., B. Van Looyand and K. Debackere (2005), “The role of interorganizational collaboration within innovation strategies: towards a portfolio approach”, *Journal of Product Innovation Management* 22(3), 238-250.

Hao, J., V. Manole, and B. van Ark (2008), “Intangible Capital and Growth – An International Comparison”, *Economics Program Working Paper Series*, EPWP#8 - 14, The Conference Board, New York.

Hernán, R., P. L. Marín and G. Siotis (2003), “An empirical evaluation of the determinants of Research Joint Venture Formation”, *Journal of Industrial Economics* 51(1), 75-89.

Huergo, E. and J. Jaumandreu (2004), “How does probability of process innovation change with firm age?”, *Small Business Economics* 22, 193-207.

Klepper, S. (1996), “Entry, exit, and innovation over the product life-cycle”, *American Economic Review* 86, 562-583.

Kleinknecht, A. and J. van Reijnen (1992), “Why do firms co-operate on R&D? An empirical study”, *Research Policy* 21, 341-360.

Lööf, H. and A. Broström (2008), “Does knowledge diffusion between university and Industry increase innovativeness?”, *Journal of Technology Transfer* 33(1), 73-90.

Lööf, H. and A. Heshmati (2002), “Knowledge capital and performance heterogeneity: a firm-level innovation study”, *International Journal of Production Economics* 76(1), 61–85.

López, A. (2008), “Determinants for R&D cooperation: Evidence from Spanish manufacturing firms”, *International Journal of Industrial Organization* 26(1), 113-136.

Luukkonen T. (1998), “The difficulties in assessing the impact of EU framework programmes”, *Research Policy* 27, 599-610.

Marín, P. L. and G. Siotis (2008), “Public policies towards Research Joint Ventures: Institutional design and participants’ characteristics”, *Research Policy* 37(6-7), 1057-1065.

Miotti, L. and F. Sachwald (2003), “Co-operative R&D: Why and with whom? An integrated framework of analysis”, *Research Policy* 32, 1481-99.

Mohnen, P. and C. Hoareau (2003), “What Type of Enterprise Forges Close Links with Universities and Government Labs? Evidence from CIS 2”, *Managerial and Decision Economics* 24(2-3), 133-145.

Moreno, L. and D. Rodríguez (2010), “Export activity, persistence and mark-ups”, *Applied Economics* 42(4), 475-488.

Mowery, D., J.E. Oxley and B.S. Silverman (1998), “Technological overlap and interfirm cooperation: implications for the resource-based view of the firm”, *Research Policy* 27(5), 507-523.

Narula, R. (2004), “R&D collaboration by SMEs: new opportunities and limitations in the face of globalisation”, *Technovation* 24, 153–161.

Negassi, S. (2004), “R&D co-operation and innovation a microeconometric study on French firms”, *Research Policy* 33, 365-384.

Nieto, M.J. and L. Santamaría (2010), “Technological collaboration: Bridging the innovation gap between small and large firms”, *Journal of Small Business Management* 48(1), 44-69.

OCDE (2009), *OCDE Science, Technology and Industry Scoreboard 2009*. Paris.

Polt, W., N. Vonortas and R. Fisher (2008), *Innovation Impact, Final report to the European Commission*, Brussels: DG Research.

Roth, F. and A.E. Thum (2010), “Does intangible capital affect economic growth?”, *CEPS Working Document* 335.

Rothwell, R. and M. Dodgson (1991), “External linkages and innovation in small and medium-sized enterprises”, *R&D Management* 21, 125–137.

Scott, T.S. (2003), “Absorptive Capacity and the Efficiency of Research Partnerships”, *Technology Analysis and Strategic Management* 15(2), 247-253

Santamaría, L. and J. Rialp (2007), “Determinantes de la elección del socio tecnológico: especificidades sectoriales y de tamaño”, *Cuadernos Económicos del ICE* 73, 37-64.

Segarra-Blasco, A. and J.M. Arauzo-Carod (2008), “Sources of innovation and industry–university interaction: Evidence from Spanish firms”, *Research Policy* 37, 1283–1295.

Van Ark, B., J.X. Hao, A.C. Corrado and C. Hulten (2009), “Measuring Intangible Capital and its Contribution to Growth in Europe”, European Investment Bank Papers 3/2009, European Investment Bank, Economic and Financial Studies.

Appendix A: Definition of variables

Age	Difference between the current year and the constituent year reported by the firm
Application in previous year	At least one of the Spanish firms involved in the consortium applied to the FP the previous year.
Biohealth	Project is related to bio and health technologies.
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization (in logs.)
Collective research project	Collective project
Construction	Company belongs to the construction activity
Exporter	Company exports during the period.
Firm size	Firm's number of employees in the current year (<10, 10-49, 50-99, 100-199
Granted project in the previous year	At least one of the Spanish firms involved in the consortium participated in a granted project 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).
ICT	Project is related to information and communication technologies.
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.)
Leadership	The leader of the consortium is (Spanish firm, Non-Spanish firm, Spanish Organism).
Leverage ratio	Ratio of total debts to total liability
Participation of Non-EU partners	At least one Non-EU partner is involved in the consortium
Participation of Central Europe partners	At least one Central Europe partner is involved in the consortium
Prior experience in 5FP proposals	The Spanish firm applied to the fifth FP.
Prior experience in 5FP granted projects	At least one of the Spanish firms involved in the consortium participated in a cooperative project financed during the fifth FP.
Rejected proposal in the previous year	At least one of the Spanish firms involved in the consortium participated in a rejected project during the previous year.
Tangible fixed assets per employee	Ratio between tangible fixed assets and total employment in the current year (in logs.)
Total budget (of consortium)	Total budget of the project financed during the sixth FP.

Appendix B: Complementary estimates

Table B1: Probability of participation within SME-specific measures of FP

	Probability of applying (1)				Probability of being awarded (2)			
	Coefficient			Std. E.	Coefficient			Std. E.
Time dummies								
Year 2004	-0.014		[-0.001]	0.036	-0.467	***	[-0.041]	0.120
Year 2005	-0.107	***	[-0.005]	0.037	-0.570	***	[-0.048]	0.127
Year 2006	-0.054		[-0.003]	0.036	-0.549	***	[-0.046]	0.122
Prior experience in FP								
Prior experience in 5FP proposals	0.528	***	[0.046]	0.051				
Application in previous year	1.030	***	[0.135]	0.072				
Rejected proposal in previous year	0.726	***	[0.075]	0.072	0.481	*	[0.072]	0.259
Prior experience in 5FP granted projects					0.147		[0.017]	0.134
Granted project in previous year					0.452	**	[0.067]	0.232
Firm characteristics								
Exporter	0.168	***	[0.010]	0.032				
Indebtedness	0.040		[0.002]	0.031				
Intangible fixed assets per employee	0.048	***	[0.003]	0.009				
EBITDA	0.009		[0.000]	0.007				
Size dummies (no. of workers)								
From 10 to 49	0.118	***	[0.006]	0.033				
From 50 to 99	0.163	***	[0.010]	0.047				
From 100 to 200	0.108	*	[0.006]	0.057				
Age dummies (years)								
From 6 to 10	-0.138	***	[-0.007]	0.041				
From 11 to 20	-0.190	***	[-0.010]	0.040				
More than 20	-0.108	**	[-0.005]	0.043				
High-tech services	0.276	***	[0.019]	0.053				
High and medium-tech manufacturing	0.161	***	[0.010]	0.036				
Construction	0.174	***	[0.011]	0.063				
Project characteristics								
Collective					0.904	***	[0.180]	0.176
Total budget (of consortium)					0.272	**	[0.028]	0.139
Leadership dummies								
Spanish firm					0.076		[0.008]	0.156
Non-Spanish firm					0.407	***	[0.042]	0.102
Spanish Organism					0.286	**	[0.037]	0.125
Biohealth					0.461	***	[0.069]	0.174
ICT					0.060		[0.007]	0.115
Non-EU partners					-1.425	**	[-0.149]	0.543
Central Europe partners					0.365	*	[0.038]	0.207
Selection term: Rho					0.139			0.176
Log of likelihood function	-5,675.17							
Number of observations	41,800							
Number of censored / uncensored obs.	40,274 / 1,526							

Marginal effects in square brackets. Std. E.: Estimated standard error. Coefficients significant at: 1%***, 5%**, 10%*. All estimates include the constant. Estimate in column (1) includes regional dummies and omits dummies for firms with fewer than 10 employees, firms less than 6 years old and year 2003. In estimate of column (2), dummies are excluded for year 2003 and Non-Spanish organism. Marginal effects are computed at sample means. For dummy variables, the marginal effect corresponds to the change from 0 to 1.

Table B2: Features of the applications. Descriptive statistics

	Total applications	Granted applications
Collective research project (%)	8.7	22.1
Experience (%)		
Prior experience in 5FP proposals	19.9	24.5
Application in previous year	39.1	40.7
Prior experience in granted 5FP projects	16.2	20.2
Granted project in previous year	6.5	10.7
Rejected project in previous year	32.6	30.0
Leadership (%)		
Spanish firm	10.0	7.5
Non-Spanish firm	31.3	39.9
Spanish Organism	18.4	15.0
Participation of Non-EU partners (%)	10.5	8.8
Participation of Central Europe partners (%)	33.9	37.8
Proposals related to *biohealth* technologies %)	4.7	7.1
Proposals related to ICT (%)	14.9	14.6
Total budget (€)	1,553,436	1,768,011
Number of observations	1,526	253

Table B3: Intangible fixed assets (*t*+3)

	Coefficient		Std. E.
SME participant	0.856	**	0.380
Exporter	0.994	***	0.058
Firm size dummies (nº. of workers)			
From 10 to 49	0.954	***	0.041
From 50 to 99	1.871	***	0.068
From 100 to 200	2.361	***	0.085
Firm's age dummies (years)			
From 6 to 10	-0.013		0.045
From 11 to 20	-0.102	**	0.051
More than 20	-0.062		0.064
High and medium-tech manufacturing	0.503	***	0.071
High-tech services	1.223	***	0.112
Construction	-0.016		0.113
Sigma of u	1.976		
Rho	0.689		
Number of observations	26,574		

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