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A territorial approach to R&D subsidies:
Empirical evidence for Catalonian firms

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A territorial approach to R&D subsidies: Empirical evidence for Catalonian firms

Agustí Segarra, Mercedes Teruel and Miquel Angel Bové

Abstract

Using a database of 2,263 responses to R&D public calls in Catalonia, during the period 2007–2010, this paper proceeds to analyse the potential interaction of the territorial and policy dimensions with the propensity to apply for, and be awarded, a public R&D subsidy. Controlling for characteristics at the firm and project level, we estimate models using a two-step procedure. In the first step, our results suggest that large firms which export and which belong to high-tech manufactures are more likely to participate in a public R&D call. Furthermore, both urban location and past experience of such calls have a positive effect. Our territorial proxy of information spillovers shows a positive sign, but this is only significant at intra-industry level. Membership of one of the sectors prioritized by the Catalan government, perhaps surprisingly, does not have a significant impact. In the second step, our results show that cooperative projects, SMEs or old firms shows a positive effect on the probability of obtaining a public subsidy. Finally, the cluster policy does not show a clear relationship with the public R&D call, suggesting that cluster policies and R&D subsidies follow different goals. Our results are in line with previous results in the literature, but they highlight the unequal territorial distribution of the firms which apply and the fact that policymakers should interlink the decision criteria for their public call with other policies.

Keywords: *Evaluation, R&D policies, territorial approach, clusters*

JEL Classifications: L53, L25, O38

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A territorial approach to R&D subsidies:
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1. Introduction

Since the 1980s, European countries have promoted R&D among firms, in particular Small and Medium Enterprises (SMEs). To achieve this, governments may use a variety of tools such as public grants, loans, tax incentives or direct research in public laboratories or universities. The tool used is relevant, since some may be more precise and efficient. Evidence shows that public grants are the most selective (vertical tools) while R&D tax incentives are less able to prioritize target firms (horizontal tools).[1] The evaluation of public policies is necessary to shed light on the best tools for promoting innovation and to offer information about the effectiveness of each.

From a theoretical approach, the main reason for providing public funding for R&D is the existence of market failures, among others, those of additionality, informational asymmetries and knowledge spillovers. It is well-known that the knowledge market usually fails to provide enough incentives for R&D investment (Nelson, 1959; Arrow, 1962). Thus, market failures of private R&D justify government intervention. Government support for R&D has been widely accepted, in contrast to public support in other areas, and recently many works have dealt with the effects of public support of R&D (Catozzella and Vivarelli, 2011). However, the ambivalent empirical results (Lichtenberg, 1984, 1987; Holemans and Sleuwaegen, 1988; Antonelli, 1989; Levy, 1990; David et al., 2000; Klette et al., 2000; Catozzella and Vivarelli, 2012)[2] have heightened the interest in the evaluation of public resources devoted to promoting R&D investment.

Growing competition has created a selection process between firms, industries and, latterly between territories. This is causing regional inequalities to emerge during the current crisis. To address this situation, coordination and accurate design of policies will be crucial, in particular when public subsidies to attract firms seem to have limited impact in territories without previous geographical agglomeration of firms. In consequence, there are implications for the geographical distribution of governmental expenditure on such incentives and for economic activity (Devereux et al., 2007). Obviously, unequal territorial distribution may imply that the distribution of R&D subsidies will also depend on territorial characteristics. Despite this, there is a lack of knowledge of the interaction between R&D policies and the territorial dimension.

[1] For 17 OECD countries between 1981 and 1996, Guellec and Pottelsberghe (2003) show the ambiguous impact of public R&D subsidies and tax incentives on private R&D investment. More recently, Santamaría et al. (2010) analyzed the differences between subsidies and credits for Spanish firms. Their results show that the Spanish public agency uses subsidies and credits as financial tools to address different objectives.

[2] Klette et al. (2000) and David et al. (2000) offer two surveys of econometric studies. Both authors discuss methodological aspects that may account, to some extent, for the absence of unambiguous results. David et al. (2000) also offer a survey of the empirical evidence accumulated over 35 years on this topic. Findings are ambivalent and depend on the database and the biases of the econometric tools used.

This paper aims to disentangle the relationship between the territorial and sectoral dimensions and the likelihood of participating and being successful in a public R&D call. Following previous literature, (Barajas and Huergo, 2009; Huergo and Trenado, 2008, 2010; Barajas et al., 2012), our empirical approach takes into account that the award of a public call is the result of two decisions. Firstly, firms have to decide to respond to the public call and, secondly, they must receive the award. Our study can handle this double decision, since our database differentiates between participants and non-participants in a public call and between awarded and non-awarded firms. We merge two sources, one from the Catalan agency responsible for promoting private innovation (ACC1Ó) and another from the Mercantile Register, Sistema de Análisis de Balances Ibéricos (SABI). Here, in line with previous works (Huergo and Trenado, 2008, 2010; Santamaría et al., 2012), we apply a Heckman model.

Our main results are the following. In regard to the determinants of participating, the variables large size, exporting activity or belonging to a high-tech manufacturer have a significant and positive impact. Furthermore, a firm's previous participation enhances its current participation in the public call. In regard to the determinants of being awarded, we find that projects presented cooperatively have a greater likelihood of obtaining an R&D award. In regard to our territorial variables, we observe different patterns. Firstly, firms in the densest Catalan metropolitan area have a lower probability of participating, while those in the second metropolitan belt have a higher probability. Hence, our results suggest that an unequal territorial propensity applies to this R&D subsidy. Secondly, our proxy of public information spillovers also shows a positive sign, but one only significant at intra-industry level. Finally, the interaction between a targeted policy, such as the R&D subsidy, and the cluster policy does not show any relation (with the exception of the Information and communications technology sector, ICT, which shows a significant but negative impact). Consequently, our results suggest that the Catalan cluster policy and public R&D subsidies pursue different goals.

This article contributes to the literature on three points. Firstly, our sample contains information at the firm and the project level, so we can analyse jointly the characteristics of participants and the innovation project submitted to the call. The vast majority of empirical work has tackled the effects of public R&D at the firm level, while the innovation project dimension has been neglected. Our database differentiates between participants and non-participants in a public R&D call ("InnoEmpresa") and between awarded and non-awarded firms. Secondly, we adopt a territorial approach since the database includes information on the firm's location. The territorial dimension has usually been ignored in previous analysis, even though the territorial characteristics of a region may condition firms to participate in and obtain public R&D subsidies. Finally, empirical literature ignores governmental goals that are achieved through different tools created by agencies. Here, we analyse whether firms located in particular clusters have a higher likelihood of participating or obtaining a subsidy. From the public policy approach, we analyse the interaction between the R&D subsidies and the sectoral cluster policy in Catalonia.

The structure of the paper is as follows: Section 2 outlines the literature related to the participation and selection of public R&D subsidies; Section 3 describes the database. Section 4 outlines the econometric methodology and descriptive statistics; Section 4 reports our results, and the final section presents the concluding remarks.

2. R&D subsidies: A literature review of public and private decisions

Klette et al. (2000) and David et al. (2000) conclude with two recommendations for tackling the ambiguous empirical results. Firstly, empirical methods must control for selection and endogeneity bias, which arise from the fact that participation in a R&D program is not random. And secondly, structural models of the decisions of both the public agency and the firm should be developed in order to improve our understanding of R&D subsidy effects. Consequently, this section reviews the literature on the factors affecting the decision to participate and to obtain a public R&D subsidy (see Table 1 for a summary).

----------Insert Table 1----------

2.1. Private decisions to participate

Previous empirical literature has tried to analyse the determinants of participation in R&D calls. However, due to limited information in the datasets, much of this literature is not able to delve into the factors that affect a firm's decision to apply for a public subsidy; neither do they have information on non-awarded participants—see Blanes and Busom (2004) for the Spanish *Encuesta sobre Estrategias Empresariales* and Busom et al. (2012) for an example of the Spanish CIS.[3] However, it is crucial to have detailed information, not only at firm level but also at project level (Clausen, 2009). Consequently, other studies have used databases from public agencies which do contain detailed information on participants and projects. Some Spanish examples are Santamaría et al. (2010), with the PROFIT initiative, and Huergo and Trenado (2008, 2010), with a CDTI program.

The empirical estimation of the determinants of participation in a public R&D call requires controlling for endogeneity. This is because the determinants for a firm which actually receives a public subsidy will be rather similar to those determinants that lead the firm to apply in the first place. This problem constitutes a limitation for studies, such as Santamaría et al. (2010) who analyse cooperative R&D project calls during the period 2000–2003 but who have only participant information. To address this problem, recent empirical studies (Huergo and Trenado, 2008, 2010; Takalo et al., 2008; Barajas et al., 2012) propose a two-step analysis methodology. Initially, the determinants that lead a firm to apply for a public subsidy are estimated and, subsequently, the model identifies the determinants that result in

[3] For instance, the CIS questionnaire asks firms the following question: "*Has your enterprise received any kind of public support for innovation-related activities in the last three years?*".

a firm obtaining a subsidy. This methodology controls for the correlation of the error terms due to unobserved characteristics.

From a sample of Spanish firms which obtained low-interest credit during the period 2002–2005, Huergo and Trenado (2008, 2010) identified that young firms, exporters, companies that belong to a high or medium-tech industry and firms with previous experience in similar programs have a higher probability of applying for credit. Also, Barajas et al. (2012) find that, in addition to financial variables, being an exporter, a smaller firm or a Knowledge Intensive Service (KIS), have positive impacts on the probability of participation in an EU Framework Programme (FP) cooperation project.

Despite the limited information, for a sample of Spanish firms Blanes and Busom (2004) find that human capital, firm size and being a domestic firm may be factors which positively affect the likelihood of participating in and obtaining a public call.[4] Czarnitzki and Licht (2006) for panel data of German firms also found that exporters and firms based abroad show a greater propensity to participate in R&D subsidies, while firms that do not take out patents are less prone to receive awards.[5] Furthermore, these authors show that there are regional differences between the input additionality of East and West Germany. Although they know whether a firm participates or not, they do not have information at project level.

In fact, the literature on regional economics shown that firm location depends both on time and space. The importance of space in the productive activity was highlighted by Alfred Marshall (1890). Later, a wide variety of theoretical and empirical contributions on the effects of geographical concentration appeared (e.g., Krugman, 1991; Audretsch and Feldman, 1996; Porter, 2003).

Space plays a key role in the generation of spillovers related to knowledge and information. In other words, production exhibits a spatial concentration, but activities related to knowledge and information depend even more on space (Feldman, 1994). Geographical concentration of firms permits them to enjoy knowledge spillovers which allow access external technological resources, facilitate cooperation and improve their absorptive capacity. The information relating to one specific event, for instance a public R&D call, can be easily codified and has a singular meaning and interpretation. However, knowledge, or what is sometimes referred to as tacit knowledge, is vague and difficult to codify (Jacobs, 1969). In this context, a firm's projects usually require not only tacit knowledge, but also information, to have access to public calls. In spite of the potential effect of space, hardly anything is known about the effects of policies aiming to promote R&D activity at the

[4] Encuesta sobre Estrategias Empresariales (ESEE) only has information on firms that apply and are awarded. Hence, they do not have information of the non-awarded participants.
[5] Similarly, the Mannheim Innovation Panel (MIP) has information on whether or not the firms have received innovation support from public sources but does not provide information on non-awarded participants.

territorial level (Engel et al., 2013).[6] And, in particular, a few works have shown evidence of a territorial dimension to the participation in a public R&D call.

Hence, we are interested here in analysing the territorial dimension of the probability that a firm applies for an R&D call, and also is awarded it by the Catalan government. Firms apply to public calls based on their past R&D activity, but also based on the support to apply to them and their capacity to find a partner to carry out the R&D project. Our goal is complementary to the recent theoretical and empirical literature on the determinants of the geographical concentration of firms and innovative activities.

In recent years, some studies have questioned the literature which highlights the linearity of economic agglomerations. Authors such as Zucker et al. (2006) and Klepper (2007), point out that there are significant learning effects arising from geographical proximity to previous adopters. Given that learning effects are higher in local agglomerations, local firms enjoy higher knowledge competences and absorptive capacities. This results in a "selection of the fittest" process emerging in the production and innovation of more dense territories. Finally, some authors such as Boschma and Frenken (2010) question any direct and simple relation between innovation and concentration. They introduced the so-called proximity paradox which explains that, while proximity may be a crucial driver for agents to connect and exchange knowledge, nevertheless too much proximity between such agents might harm their innovative performance. In other words, while a high degree of proximity may be considered a prerequisite for agent connection, proximity between agents does not necessarily increase their innovative performance. They argue that the relationship between innovation and geographical concentration follows an inverted U-shape curve.

Based on the above, it is possible that firms in regions with greater density may have larger knowledge flows or even more competition which implies that they may apply for more subsidies.

> Hypothesis 1. Firms in denser territories will be more likely to participate in a public call.

However, public policies have an impact at territorial level, not only via awarded firms, but also indirectly to non-awarded firms. On the one hand, subsidies that other firms receive may have a positive effect on the propensity of a firm to apply for subsidies. This situation may be the result of flows of R&D personnel and R&D cooperation agreements. On the other hand, it may be the case that subsidies given to specific firms may discourage access to these for other firms due to the fact that a subsidized project absorbs a large amount of scientific resources.[7] Consequently, competitors will observe a reduction of profitability in their R&D projects (David et al., 2000). Here, we consider that the impact may be different

[6] As Glaeser et al. (1992, p. 1126) noted "intellectual breakthroughs must cross hallways and streets more easily than oceans and continents". Hence, knowledge has a complex dimension that must interact with workers, assets and some external services of advisors and management.

[7] The inelastic supply of R&D inputs may result in an increase of R&D inputs which displaces inputs from non-subsidized firms to subsidized firms that have more capacity to pay higher prices (David and Hall, 2000). In particular, this effect has been pointed out for researchers' wages (Goolsbee, 1998; Reinthaler and Wolff, 2004; Ali-Yrkkö, 2005; Aerts, 2008).

depending on whether the firm which receives the subsidy belongs to the same or to a different sector. Consequently, there may be two different hypotheses.

Hypothesis 2. The awarded projects of firms in a particular sector act as an incentive for the participation of other territorially close firms in the same sector.

Hypothesis 3. The awarded projects of firms in a particular sector act as an incentive for the participation of other territorially close firms in different sectors.

2.2. R&D subsidies and agency selection

In spite of the fact that governments design their public policies to promote private R&D through their public agencies, few studies examine the criteria used by governmental evaluators to select projects (Hsu et al., 2003; Lee and Om, 1996, 1997; Takalo et al., 2008). However, for a number of reasons, it is crucial to delve deeper into this issue. Firstly, the selection process reflects the real objectives of policymakers. Secondly, they determine the characteristics of those projects that are developed and, consequently, the results obtained. Thirdly, public calls have impacts at sectoral and territorial level. Methodologically, the most recent articles with information at project level (Takalo et al., 2008; Huergo and Trenado, 2008, 2010; Barajas et al., 2012) apply a two-step methodology where the probability of receiving a public R&D call depends on the previous participation.

The design of public R&D subsidies entails multiple decisions relating to the assignation of public resources with respect to other tools available, the time of applicability, the criteria of the call, the profile of firms that will be prioritized and the sectoral and territorial dimensions, among other questions. In our case, the Catalan public agency makes three decisions during the selection process. Firstly, if the project accomplishes all the requirements of a call it will be accepted for later evaluation; secondly, an ad-hoc technical commission will be formed to decide to accept or reject a project according to established selection criteria; and finally, this technical commission will allocate an amount of funding to an accepted project. The first decision is automatic —if negative, it excludes a project from further consideration. The second and third decisions entail some discrimination among the accepted projects in terms of the type and amount of finance provided (Santamaría et al., 2010). Consequently, governments may include other criteria which are not strictly related to the characteristics of the firm or project in question.

Different sets of variables may influence the decision to select a firm for receipt of a subsidy. A first set includes characteristics of the firm such as age, size, sector and dynamicity. A second set includes project characteristics such as the project size or the internal quality evaluation of the project. Finally, regional variables may also affect the decision. Santamaría et al. (2010, p. 552) recognize the difficulties of modelling these

political criteria and they introduce different empirical dummies to capture the differences between the Spanish regions.[8]

The capacity to discriminate is pointed out in Blanes and Busom (2004). According to these authors, public agencies may use financial support for R&D to achieve two important goals: i) fostering national champions; and ii) encouraging the technological upgrading of firms in declining or traditional industries. In the first case, the idea would be to fund those R&D projects that are most likely to achieve technological and/or commercial success. In the second case, the objective is to increase the chances of a firm's survival. Such reasoning implies that an agency's goals, or combinations of goals, will vary across industries.

Thus, governments may take into account the existence of clusters as a starting point to formulate policies and strategies.[9] Our hypothesis is that the Catalan government may take sectoral cluster specialization into account; we may consider that it does not focus on one goal, but on a diversity of goals: to promote R&D, but also to concentrate on specific sectoral clusters. This disagrees with Afcha (2012) who states that public agencies tend to prioritize high-tech firms. That hypothesis is also emphasized by Klette et al. (2000) who notes that "a significant portion of the support to commercial R&D is targeted towards new and high-tech businesses and emerging technologies, and it seems to be based on infant industry arguments." By considering the cluster policy, we may assess not only the published objectives of the public call, but also those "revealed" objectives which were not official.

> Hypothesis 4. The Catalan government prioritizes firms that belong to a particular sectoral cluster.

Furthermore, Afcha (2012) points out that public agencies also tend to prioritize those firms with better opportunities for success. Thus, they may apply a "picking-the-winner" strategy that gives subsidies to projects that are already viable. In that case, non-subsidized firms will leave the market.[10] Lerner (2002, p.81–82) underlines that "past grants, regardless of project outcomes, help a company gain legitimacy in a particular area of research, as well as acquire the equipment and personnel needed to do future work. There is also a tendency for some government programs to try to 'piggyback' on other government programs, hoping to leverage their grant dollars. In addition, firms gain considerable insight on the grant application process with each proposal they submit. These firms consequentially often have a greater chance of being awarded future government grants than other firms." Generally, the "Picking-the-winner" strategy appears because: i) technocrats in charge of policies do not want to give the impression of "wasting public money"; ii) policymakers

[8] According to Santamaría et al. (2010, p. 552): "it is possible that regional differences in the selection of projects are related to the peculiarities of regional industrial systems (i.e. firm characteristics), which may influence the level of support given to firms from different regions. It is possible also that politics plays a part in regional differences".

[9] Public agencies may have more incentives to choose those projects belonging to more innovative firms, which have a higher likelihood to succeed and offer a higher return from taxes (Kauko, 1996; Lichtenberg, 1984; Stiglitz and Wallsten, 2000). In this case, public subsidies are given to projects that would be funded with private resources (for a recent survey see Cantner and Kösters (2012)).

[10] However, if policy-makers are able not only to distinguish viable projects but also those that need additional public resources, then the distortion will be minimized (Shane, 2009).

may prefer to focus on technological sectors with more future potential. However, public subsidies may be more effective in the case of funding R&D projects that would not be continued without this public funding (Lach, 2002).

> Hypothesis 5. The Catalan government prioritizes firms that have previously obtained an R&D subsidy.

3. Database description

Our sample is a merge of an ACC1Ó database and the SABI database. The latter comprises Catalan firms registered in the Mercantile Register and offers information related to balance sheets at a firm level from 2004 until 2011. One particularity of our database is that we know firm location; as opposed to previous scholars, we are in a position to adopt a territorial approach.[11]

ACC1Ó is the Catalan public agency which promotes innovation and internationalization of firms, in particular SMEs. It aims to facilitate the competitiveness of Catalan firms. Since 2004, the main policy tool of the Catalan government has been public R&D subsidies. Although governmental aims are diverse, they mainly focus on reducing the cost of R&D and innovation projects of Catalan firms.

The database from ACC1Ó is associated with four public calls between 2007 and 2010 from the initiative "InnoEmpresa". The public call consisted of non-refundable R&D subsidies targeted at innovation projects presented by Catalan firms. The project needed to develop a new product, a new process, a new methodology of commercialization or a new organizational methodology in order to increase the firm's competitive advantages. Participants could either present their project individually or jointly with other firms via intermediate organisms, such as technological centres. At sectoral level, the public call did not have any target sector—participants were basically SMEs in manufacturing sectors, real estate, tourism, retail and services.

The database from ACC1Ó contains 2,263 innovation projects pertaining to the public calls between 2007 and 2010. 1,093 innovation projects received a total subsidy amount of 45,204,656 euros. With respect to the available information, there is general data about the firm (location, size, etc.) and some characteristics of the innovation projects. Furthermore, the information follows-up on the firm. That means we are able to know if the subsidy was finally accepted by the firm and if the project has been finished.[12] Hence, we can study separately which factors determine a firm's decision to apply and which ones affect the agency's selection.

[11] In fact, our territorial dimension will be at county level. Catalonia has 41 counties. Counties are administrative territorial areas intermediate between provinces and municipalities.

[12] However, the end date of the project is not available for many of the subsidized projects since many of them are unfinished or because the firm has not yet presented the final report. As a consequence, this information has not been considered in the analysis.

The selection of the final database was based on the following. Firstly, we excluded firms without a municipality postal code. Secondly, we selected firms that were observed over a period of 5 or 6 years. Thirdly, we selected firms that had declared themselves as being "active" in the market in 2010. Finally, we also selected firms belonging to the OECD's sectoral classification as high-tech manufacturers, low-tech manufacturers and knowledge-intensive services.[13] Our sample consists of 21,531 firms that did not participate in any call and 608 participants in at least one of the four calls. The period of observation is between 2006 and 2010, since some explanatory variables are lagged by one period.

As a result, our database contains information at firm level for three different groups of firms. A first group includes those firms that did not apply for a subsidy. A second group includes those firms that applied for a R&D subsidy but were evaluated negatively. And finally, a third group includes those firms that obtained the R&D subsidy.

Table 2 reveals that participants represent around 1.2% of all non-participants in this public call. With respect to the number of participants, we observe that the number diminishes slightly, with an increase during the last call. Furthermore, the mean value of the expected cost remains quite stable over the different calls. With respect to the amount of subsidy obtained and the final value that firms spent, there is an increase in the mean value between 2007 and 2008, while simultaneously the number of firms increases. During the last year of observation, the average value decreases slightly.

--- Insert Table 2 ------

We consider Catalonia an interesting region to evaluate the interaction between R&D public subsidies and the territorial dimension. Firstly, this territory is one the most dynamic in economic and cultural terms in Spain. Secondly, Catalonia has a long tradition in R&D and innovation and it has competences in the design of policies in the fields of universities, research and innovation. Thus, firms are subject to policies at Catalan, Spanish and European level which necessitate a certain complementarity, but also coordination.

Finally, we must comment on some shortcomings in our data. Firstly, although we have information about the R&D investment for a project, we lack information relating to a firm's total R&D investment and, thus, we are unable to determine a firm's capacity to carry on R&D activities. However, firm size and sectoral dummies may be good proxies. Secondly, there is no information as to whether a firm applies for other R&D programs (subsidies, taxes…). Consequently, there is a lack of information about their experience of applying for other programs, even if they have other R&D funds. Thirdly, there is no direct quality ranking given by the evaluators. Finally, we assume that firms are aware of the existence of public support. As a consequence, we must be cautious with our results but all these problems are also common in previous literature.

[13] Here, we classify firms into one sector in accordance with their main activity. Thus, we do not consider the possibility that a firm may be operating in similar or completely different sectors simultaneously.

4. Econometric methodology and descriptive statistics

4.1. Econometric methodology

In line with previous scholars (Huergo and Trenado, 2008, 2010), we are able to distinguish between a firm's decision to apply for the subsidy and the probability of receiving an award for an R&D project. Consequently, our model is the following:

$$\Pr\left(receive\ \ an\ \ award=1\right)=\Pr\left(application=1,award=1\right)$$

$$=\Pr\left(award=1\middle|application=1,x\right)\cdot\Pr\left(application=1,x\right)$$

Our first equation considers the probability that a firm decides to apply for a public R&D subsidy. We will consider the following equation:

$$y_{1i}=\begin{cases}1\ \ if\ \ \ y_{1i}^{*}=f\left(x_{1i}\beta_1+u_{1i}\right)\succ 0\\ 0\ \ otherwise\end{cases}\quad\textbf{(1)}$$

where y_{1i} is a dummy variable which indicates that a firm decides to apply for a public R&D subsidy. Furthermore, y_{1i}^{*} is a latent dependent variable, x_{1i} are the determinants of the firm's decision to apply, β_1 corresponds to the vector of coefficients to be estimated and u_{1i} is the error term which follows $N\left(0,\sigma_1^2\right)$. Firm "i" applies for the subsidy if y_{1i}^{*} is positive.

Equation (1) will depend on the following set of explanatory variables (x_{1i}):

1. **Firm size**: Empirical evidence shows a positive relationship between firm size and the likelihood of engaging in R&D activities. Hence, we expect a positive relationship between firm size and the probability of participating. This variable is measured by the value of ln(sales) and it is lagged by one period.
2. **Firm age**: On the one hand, R&D and innovation are dynamic processes where temporal persistence is relevant, so older firms have more capacity to engage in R&D activities. On the other hand, young firms suffer more financial constraints, so they may need to have access to R&D subsidies. This leads to an unexpected result. This variable is measured as ln(age) and it is lagged by one period.
3. **Cash-flow ratio**: R&D projects are subject to higher risks and financial barriers. Empirical literature shows the existence of a negative correlation between financial barriers and R&D performance and a positive correlation between cash-flow and the probability of doing R&D. We expect a positive correlation between cash-flow and the probability of applying for a subsidy. This variable is measured as the ratio of cash-flow to total assets and is lagged by one period.
4. **Long-term debt ratio**: Firms with long-term debt contracts may diminish financial constraints. Thus, long-term debt ratio may show a positive impact on the probability of applying for an R&D subsidy. However, these firms are more likely to engage in R&D and they may be more prone to apply for public R&D subsidies. The impact is

unexpected. This variable is the ratio of long-term debt to total assets and is lagged by one period.

5. **Export:** Export activity is a proxy for a firm's internationalization strategy. Exporting enlarges market opportunities and intensifies interactions with foreign partners that may allow for (technological) learning effects in R&D (Keller, 2010). Exporters may have more need to invest in R&D and, hence, to apply for public R&D subsidies.
6. **Priority**: A dummy variable that indicates if a firm belongs to a sector that the Catalan agency considers as a priority. These sectors are automotive and motorcycle (cnae93: 2911), biotechnology (cnae93: 3310), consumer electronics (cnae93: 30 & 31), renewable energy (cnae93: 4011), pharmaceutical industry (cnae93: 24), chemical industry (cnae93: 24), advanced alimentary products (cnae93: 73) and ICT (cnae93: 6420 – telecommunications & cnae93: 72 computer activities).
7. **Low-tech manufactures** and **KIS:** Sectoral particularities may cause significant differences. In that sense, according to Blanes and Busom (2004), firms in the same industry may face different hurdles in participating in the programs of different agencies and patterns differ across high-tech and low-tech industries. Furthermore, Capron and Van Pottelsberghe (1997) show that the public R&D subsidy may have a different impact on the private R&D investment depending on the sector. Two dummy variables indicate whether the firm belongs to a low-tech manufacturing industry or to a knowledge-intensive service.
8. **Previous application:** Applying for a public subsidy requires experience of dealing with all the consequent administrative burdens. We expect that those firms with experience of applying for a public call will be more prone to participate. This variable corresponds to the number of previous times that a firm had applied for this public subsidy.
9. **Metrop Area 1**: This dummy variable identifies firm located in the densest metropolitan area of Catalonia. The counties are *Barcelonès, Vallès Occidental, Vallès Oriental* and *Baix Llobregat* (with a population equivalent to 63.4% of Catalonia's inhabitants and to 58% of the firms located in Catalonia). We may expect that large metropolitan areas create positive externalities due to the diversity and flow of knowledge.
10. **Metrop Area 2**: This dummy variable identifies firms located in a belt surrounding the densest metropolitan region. The counties included are *Bages, Osona, Maresme* and *Anoia* (with a population equivalent to 11.8% of Catalonia's inhabitants and 10.5% of all firms located in Catalonia. This area has a strong industrial tradition).
11. **InterSpillovers:** Inter-industry spillovers are defined as the stock of knowledge available to firms located in a region that originates in sectors different to the ones in which the firms operate. This stock varies according to firms and regions. Inter-industry spillovers are an approximation to R&D linkages between firms that operate in different industries and do not trade with each other, but "borrow" each other's knowledge (Bernstein and Nadiri, 1989). We estimate these externalities as:

$$InterSpill_{i,t} = \ln(SUBSIDIEScounty_{i,t} - SUBSIDIEScounty\_sector_{i,t})$$

where $InterSpillovers_i$ is the total amount of subsidies received by other firms in different sector and same county of a particular firm "i". A positive sign implies a positive influence mediated by the firm possibly capturing positive externalities from nearby

firms that invest in R&D. A negative sign may imply difficulties in applying knowledge generated by other sectors.

12. **IntraSpillovers:** Intra-industry spillovers refer to the stock of accessible know-how from firms in the same sector. The estimation is the following:

$$\text{IntraSpillovers}_{i,t} = \ln(\text{SUBSIDIEScounty\_sector}_{i,t} - \text{SUBSIDYfirm}_{i,t})$$

where *intraSpillovers* is the total amount of subsidies received by other firms in the same sector and county of a particular firm "i". A positive sign exists when knowledge spreads to other firms in the same sector and a negative sign exists if firms protect the knowledge they generate and/or compete for the same R&D resources.

The second equation is the probability that a firm is awarded a subsidy through agency selection. The dependent variable y_{2i} is a dummy variable that takes a value equal to 1 when the project is awarded. This second equation will have the following form:

$$y_{2i} = \begin{cases} 1 \;\; if \quad y_{2i}^{*} = f\left(x_{2i}\beta_2 + u_{2i}\right) \succ 0 \\ 0 \;\; otherwise \end{cases} \quad \textbf{(2)}$$

where y_{2i}^{*} is the latent dependent variable, x_{2i} are the determinants of the agency's selection, β_2 corresponds to the vector of coefficients to be estimated and u_{2i} is the error term which follows $N\left(0,\sigma_2^2\right)$. The proposal is approved if y_{2i}^{*} is positive. Equation (2) will depend on the following set of explanatory variables (x_{2i}):

1. **Project size**: Empirical evidence (Heijs, 2005, Acosta and Modrego, 2001; Santamaría et al., 2010) shows the total budget of the R&D project to be significant in the selection process. This variable is measured logarithmic terms.
2. **Cooperation**: Presenting a project jointly with other projects may be a characteristic that evaluators consider as relevant. This dummy variable identifies cooperative project.
3. **Previous concession**: Evaluators may apply a "picking-the-winner". The variable measures the number of times that a firm has obtained an R&D subsidy in the same call.
4. **Quality project**: The best projects considered have a greater chance of obtaining a subsidy. This variable corresponds to the amount of subsidy that the firm has obtained as a percentage of the total amount of money requested.
5. **Quality firm**: This index measures the capacity of the firm to plan and carry out the research project during the period of time. This variable corresponds to the amount that the firm finally uses as a percentage of the total amount of subsidy.
6. **Small firm** and **Medium-sized firm**: Larger firms are in a better position to ask for R&D subsidies and to define better R&D projects. However, public agencies may prioritize SMEs and so the impact is unpredictable. This variable is a dummy variable with a value equal to 1 in the case that a firm is smaller than 50 employees and equal to 1 in the case that a firm is between 50 and 250 employees.
7. **Firm age**: Young firms may be more innovatively dynamic or they may suffer more financial constraints. As a consequence, they may need to have access to these public

R&D subsidies. However, public agencies may also prioritize old firms which need a transformation. This variable is equal to ln(age) and it is lagged by one period.

8. **Firm growth:** Firm growth may be an indicator for evaluators that a firm is in a dynamic sector. We expect a positive impact on the probability of obtaining an R&D subsidy. This variable is measured by the annual growth of sales (%).

1. **Low-tech manufactures** and **KIS:** Evaluators may prioritize firms in some sectors. We include two dummy variables indicating whether they belong to a low-tech manufacturing industry or to a knowledge-intensive sector.
2. **Cluster_agro, cluster_metal, cluster_ict**: Projects of firms located in a strategic cluster may be preferable to evaluators when they want to promote these clusters. Three dummies indicate whether a firm belongs to the Catalan agroindustrial cluster (cluster_agro), metal cluster (cluster_metal) or ICT cluster (cluster_ict).

Both equations include time dummies since, during an expansion, there are better facilities to gain access to financial resources, while during a financial crisis resources decrease. The error terms in Equations (1) and (2) might contain some commonly omitted variables, and therefore the correlation term ϱ between u_1 and u_2 might be non-zero. There are different channels through which this bias may appear. Firstly, some firms apply for support because they have discovered particularly promising R&D projects. Secondly, screening of projects in the government agencies will also tend to create selection bias, since those firms that obtained a subsidy may attract more external funds due to the certifying role of public subsidies. Thus, in consequence, those firms may perform better and may be in a better position for future calls. Empirically, there may be a sample selection bias, and the estimation of coefficients $\beta_{2,}$ only for proposals, yields inconsistent estimates. Following Huergo and Trenado (2008, 2010), we estimate both equations as a probit model with sample selection by maximum likelihood.

4.2. Descriptive statistics

Table 3 shows descriptive statistics for firms' characteristics. We classify firms according to our three groups of interest: firms that do not participate, firms that participate but are not awarded with a subsidy, and those non-awarded participants. Our results show that non-participants are smaller and younger. However, on average their average growth rate is much higher which may be closely related to both previous characteristics. Also, the percentage of firms that export is significantly smaller than the percentage of firms that participate in this program. Regarding the financial ratios, non-participants obtain a smaller cash-flow ratio and long-term debt ratio. With respect to location, the largest percentage of non-participants is located in the metropolitan area of Barcelona, while a smaller percentage of firms is located in the second metropolitan area. However, a smaller percentage of firms do not belong to industries that are considered a priority by the Catalan government. Furthermore, non-participants have less previous experience on average than those that do decide to participate. Finally, with respect to spillovers, mean values are rather similar to firms awarded an R&D subsidy, but significantly smaller in comparison to non-awarded firms.

--- Insert Table 3 ------

Awarded firms are larger and older, but they grow less than non-awarded participants. Furthermore, a larger percentage of awarded firms export. The financial ratios show that awarded firms have a larger cash-flow ratio but a smaller long-term debt ratio. Regarding location, a lower percentage of awarded firms are located in the first metropolitan area, while a higher percentage are located in the second metropolitan area. Furthermore, awarded firms obtain slightly larger mean values as compared to the levels of previous public grants. We need to highlight that intra-industry spillovers enjoyed by awarded firms are smaller than those of non-awarded firms. This is a reasonable result, since awarded firms will not be affected by their own subsidies. However, awarded firms may benefit from larger inter-industry spillovers.

Table 4 presents those variables related to the project characteristics and determinants of the probability of achieving a public R&D subsidy. Firms are classified as either awarded or non-awarded firms. Firstly, the project budget is slightly larger for awarded firms. Secondly, the percentage of projects which are cooperative is smaller for the awarded projects. Thirdly, the number of times that a firm had previously received the same R&D subsidy is quite similar between both groups. With respect to the quality of the project and the firm, as is to be expected, the values are larger for awarded firms (non-awarded firms may obtain a positive value should they refuse to accept the subsidy, despite it being awarded). Results show that R&D subsidies cover around 35% of the project budget and nearly all of the subsidy ends up being continued (90.16%). Furthermore, it seems that a smaller percentage of awarded firms are SMEs. Finally, a smaller percentage of awarded firms belong to the agricultural cluster, while a larger percentage belong to the metallic and ICTs cluster.

--- Insert Table 4 ------

5. Empirical results

Table 5 contains the results for the estimation of the probit model with sample selection. The strategy for the estimations is the following: estimation (1) includes firm characteristics and some characteristics of the project (project size and cooperative project), estimation (2) includes the project characteristics and some variables related to the firm's past behaviour, estimation (3) includes variables related to the territorial location in one metropolitan area, estimation (4) includes the cluster variables if the firm does or does not belong to one of the prioritized sectors of Catalan industrial policy, and estimation (5) includes spillover variables, both intra-industry and inter-industry effects. To begin with, we comment on the likelihood that a firm applies for a R&D subsidy.

Firstly, firm size shows a significant positive impact, while firm age shows a negative but non-significant impact (except for the first estimation). Consequently, larger firms will be more likely to apply for a public R&D subsidy. Our evidence may confirm the fact that large firms are more likely to have the required financial and non-financial resources to

carry out R&D activities that involve sunk costs and high uncertainty. Our results are in line with Blanes and Busom (2004), Czarnitzki and Licht (2006), González et al. (2005), Takalo et al. (2008) and Bannò and Sgobbi (2010). However, we must have in mind that Barajas et al. (2012) have found a negative impact of firm size on the participation of cooperative FP projects. Hence, this result may depend also in the type of public tool.

Secondly, with respect to the financial ratios, we do not find any significant impact although the cash-flow ratio has a significant positive impact in estimation (1) and (2), while the long-term debt ratio shows a non-significant negative impact. This result is in line with Blanes and Busom (2004) who also find a non-significant impact while Barajas et al. (2012) find a significant and negative impact on the probability of participating.

Thirdly, firms that compete in international markets show a greater probability of applying for R&D subsidies in Catalonia. This result may indicate that participation in international markets generates knowledge flows through improvements in a firm's knowledge due to its exposure to a wider range of technologies, better international practice, and more intense competition in international markets. Similar results are obtained in Czarnitzki and Licht (2006), González et al. (2005), Barajas and Huergo (2010), Bannò and Sgobbi (2010), Huergo and Trenado (2010) and Barajas et al. (2012).

Therefore, belonging to one of the sectors prioritized by the Catalan government does not seem to exert a significant impact on the probability of participating. However, it seems that firms in high-tech manufacturing apply more often for R&D subsidies than low-tech manufacturers and knowledge-intensive services. This result may be explained by the type of firms participating in this public call, since other works such as Barajas et al. (2012) find that firms in KIS sectors have a higher probability of participation.

With respect to past experience, whether a firm that has applied previously increases significantly its propensity to participate in subsequent calls. Our results are in line with previous evidence such as Huergo and Trenado (2010) and Barajas et al. (2012), while Takalo et al. (2008) find non-linear effects for Finland. This result may explain a certain persistence of the R&D activity and application. But it also may be the consequence of firms applying for public subsidies learning from their previous experience. Along these lines, Blanes and Busom (2004, p. 1460) state that their results show that R&D programs had a limited success in reaching firms that were not already doing R&D.

Regarding the location, operating in the first metropolitan area significantly decreases the probability of applying for a subsidy. Although the first metropolitan area agglomerates Catalonia's largest percentage of firms and population, the typology of firms is also rather diverse, while the second metropolitan area has traditionally been more industrialized. Therefore, we would not accept the hypothesis that firms in the densest metropolitan area have a larger propensity to apply for this public R&D subsidy. This may confirm the unequal distribution of firms which apply.

--- Insert Table 5 ------

Finally, we observe that both types of spillovers show a positive impact, but these are only significant for intra-industrial spillovers. Thus, our results seem to shed light on the existence of some kind of externalities of R&D resources and knowledge flows. This would appear to confirm the hypothesis that the granting of R&D subsidies to a firm will positively affect competitors' efforts and other firms in the same sector. Consequently, our second hypothesis would be accepted, while the third hypothesis would not be accepted.

With respect to the likelihood of receiving an R&D subsidy, we obtain the following results.

Firstly, project size does not seem to be a significant variable, although in general it shows a positive sign. Previous empirical evidence shows ambiguous results, since authors such as Barajas et al. (2012) show a non-significant impact of the project budget, while authors such as Santamaría et al. (2010) find a positive impact. Hence, the size of the project must have a certain impact on the final selection since some calls may limit the amount of money of the project.

Secondly, and more interestingly, those projects that are jointly presented by a group of firms through an intermediate agent, demonstrate, with the exception of estimation (1), a higher probability of obtaining an R&D subsidy. This result provides evidence that joint projects are preferred by evaluators for several reasons. Firstly, collective projects may include a larger number of private agents under the same umbrella. Secondly, a positive attitude towards cooperation increases the likelihood of cooperating with new partners and further spreading the externalities. This result is in line with Santamaría et al. (2010), where the probability of obtaining a subsidy increases with the participation of a university or a technology institute.

Thirdly, when a firm obtains an R&D subsidy and decides to participate in a future call, it will be less likely to obtain an R&D subsidy. Being a successful firm in the past does not guarantee that evaluators are going to choose these past winners in the future. This result may be a signal of a direct rejection of the "picking-the-winner" strategy since evaluators are not prioritizing past successful firms. This result is in line with Barajas et al. (2012). Furthermore, Takalo et al. (2008) analyse the relationship between previous applications and the probability of being awarded and do not find a significant impact.

Fourthly, in regard to the variables related to the quality of the project and the firm, our results show a positive impact on the probability of obtaining an R&D subsidy. Hence, the better the evaluation of a firm's quality, the better the chances of obtaining a public subsidy.

Fifthly, in line with Takalo et al. (2008), our results show that, while large firms seem to participate more, small and medium firms have a higher probability of obtaining a public subsidy. This result is closely related to the Catalan government's aims, since it is trying to

promote R&D and innovation among SMEs. However, a firm's age shows a significant and positive sign once we control for the project characteristics and the persistence in participating and achieving public R&D subsidies. Consequently, old firms have a higher likelihood of obtaining an R&D subsidy, once we control quality, past experience, and locational variables.

Sixthly, being a more dynamic firm has a non-significant impact, while firms in KIS services have a significantly lower probability of obtaining an R&D subsidy. Based on our data, we might say that the Catalan public agency seems to prioritize firms involved in high-tech manufacturing in order to encourage the technological upgrading of firms with higher opportunities for growth. This result is partially in line with Huergo and Trenado (2010) who find that high-tech and medium-high-tech manufacturers have a lower probability of securing low-interest credit. However, their result may be specific to the type of policy tool.

With respect to cluster policy, belonging to the agroindustry or metal clusters does not have a significant impact, while those belonging to ICT are negatively affected in terms of their probability of being awarded a subsidy. This result may highlight the misalignment between calls for R&D subsidies and a clusters' policy. Hence, we would not accept the hypothesis that firms located in sectoral clusters have a larger advantage in receiving subsidies; the non-relationship between the cluster policy and the R&D subsidy seem to confirm that different policies have different goals.

Finally, similarly to Huergo and Trenado (2010), when omitting project level variables, we may omit relevant variables that are good proxies of unobserved factors. In consequence, the correlation term ϱ between u_1 and u_2 might be unequal to zero. This would be the case in estimation (1). We should also remark that Takalo et al. (2008) show a significant coefficient, but the data related with the project is only based on the risk and the technical challenge.

6. Conclusions

This paper explores the determinants of Catalan firms for participation in public calls for R&D subsidies and the factors that explain the likelihood of obtaining them. Our strategy thus has two different stages. Following previous empirical literature, we apply a probit model that controls for sample selection.

For the first stage, the results suggest that larger firms which export and belong to the high-tech manufacturing sector are the most regular participants in public calls. Furthermore, a firm's previous participation enhances its current participation in a public call. This result shows that exporters and firms in high-tech sectors face higher technological pressures and try to find public funds. Our results are fairly robust under different specifications.

Regarding locational variables, we observe that firms located in the Barcelona metropolitan area have a lower probability of participating, while those in the second metropolitan region—in the manufacturing belt of Catalonia—have a higher probability. Finally, locational spillovers show a positive sign, but are only significant at an intra-industry level. Therefore, our results show that there is an unequal distribution of firms which policymakers should take into account.

With respect to the determinants of being awarded a subsidy, projects presented cooperatively have a better likelihood of succeeding. In addition, our results do not suggest the existence of a "picking-the-winner" strategy, since firms that have received previous R&D subsidies do not show a higher probability. Our quality proxies of the firm and of the project seem to be significant and positive. Once we control for locational variables, firm age shows a positive sign on the likelihood of obtaining a subsidy. In general, firms operating in KIS services have lower probabilities of obtaining an R&D subsidy. With respect to the interaction between a targeted policy such as the R&D subsidy and the cluster policy, we observe that only firms belonging to the ICT sector show a significant (but negative) effect.

The main policy implications are the following. The complex dynamics of innovation performance, knowledge and pecuniary spillovers and space concentration must be taken into account. Policymakers should design and implement R&D promotion policies considering that not all firms have the same propensity to participate in calls for public R&D subsidies. They must bear in mind what is their target group of firms and whether they have enough resources to participate. This requires combining initiatives in order to both reduce administrative costs to allow participation and also to enhance and facilitate the communication of experiences of local firms in the same sector where a firm is located. These policy implications may be particularly relevant for SMEs given that their lack of financial assets, and the absence of economies of scale and scope, place them at a disadvantage. In fact, the evaluation must be conceived as part of a process and must give useful information to policymakers.

However, the selection of R&D projects is difficult due to expected externalities, a variety of objectives and multiple actors with different goals and preferences (Schilder, 2000; Corbett and Lennon, 2002; Bannò and Sgobbi, 2010). The interaction between all those factors determines the total budget allocated to R&D programs, its distribution across industries, the ranking criteria and screening rules applied in the selection of projects and firms, and the funding awarded to individual firms (Blanes and Busom, 2004, p. 1465). The selection of innovation projects and firms is crucial in order to tackle the regional innovation paradox of Oughton et al. (2002). This paradox refers to the apparent contradiction between the comparatively greater need to spend on innovation in lagging regions, and relatively lower capacity of these regions to absorb public funds. According to these authors, this is due to the fact that, although there are strong complementarities between firms, education and government spending on R&D, nevertheless innovation and industrial policies tend to work in opposite directions.

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Table 1.
Revision of the empirical literature

Country	Database	Project? Type of program	Methodology	Determinants to participate	Determinants to be awarded
Blanes and Busom (2004)					
Spain	Survey of Firm Strategies (ESEE- Encuesta sobre Estrategias Empresariales)	NO – public support	Multinomial logit	Firm age, human capital (+), firm size (+), domestic (+), cash-flow	NO
Czarnitzki and Licht (2006)					
Germany	Mannheim Innovation Panel (MIP) and information from the German Patent Office.	NO - Subsidies	Probit	Firm size, R&D department (+), patents (+), no patents (-), age(-), export (+), foreign (-), within group (-), concentration ratio (+).	NO
Huergo and Trenado (2008)					
Spain	Centre for the Development for Industrial Technology and Iberic System of Balance Sheets (SABI)	YES - Low-Interest R&D Credits at the CDTI	Two-step methodology	Frim size (+), High-tech manufactures and kis (+), export (+), firm age (-), fixed assets (+), previous experience (+)	SMEs (+),budget (+), High-tech manuf (-), technological innovation project (+), technical capability (+), collaboration with research centres (+), need for the new product/process (+), commercial perspectives (+), export possibilities (+), degree of substitution (-)
Takalo et al. (2008)					
Finland	Tekes and Asiakastieto Ltd	YES - Subsidies	Two-step methodology	Not presented	Risk (-), technical challenge (-), firm age, size (+), sales/employment, SMEs (+), parent company, previous applications, CEO, board size, exporter.
Huergo and Trenado (2010)					
Spain	Centre for the Development for Industrial Technology and Iberic System of Balance Sheets (SABI)	YES - Low-Interest R&D Credits at the CDTI	Two-step methodology	High-tech manufactures and kis (+), export (+), firm age (-), liquidity ratio, intangible fixed assets (-), previous experience (+)	High-tech manuf (-), KIS, export, firm age, liquidity ratio, intangible fixed assets, previous experience, technological innovation project, R&D intensity (+), contribution of new knowledge (+), technical capability (+), collaboration with research centres (+), need for the new product/process (+), commercial perspectives (+), export possibilities (+), degree of substitution (-)
Santamaría et al. (2010)					
Spain	PROFIT programme	YES - subsidies and credits without interest	Probit	NO	Pre-development (+), demonstration (+), viability (+), diffusion (+), international (+), expected R&D, expected investment (+), expected employment, universities, technology institutes, partners, budget (+), hours (+)
Barajas et al. (2012)					
Spain	Centre for the Development for Industrial Technology and Iberic System of Balance Sheets (SABI)	YES - sixth EU FP	Two-step methodology	Previous application (+), previous projected (+), small firms (+), liquidity (-), profits, export (+), KIS (+), manufactures (+), intangible fixed assets (+), Leverage	Previous experience (+),project budget, geographical distance (-), leader nationality, size of consortium (+)
Busom et al. (2012)					
Spain	Panel of Technological Innovation (PITEC-Panel de Innovación Tecnológica)	NO – tax incentives and subsidies	Bivariate Probit regression	Financially constraint (+), dominant firm, demand risk, appropriability, productivity (-), human capital (+), group, export (-), internal R&D (-), firm size, new firm.	NO

Source: Current authors

Table 2.
Summary statistics of firms, the innovation projects and subsidies (mean values).

	2007	2008	2009	2010
Number of firms				
Non-participants	16433	13343	13462	13297
Participants	205	172	149	161
Non-awarded participants	140	84	75	89
Awarded participants	65	88	74	72
Expected cost				
Non-awarded participants	98,379.1	146,172.5	165,155.8	108,976.5
Awarded participants	130,069.8	132,096.4	138,932.9	136,191.3
Subsidy				
Amount of subsidy	16,946.1	24,383.8	33,534.95	29,565.6
Final amount of subsidy	15,837.1	21,021.2	30,747.6	27,609.0

Source: SABI database and ACC1Ó

Table 3.
Descriptive statistics for Catalan firms. Mean and standard deviations (in brackets)

	Non-participants	Non-awarded participants	Awarded participants
Sales (thousands €)	4,477.72 (4868.85)	5,377.26 (7429,98)	6,441.62 (8120,01)
Sales growth rate *	-3.46% (16143.00)	0.07% (172.02)	-0.85% (39.95)
Firm age (years)	15.06 (11.45)	18.42 (13.08)	19.56 (13.10)
Exporting activity (% firms)	24.51% (0.43)	52.97% (0.49)	61.53% (0.48)
Cash-flow ratio	3.95% (0.68)	5.87% (0.16)	7.62% (0.10)
Long- term debt ratio	20.91% (21.45)	89.02% (9.91)	42.08% (4.04)
Location first area (% firms)	56.82% (0.49)	53.74% (0.49)	51.17% (0.50)
Location second area (% firms)	16.88% (0.16)	20.41% (0.40)	24.08% (0.42)
Priority industries (% firms)	17.79% (0.36)	26.35% (0.44)	26.75% (0.44)
Previous public grant (number of times)	0.02 (0.16)	0.21 (0.47)	0.24 (0.51)
Inter-spillovers	171,165.2 (172,077.1)	193,693.8 (158,941.0)	197,160.7 (158,774.2)
Intra-spillovers	3,516.6 (15,414.0)	7,920.0 (25,148.5)	6,217.5 (18,388.9)

** Median values*
Source: SABI database

Table 4.
Descriptive statistics for Catalan firms. Mean and standard deviations (in brackets)

	Non-awarded participants	Participants awarded with a subsidy
Project budget	124,385.4 (175,228.6)	134,333.9 (309,239.6)
Cooperation (% projects)	28.68 (45.29)	17.06 (27.68)
Number of awards previously	0.10 (0.34)	0.13 (0.36)
Quality of the project	5.40 (13.22)	35.98 (11.06)
Quality of the firm	0.31 (4.75)	90.16 (17.23)
Small firm (% firms)	56.07% (49.69%)	55.85% (49.74%)
Medium-sized firms (% firms)	17.31% (37.88%)	15.38% (36.14%)
Agricultural cluster (% firms)	9.82% (29.80%)	6.02% (23.82%)
Metallic cluster (% firms)	27.13% (44.52%)	29.76% (45.80%)
ICT cluster (% firms)	8.01% (27.18%)	8.70% (28.22%)

Source: SABI database and ACC1Ó

Table 5.
Heckman probit estimation of the probability of obtaining an R&D subsidy for Catalan firms.

	(1)	(2)	(3)	(4)	(5)
Probability of applying for a subsidy					
Firm size (t-1)	0.131	0.122	0.124	0.124	0.125
	(0.009)*	(0.009)*	(0.009)*	(0.009)*	(0.009)*
Firm age (t-1)	-0.0004	-0.002	-0.001	-0.001	-0.001
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Cash-flow ratio (t-1)	0.034	0.030	0.028	0.028	0.029
	(0.017)***	(0.018)***	(0.018)	(0.018)	(0.018)
Long-term debt ratio (t-1)	-0.00004	-0.00003	-0.00004	-0.00004	-0.00004
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)
Export	0.334	0.312	0.313	0.313	0.310
	(0.039)*	(0.039)*	(0.039)*	(0.039)*	(0.039)*
Priority	-0.045	-0.013	-0.006	-0.006	0.001
	(0.051)	(0.054)	(0.054)	(0.054)	(0.055)
Low-tech manufactures	-0.308	-0.279	-0.299	-0.299	-0.243
	(0.057)*	(0.059)*	(0.059)*	(0.059)*	(0.061)*
KIS	-0.449	-0.396	-0.427	-0.427	-0.372
	(0.064)*	(0.067)*	(0.067)*	(0.067)*	(0.070)*
Previous application (t)		0.872	0.865	0.865	0.860
		(0.048)*	(0.048)*	(0.048)*	(0.048)*
Metrop Area 1			-0.074	-0.074	-0.123
			(0.038)*	(0.038)***	(0.055)**
Metrop Area 2			0.427	0.130	0.094
			(0.046)*	(0.046)*	(0.057)***
InterSpillovers (t)					0.004
					(0.006)
IntraSpillovers (t)					0.014
					(0.005)*
cons (t)	-8.246	-9.739	-9.469	-9.495	-9.613
	(-)	(-)	(0.098)	(0.613)*	(-)
Probability of obtaining a subsidy					
Project size (t)	-0.004	0.117	0.127	0.111	0.114
	(0.030)	(0.178)	(0.180)	(0.190)	(0.192)
Cooperation (t)	-0.141	1.207	1.230	1.192	1.190
	(0.112)	(0.416)*	(0.391)*	(0.350)*	(0.335)*
Previous concession (t)		-1.620	-1.536	-1.557	-1.494
		(0.596)*	(0.599)*	(0.589)*	(0.584)**
Quality project (t)		0.026	0.025	0.025	0.025
		(0.006)*	(0.006)*	(0.006)*	(0.007)*
Quality firm (t)		0.092	0.094	0.093	0.093
		(0.024)*	(0.021)*	(0.019)*	(0.017)*
Small firm (t)	0.115	0.732	0.721	0.746	0.726
	(0.092)	(0.396)***	(0.405)***	(0.390)***	(0.392)***
Medium-sized firm (t)	0.253	0.861	0.835	0.821	0.792
	(0.140)***	(0.466)***	(0.488)***	(0.460)***	(0.464)***
Firm age (t-1)	-0.047	0.141	0.141	0.195	0.196
	(0.027)***	(0.145)	(0.142)	(0.098)**	(0.096)**
Firm growth (t)	-0.0004	-0.005	-0.006	-0.006	-0.006
	(0.0002)	(0.005)	(0.005)	(0.005)	(0.005)
Low-tech manufactures	0.087	-0.343	-0.360	-0.649	-0.663
	(0.125)	(0.397)	(0.414)	(0.482)	(0.483)
KIS	0.145	-1.288	-1.347	-1.667	-1.685
	(0.123)	(0.664)***	(0.656)**	(0.691)**	(0.682)**
cluster_agro				-0.935	-0.937
				(0.701)	(0.684)
cluster_metal				-0.034	-0.023
				(0.275)	(0.270)
cluster_ict				-1.380	-1.381
				(0.630)**	(0.625)**
cons (t)	1.605	-4.800	-5.236	-4.938	-4.815
	(0.455)*	(2.467)***	(2.348)**	(2.295)**	(2.030)**
ρ	-0.876	-0.188	-0.052	0.010	0.097
	(0.210)*	(0.505)	(0.508)	(0.497)	(0.465)
Uncensored obs.	73709				
Censored obs.	686				
Wald χ^2	30.24	86.64	103.58	185.07	199.03
Prob > χ^2	0.001	0.000	0.000	0.000	0.000

Time dummies included.
*, ** and *** correspond at significance levels at 1%, 5% and 10%