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and the failure of innovation projects

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Financial constraints and the failure of innovation projects

Agustí Segarra (♣), José García-Quevedo (♠) and Mercedes Teruel (♣)

Abstract:

Theoretical and empirical approaches have stressed the existence of financial constraints in innovative activities of firms. This paper analyses the role of financial obstacles on the likelihood of abandoning an innovation project. Although a large number of innovation projects are abandoned before their completion, the empirical evidence has focused on the determinants of innovation while failed projects have received little attention. Our analysis differentiates between internal and external barriers on the probability of abandoning a project and we examine whether the effects are different depending on the stage of the innovation process. In the empirical analysis carried out for a panel data of potential innovative Spanish firms for the period 2004-2010, we use a bivariate probit model to take into account the simultaneity of financial constraints and the decision to abandon an innovation project. Our results show that financial constraints most affect the probability of abandoning an innovation project during the concept stage and that low-technological manufacturing and non-KIS service sectors are more sensitive to financial constraints.

Keywords: barriers to innovation, failure of innovation projects, financial constraints
JEL Classifications: O31, D21

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1. Introduction

Theoretical and empirical approaches have stressed the existence of financial constraints in the innovative activities of firms. However, only a scarce amount of empirical evidence has analysed the effect of financial constraints on the probability of abandoning an innovation project. Our data shows that a 23.3% of Spanish potential innovators abandon an innovation project and that 37.7% of firms state to face medium-high financial constraints. Innovation projects show different characteristics in comparison with other projects. In particular, innovative firms encounter higher external financial difficulties to be able to invest in new R&D projects, because their specific features increase risk and reinforce the informational problems with external investors (Hall, 2002). Hence, due to specific features of innovation in terms of risk and informational asymmetries, innovative firms usually find persistent barriers for accessing external financial support. Surprisingly, empirical evidence has usually focused on the determinants of innovation and the characteristics of innovative firms, while the failure of innovation projects has received very little attention.

Literature stands out access to financing as being the one crucial determinant for innovative firms (D'Este et al., 2012; Hölzl and Janger, 2012; Segarra et al., 2008). Among the different types of constraints, financial constraints are highly important due to the possible macroeconomic consequences. In particular, where financial constraints affect innovating firms more intensely, this may cause a decrease in the new knowledge required for economic development. This may potentially inhibit economic growth. For instance, Carpenter and Petersen (2002) indicate that firms in high-tech sectors may have been under-investing due to financial constraints. Furthermore, financial constraints are crucial in that they may lead to the reinforcement of other innovation barriers. As a consequence, it is by no means a negligible question to analyse financial barriers on innovation projects.

In accordance with previous findings, Spain represents an interesting country in which to analyse the effect of financial barriers (Hölzl and Janger, 2012). Hence, this paper analyses the role of financial constraints on the likelihood of Spanish firms abandoning an innovation project during the period 2004-2010. In line with previous studies (D'Este et al., 2012; Mohnen et al., 2008; Savignac, 2008), we exclude those firms which are non-innovation active and did not experience any barriers. This is done in order to correct the bias problems for a sample selection that can appear when asking all surveyed firms about barriers to innovation. We call 'potential innovative firms' those firms who engaged in innovation activities or did not do so due to one or more obstacles.

Our panel data offers an extensive sample of Spanish firms from some waves of Community Innovation Survey. After the dataset treatment, our sample contains 4,882 potential innovative firms of which 3,779 firms belong to the manufacturing sector and 1,043 firms to the service sector. From the total number of potential innovators, 335 firms did not innovate but felt barriers against them engaging in innovation activities, while 4,487 firms innovated successfully during the analysed period. The empirical treatment applied is

a recursive biprobit model to take into account financial constraints simultaneously with the decision to abandon an innovation project. The empirical model measures the probability that an innovative firm abandons an innovation project due to the existence of financial barriers: lack of funds within the firm or group and lack of finance from sources outside the firm[1]. Our results show that financial constraints have more effect on the probability of abandoning an innovation project during the concept stage. Also, low-technological industries and non-KIS service industries show more sensitivity to financial constraints.

This article makes several contributions. First, the access to sources of finance may restrict the capacity of potential innovative firms to carry out innovation projects. However**,** empirical literature is not as conclusive as one might expect concerning the existence of significant financial constraints[2]. We contribute to this line of empirical literature by differentiating the effect of internal and external financial barriers on the probability of abandoning a project. Second, we consider that the financial sources may have different effects depending on the stage of the innovation projects. Third, research on capital market imperfections has not focused on particular sectors of the economy (see, Carpenter and Petersen 2002, p. 55). In particular, empirical literature has devoted scarce interest to the link between financial constraints and innovation performance at the sectoral level. We contribute to covering this gap partially by analysing four industrial classifications (high and low tech manufacturing industries, KIS and non-KIS services). Hence, we examine if financial constraints affect the probability of abandoning the innovation project prematurely or once it has started[3].

The remainder of the article is structured as follows. Section 2 analyses the literature related to financial constraints to innovation. Section 3 presents our main hypotheses. Section 4 describes the database and main statistics. The next section presents the econometric methodology. Section 6 shows our main empirical results. Finally, Section 7 presents the main conclusions.

[1] Here, we decided not to include the barriers related to the excessive costs of innovation projects while we focus on financial obstacles.

[2] Some articles have strongly criticized the positive correlation between R&D and internal financial sources, in particular cash-flow, since it may also reflect that innovative firms anticipate high future profits that lead them to invest strongly (Savignac, 2008). The presence of financial constraints for innovative firms is frequently investigated via the sensitivity of R&D investment to financial factors (Himmelberg and Petersen, 1994; Harhoff, 1998; Mulkay, Hall and Mairesse, 2001; Tiwari et al., 2007). During recent years, a new line of research has focused on the analysis of the impact of financial constraints on R&D risk projects.

[3] CIS include as innovation activities the acquisition of machinery, equipment, software, and licenses; engineering and development work, training, marketing and R&D when they are specifically undertaken to develop and/or implement a product or process innovation.

2. Innovation projects and financial constraints

Financial constraints of innovation projects are linked with the nature of knowledge (Hall and Lerner, 2009). Innovation shows a heterogeneous, asymmetrical and accumulative nature (Benedetti, 2009). First, innovation activities are heterogeneous in the sense that some firms do not innovate, some concentrate on specific types of innovation –product, process, organization or marketing– while others carry out various types of innovation. Second, innovation strategies are asymmetric; that is, the distribution of innovation and its impact on a firm's productivity and growth is asymmetric, with its distribution being more skewed towards the right. Third, innovations are accumulative since innovation increases when a firm has already introduced other innovations. Additionally, innovation projects present a high degree of uncertainty, in particular at the beginning of research programmes. This considerable uncertainty and risk reduces the capacity of innovative firms to find external sources of finance and, as an alternative, they have to generate internal funds.

In essence, innovative firms encounter financial obstacles for investment in innovative activities through the presence of externalities, problems of informational asymmetries and problems of appropriability with the return on R&D investment (Nelson, 1959; Arrow, 1962). Consequently, innovative firms experience high costs for R&D investments and induce underinvestment in innovation activities. Obstacles associated with asymmetric information or moral hazard problems can derive from a gap between external and internal costs that lead to R&D underinvestment or liquidity constraints.

From the point of view of financial markets, these may under-invest in innovation projects due to different reasons. Hence, financial barriers to innovation projects are closely related to some of their inherent characteristics (Hall, 2002) such as the low return expectation due to an inability to secure profits from an innovation, the higher cost of innovation projects, the high sunk costs, the specific dimension of the physical capital, the presence of externalities and free-riders, among others. All these characteristics reduce the capacity of financial institutions and financial markets to increase sources to firms' innovation projects.

Some innovation projects may not be started, have to be delayed or are abandoned because of lack of access to financial resources. Some of the factors that may increase barriers to external funds are the risk of bankruptcy and the low value of intangibles in case of liquidation. The empirical analysis remarks how financial barriers restrict the capacity of innovative firms to carry out innovation projects ("hampering barriers"), and how financial constraints reduce the capacity of potential innovative firms to become innovative firms ("deterring barriers").

Hence, financial constraints for innovation are an important constraint impeding firms from catching up and developing innovations to reduce the gap between themselves and the technological frontier.

2.1. Empirical evidence

Since Fazzari et al. (1988) an increasing number of econometric studies have tried to observe the existence of financial constraints by analysing the sensitivity of investment to changes in available financial resources. In those works, the presence of financial restrictions is derived in an indirect way, given that when a firm's R&D investment is sensitive to cash flow, this is reflected indirectly by the firm's lack of access to the credit market.

During recent years, the access to new datasets on external financial sources facilitates applying direct methods to observe the presence of financial restrictions at firm level (Czarnitzki, 2006; Czarnitzki and Hottenrott 2009; Piga and Atzeni 2007). In addition, the increased free access to datasets from some countries with harmonized surveys on innovation activities at firm level has facilitated the identification of potentially financially constrained firms (Canepa and Stoneman, 2002; Savignac, 2008).

A strand of empirical literature remarks on the existence of financial constraints as a significant determinant for abandoning a project. For instance, Mohnen et al. (2008) analyse the impact of financial constraints on hampering innovation using the Dutch CIS survey. Specifically, those authors analyse four different situations: abandoning, prematurely stopping, seriously slowing down, or not starting a project. According to their results, financial constraints "have a significant and positive impact on the three probabilities of prematurely stopping, seriously slowing down and not starting a project, but not on that of abandoning a project". Similarly, for a sample of French firms, Savignac (2008) finds the probability of innovating diminishes due to the existence of financial barriers. In fact, this author finds that barriers exert a negative effect among non-innovative firms that try to innovate. More recently, Garcia-Vega and Lopez (2010) analyse a sample of more than 8,300 innovative Spanish firms for the period 2005-2007. Their results show the importance of the lack of funds on the probability of abandoning innovation projects. In particular, large firms are much more affected since they invest in innovation projects that involve a larger amount of funds.

In spite of this evidence, another strand of empirical literature finds some mixed results. For instance, Galia and Legros (2004) show that financial constraints are not among the main obstacles to innovation (their database is composed of firms with 20 or more employees from French CIS2). Also Hölzl and Janger (2012) show ambiguous results with respect to the effect of financial barriers on the probability of hampering and deterring an innovation project. For a sample of firms from 18 countries and using CIS4 and CIS 2006, Hölzl and Janger (2012) highlight the differences between country groups. According to their results, in Southern European countries and emerging countries, R&D and non-technological innovators are most hampered by financial barriers. However, they exert a less important effect on countries at the cutting edge of technology. Finally, using CIS 2

data for European countries, Canepa and Stoneman (2008) show ambiguous results for UK CIS. While they can accept for CIS 2 that high-tech firms are more financially constrained than low-tech firms, for CIS 3 the test statistics reject the null hypothesis.

Furthermore, some studies have highlighted the existence of higher financial barriers for firms in high-tech industries. Firms operating in technologically intensive sectors face higher risks since they usually have to invest in innovations which are less likely to have been undertaken elsewhere. As a consequence, they are going to suffer from higher information asymmetries (Canepa and Stoneman, 2008; Revest and Sapio, 2012)[4]. According to Guiso (1998, p. 40), higher financial barriers are due to the more severe informational frictions which affect high-tech firms[5].

Hence, our aim is that after applying controls through traditional factors such as size, age, group membership and the technological intensity of the sector, we observe how financial constraints affect to the risk of failure of innovation projects.

3. Main hypotheses

As we have seen previously, economic theory and empirical evidence have stressed the existence of financial constraints in R&D and innovation activities (Hall, 2002; Canepa and Stoneman, 2008). Recent empirical analyses have shown that financial obstacles negatively affect the propensity of firms to innovate (Savignac, 2008; Blanchard et al., 2012).

In this paper we focus on the impact of financial obstacles in the failure of innovation projects. Although the conceptualization of failures of innovation projects has received less attention in literature and specific evidence on their determinants is scarce, empirical findings tend to point out that facing financial barriers increases the likelihood of failure of innovation projects (Mohnen et al., 2008). Financial obstacles may be internal, when firms' own resources are insufficient to develop innovation projects, or external when there is a lack of access to external funding, either public or private. Based on the literature on financial constraints and innovation, our first hypothesis is that firms that state they face lack of funds will be more likely to have innovation projects that fail.

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[4] According to Carpenter and Petersen (2002, p.54), *"there are three reasons why high-tech investment is particularly likely to be affected by capital market imperfections. First, the returns to high-tech investment are skewed and highly uncertain, in part because R&D projects have a low probability of financial success. Second, substantial information asymmetries are likely to exist between firms and potential investors. Because high-tech investments are difficult to evaluate and frequently embody new knowledge, insiders will have much better information than outsiders about the prospects of the firm's investments. […] Third, high-tech investments often have limited collateral value R&D investment, which is predominantly salary payments, has little salvage value in the event of failure. Furthermore, physical investments designed to embody R&D results are likely to be firm specific and therefore have little collateral value."*

[5] This is due to the fact that innovation projects are much less well understood by outside observers, since past experience or observed past realisations can offer little guidance in assessing the prospects of truly new projects; rather it is likely that the entrepreneur undertaking the innovation project has, if not more knowledge, at least a better perception of its likelihood of success.

Departing from this main hypothesis, two sources of heterogeneity may exist in the effects that financial obstacles have on the probability of abandoning an innovation project. First, the effects may be different depending on the stage of the lifecycle of the innovation project. Second, facing internal or external barriers may affect the likelihood that an innovation project fails with a different degree or intensity.

Firstly, failure is inherent to innovation projects and there are different stages where firms may consider it convenient to abandon a project. The information available in the PITEC allows for two stages to be distinguished, to abandon during the conceptual phase or once the project has started.

Theoretical literature does not provide a clear prediction whether there are differences on the effects of financial obstacles on the probability that a firm abandons a project at one specific stage. Nevertheless, the characteristics of R&D and innovation projects suggest the existence of possible differences. Firstly, R&D projects are characterised by the existence of high sunk and fixed costs. Therefore, once firms have decided to begin an innovation project it is less likely that they abandon it because of financial obstacles. Secondly, the asymmetric information problem that affects obtaining external funds is more relevant in the concept stage when it is more difficult to give indications of the quality of the innovation project. Once the project has started, the returns are less uncertain and to obtain external funds will probably require a lower risk premium than in the concept stage. Thirdly, firms mostly apply for public subsidies for their R&D projects in the concept stage and, in the case of it not being granted, may cause the abandonment of the project. Finally, some empirical analyses have pointed out that financial constraints have a significant and positive impact on the probability of stopping prematurely, seriously slowing down and not starting a project, but not on the probability of abandoning a project (Mohnen et al., 2008). Departing from these arguments, our hypothesis is that financial obstacles will impact on the likelihood of abandoning a project in the concept stage but not once the project has started.

Although facing financial barriers, external or internal, should increase the probability of abandoning an innovation project, the effects of both types of financial barriers on the likelihood of abandoning an innovation project may be different. In a model of firm-level investment in R&D it is assumed that a firm faces a marginal cost of capital schedule with an upward slope (David et al., 2000). This upward slope shows that when the volume of R&D increases the firm will have to move from financing projects with internal funds to resort to external sources where the cost of capital is higher. The literature on the financing of R&D shows that the source of financing matters because of the specific characteristics of R&D investment, the existence of information asymmetries and other imperfections in capital markets.

This literature has also pointed out that the degree of credit constraints also depends on the characteristics of firms and R&D projects and they affect high-tech sectors in particular

(Canepa and Stoneman, 2008). All these arguments suggest that to face external barriers may have greater effects on the decision not to start or to abandon a project than the lack of internal funds and that these effects are probably greater for riskier projects. In addition, one of the sources of external funds is public subsidies that have their own criteria to select approved projects and currently they finance high impact and risky projects that the firms themselves would not have financed on their own (Takalo et al., 2012). Therefore, our hypothesis is that the lack of access to external funding will be more positively associated with the likelihood of abandoning an innovation project than when the main limitation is the lack of funds within the firm or the group.

4. Database

4.1. The database

The data used is from the Spanish Technological Innovation Panel (henceforth, PITEC). PITEC is the result of the collaboration between the Spanish National Statistics Institute and COTEC foundation with the aim of providing data from the Community Innovation Survey (CIS). The main advantage of CIS data is that it contains detailed information on innovation behaviour at firm level. However, CIS data has several constraints. First, it does not offer information on firms' balance sheets, which would allow us to assess the effect of internal or external finance on the behaviour of R&D investment. Second, financial constraints and the innovation pattern at firm level present a dynamic nature where time may be a relevant dimension. However, CIS dataset offers a cross section. Spanish PITEC overcomes this drawback by offering panel data. This panel data covers the period 2004-2010.

Our dataset provides exhaustive information for a sample of Spanish firms over a seven year period. The sample used in the econometric estimations only includes innovative firms in the manufacturing and service sectors. Furthermore, since 2010 PITEC provides the setup year so we may take into consideration the firm's age. Hence, PITEC is the best database for observing the innovation activities of Spanish firms over time (Barge-Gil, 2010). However, the primary data has two main drawbacks. First, 'potential innovators' might be underrepresented since CIS tends to have an overrepresentation of firms that carry out innovative activities. Second, our indicators for lack of finance have a qualitative dimension and are proxies of the existence of financial constraints.

The procedure for filtering our sample is the following. First, we restrict our sample to firms with at least 6 or 7 observations, hence, those that appear in 2004 or 2005 and remain active until 2010. Second, we drop firms that have suffered a process of mergers. Third, to avoid problems with sample selection, we select firms that are potential innovators since they will perceive financial constraints more directly. Following Savignac (2008), D'Este et al. (2012) and Blanchard et al. (2012), we exclude firms that do not have the intention of

innovating since they will not perceive any financial constraint in relation to R&D activities. Hence, we do not take into account firms that do not innovate and do not declare that they face financial barriers.

After empirical treatment, our sample contains 4,882 firms, of which 3,779 firms belong to the manufacturing sector and 1,043 firms to the service sector.

4.2 Dependent variables

We consider two groups of dependent variables. The first group captures whether potential innovative firms perceive financial constraints. *FCinternal* captures the lack of funds within a firm or group; *FCexternal* captures the lack of funds from sources outside a firm, and *FC* captures the lack of funds regardless of the source. These three dummy variables are equal to 1 in the case that the firm states it perceives a high level of financial constraint and nil when the degree is medium, low or null.

The second group captures whether a firm abandons an innovation project. *AB_conc_proj* indicates those firms that abandon a project, while *AB_conc* and *AB_proc* indicate when the project is abandoned: during the initial period (*AB_conc*) or once the innovation project had started (*AB_proj*)[6].

4.3 Explanatory variables

The explanatory variables are the following. *Age* measures the firm's age (in natural logs) as the difference between the period of observation and the year of creation. *Size* measures the number of employees in the firm (in natural logs). *RD* is a dummy variable that captures whether the firm invests in R&D or 0 otherwise. *Group* is a dummy variable that takes a value equal to 1 if the firm belongs to a group. *FCpersist* is a dummy variable with a value equal to 1 in the case that the firm indicates high financial barriers during six or more periods. *Know* and *Market* are dummy variables that indicate whether the firm perceives a medium or high level of barriers related to knowledge or market factors. *Coop* is a dummy variable controlling whether a firm cooperates with other agents. *InternatMarket* takes a value equal to 1 in the case that the firm participates in international markets. *RDintensity* is the R&D investment per employee in thousands of euros (in natural logs). Finally, we also include industry and time dummies to control possible differences in the probability of abandoning a project and of suffering financial constraints across sectors and over time.

4.4. Descriptive analysis

Table 1 presents the distribution of observations according to whether firms abandon a project or not and according to whether they perceive financial constraints. We observe

[6] Spanish CIS questionnaire considers other alternatives related to the seriously delay of the innovation project, but it only appeared in 2004.

that 23% of potential innovative firms state that they abandon an innovation project during the concept and/or project stage. First, we must highlight that the percentage of firms perceiving financial constraints is larger among the group of firms that abandon an innovation project than those that do not abandon one. Second, differences appear when distinguishing according to the stage: 61.64% of firms that abandon the project once the project has started state they do not perceive any financial constraint, while this percentage diminishes to 52.34% for firms that abandon the project during the concept stage. Third, when comparing firms that abandon during the concept and project stage, the percentage of firms abandoning during the project stage and that perceive external financial barriers is significantly lower than the percentage of firms that abandon during the concept stage. Hence, this preliminary descriptive would indicate a considerably larger incidence of financial barriers acting on the probability of abandoning a project, in particular during the concept stage.

---- Insert Table 1 ----

Additionally, following Canepa and Stoneman (2008), for Pearson's χ^2 and the LR test statistics for hypotheses, we estimate that the rows and columns in the two-way tables are independent. That the rows and columns in the two-way tables are independent for Pearson's χ^2 and the LR test statistics for the hypotheses, suggests that there are differences in the percentage of firms perceiving financial constraints according to whether they abandon or not an innovation project.

Table 2 provides the overall means of the main variables used in our econometric analysis and compares fours groups of firms: (i) firms that do not abandon a project; (ii) firms that abandon a project during any stage; (iii) firms that abandon a project during the concept stage; and (iv) firms that abandon a project once the project has started.

---- Insert Table 2 ----

First, it is interesting to note that firms that abandon a project are, on average, older and larger than those than do not abandon a project. This clearly shows that older and larger firms have more capacity to start an innovation project and, of course, they are more likely to abandon it. *RD* and *RDintensity* are significantly higher for those firms that abandon a project. In particular, firms that abandon during the project stage demonstrate a higher average of R&D intensity. Third, a considerable percentage of firms perceive continuous financial constraints. For instance, the percentage of firms that do not abandon a project but perceive continuous financial barriers is equal to 18.20%, while this percentage increases up to 24.07% for firms that abandon during the concept stage. Fourth, a large percentage of firms state that they perceive some type of knowledge or market barriers. However, this percentage increases up to more than 90% for firms that abandon a project. Finally, significant differences appear when considering the proportion of firms belonging to a group, cooperating with other firms and competing in international markets. In these

categories, there are a larger proportion of firms that abandon a project than those that do not abandon.

---- Insert Table 3 ----

Table 3 shows the correlations between our explanatory variables. All the correlations show a high level of significance. However, the correlations are far from perfect. The main exception is the correlation between the R&D intensity and the R&D dummy variable (with a correlation equal to 0.7078), between *FC* and *FCpersist* (with a correlation equal to 0.5768) and between the barriers related to knowledge and market factors (with a correlation equal to 0.5746).

5. Econometric methodology

Our aim is to examine the determinants of Spanish firms abandoning innovation projects between 2004 and 2010. In line with previous scholars (Savignac, 2008; Blanchard et al., 2012), we consider that financial obstacles affect the probability of deterring innovation projects. In others words, financial constraints significantly affect the likelihood that firms abandon innovative activities. We employ a bivariate probit model to estimate this. The first equation measures the probability that a potentially innovative firm perceives financial constraints. We will consider three different equations of financial constraints:

$$FC_{it}^{*} = m_{it}'\delta_1 + u_{11it} \quad (1)$$

$$FCinternal_{it}^{*} = m_{it}'\delta_2 + u_{12it} \quad (2)$$

$$FCexternal_{it}^{*} = m_{it}'\delta_3 + u_{13it} \quad (3)$$

FC, FCinternal** and *FCexternal** are dummy variables which indicate that a firm perceives financial constraints, internal financial constraints and external financial constraints. δ corresponds to the vector of parameters to be estimated and u is the error term. In line with Blanchard et al. (2012), equations (1) – (3) depend on the following set of explanatory variables (m_{it}'):

1. Firm size: we consider that large firms are in a better position to overcome financial obstacles. We expect that large firms face fewer obstacles than small firms.
2. Firm age: we consider young firms will suffer more financial constraints.
3. R&D: firms investing in R&D will often perceive more financial obstacles.
4. Group: we consider a firm belonging to a corporate group will overcome financial barriers more easily in comparison to an independent firm.
5. Sectoral dummies: we consider that firms in some sectors may suffer higher financial constraints due to higher sunk costs or competitiveness levels.
6. Time dummies: during expansion there are better facilities to gain access to financial resources, while during a crisis financial resources decrease.

The second equation is the probability that a firm abandons an innovation project. We consider three dependent variables: i) a dummy variable when a firm abandons a project, regardless of the stage (*AB_conc_proj*); ii) a dummy variable which takes a value equal to 1 when the firm abandons a project during the concept stage (*AB_conc*); iii) and a dummy variable which takes a value equal to 1 when the project is abandoned once the project has started (*AB_ proj*). Since equations (1) to (3) will be introduced with respect to those 3 variables, we will obtain the following equations:

$$AB\_conc\_proj_{it} = FC_{it}*\gamma_{21} + x_{it}'\phi_{21} + u_{21,it} \quad (4)$$
$$AB\_conc\_proj_{it} = FCinternal_{it}*\gamma_{22} + x_{it}'\phi_{22} + u_{22,it} \quad (5)$$
$$AB\_conc\_proj_{it} = FCexternal_{it}*\gamma_{23} + x_{it}'\phi_{23} + u_{23,it} \quad (6)$$

$$AB\_conc_{it} = FC_{it}*\gamma_{31} + x_{it}'\phi_{31} + u_{31,it} \quad (7)$$
$$AB\_conc_{it} = FCinternal_{it}*\gamma_{32} + x_{it}'\phi_{32} + u_{32,it} \quad (8)$$
$$AB\_conc_{it} = FCexternal_{it}*\gamma_{33} + x_{it}'\phi_{33} + u_{33,it} \quad (9)$$

$$AB\_proj_{it} = FC_{it}*\gamma_{41} + x_{it}'\phi_{41} + u_{41,it} \quad (10)$$
$$AB\_proj_{it} = FCinternal_{it}*\gamma_{42} + x_{it}'\phi_{42} + u_{42,it} \quad (11)$$
$$AB\_proj_{it} = FCexternal_{it}*\gamma_{43} + x_{it}'\phi_{43} + u_{43,it} \quad (12)$$

Where γ and ϕ correspond to the vectors of parameters to be estimated and u is the error term. With respect to the explanatory variables introduced (x):

1. Financial constraints (internal, external or both): we consider that they will increase the probability of abandoning an innovation project.
2. Persistence of financial constraints: firms that perceive continuous financial constraints may suffer a higher probability of abandoning a project. However, this variable may identify firms that are innovating continuously.
3. Knowledge and Market barriers: given previous literature, we also introduce both barriers since they may also cause a firm to abandon a project.
4. Firm age: we consider that young firms will have less experience and they may abandon a project before its completion.
5. Firm size: similarly, small firms may have more problems in continuing with innovation projects. However, large firms usually have a larger portfolio of innovations. Hence, large firms may state more often that they have abandoned a project.
6. Cooperation: firms participating in a project through cooperation may be doing so because the projects are riskier. Consequently, this variable is expected to affect positively the probability of abandoning an innovation project.
7. International markets: firms in international markets are engaged in more intense competition; hence, it is likely that they will carry out more innovation projects.
8. R&D intensity: Firms with higher R&D intensity will be more probable to engage in riskier projects and, consequently, their probability of abandonment may be higher.

9. Sectoral dummies: we consider that firms in some sectors may engage in riskier projects due to the nature of their activities.
10. Time dummies: we include time dummies to control the effect of expansions and crisis on the probability of abandoning innovation projects.

Finally, we must mention three different points. First, CIS datasets present a potential endogeneity. Firms may be more likely to indicate 'some' lack of finance the more innovation projects they conduct and thus the amount they invest in R&D. To solve this situation, the estimation methods usually use instrumental variables (Czarnitzki and Hottenrott 2009). According to Savignac (2008), the probability of deterring innovative activities and the presence of financial restrictions must be estimated simultaneously, since there is a strong endogeneity between innovative activities and financial constraints. In others words, financial constraints significantly reduce the likelihood that firms carry out innovative activities and, in counterpart, innovative firms enjoy a higher probability of generating ex-ante internal resources in order to reduce financial restrictions in investment decisions. In that sense, the bivariate probit model takes the correlations between the likelihood of failure of an innovation project and the facing of financial barriers into account. These correlations may arise if there are factors omitted or unobservable that simultaneously affect both aspects (Savignac, 2008). The bivariate probit estimation, where we assume normality of the error terms, provides a correlation parameter that yields information about the co-variation of the error terms of the two estimations.

Second, our sample consists of a panel data between 2004 and 2010. This characteristic led to control for the existence of persistence of financial constraints. Third, previous literature has mentioned the possibility that their results suffer a "survivorship bias" (Mohnen et al., 2008; Landry et al., 2008), since they are not able to "control for firms that did not survive after the failure of an innovation project". In that sense, our results may suffer the same bias since we have all those firms that survived until 2010. However, a few firms are excluded because we are not able to observe them. According with our data, 4% of firms are not observed at the end of the period. Hence, we consider that the impact of these firms on our estimations should not cause a significant bias.

6. Results

Table 4 presents the analysis of the effect of financial constraints and other control variables on the probability of abandoning a project.

With respect to the determinants affecting the probability of suffering financial constraints, the main results are the following. First, the probability of perceiving financial restrictions declines with firm age and size. This is consistent with the theory that asymmetric information diminishes: when a firm gets older and larger its track records and collateral increase. Innovative new firms experience tough barriers for access to external resources, in particular small firms, while large and incumbent firms generate internal funds to finance

such innovation activities. Evidence shows that smaller firms are more likely to face financing constraints, as they usually cannot provide as much overall collateral value compared to larger firms. For instance, Savignac (2008) finds that the probability of financing constraints decreases with firm size and depends on the firms' ex-ante financing structure. In addition, younger firms may be restricted in their R&D investment due to additional factors that affect financing conditions (Czarnitzki and Hottenrott, 2009). Similar empirical evidence might be found in Canepa and Stoneman (2005), Schneider and Veugelers (2010), Blanchard et al. (2012) and Galia et al. (2012).

Second, firms that invest in R&D are more likely to suffer financial constraints, in particular, external funds. This result is consistent with Blanchard et al. (2012) who assert that firms investing in R&D will be more likely to face obstacles. Finally, the fact that a firm belongs to a group of firms diminishes the probability of suffering financial constraints. In line with Tiwari et al. (2008) and Galia et al. (2012), this evidence indicates that firms belonging to a group may obtain financial support for their R&D activities more easily when they belong inside a group of firms. All the determinants are significant at 1%.

With respect to the determinants affecting the probability of abandoning a project, our findings are the following. Table 4 presents the estimation of the determinants of abandoning an innovation project, secondly the probability of abandoning a project during the concept stage, and finally the probability of abandoning once the project has started. Each equation will consider our three types of financial constraints, *FCinternal*, *FCexternal* and *FC* (equations (4) to (12)).

---- Insert Table 4 ----

First, in line with Mohnen et al. (2008) financial constraints in general increase the probability of abandoning a project. However, the distinction with the stage of abandonment seems important given that financial constraints are only significant to abandoning the project during the concept stage. One likely explanation may be related to the existence of the high sunk costs of R&D activities. Once a firm carries out R&D activities, other factors may be more important for abandoning a project. Finally, there seems that the effect of external financial restrictions is much more important on the probability of abandoning an R&D project.

Second, with respect to the incidence of those firms perceiving persistent financial constraints, we observe that this variable is only significant on the probability of abandoning the project during the concept stage. This result may be explained by two different facts. On the one hand, the capacity to search for funds increases once the project starts. On the other hand, the high sunk costs related to R&D projects lead to financial constraints not being so important once the project starts and, as a consequence, the perception of financial constraints does not influence so intensely the decision to abandon an innovation project.

Third, other barriers related to knowledge and market increase the probability of abandoning a project. The results are significant regardless of the estimation. However, the incidence is higher for firms that state the abandonment of a project during the concept stage. This result may indicate the fact that the probability of abandonment not only depends on financial constraints but also on other barriers.

Fourth, with respect to firm age we observe that the impact is not significant. This result may be due to the fact that young firms assume more risks through lack of experience, while older firms will have more experience but also a larger number of R&D projects. Hence, it is probable that firm age does not show a clear pattern.

Fifth, we observe that firm size gives a positive indication on the probability of abandoning a project. Hence, older firms are more likely to abandon a project. According with Canepa and Stoneman (2008, p. 720) this "may reflect the fact that larger firms on average have higher levels of R&D spending and broader production programmes, and thus may have a greater likelihood of engaging in risky projects; as a result they may be more likely to terminate projects". Hence, large firms may have a wider portfolio of R&D projects and, consequently, they will abandon innovation projects more frequently.

With respect to the R&D cooperation, our results indicate a positive and significant impact on the likelihood of abandoning a project. However, when we consider the stage of the project it is only significant on the probability of abandoning during the concept stage. This result must be interpreted carefully since this variable may indicate that firms that start risky projects will cooperate more frequently. Evidence along this line can be found in Lhuillery and Pfister (2009). Those authors observe that firms which area collaborating are more likely to delay or stop an innovation project because of difficulties encountered in their R&D partnerships. Furthermore, their results show that firms collaborating with their suppliers also face a higher risk of cooperation failures.

With reference to international competition, the coefficient shows a positive and significant impact on the probability of abandonment regardless of the stage of the project. The explanation of this result may be the fact that international competition obliges firms to be more competitive by investing in R&D projects. However, R&D projects diminish profit and cost margins and consequently dangerously increases the probability of abandoning projects.

Finally, investment in R&D has a positive and significant effect on the likelihood of abandoning a project. However, when distinguishing according to the stage, this impact is only significant when the abandonment happens during the concept stage. Our results may be related to the fact that those firms with higher capacity to invest in R&D activities may have more capacity to carry out new and different projects and, consequently, the probability that they will abandon any given project will also diminish.

Sectoral differences

The next step is to distinguish between high-tech manufacturing industries, low-tech manufacturing industries, knowledge intensive services and non-knowledge intensive services. In that sense, our results show some interesting results (Table 5).

First of all, financial constraints are not significant for high-tech manufacturing industries, while they continue to exert a significant and direct effect on the probability of abandoning a project during the concept stage for the rest of groups. According to Westhead and Storey (1997), Guiso (1998) and Canepa and Stoneman (2008), firms in the technological sectors will suffer higher financial constraints since by nature their projects are riskier. In fact, those authors note that firms in the high-tech sector are more likely to delay a project. A likely reason why our proxies of financial constraints are not significant is that firms in high-tech manufacturing industries suffer more financial constraints and, consequently, they fund a higher proportion of their innovation activity through internal financial sources. In this line, Himmelberg and Petersen (1994) found a large and significant relationship between R&D and internal finance for US small firms in high-tech industries.

Second, our proxy indicating persistent financial constraints becomes non-significant for firms in high-tech manufacturing industries, while the impact for low-tech manufacturers is significant and positive at the concept stage. Surprisingly, the impact becomes negative for firms in the service sector. Two possible explanations arise from this evidence. First, persistent financial constraints are not so important for firms in the high-tech sector. This may be indicative of the capacity of these firms to overcome the persistent financial constraints. Second, firms in the service sectors that perceive persistent financial constraints may not be able to find the funds to invest and, consequently, they do not start an innovation project.

---- Insert Table 5 ----

As we have seen previously, market barriers show a slightly lower impact on the probability of abandonment compared to the knowledge barriers. However, the coefficient of market barriers is larger than the coefficient of knowledge barriers for firms involved in high-tech manufacturing industries. A possible explanation may be the fact that firms in high-tech manufacturing industries are more sensitive to the potential of reaping profits from the market when they introduce an innovation. In that sense, Guiso (1998, p. 48) asserts that high-tech firms are more uncertain about the demand for their products.

The non-significant impact of firm age for the whole database shows the heterogeneous performance at a sectoral level. In that sense, firm age increases the likelihood of abandoning a project for firms in high-tech manufacturing industries, while the coefficient becomes negative for service industries.

For non-knowledge intensive services, the variable of cooperation and internationalisation does not exert a significant impact.

Finally, for knowledge intensive services, the impact of R&D investment indicates a different impact on the probability of abandonment depending on the stage of the project. While firms with larger investment in R&D per employee show a larger probability to abandon a project during the concept stage, this probability becomes negative when considering the probability of abandonment during the project stage.

7. Concluding remarks

The aim of this paper is to analyse the effects of financial barriers on the failure of innovation projects. Although the conceptualisation of failures of innovation projects has received less attention in literature and the specific evidence on their determinants is scarce, empirical findings tend to point out that facing financial barriers increases the likelihood of failure of innovation projects (Mohnen et al., 2008). Our interest is to contribute to the existing literature by analysing the different effect of internal and external financial barriers on the probability of abandonment during the initial stage of concept and during its development.

The sensitivity of our proxies of financial constraints on the probability of abandonment indicates the necessity to increase the mechanisms that define firms in order to diminish information asymmetries. The existence of higher financial constraints in innovating firms justifies government intervention (Schneider and Veugelers, 2010). Governments should create new mechanisms to promote the access to external funds for R&D projects. We must take into account that banks usually do not have tools to properly measure the risk of innovation projects. However, other variables explain the probability of abandoning a project. Thus, not only money matters in order to abandon a project.

Our results may complement previous literature since we are disentangling whether different sources of funds may exert a significantly increased probability of abandoning a project taking into consideration the stage of the project.

We must mention two different drawbacks. First, our proxies for barriers are of subjective nature, being based on the personal appreciation of the respondents. However, we consider a firm suffering from barriers when the respondent states a medium-high level barrier. Second, we ignore the amount of projects that are abandoned. Hence, a firm that abandons one innovation project is considered identical to a firm that abandons three different projects. However, variables such as belonging to a group of firms, firm size and firm age may capture a firm's capacity to carry on innovation projects.

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Table 1.
Number of observations. Distribution of observations according with the FC and whether they abandon or not a project. 2004-2010.

Firms that…	Number of observations	Financial constraints (%) Internal	External	Internal and external	No financial constraints
Do not abandon	25,202	8.88	7.95	19.15	64.03
Abandon only during the concept stage	2,757	10.92	11.50	25.24	52.34
Abandon only during the project stage	1,984	10.23	7.76	20.36	61.64
Abandon during concept & project	2,934	11.04	9.95	22.29	56.71
Pearson χ^2 = 196.7 Pr = 0.000					
LR χ^2 = 192.08 Pr = 0.000					

Source: PITEC database.

Table 2.
Statistical descriptive. Mean and Standard deviations between brackets. 2004-2010

	Potential innovators that do not abandon a project	that abandon a project during any phase	that abandon a project during the phase of concept	that abandon a project during the phase of project
Age (ln)	3.02	3.06	3.07	3.09
	(0.75)	(0.76)	(0.76)	(0.76)
Size (ln)	4.19	4.34	4.40	4.36
	(1.29)	(1.28)	(1.29)	(1.28)
RD	0.63	0.81	0.89	0.78
RDintensity	-3.81	-1.29	0.23	1.84
	(7.93)	(6.40)	(4.55)	(6.84)
FCpersist	0.18	0.23	0.24	0.21
Know	0.82	0.92	0.94	0.91
Market	0.81	0.91	0.94	0.91
Group	0.35	0.42	0.44	0.43
Coop	0.27	0.44	0.47	0.43
InternatMarket	0.69	0.81	0.83	0.81
Observations	25,202	7,675	5,691	4,918

Source: PITEC database.

Table 3.
Spearman's rank correlation.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) AB_conc_proj	1.000											
(2) FC	0.066*	1.000										
(3) Age	0.026*	-0.110*	1.000									
(4) Size	0.052*	-0.182*	0.318*	1.000								
(5) RD	0.157*	0.058*	-0.004	0.061*	1.000							
(6) Group	0.060*	-0.129*	0.093*	0.480*	0.066*	1.000						
(7) FCpersist	0.048*	0.577*	-0.092*	-0.138*	0.095*	-0.099*	1.000					
(8) Know	0.116*	0.220*	-0.014*	-0.042*	0.237*	-0.022*	0.146*	1.000				
(9) Market	0.120*	0.188*	-0.006	-0.064*	0.218*	-0.020*	0.129*	0.575*	1.000			
(10) Coop	0.154*	0.029*	0.002	0.128*	0.303*	0.148*	0.044*	0.133*	0.113*	1.000		
(11) InternatlMarket	0.116*	0.002	0.176*	0.124*	0.252*	0.117*	0.017*	0.125*	0.142*	0.110*	1.000	
(12) RDintensity	0.131*	0.076*	-0.093*	-0.080*	0.708*	0.052*	0.114*	0.194*	0.192*	0.338*	0.197*	1.000

** signficant at 5%.*
Source: PITEC database.

Table 4.
Recursive bivariate probit of the probability of abandoning a project and the probability to suffer financial constraints. Whole database.

	Probability to suffer financial constraints								
	FC	FCinternal	FCexternal	FC	FCinternal	FCexternal	FC	FCinternal	FCexternal
Age	-0.109***	-0.111***	-0.0909***	-0.109***	-0.111***	-0.0909***	-0.109***	-0.111***	-0.0911***
	(0.0110)	(0.0115)	(0.0115)	(0.0110)	(0.0115)	(0.0115)	(0.0110)	(0.0115)	(0.0115)
Size	-0.121***	-0.117***	-0.106***	-0.122***	-0.118***	-0.106***	-0.121***	-0.117***	-0.106***
	(0.0073)	(0.0077)	(0.0076)	(0.0073)	(0.0077)	(0.0076)	(0.0073)	(0.0077)	(0.0076)
RD	0.202***	0.111***	0.235***	0.208***	0.118***	0.237***	0.198***	0.111***	0.231***
	(0.0181)	(0.0190)	(0.0183)	(0.0176)	(0.0185)	(0.0181)	(0.0174)	(0.0182)	(0.0179)
Group	-0.194***	-0.226***	-0.191***	-0.192***	-0.223***	-0.192***	-0.198***	-0.227***	-0.194***
	(0.0188)	(0.0187)	(0.0190)	(0.0181)	(0.0187)	(0.0186)	(0.0183)	(0.0186)	(0.0190)
Constant	0.678***	0.546***	0.309***	0.678***	0.546***	0.309***	0.677***	0.545***	0.309***
	(0.0534)	(0.0554)	(0.0557)	(0.0534)	(0.0554)	(0.0557)	(0.0534)	(0.0554)	(0.0557)
	Probability to abandon a project								
	Regardless the stage			During the concept			Once the project has started		
FC	0.350**			0.581***			0.109		
	(0.175)			(0.129)			(0.199)		
FC_internal		-0.0240			0.245*			-0.185	
		(0.180)			(0.145)			(0.205)	
FC_external			0.362**			0.464***			0.182
			(0.141)			(0.106)			(0.173)
FCpersist	-0.0091	0.0272	0.0352	-0.0034	0.0436*	0.0447*	-0.0159	-0.0059	0.0188
	(0.0239)	(0.0228)	(0.0226)	(0.0254)	(0.0247)	(0.0244)	(0.0267)	(0.0251)	(0.0250)
Know	0.220***	0.229***	0.230***	0.298***	0.313***	0.310***	0.170***	0.172***	0.178***
	(0.0298)	(0.0297)	(0.0296)	(0.0353)	(0.0356)	(0.0354)	(0.0327)	(0.0325)	(0.0326)
Market	0.228***	0.232***	0.233***	0.291***	0.300***	0.299***	0.190***	0.190***	0.194***
	(0.0288)	(0.0287)	(0.0286)	(0.0337)	(0.0341)	(0.0338)	(0.0318)	(0.0316)	(0.0318)
Age	0.0011	-0.0111	-0.0012	0.0033	-0.0084	-0.0042	0.0139	0.0043	0.0151
	(0.0133)	(0.0132)	(0.0124)	(0.0136)	(0.0137)	(0.0132)	(0.0148)	(0.0148)	(0.0138)
Size	0.0794***	0.0602***	0.0773***	0.112***	0.0951***	0.102***	0.0651***	0.0492***	0.0681***
	(0.0115)	(0.0119)	(0.00892)	(0.00967)	(0.0103)	(0.00857)	(0.0134)	(0.0140)	(0.0105)
Coop	0.306***	0.305***	0.306***	0.246***	0.249***	0.248***	0.257***	0.254***	0.257***
	(0.0178)	(0.0179)	(0.0177)	(0.0186)	(0.0187)	(0.0186)	(0.0196)	(0.0199)	(0.0196)
InternatMarket	0.143***	0.143***	0.140***	0.130***	0.131***	0.127***	0.115***	0.114***	0.114***
	(0.0213)	(0.0214)	(0.0213)	(0.0238)	(0.0241)	(0.0239)	(0.0238)	(0.0238)	(0.0238)
RDintensity	0.0090***	0.0101***	0.0086***	0.0362***	0.0381***	0.0364***	-3.60e-05	0.0006	-0.0005
	(0.0014)	(0.0013)	(0.00137)	(0.0018)	(0.0016)	(0.0017)	(0.0015)	(0.0014)	(0.0015)
Constant	-2.232***	-1.959***	-2.205***	-2.700***	-2.470***	-2.576***	-2.351***	-2.119***	-2.397***
	(0.143)	(0.153)	(0.103)	(0.113)	(0.125)	(0.0978)	(0.176)	(0.191)	(0.126)
Rho	-0.125	0.0848	-0.159*	-0.256***	-0.0701	-0.205***	-0.0165	0.165	-0.0870
	(0.108)	(0.108)	(0.0849)	(0.0830)	(0.0858)	(0.0634)	(0.121)	(0.128)	(0.102)
χ^2	4098.68	3862.39	3750.08	4638.01	4197.83	4153.60	3277.41	3174.92	2917.66
Prob (χ^2)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	32,642								

Estimations control for time and sector dummies
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.
Recursive bivariate probit of the probability of abandoning a project and the probability to suffer financial constraints. Classification according with the technological intensity..

	Probability to suffer financial constraints															
	High-tech manufactures				Low-tech manufactures				KIS services				Non-KIS services			
	Abandon concept		Abandon project		Abandon concept		Abandon project		Abandon concept		Abandon project		Abandon concept		Abandon project	
	FCinternal	FCexternal	FCinternal	FCexternal	FCinternal	FCexternal	FCinternal	FCexternal	FCinternal	FCexternal	FCinternal	FCexternal	FCinternal	FCexternal	FCinternal	FCexternal
Age	-0.113***	-0.0720***	-0.113***	-0.0726***	-0.111***	-0.103***	-0.110***	-0.103***	-0.0605*	-0.0798**	-0.0591	-0.0798**	-0.131***	-0.0934**	-0.127***	-0.0911**
	(0.0192)	(0.0191)	(0.0192)	(0.0190)	(0.0175)	(0.0173)	(0.0176)	(0.0174)	(0.0361)	(0.0363)	(0.0363)	(0.0363)	(0.0368)	(0.0386)	(0.0376)	(0.0389)
Size	-0.101***	-0.0990***	-0.101***	-0.0979***	-0.170***	-0.117***	-0.168***	-0.115***	-0.0817***	-0.100***	-0.0844***	-0.101***	-0.0494**	-0.0820***	-0.0468**	-0.0817***
	(0.0138)	(0.0137)	(0.0137)	(0.0136)	(0.0124)	(0.0122)	(0.0124)	(0.0122)	(0.0202)	(0.0203)	(0.0205)	(0.0197)	(0.0199)	(0.0199)	(0.0200)	(0.0201)
RD	0.0469	0.179***	0.0483	0.174***	0.143***	0.218***	0.132***	0.207***	0.177***	0.355***	0.171***	0.354***	0.295***	0.456***	0.270***	0.447***
	(0.0350)	(0.0331)	(0.0319)	(0.0325)	(0.0264)	(0.0259)	(0.0260)	(0.0257)	(0.0522)	(0.0536)	(0.0536)	(0.0542)	(0.0569)	(0.0563)	(0.0656)	(0.0572)
Group	-0.218***	-0.206***	-0.218***	-0.208***	-0.192***	-0.196***	-0.199***	-0.204***	-0.229***	-0.111**	-0.225***	-0.109**	-0.236***	-0.159***	-0.256***	-0.160**
	(0.0312)	(0.0318)	(0.0312)	(0.0317)	(0.0302)	(0.0296)	(0.0299)	(0.0296)	(0.0506)	(0.0541)	(0.0501)	(0.0510)	(0.0607)	(0.0606)	(0.0630)	(0.0648)
Constant	0.861***	0.833***	0.866***	0.832***	0.789***	0.629***	0.788***	0.633***	0.266**	0.229*	0.275**	0.233*	0.247*	0.0929	0.242	0.0852
	(0.149)	(0.149)	(0.150)	(0.148)	(0.0926)	(0.0914)	(0.0928)	(0.0913)	(0.124)	(0.125)	(0.125)	(0.126)	(0.149)	(0.152)	(0.148)	(0.151)
	Probability to abandon a project															
FC_internal	-0.0543		-0.254		0.472**		-0.0255		0.555***		-0.348		1.304***		-0.197	
	(0.365)		(0.352)		(0.223)		(0.258)		(0.192)		(0.598)		(0.396)		(0.658)	
FC_external		0.297		0.0984		0.731***		0.223		0.418		-0.0675		1.228***		0.662
		(0.246)		(0.378)		(0.199)		(0.235)		(0.301)		(0.573)		(0.358)		(0.455)
FCpersist	-0.00525	0.0422	-0.0128	0.0319	0.192***	0.151***	0.00843	0.0165	-0.120*	-0.141**	-0.0301	0.0076	-0.313**	-0.218	-0.0452	-0.0537
	(0.0375)	(0.0388)	(0.0385)	(0.0395)	(0.0397)	(0.0370)	(0.0409)	(0.0394)	(0.0616)	(0.0625)	(0.0627)	(0.0642)	(0.128)	(0.133)	(0.138)	(0.137)
Know	0.304***	0.309***	0.174***	0.184***	0.354***	0.341***	0.200***	0.200***	0.257**	0.260**	0.0788	0.0920	0.232*	0.274**	0.201*	0.213*
	(0.0539)	(0.0534)	(0.0516)	(0.0520)	(0.0575)	(0.0570)	(0.0502)	(0.0500)	(0.110)	(0.110)	(0.0984)	(0.101)	(0.130)	(0.130)	(0.120)	(0.119)
Market	0.372***	0.374***	0.341***	0.348***	0.252***	0.247***	0.0893*	0.0901*	0.173*	0.197*	0.0866	0.108	0.317***	0.294***	0.266**	0.262**
	(0.0555)	(0.0555)	(0.0541)	(0.0543)	(0.0526)	(0.0521)	(0.0474)	(0.0473)	(0.101)	(0.101)	(0.0947)	(0.0972)	(0.109)	(0.109)	(0.107)	(0.106)
Age	0.0234	0.0314	0.0573**	0.0694***	0.0025	0.0077	0.0093	0.0164	-0.0915**	-0.0869**	-0.162***	-0.165***	-0.104**	-0.109**	-0.0870	-0.0686
	(0.0241)	(0.0212)	(0.0253)	(0.0225)	(0.0207)	(0.0203)	(0.0215)	(0.0208)	(0.0404)	(0.0414)	(0.0416)	(0.0434)	(0.0492)	(0.0483)	(0.0530)	(0.0485)
Size	0.0636***	0.0814***	0.0274	0.0472**	0.141***	0.143***	0.0871***	0.0987***	0.103***	0.0964***	0.0660	0.0837**	0.0413	0.0523*	-0.0255	-0.0037
	(0.0224)	(0.0158)	(0.0228)	(0.0208)	(0.0163)	(0.0134)	(0.0202)	(0.0151)	(0.0223)	(0.0242)	(0.0416)	(0.0338)	(0.0270)	(0.0272)	(0.0317)	(0.0296)
Coop	0.174***	0.177***	0.185***	0.191***	0.268***	0.266***	0.308***	0.308***	0.498***	0.501***	0.322***	0.330***	0.107	0.102	0.260***	0.249***
	(0.0294)	(0.0288)	(0.0311)	(0.0304)	(0.0295)	(0.0297)	(0.0306)	(0.0306)	(0.0523)	(0.0526)	(0.0600)	(0.0560)	(0.0839)	(0.0837)	(0.0921)	(0.0934)
InternatMarket	0.0931**	0.0894**	0.0365	0.0345	0.127***	0.123***	0.123***	0.122***	0.140***	0.140***	0.149***	0.154***	0.130	0.115	0.197**	0.182**
	(0.0444)	(0.0441)	(0.0431)	(0.0435)	(0.0382)	(0.0377)	(0.0366)	(0.0365)	(0.0498)	(0.0502)	(0.0524)	(0.0526)	(0.0862)	(0.0878)	(0.0909)	(0.0906)
RDintensity	0.0404***	0.0388***	-0.0005	-0.0013	0.0393***	0.0377***	0.0021	0.0013	0.0144***	0.0137***	-0.0106**	-0.0117**	0.0380***	0.0351***	0.0024	-0.00165
	(0.0030)	(0.0032)	(0.0025)	(0.0027)	(0.0024)	(0.0025)	(0.0020)	(0.0020)	(0.0047)	(0.0051)	(0.0051)	(0.0057)	(0.0065)	(0.0064)	(0.0055)	(0.0054)
Constant	-2.469***	-2.786***	-2.249***	-2.609***	-2.782***	-2.895***	-2.178***	-2.355***	-1.868***	-1.821***	-1.071**	-1.335***	-1.993***	-2.004***	-1.684***	-2.128***
	(0.415)	(0.307)	(0.435)	(0.386)	(0.181)	(0.160)	(0.239)	(0.190)	(0.192)	(0.246)	(0.529)	(0.446)	(0.249)	(0.245)	(0.496)	(0.258)
Rho	0.0940	-0.173	0.214	-0.0548	-0.232*	-0.339***	0.0390	-0.116	-0.167	-0.0768	0.363	0.115	-0.548**	-0.577**	0.203	-0.304
	(0.222)	(0.149)	(0.225)	(0.226)	(0.134)	(0.126)	(0.153)	(0.137)	(0.118)	(0.183)	(0.418)	(0.357)	(0.256)	(0.226)	(0.398)	(0.251)
χ^2	1123.60	1086.07	939.45	837.96	1892.44	1689.10	1321.55	1040.91	439.72	465.16	238.44	245.15	497.09	494.88	366.00	371.64
Prob (χ^2)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	11,557				14,040				4,017				3,028			

Estimations control for time and sector dummies
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1