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DEPARTAMENT D'ECONOMIA – CREIP
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Young Firms and R&D subsidies in Catalonia

Agustí Segarra(♣) and Mercedes Teruel (♣)

Abstract:
Based on four different public R&D calls from the Catalan government, this article evaluates the propensity of entrants and young firms to apply for R&D public grants and, as compared to their counterparts, their capacity for obtaining subsides. This analysis is particularly relevant since entrants and young firms encounter greater market difficulties. Our sample contains 22,139 firms and corresponds to a merge of two databases: one from the Catalan agency responsible for promoting private innovation (ACC1Ó) and the other from the Mercantile Register. Merging these databases has two advantages. Firstly, participants and non-participants in the public R&D call ("InnoEmpresa") are included and, secondly, it provides us with information at firm and project level. The period of observation is between 2006 and 2010, since some explanatory variables are lagged by one period. We apply a two-step methodology. Our results show that entrants and young firms show a lower propensity to apply for R&D subsidies and to obtain R&D public grants. Firm size, exports and participation in a previous call show a positive impact on the likelihood of applying, and firms located in the Barcelona metropolitan area have a greater propensity to apply. Additionally, project quality and R&D cooperative reports presented jointly with other partners have a positive impact on the likelihood of obtaining the R&D subsidy. Finally, firms that have previously obtained an R&D subsidy do not exhibit a greater propensity for obtaining subsequent grants.

Keywords: *R&D subsidies, entrants and young firms*
Classification JEL: L53, L25, O38

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1. Introduction

The knowledge market usually fails to provide enough incentives to private firms to invest in R&D and innovation. Information asymmetries, knowledge externalities and the high risk of R&D activities limit firms capacities to carry out R&D activities. In consequence, the presence of externalities creates a gap between the private and social profitability of these activities and therefore firms spend less on R&D than is socially optimal. Most governments in industrialized economies have tried to correct this by designing policies, which include, for example, intellectual property right systems to improve knowledge appropriability, R&D tax or grants reliefs to reduce the cost of R&D (Nelson, 1959; Arrow, 1962).

Furthermore, the negative impact of market failures on private R&D investments is asymmetrical. In particular, the negative impact is larger for young and small firms, so usually governmental agencies design a variety of tools in order to promote the R&D activity of these firms. Public agencies try to: i) guarantee intellectual property through the development of a system of patents and copyrights; ii) promote knowledge transfer between scientific partners and firms by means of technological centres with technological platforms; iii) promote the technological market by means of public procurement of technological products; and iv) reduce the cost of R&D activities with tax incentives, loans or public subsidies. The effects on a firm's reaction differ depending on the tool and, hence, governments usually apply a combination of tools. Usually, public grants are the most selective instruments (vertical tools), while patents and R&D tax incentives are less able to prioritize target firms (horizontal tools).

Innovation activities differ across markets, territories and firms. Among sectors, innovation obstacles, and in particular financial constraints, are more important in the manufacturing and service sectors which need intensive knowledge skills and which require product differentiation. Geographically, innovative activity is concentrated in denser areas, thus causing territorial disequilibrium between innovative areas and rural areas (Audretsch and Feldman, 1994). Finally, among firms' lifecycles, young firms encounter strong barriers in accessing external financial resources and in generating internal cash-flow, while these barriers diminish with firm age. Governmental tools try to overcome this heterogeneous distribution of innovation activity among sectors, territories and firms. However, regional agencies often try to achieve these three objectives—sector, territory and firm age—with a single tool, hence limiting their effectiveness. The lack of evaluations of public policies may prolong these mistakes over time, while accurate evaluations may correct them.

The accurate design of policies is necessary to promote innovation and to reduce the innovation gap between Europe and US. This gap in R&D and innovation may have worrying negative consequences for the long-term potential of innovation, growth and employment creation in Europe (Czarnitzki et al., 2007). However the innovation and productivity gap needs to be explained in terms of its firm structure (whereby new firms do not play a significant role), and this is particularly so in high-tech sectors. Comparing their

industrial structures, the EU has fewer young firms among its leading innovators than the US. Cincera and Veugelers (2013) apply a decomposition analysis to show that having fewer young firms accounts for about one-third of the EU–US differential in R&D intensity, while 55% of the differential is due to the fact that young leading innovators in the EU are less R&D intensive than their US counterparts. These authors show clear evidence that the EU–US private R&D gap is indeed mostly a structural issue.

This evidence has opened an intense debate at European level about the main objectives and targets of governmental agencies in an effort to intensify the promotion of R&D and innovation. However, few studies have tackled the characteristics of European young firms and their contribution to Europe's innovative performance.

The main purpose of this paper is to analyse two aspects closely related to the recent European innovation debate. On the one hand, we study the pattern of entrants and young firms applying for a public R&D call as compared to that of mature firms. On the other hand, we study the probability of obtaining an R&D grant in relation to firm age. In the light of the aim of this paper, we distinguish three categories of firm: entrant firms are those with less than 6 years old; young firms are those with 6 or more but less than 20 years old; and mature firms with at least 20 years old.

To conduct empirical estimations, we merge two different sources: one from the Catalan agency responsible for promoting innovation and internationalization of Catalan firms (ACC1Ó) and another from the Mercantile Register (SABI – Sistema de Análisis de Balances Ibéricos). The merge of both databases allows us to have a complete set of variables with a quadruple dimension (project, firm, territory and sector) and additionally to differentiate between participants and non-participants in a public call and between awarded and non-awarded firms. Following the literature (Huergo and Trenado, 2008, 2010; Santamaría et al., 2012; Segarra et al., 2014), we apply a Heckman model to this data.

We find five main results. Firstly, we observe that being either an entrant or a young firm negatively affects the propensity to apply for R&D subsidies, but that this is only significant for young firms. Secondly, neither of these two groups of firms has a higher probability of obtaining these public resources. Thirdly, variables such as firm size, being an exporter, being in high-tech and a Knowledge-Intensive Service (KIS) sectors, or having applied previously, have a positive and significant impact on the likelihood of applying – in addition, firms located in the main Barcelona metropolitan area show a larger propensity to apply. Fourthly, firms in high-tech manufactures and KIS have a larger likelihood of obtaining an R&D subsidy. Our proxy for the firm also has a positive coefficient. Furthermore, highly-qualified projects and those presented jointly with other organizations have a greater likelihood of obtaining the R&D subsidy. Finally, firms that had previously obtained a subsidy from the same call do not show a larger propensity to obtain the R&D subsidy currently being applied for.

Empirical evidence shows that the relationship between firm age and innovation capacity is not simple, since innovation intensity varies widely across sectors and over the firm's life-cycle. Entrants and young firms tend to innovate more than mature firms, but the financial and knowledge constraints differ between entrants and young firms. Our contribution is to the effort to elucidate whether young small companies exhibit a different propensity to participate, and obtain an R&D subsidy, than their counterparts.

The structure of the paper is as follows. Section 2 outlines the literature related to the participation and selection of public R&D subsidies and we highlight the importance of firm age in this process. Section 3 presents the database. Section 4 describes the econometric and statistical methodologies. Section 5 reports the results, and the final section presents our concluding remarks.

2. Review of the literature

This section presents a review of the literature. Firstly, we present the empirical evidence of the determinants of participation in public R&D calls. Secondly, we outline the determinants affecting the selection process. Finally, we advance some arguments as to why entrants and young firms may show a different behaviour with respect to their counterparts. This section will not focus on the different methodologies or databases since the development of econometric tools will be presented in Section 4.

2.1. Determinants to participate in public R&D call

Our first step attempts to disentangle the determinants of participation in a public R&D call. We highlight the work of Blanes and Busom (2004), Czarnitzki and Licht (2006) Huergo and Trenado (2008, 2010), Barajas et al. (2012) and Segarra et al. (2014). To our knowledge, they are the main contributors to the relatively sparse literature on this topic. For Spanish manufacturing firms, González and Pazó (2008) indicate that small firms and those operating in low technology sectors would not have engaged in R&D activities in the absence of subsidies. Hence, such grants appear to be crucial for this particular group of firms.

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. We should point out that these authors use *Encuesta sobre Estrategias Empresariales* and hence only have information on firms that apply and are awarded, but lack information on non-awarded applicants. Another limitation of their database is that the data is not available at project level.

Subsequently, Czarnitzki and Licht (2006) observe, for a panel of German firms, that exporters and firms based abroad show a greater propensity to participate in R&D subsidy

applications, while firms that do not take out patents are less prone to receive awards.[1] Furthermore, these authors show that there are regional differences between the input additionality of East and West Germany. Similarly to Blanes and Busom (2004), Czarnitzki and Licht (2006) do not have information at project level.

The objective of this paper is to contribute to the empirical literature that evaluates the effects of public R&D support on private R&D investment. We apply a matching approach to analyse the effects of public R&D support on Spanish manufacturing firms. We examine whether or not these effects differ depending on the size of the firm and the technological level of the sectors in which the firms operate. We evaluate the effect of R&D subsidies on the subsidized firms, considering both the effect of subsidies on firms that would have performed R&D in the absence of public support, and also the effect of the inducement to undertake R&D activities. Additionally, we analyse the effect that concession of subsidies might have on firms which do not enjoy this type of support.

The main conclusions indicate an absence of "crowding-out", either full or partial, between public and private spending and that some firms—mainly small and operating in low technology sectors—might not have engaged in R&D activities in the absence of subsidies.

This lack of information at project level is overcome in the work of Huergo and Trenado (2008, 2010), Barajas et al. (2012) and Segarra et al. (2014). They analyse the participation of Spanish firms in a public call for low-interest credit during the period 2002–2005. They show 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. Similarly, Barajas et al. (2012) find that, in addition to financial variables, being an exporter, a smaller firm or a KIS, have positive impacts on the probability of participation in an EU Framework Programme (FP) cooperation project.

More recently, Segarra et al. (2014) analyse a group of Catalan firms participating in a public R&D call. Their results show that large firms, exporters and those belonging to high-tech manufactures are more likely to participate in a public R&D call. Furthermore, location and past experience of such type of calls have a positive effect on the probability of participating. Other territorial variables which try to capture the information spillovers show a positive impact at intra-industry level.

2.2. Determinants of obtaining a public R&D subsidy

After the application for a public R&D call, there is a selection process designed by governments. Firstly, if the project accomplishes all the requirements of a call it will be accepted for later evaluation; secondly, usually an ad-hoc technical commission will be formed to decide to accept or reject a project according to established selection criteria;

[1] 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.

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.

In spite of the importance of the assignation of public economic resources, few studies have analysed the different criteria used by governmental evaluators to select projects (Hsu et al., 2003; Lee and Om, 1996, 1997; Takalo et al., 2013). Hence, it is crucial to delve deeper into this issue (Lerner, 2002 p81). Firstly, the selection process reflects the real objectives of policymakers. Secondly, they determine the characteristics of those projects that progress and, consequently, the results obtained. Thirdly, public calls have impacts at sectoral and territorial level.

In order to capture the decision process, databases must compile information at project level. Takalo et al. (2013), Huergo and Trenado (2008, 2010), Barajas et al. (2012), Segarra et al. (2014) have such information and apply a two-step methodology where the probability of receiving a public R&D call depends on the previous participation.

Among the determinants that affect the likelihood of being awarded, we highlight two different sets of variables. The first set includes characteristics of the firms such as firm age, firm size, sector and dynamism. Firm age generally shows a non-significant impact, except for Segarra et al. (2014) who observe a positive impact. Firm size measured in log terms usually shows a positive sign (Takalo et al., 2013), but the majority of the studies include dummies to capture the behaviour of SMEs and observe a positive and significant impact. Hence, the results basically show that awarded projects normally belong to SMEs. Finally, belonging to high-tech manufactures or to KISs is not conclusive, since some authors such as Huergo and Trenado (2008, 2010) find a negative impact for firms belonging to high-tech manufactures and a positive one for KIS, while other authors have found a negative, but non-significant, impact for firms in low-tech manufactures.

The second set includes project characteristics such as project size or the internal quality evaluation of the project. Generally speaking, the variables included in the different works depend in large measure on the information available to the researchers. However, results in general show a significant positive impact of the project budget and export possibilities (Huergo and Trenado, 2008; Santamaría et al., 2010; Segarra et al., 2014) and the collaboration (Huergo and Trenado, 2008, 2010; Barajas et al., 2012; Segarra et al., 2014).

Finally, Afcha (2012) points out that public agencies may try to prioritize those firms that have better opportunities for success. Thus, they may apply a "picking-the-winner" strategy which gives subsidies to projects that are already viable. In that case, non-subsidized firms will leave the market. In this line of research, Santamaría et al. (2010) and Huergo and Trenado (2008, 2010) find that there is a positive sign between the evaluation of the

commercial perspectives and viability and the probability of being awarded. However, Segarra et al. (2014) do not find significant impact of sales growth on the likelihood of obtaining an R&D subsidy.
One of the criticisms of public R&D subsidies is that they may cause a crowding-out effect on R&D private investment. However, the results are not conclusive. On the one hand, authors such as Czarnitzki and Lopes-Bentoa (2013) reject the idea that R&D subsidies cause total crowding-out. Their results indicate the persistence of this pattern, since there is no declining effect if firms get subsidies recurrently or if firms additionally receive support from other sources. On the other hand, some authors such as Gorg and Strobl (2007) find that there is a crowding-out effect of public R&D subsidies on private R&D investment.

2.3. Why may entrants and young firms be different?

One of the intrinsic characteristics likely to affect the behaviour of a firm is its age. The life-cycle defines a different pattern at different ages.

Firstly, entrants present a different set of characteristics than young or older firms. Entrants have lower values of tangible and intangible assets. Furthermore, financial and technological resources are scarce and their physical stock is limited due to higher transaction costs and risk premiums (Beck and Demirguc-Kunt, 2006; Beck et al., 2005, 2006; Schiffer and Weder, 2001). Information asymmetry and moral hazard may result in a higher cost of financing for young firms as compared to their counterparts. Additionally, entrants usually have a less specialized workforce, a small market penetration and a lower knowledge of the market. In other words, entrants may suffer from higher risks of failure or "liability of newness".

However, those entrants that manage to survive the first few years improve their market penetration by achieving larger growth rates than their counterparts (Coad et al., 2013). In consequence, they are able to diminish their asset gap with entrants. This better performance causes young firms to be able to invest more in internal and external R&D and improve their absorptive capacity. In fact, evidence shows that on average young firms tend to invest more intensely in R&D (Audretsch et al., 2014).

These young firms still may suffer from some difficulties in financing innovative projects since external investors may find it more difficult to evaluate young firms. Hence, their capital structure would present lower levels of leverage, because private external investors are reluctant to lend when the investment is concentrated essentially on intangible assets (Hall, 2002; Hall and Lerner 2010). However, mature firms usually suffer from "liability of obsolescence" since they may have a larger rigidity for adapting to changes in the market and lower organizational flexibility – see Coad et al. (2013) for a review of the literature on the relationship between firm age and firm performance.

The previously mentioned empirical evidence suggests that the participation of entrants and young firms in public R&D calls may differ in comparison to mature firms. On the one

hand, given that they have larger costs to finance externally, young firms may show a greater propensity to apply for R&D subsidies. On the other hand, they may have also more difficulties since applications usually entail a bureaucratic overhead that young firms may not be able to cope with. Hence, they may show a lower propensity to apply for these calls. In consequence, the final result may be unexpected.

Regarding the selection process, once young firms have applied public agencies may have more incentives to choose those projects belonging to young firms and in particular to Young Innovative firms (YICs). Public agencies' 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 sectors. Hence, public agencies' goals may condition the criteria for selecting new proposals and, in particular, may include non-financial criteria, such as competition and employment.

Public agencies may consider that entrants and young firms have more desirable characteristics than mature firms. Firstly, they may have advantages in the race for innovation since they may have better managerial control and lower bureaucratization of innovation activity. Secondly, they usually occupy small market niches in sectors that incumbents may not be interested in entering due to the low economies of scale they may achieve in this market. Conversely, entrants and young firms might encounter a fear of competition by mature firms who may opt to introduce their products into each market even if they are not profitable. In general, entrants and young firms are usually seen as a group of highly dynamic firms that may be pressurized by market competition at an aggregate level.

As a consequence, public agencies may show a higher propensity to give young firms access to public funds. This would be the case when public agencies aim to promote the introduction of competition in small niches and occasionally in high-growth markets. However, it will depend if they have designed a horizontal tool where they consider that the introduction of firms not necessarily young, small or in high-tech sectors will also be crucial for the renewal of some markets.

3. Database and descriptive statistics

Our sample is a merge of a database from ACC1Ó 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 to 2011.

ACC1Ó is the Catalan public agency that promotes innovation and internationalization of firms, in particular SMEs. 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 for 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 present their project individually or jointly with other firms via intermediate organisms, such as technological centres. These four public calls were open to all firms, but SMEs in manufacturing sectors predominated.

According the available information, there is a vector of firm characteristics (location, size, age…) and a vector of features of the innovation projects. Furthermore, the information follows-up on the firm. Hence, we can know if the subsidy was finally accepted by the firm and if the project has been finished.[2] Consequently, we can separately study which factors determine a firm's decision to apply and which ones affect the agency's selection.

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 had been 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 manufactures, low-tech manufactures and knowledge-intensive services.[3] Our sample contains 22,139 firms consisting of non-participants and participants in at least one of the four calls. The period of observation is 2006 to 2010, since some explanatory variables are lagged by one period.

Hence, our database contains information at firm level for three different groups of firms. The first group comprises those firms that did not apply for a subsidy (non-participants). The second group comprises those firms that applied for a R&D subsidy but which were evaluated negatively (non-awarded participants). Finally, the third group comprises those firms that obtained the R&D subsidy (awarded participants). In line with the aim of this paper, we consider two subsamples of firms according to firm age: entrants being those firms with ages less than 6 years and young firms being those firms between 6 or more years but less than 20 years.

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

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

Table 1 shows the distribution of firms and the value of the main characteristics of innovation projects. Regarding the number of participants, entrants and young firms represent approximately 20% and 40% respectively of all participants. However, these percentages are smaller with respect to the representation of both firms among non-participants (the corresponding values being 30% and 49%). Regarding the budget of the innovation project, we observe that among non-awarded firms, entrants and young firms were presenting lower budgets. Among awarded firms, we observe that entrants show a larger value than their counterparts, while awarded young firms show a lower mean value. This first table seems to point out that awarded entrants and young firms present larger budgets. This sentence is confirmed by the mean values of the subsidy which are larger for entrants, while young firms are below the mean value of all observations.

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

Table 2 shows the descriptive statistics of our explanatory variables. Firstly, regardless of whether firms participate or not, entrants show a lower mean value of sales in comparison with young firms and young firms. Export activity seems to require a certain experience in the market since the percentage of entrants which export is lower than that of young firms and in the database as a whole. However, there is a significantly larger percentage of firms who participate in the public call and who are already exporting. Regarding the financial ratios, we observe that that the cash-flow ratio of entrants that do not participate is smaller than the mean value for all non-participants, while young firms show a higher mean for their long-term debt ratio. However, among participants, entrants have a larger long-term debt ratio. More significantly, participants show a larger cash-flow ratio than non-participants, while their long-term debt ratio is smaller. Hence, it seems that those firms that participate in the public R&D call exhibit a different financial structure. Finally, with respect to location, among participants young firms have a lower percentage of firms in the first and second metropolitan areas. However, the majority of the firms are located in the first metropolitan area from Barcelona, emphasizing the key importance of this prime location.

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

Table 3 shows the main characteristics of the innovation projects. Firstly, the budget of innovation projects is higher for entrants than for all participants, while young firms present a lower mean value than for all participants. Secondly, among entrants there is a lower percentage of participants presenting cooperative projects. Thirdly, entrants show a larger number of attempts to participate in this public call than do the other groups. Furthermore, among those entrants that decide to participate, the number of previous awards is slightly higher. Finally, with respect of the evaluation, we observe no significant differences between the different groups.

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

Therefore, we note that some characteristics of firms that apply and are awarded the public R&D call differ significantly between groups. In fact, Catalonia is an interesting region in which to evaluate the interaction between R&D public subsidies and the territorial dimension. Firstly, this territory is one of the most dynamic in Spain in economic and cultural terms. Secondly, it has a long tradition in R&D and innovation and it has competencies in designing policies in the field of universities, research and innovation.

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

Finally, we must comment on some shortcomings of our data. In the first place, we have information about the innovation project, but we do not have information about a firm's total R&D investment. This is a shortcoming shared by other studies in the same field. However, firm size and sectoral dummies may be good proxies. Secondly, there is no information on whether a firm applies for other R&D programs (subsidies, taxes…). Hence, 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. And 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 in common with previous studies.

4. Econometric methodology

In line with previous scholars (Huergo and Trenado, 2008, 2010, Takalo et al, 2013), we are able to distinguish between a firm's decision to apply for a subsidy and the probability of receiving an award for an R&D project. Firstly, firms with R&D ideas decide whether to apply for a subsidy. Conditional on this decision, they decide how much to invest in the R&D project. Secondly, public agency decides the level of the subsidy rate, that is, the share of the R&D cost that the agency will subsidize. We can represent our model with the following expressions:

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

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

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

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

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 $N(0,\sigma_1^2)$. Firm *i* applies for the subsidy if y_{1i}^* is positive.

The second equation is the probability that a firm is awarded a subsidy by means of 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:

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

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 $N(0,\sigma_2^2)$. The proposal is approved if y_{2i}^* is positive.

Equation (1) and Equation (2) depend on the following set of explanatory variables (x_{1i}) (Table 4):

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

The expected behaviour of variables is the following:

Firm characteristics:

1. **Firm size**: On the one hand, 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 likelihood to apply for a public R&D subsidy. On the other hand, larger firms may have R&D departments with capacity to undertake the definition of R&D and innovation projects. However, public agencies may prioritize SMEs. Hence, the expected sign of the likelihood of obtaining the R&D subsidy is unknown.
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. Additionally, young firms suffer more financial constraints, so they may need to have access to R&D subsidies. On the other hand, young firms may be more innovatively dynamic or they may suffer more from 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. Hence, it is unclear what sign should be expected for the likelihood of applying and of obtaining a public R&D subsidy.
3. **Entrants** and **Young firms:** According with the literature developed in subsection 2.3, we expect an unknown impact on the likelihood of applying and obtaining the R&D subsidy.

4. **Cash-flow ratio**: R&D projects are subject to higher risks and financial barriers. Empirical literature shows the existence of a positive correlation between financial constraints and the failure of innovation projects (Segarra et al., 2013) and a positive correlation between cash-flow and the probability of doing R&D. Hence, we expect a positive correlation between cash-flow and the probability of applying for a subsidy.
5. **Long-term debt ratio**: Firms with long-term debt contracts may diminish financial constraints. Hence, long-term debt ratio may show a positive impact on the probability of applying for an R&D subsidy. However, these firms are more probable to engage in R&D and they may be more prone to apply for public R&D subsidies. The impact on the probability to apply for public R&D subsidies is unclear.
6. **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.

Sectoral characteristics

7. **High-tech manufactures** and **KIS:** Sectoral particularities may have significant differences. On the one hand, firms in the same industry may face different hurdles in participating in different agencies' programs and patterns differ across high-tech and low-tech industries (Blanes and Busom, 2004). Furthermore, Capron and Van Pottelsberghe (1997b) show that the public R&D subsidy may have a different impact on the private R&D investment depending on the sector. On the other hand, evaluators may prioritize firms in some sectors. Hence the sign to be expected on the likelihood to apply and to obtain a public R&D subsidy is again unclear.

Territorial characteristics

8. **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. However, this is an area where there is also a higher concentration of firms and the competition may be fierce.
9. **Metrop Area 2**: This dummy variable identifies firms located in the second ring 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 and having an industrial tradition).

Project characteristics

1. **Project size**: Empirical evidence (Heijs, 2005b, Acosta and Modrego, 2001) shows project size to be significant in the selection process.
2. **Cooperation**: Presenting a project jointly with other projects may be a characteristic that evaluators consider relevant.

3. **Previous application:** Applying for a public subsidy requires experience of dealing with all the administrative burdens. Hence, we expect that those firms with experience of applying for a public call will be more prone to participate.
4. **Previous concession**: If evaluators may apply a "picking-the-winner" strategy, the expected sign would be positive. However, they may not consider it to be a relevant indicator.
5. **Quality project**: The best-regarded projects have a better chance of obtaining a subsidy. We expect a positive sign on the likelihood of obtaining an R&D subsidy.
6. **Quality firm**: This index measures the capacity of the firm to plan and carry out the research project over the time period. We expect a positive sign on the likelihood of obtaining a R&D subsidy.

Both equations include time dummies since, during an expansion, there are more public financial resources, while during a financial crisis they decrease. The error terms in Eqs. (1) and (2) might contain some commonly omitted variables, and therefore the correlation term ρ between u_1 and u_2 might not equal zero. This bias may appear for different reasons. Firstly, some firms apply for support because they have discovered particularly promising R&D projects. Secondly, screening of projects by 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. 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 β_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.

5. Empirical results

Table 5 contains the empirical estimation of our model. It presents a two-step probit model with sample selection by maximum likelihood which we applied with the dataset. At the bottom it shows the determinants of applying for a public R&D subsidy from the Catalan agency. And at the top the factors related to the probability of obtaining an award are given. Columns [1] to [3] present results without controlling by entrants and young firms, while columns [4] to [6] include our variables. Our estimations show some interesting results.

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

Regarding the determinants of applying for the public R&D call, we observe that export and firm size are two characteristics of firms which affect positively the capacity of Catalan firms to participate in this public call to promote R&D projects. Both results are interesting and they may point out two facts. Firstly, entrants and young firms have lower scale economies in order to bear the administrative costs of applying. Secondly, there are some linkages between export activity and the necessity to innovate. This relationship is crucial

for a Catalan economy which needs to increase its technological endowment and improve its share of international markets, in particular in goods and services which are knowledge- and technology-intensive.

Regarding the financial ratios, the cash-flow ratio shows a positive sign on the likelihood of applying – except in columns (3) and (6) where the long-term debt ratio shows a negative non-significant impact. Those results are in line with our expectations, since they confirm that firms with higher cash-flow ratios may be more prone to participate in public R&D calls, while these firms with access to long-term funds may not need R&D public calls.

Additionally, the variable *Previous application* shows a positive and significant sign. This result indicates that experience in public R&D calls is a crucial factor for trying to apply in subsequent calls. In consequence, the younger firms may have a limited experience in public calls and, hence may not benefit from learning economies by comparison with mature firms. In fact, the potential non-linearity of firm age on the probability of applying is revealed with a non-significant impact of firm age on this estimation.

Indeed, when we introduce the dummy variables indicating firms which are entrants or young firms (equations (4) to (6)), we obtain negative parameters. In other words, our results indicate show evidence that both subsamples of firms have a lower capacity to participate in public calls.

At the sectoral level, firms in high-tech and KIS sectors are more prone to apply more for Catalan public R&D calls than their counterparts. However, firms in KIS show a larger propensity to respond to public R&D calls. Finally, the territorial proxies show a negative parameter which is only significant for the densest metropolitan area, while the impact is positive for those firms surrounding this densest area from Catalonia. These results may indicate the larger competition in Catalonia's core geographic area, but also the fact that a large share of firms located in this area are devoted to services and, hence, the percentage of firms in high-tech and knowledge-intensive sectors is lower.

Regarding the second decision, we observe that firm size becomes a non-significant variable, while firm age has a negative impact which is only significant in equations (1) and (4) while being positive but non-significant in the other equations. Hence, generally speaking, we may say that, in selecting innovation projects, the Catalan public agency does not take into account both characteristics.

Those variables related to the sector show a positive impact on the probability that a firm obtains a public R&D call, however they are significant only when we introduce the projects' characteristics.

Among the variables which characterised the innovation projects' characteristics, those projects where different agents apply jointly, show a positive impact. However, having previously obtained a public R&D subsidy does negatively affect the probability of

obtaining the subsidy in this call. Hence, our results point out that the public agent does not apply a "picking-the-winner" strategy. Hence, at least for the "InnoEmpresa" call and during our period of observation, there seems that past grants, regardless of project outcomes, do not help a firm increase their legitimacy to obtain the same subsidy. Our proxies of the quality of the firm and the quality of the project have a positive effect on the probability of being selected.

Finally, the fact that the firm is an entrant or a young firm does not have a significant impact on the probability that a firm is awarded a public R&D subsidy. As a consequence, it seems that the Catalan public agency applies R&D subsidies as a horizontal tool since basically the innovation projects' characteristics are the most relevant when estimating the probability of obtaining the subsidy.

Table A-2 analyses estimates for the basic equation (it was not possible to obtain the results for equation (2) and (3). The results are similar to those in Table 5. However, there are two results that differ. Firstly, entrants show a significant positive sign of the cash-flow ratio and the long-term debt on the probability of applying for the public R&D subsidy. This relationship may indicate that among all entrants those that decide to apply for this R&D subsidy show higher cash-flow ratios and larger long-term debt ratios. This may suggest that they are a particular subgroup of firms with higher leverage levels. Secondly, firm age shows a significant and negative impact on the probability of being awarded for entrants. Hence, with some degree of caution, we may say that entrants suffer from higher difficulties in obtaining public subsidies.

6. Conclusions

The main aim of this paper is to evaluate the effects of a specific tool such as R&D subsidies on R&D private firms, paying special attention to the effects on young and small firms. In recent years, R&D public subsidies have become one of the main policy tools of governments in diminishing the gap between the social demand and private investments in R&D. In line with previous literature, we apply a two-stage model. Firstly, firms with R&D projects decide whether to apply for a subsidy, conditional on this decision and the outcome of the application they decide how much to invest in the R&D project. Secondly, public agency decides those projects that will be subsidized and the amount granted.

The importance of the policy evaluation has drawn scholars' attention to the analysis of the determinants of public agencies' selection process of innovation projects. This literature has been enriched by the capacity to merge different databases. This paper uses information of a public R&D call for Catalan firms, "InnoEmpresa", developed by the ACC1Ó (Catalan government) between 2007 and 2010. This database with information at project and firm levels is merged with information available in the Mercantile Register.

The total budget of this call between the call period (with more than €45 million) highlight the importance given by the Catalan government to the innovation process as a means of catching up with more developed economies. This justifies the analysis of the determinants of participation and obtaining this public R&D subsidy. In particular, this process is more crucial for entrants and young firms (who usually show lower productivity levels and higher innovation efforts). From the point of view of the public agencies involved in the promotion of firm innovation, they usually find considerable difficulties in attracting and selecting firms with innovation potential.

In general, our results are in line with previous literature. Firstly, entrants and young firms show a lower relative capacity to apply for R&D subsidies, but this coefficient is only significant for young firms. Secondly, neither group of firms has a higher probability of obtaining these public resources. Thirdly, variables such as firm size, being an exporter, being in high-tech and KIS sectors, and having applied previously show a positive and significant impact on the likelihood to apply. Also, firms located in the main metropolitan area from Barcelona show a larger propensity to apply. Forth, firms in high-tech manufactures and KIS show a higher likelihood of obtaining an R&D subsidy.

Furthermore, in regard to innovation projects' features, we find that well-qualified projects and those presented jointly with other organizations are more likely to obtain the R&D subsidy. Also, the project size measured in terms of Euros shows ambiguous effects. Our proxy of firm quality, as measured by the amount of the subsidy finally invested in the project, shows a positive impact. Finally, firms that had previously obtained a subsidy from the same call do not show a larger propensity for obtaining this R&D subsidy.

Our results emphasise the difficulties that entrants and young firms still have in order to apply. Also, there are some differences between entrants and young firms, since among all entrants those that are more prone to apply for a R&D subsidy are those with higher cash-flow and long-term debts ratios. Furthermore, empirical results show the difficulties that innovative entrants and young firms find in public calls. Governments should make an additional effort when applying vertical tools, such as R&D subsidies, in order to facilitate young firms responding to an R&D public call. This is very relevant since, in accordance with the European debate on innovation, Young, Small and Innovative firms (YICs) are more prone to invest in R&D, to cooperate more with externals partners and to generate more knowledge spillovers which impact on other firms.

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Tables

Table 1.
Summary statistics of firms, the innovation projects and subsidies. Period 2007-2010.

	All	Entrants	Young firms
Number of firms and Percentage over total firms			
Non-participants	68,837	20,598 (30%)	34,406 (49%)
Non-awarded participants	388	85 (22%)	168 (73%)
Awarded participants	299	64 (21%)	122 (41%)
Expected cost (Mean value)			
Non-awarded participants	124,064.8	103,120.5	108,890.3
Awarded participants	134,333.9	176,050.6	97,879.68
Subsidy (Mean value)			
Amount of subsidy	26279.55	28677.17	24220.9

Source: SABI database and ACC1Ó

Table 2.
Descriptive statistics for Catalan firms. Mean and standard deviations (in brackets). Period 2007-2010.

	Non-Participants			Participants		
	All	**Entrants**	**Young**	**All**	**Entrants**	**Young**
Sales (thousands €)	4,477,7 (48,648,8)	1,643.4 (10,625.8)	3,112.1 (17,573.5)	5,835.81 (7,746.18)	2,542.7 (4,608.9)	4,469.96 (5,396.0)
Firm age (years)	15.06 (11.45)	4.47 (2.58)	14.49 (4.16)	18.91 (13.09)	4,42 (2.22)	14.85 (4.11)
Exporting activity (dummy)	0.25 (0.43)	0.11 (0.31)	0.23 (0.42)	0.57 (0.50)	0.31 (0.46)	0.54 (0.50)
Cash-flow ratio	0.04 (0.69)	0.02 (0.96)	0.05 (0.30)	0.07 (0.15)	0.08 (0.18)	0.06 (0.17)
Long- term debt ratio	1.29 (156.82)	0.35 (1.26)	2.26 (221.80)	0.68 (7.90)	0.30 (0.28)	1.06 (11.43)
Location first area (dummy)	0.59 (0.50)	0.55 (0.50)	0.57 (0.50)	0.53 (0.50)	0.59 (0.49)	0.49 (0.50)
Location second area (dummy)	0.17 (0.37)	0.17 (0.37)	0.17 (0.38)	0.22 (0.41)	0.25 (0.43)	0.21 (0.41)

** Median values*
Source: SABI database

Table 3.
Descriptive statistics for Catalan firms. Mean and standard deviations (in brackets). Period 2007-2010.

	Participants		
	All	**Entrants**	**Young**
Project budget	128,534.2 (242,625.6)	134,446.2 (408,955.7)	104,258.2 (131,516.5)
Cooperation (dummy)	0.24 (0.43)	0.16 (0.37)	0.25 (0.43)
Number of times participating previously	0.23 (0.50)	0.32 (0.63)	0.18 (0.41)
Number of awards previously	0.11 (0.34)	0.15 (0.41)	0.10 (0.33)
Quality of the project	18.70 (19.55)	19.66 (20.56)	18.71 (19.79)
Quality of the firm	39.42 (46.14)	39.40 (46.71)	37.47 (45.56)

Source: SABI database and ACC1Ó

Table 4. Definition of variables

		Expected sign	
Variables	**Measure**	**Applying**	**Being awarded**
	Firms' characteristics		
Firm size	Lagged ln(sales)	Positive	?
Firm age	Lagged ln(age)	?	?
Entrants	Dummy variable indicating if a firm has 6 or less years	?	?
Young firms	Dummy variable indicating if a firm has between 7 and 20 years	?	?
Cash-flow ratio	Lagged CF/assets	Positive	
Long-term debt ratio	Lagged Long-term debt/assets	?	
Export	Dummy variable indicating if a firm exports	Positive	
	Sectoral characteristics		
High-tech manuf	Dummy variable indicating if a firm belongs to high-tech sectors.	?	?
KIS	Dummy variable indicating if a firm belongs to Knowledge intensive sectors.	?	?
	Territorial characteristics		
Metrop Area 1	**Dummy** variable indicating if a firm belongs to the densest metropolitan area in Catalonia.	?	
Metrop Area 2	**Dummy** variable indicating if a firm belongs to the crown surrounding the densest metropolitan area in Catalonia.	?	
	Projects' characteristics		
Project size	Ln(budged)		Positive
Cooperation	Dummy		Positive
Previous application	Number of previous times a firm had applied for this R&D public call	Positive	
Previous concession	Number of times the firm has obtained an R&D subsidy		?
Quality project	(Amount of subsidy / requested money) x 100		Positive
Quality firm	(Invested subsidy / amount of subsidy) x 100		Positive

Source: own elaboration

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

	(1)	(2)	(3)	(4)	(5)	(6)
	Probability to obtain					
Firm size (t-1)	0.0753	-0.143	-0.122	0.0719	-0.139	-0.119
	(0.0798)	(0.138)	(0.133)	(0.0797)	(0.132)	(0.134)
Firm age (t-1)	-0.0612*	0.177	0.167	-0.0715*	0.220	0.205
	(0.0354)	(0.136)	(0.150)	(0.0425)	(0.251)	(0.308)
High -tech manufactures	0.0125	1.133	1.235*	0.0166	1.185**	1.263**
	(0.114)	(0.733)	(0.642)	(0.115)	(0.581)	(0.543)
KIS	0.0212	1.068*	1.206**	0.0401	1.047**	1.145**
	(0.194)	(0.608)	(0.554)	(0.204)	(0.509)	(0.532)
Project size (t)	-0.0129	-0.0014	0.0111	-0.0126	-0.0006	0.0090
	(0.0363)	(0.148)	(0.156)	(0.0363)	(0.151)	(0.156)
Cooperation (t)	-0.200	1.051**	1.117***	-0.200	1.121***	1.173***
	(0.139)	(0.518)	(0.421)	(0.139)	(0.425)	(0.371)
Previous concession (t)		-1.800***	-1.731**		-1.833***	-1.751**
		(0.651)	(0.696)		(0.681)	(0.732)
Quality project (t)		0.0231***	0.0234***		0.0241***	0.0241***
		(0.0062)	(0.0052)		(0.0058)	(0.0057)
Quality firm (t)		0.0881***	0.0927***		0.0922***	0.0953***
		(0.0299)	(0.0249)		(0.0221)	(0.0209)
Entrants				-0.0734	0.165	0.149
				(0.181)	(0.631)	(0.723)
Young firms				-0.0167	-0.0800	-0.139
				(0.118)	(0.475)	(0.486)
Constant	0.442	-2.532	-3.481	0.512	-3.137	-3.961
	(1.396)	(4.301)	(3.442)	(1.392)	(3.624)	(3.085)
	Probability to apply					
Firm size (t-1)	0.130***	0.124***	0.127***	0.126***	0.121***	0.123***
	(0.0088)	(0.0092)	(0.0093)	(0.0089)	(0.0093)	(0.0094)
Firm age (t-1)	-0.0005	-0.0023	-0.0014	-0.0054	-0.0071	-0.0068
	(0.0117)	(0.0117)	(0.0119)	(0.0134)	(0.0134)	(0.0134)
Cash-flow ratio (t-1)	0.0322*	0.0294*	0.0279	0.0332*	0.0302*	0.0288
	(0.0177)	(0.0178)	(0.0181)	(0.0178)	(0.0178)	(0.0180)
Long-term debt ratio (t-1)	-3.64e-05	-3.16e-05	-4.13e-05	-3.35e-05	-2.92e-05	-3.86e-05
	(2.76e-05)	(3.00e-05)	(3.51e-05)	(2.62e-05)	(2.85e-05)	(3.35e-05)
Export	0.338***	0.304***	0.307***	0.331***	0.298***	0.300***
	(0.0374)	(0.0386)	(0.0387)	(0.0380)	(0.0391)	(0.0392)
High-tech manufactures	0.125***	0.115***	0.128***	0.125***	0.115***	0.129***
	(0.0349)	(0.0360)	(0.0360)	(0.0349)	(0.0359)	(0.0360)
KIS	0.406***	0.381***	0.420***	0.413***	0.387***	0.428***
	(0.0456)	(0.0464)	(0.0469)	(0.0458)	(0.0468)	(0.0472)
Previous application (t)		0.861***	0.855***		0.859***	0.852***
		(0.0481)	(0.0480)		(0.0480)	(0.0480)
Metrop Area 1			-0.0776**			-0.0791**
			(0.0373)			(0.0373)
Metrop Area 2			0.133***			0.133***
			(0.0454)			(0.0454)
Entrants				-0.0599	-0.0551	-0.0605
				(0.0561)	(0.0573)	(0.0575)
Young firms				-0.0877**	-0.0716*	-0.0750*
				(0.0391)	(0.0401)	(0.0402)
Constant	-8.161	-10.29	-10.06***	-8.046***	-10.01	-9.980
		(0)	(0.330)	(1.114)		
rho	-0.356	-0.418	-0.211	-0.355	-0.286	-0.0805
	(0.374)	(0.919)	(0.697)	(0.382)	(0.670)	(0.537)
Observations	74,421					

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Annex

Table A.1.
Matrix of Person correlations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Firm size	1.000												
Firm age	0.406*	1.000											
Export	0.533*	0.262*	1.000										
Cash-flow ratio	0.056	-0.091*	-0.021	1.000									
Long-term debt ratio	0.048	-0.008	0.047	-0.172*	1.000								
Metrop Area 1	-0.060	-0.043	-0.029	-0.011	0.034	1.000							
Metrop Area 2	-0.038	-0.023	-0.082*	0.011	-0.031	-0.560*	1.000						
Previous application	-0.002	-0.005	0.055	0.036	-0.029	-0.013	-0.026	1.000					
Project size	0.206*	0.037	0.049	0.021	-0.019	0.052	-0.062	0.108*	1.000				
Cooperation	-0.026	0.082*	-0.034	0.014	-0.034	-0.010	0.087*	-0.168*	-0.452*	1.000			
Previous concession	-0.008	0.012	0.025	0.062	-0.020	-0.056	0.046	0.728*	0.054	-0.119*	1.000		
Quality project	0.018	-0.056	0.017	0.029	-0.014	-0.038	0.078*	-0.003	-0.020	-0.048	-0.006	1.000	
Quality firm	0.114*	-0.029	0.089*	0.061	-0.025	-0.028	0.051	0.051	0.076*	-0.132*	0.067	0.761*	1.000

** Significant at 5%.*
Source: authors

Table A.2.
Heckman probit estimation of the probability of obtaining an R&D subsidy for Catalan firms.

	Entrants	**Young firms**
	Pobability to obtain	
Firm size (t-1)	0.00566	0.0804
	(0.0979)	(0.140)
Firm age (t-1)	-0.0804*	0.251
	(0.0453)	(0.278)
High-tech manufactures	0.427	-0.0400
	(0.416)	(0.172)
KIS	0.101	0.0983
	(0.433)	(0.263)
Project size (t)	0.0247	0.00361
	(0.0973)	(0.0526)
Cooperation (t)	0.207	-0.216
	(0.376)	(0.211)
Constant	1.070	-1.126
	(2.068)	(2.776)
	Probability to apply	
Firm size (t-1)	0.108***	0.158***
	(0.0208)	(0.0134)
Firm age (t-1)	-0.00773	0.0624
	(0.0143)	(0.0789)
Cash-flow ratio (t-1)	0.307***	-0.0205
	(0.116)	(0.103)
Long-term debt ratio (t-1)	0.0162*	-3.58e-05
	(0.00870)	(2.64e-05)
Export	0.391***	0.303***
	(0.0910)	(0.0533)
High-tech manufactures	0.357***	0.0535
	(0.0813)	(0.0538)
KIS	0.676***	0.245***
	(0.0739)	(0.0764)
Constant	-8.440	-16.96
	(0)	(53.97)
rho	-0.839	-0.160
	(0.580)	(0.621)
Observations	22,812	36,909

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1