THE IMPACT OF PRODUCT INNOVATION ON FIRM GROWTH USING A MULTI-STAGE MODEL: EVIDENCE IN A PERIOD OF ECONOMIC CRISIS

Pablo Garrido Prada
Desiderio Romero Jordán
Maria Jesús Delgado Rodriguez

FUNDACIÓN DE LAS CAJAS DE AHORROS
DOCUMENTO DE TRABAJO
Nº 796/2018

De conformidad con la base quinta de la convocatoria del Programa de Estímulo a la Investigación, este trabajo ha sido sometido a evaluación externa anónima de especialistas cualificados a fin de contrastar su nivel técnico.

ISSN: 1988-8767

The impact of product innovation on firm growth using a multi-stage model: Evidence in a period of economic crisis

Pablo Garrido Prada*
Desiderio Romero Jordán**
Maria Jesús Delgado Rodriguez**

ABSTRACT

The period of economic crisis started in late 2008 meant a change in the conditions of the environment, reducing the number of innovative companies as well as investment in innovation. An adverse macroeconomic environment can also determine the outputs of innovation and its effect on firm growth. The objective of the article is therefore (i) to analyze the determinants of innovation output and (ii) to examine how these outputs influences firm growth during a period of economic crisis. For this purpose, we used a panel of Spanish firms during the period 2005-2013, employing a sequential multi stage approach based on four phases: decision to innovate, how much innovate, innovation outputs and finally, the effect of these innovations on firm growth. The results confirm that for the period of economic crisis, investment in innovation remains decisive for generating innovations outputs, albeit with a slightly smaller effect. In contractive periods, both previous experience and continuous activities of intramural R&D are two fundamental factors to generate outputs from innovations. In any case, the positive effect of innovation outputs on firm growth is reduced by half in times of crisis. The results imply that companies must recalculate the opportunity cost of innovation, given that both previous experience in innovation and a continued effort in R&D can reduce the negative effects of contractionary macroeconomic periods on innovation.

Keywords: Product innovation, economic crisis, firm growth, multi-stage model, Spanish firms.

Corresponding author: Pablo Garrido Prada. E-mail: gapra.pablo@gmail.com

* Facultad de Ciencias Económicas y Empresariales; Departamento de Economía Aplicada, Universidad Autónoma de Madrid, C/ Francisco Tomás y Valiente, 5, 28049 Madrid, España.

** Facultad de Ciencias Jurídicas y Sociales; Economía de la Empresa (ADO) Economía Aplicada II y Fundamentos de Análisis Económico, Universidad Rey Juan Carlos, Paseo de los Artilleros s/n, 28032, Vicálvaro, Madrid, España.

1. INTRODUCTION

The relationship between innovation and firm growth (and productivity) has been widely studied for many decades, both at the macroeconomic and microeconomic levels (Audretsch, Coad, & Segarra, 2014). There is considerable support that innovation (leading to technological progress) is one of the main driving forces of economic growth (Romer, 1990), in which firms play a core role to introduce those innovations in the society and markets. However, the results about the relationship between innovation and firm growth is usually obtained, and theoretically discussed, on the background of period of macroeconomic expansion (Antonioli, Bianchi, Mazzanti, Montresor, & Pini, 2013).

The global financial crisis, started in late 2008 hit many countries in the world, devastating their economies, nearly collapsing the banking systems and decimating the financial resources of their companies and citizens in their countries (Hausman & Johnston, 2014). Previous studies found a sharp reduction in the number of innovative firms and in innovative investment during the last period of crisis for many develop countries (Archibugi, Filippetti, & Frenz, 2013b; Filippetti & Archibugi, 2011; OECD, 2009, 2012; Paunov, 2012). However, this study aims is to give a step further and analyse the determinant and consequences of innovation on firm growth in a period of economic crisis. What is the role of investment in innovation over innovation output during downturns? Does the outputs of innovation have the same effect on firm growth in periods of crisis as in expansive ones? Which other factors determine the innovation output and firm growth in period of crisis?

The severity and pervasiveness of the economic recession stimulated the analysis of the relation between innovation and firm growth on the crisis challenges. (Antonioli et al., 2013). Develop successful innovations is a difficult task, which depend among other, on firm and market characteristics, time period and macroeconomic environment (Audretsch, Segarra, & Teruel, 2014). Li and Atuahene-Gima (2001) proved that the innovation effectiveness is to large extent determined by environmental factors and institutional support. Therefore, it is to be expected that during downturns, the challenge to innovate and gather benefit from them, is likely amplified given demand uncertainty, revenues decline, and financial constraints (Amore, 2015).

For this purpose, we used a panel of Spanish firms from 2005-2013. Spain entered into a deep recession in 2008, due to lack of liquidity, rising defaults and debt that caused a bank bailout, 25,5% unemployment rate in late 2013 and long GDP constrictions from 2008 to 2013[1]. Thus, inspect Spanish firms provides an appropriate setting for an analysis of innovation in a period of economic crisis. We estimated a sequential model (generally called CDM models) based on four stages: innovation decision, innovation investment, the innovation outputs and finally the effect of innovation output on firm growth.

The paper is structured as follows. Next Section 2 reviews the literature. Section 3 describes the data and the sample selection criteria. Section 4 defines the model, the estimation method and variable. The results are presented in section 5; and we finish with conclusions and a discussion of the research in Section 6.

2. LITERATURE REVIEW

2.1 Innovation output determinants

There is a large volume of published studies analyzing the impact of innovation on growth and company productivity since the work of Griliches (1986). The study of the effect of innovation on firm performance has evolved, from a perspective of the inputs of innovation to an output perspective (Crepon, Duguet, & Mairessec, 1998). The underlying idea is that investing in innovation is a necessary but not sufficient requirement for introducing successful new products, services, processes, organization and marketing methods for companies (Bessler & Bittelmeyer, 2008). Only the innovations implemented are those that have the capacity to modify the performance and growth of the firm.

Thus, innovation output means the company's ability to introduce new or significantly improved products, services, processes, methods of organization and distribution for the company or market (Oslo Manual, 2005).

According to the Shumpeterian theory, innovation allows to overcome the equilibrium, gaining profits through a more dominant position in the market (Arrow, 1962). The innovation expands not only the limits of knowledge, but also the market, replacing the current technology. Thus, through investment in innovation, the

[1] Source for the Spanish GDP: AMECO.

company can generate outputs of innovation as new products, processes, methods of organization or distribution. This helps to produce at lower cost and open new markets that end up having a positive impact on the productivity and growth of the firm (Bayus, Erickson, & Jacobson, 2003). The accumulation of technology, both tangible and intangible, is difficult to replicate by the firm's competitors in the short term (Freeman, 1994), and it creates new opportunities that non-innovative firms cannot achieve (Breschi, Malerba, & Orsenigo, 2000).

Hence, it is expected that the greater innovation input (investment), the greater outputs of innovation. However, not many studies have found this positive relationship (Klomp & Van Leeuwen, 2001). This is because the innovation performance depends not only on investment in innovation, but also on the objectives of that innovation, the type of innovation, the sources of information, the cooperation, the public aid, the sector to which it belongs, the internal characteristics of the company itself, and on the macroeconomic environment. The sum of investment in innovation plus all factors determine the ability to introduce new products, services, processes, organization and distribution (Hashi & Stojčić, 2013).

As any other investment, innovation is not risk free. In times of economic crisis, uncertainty about the macroeconomic environment coupled with the complexity of technology may undermine and underestimate the potential benefits of innovation (Miller, 2006). Firms (and financial markets) are more reluctant to invest in innovations when the risks of such innovation are higher because of uncertainty. This may lead companies to simply defend their position in the market (Auh & Menguc, 2005) and prefer to exploit existing technology and knowledge (March, 1991). If the company does not have a clear commitment to innovation, new knowledge may not be enough to radically challenge the existing knowledge base and the technology driving sales (Choi & Williams, 2014). This implies that the new knowledge generated is not sufficient to sustain sales growth, or to taking advantage of the economies of scale of learning that stem from innovations. In this way, investment in innovation may not increase the outputs of innovation in times of crisis in comparison with the expansion periods.

2.2 Innovation output and firm's growth

Companies innovate seeking the outputs of the innovation that may lead to a competitive advantage. New products or services imply new markets, which can increase sales (Bayus et al., 2003). Innovation output can also improve productivity and growth by increasing the ability to use the company's assets, and by promoting technological changes. In addition, Innovations develop and update routines, which favors the adaptability and use of company resources. These routines help the spread of new knowledge to any company activity increasing economies of scale (Choi & Williams, 2014). Although the innovation of a new product, service -or process-, cannibalizes old products, services and manufacturing methods, which may reduce productivity and growth. It is also an evolutionary method that generate sustainable competitive advantage against its competitors, and create market power through sales increases, and cost reduction.

Previous studies have found a positive relationship between innovation output and firm growth, both in sales (e.g. Coad & Rao, 2010) and in employment (e.g. Dachs & Peters, 2014; Harrison, Jaumandreu, Mairesse, & Peters, 2014). There is also an extensive literature that finds a positive relationship between innovation output and productivity (see B. H. Hall, Mairesse, & Mohnen, 2010; Mohnen & Hall, 2013).

Both, the Shumpeterian and the evolutionist theory advocate innovation as the engine to overcome the economic crisis. For the Shumpeterian, radical innovations leads the company to give a qualitative leap that generates new demand, reduction cost, extra profits and investment. These radical innovations affect positively the macroeconomic as well as help to overcome the constraints that occur in contractionary periods. In the same way, evolutionists suggest that innovations allow the updating of technologies, routines and processes, which improve the benefit of the company. Only the best adapted survive and allow the economy to evolve to overcome the economic crisis.

Apart from the internal factor, external environment can moderate the effect of innovation output on firm growth. In periods of crisis, the company has to face higher levels of uncertainty, lack of financing and lower demand, which can break the positive relationship between innovation performance and growth. From the supply perspective, the economic crisis can lead to invest inefficiently in innovation, due to

lack of resources or information. This can undermine the ability to introduce radical innovations in both the company and the market. If these innovations are not differentiated enough, it can reduce the potential performance of innovation, which directly affects the sales of that good or service. From the perspective of demand, in times of crisis, when consumer disposable income is lower, preferences vary focusing on covering basic needs at the lowest possible price. This can affect sales of innovative products, which usually have a higher manufacturing cost in the early stages of the product. Altogether, the benefits of product innovation can be affected in times of crisis. As discussed earlier, investing in innovation is not synonymous of obtaining innovation output in crisis, and likewise, being able to produce innovation output may not ensure an increase in sales, employment or productivity of the firm before under macroeconomic conditions.

3. THE DATABASE

The Technological Innovation Panel (PITEC) is a panel survey to study the innovation activity of Spanish firms over time. PITEC consists of repeated observations on the same firms over time, with annual statistical information on their innovation activities. It follows the guidelines in Oslo Manual (OECD, 2005) and Frascati Manual (OECD, 2015) using a standardized questionnaire. The database is based on the Spanish Innovation Survey and the Community Innovation Survey (CIS). PITEC is carried out by the INE (The National Statistics Institute), which counts on advice from a group of university researchers and the sponsorship of FECYT and Cotec[2].

Specifically, PITEC provides detailed information on the innovation activities of Spanish firms for the period 2003-2014. For instance, it offers information on different types of innovation, R&D expenditures, R&D employees characteristic, innovation outputs, cooperation, or funding to undertake innovation activities. For reasons of opportunity and viability, PITEC started with two samples with data from 2003: a sample of firms with 200 or more employees (sample of large firms, which represented 73% of all firms with 200 or more employees according to data from the

[2] FECYT: Spanish Foundation for Science and Technology.
COTEC: Spanish Foundation for innovation.
PITEC web page: https://icono.fecyt.es/PITEC/Paginas/por_que.aspx
DIRCE: Central Directory of Companies in Spain.

DIRCE), and a sample of firms with intramural R&D expenditures. Given the improvements made by the INE in information on firms undertaking R&D activities, there were enlargements of the second sample in 2004 and 2005. Thus, in 2004, the database was expanded with a sample of firms with fewer than 200 employees, external R&D expenditure and no intramural R&D expenditure; and in 2005 with a representative sample of firms with fewer than 200 employees and no innovation expenditure. This database has been used for several articles (e.g. Coad, Segarra, & Teruel, 2016; Segarra & Teruel, 2014).

Our sample contains information for the period 2005-2013, since information in 2003 and 2004 is limited. In the pre-crisis period, the annual GDP growth rate was 3.5%. The financial crisis began in 2008, moving from a Spanish GDP growth of 1.02% in the first quarter of such year to a decline of 1.73% in the first quarter of the following year. Although economic growth remained constant (0.2%) in 2010, it started to decline again in 2011 until the end of 2013 with an annual GDP growth rate of -1.7%. In 2013 was the last year of the Spanish economic recession.

The initial sample contains 8492 firms (76428 observations) belonging to all sector. We eliminate observations that included some kind of incident (problems of confidentiality, sales or employees variation due to takeovers, mergers, or bankruptcy, etc.) and those with an obvious anomaly variable (such as null or below to 10000 euros sales). However, we did not drop outliers' observation that had been winsorized to avoid estimation bias. Finally, we keep those firms that remain with information in the whole period 2005-2013. Thus, the final sample consisted of a balanced panel of 6661 firms (59,949 observations). Our final sample include firms from all sector.

Table 1 and 2 summarize some descriptive statistics about innovation. Table 3 inspects the average and mean firm's sale growth (in percentage) in different groups of firms. Starting by table 1, we find that the proportion of innovative firms, follow Manual Oslo (2005) definition, decreased during the period of crisis especially for technological innovations (product and process). Since the definition of innovative firm refers to the period t to t-2, in year 2011, there was a clear decline in the proportion of innovative firms. This year includes innovative companies in the period 2009, to 2011. The decline was keeping up until the end of the crisis. It also

highlights that the decline was stronger in technological innovations (product or process) which is usually associated with greater expenses.

Nevertheless, the incidence of the crisis was uneven depending on the size of the company. In micro and small enterprises, the proportion of firms that stopped their innovation process was larger than in medium and large companies.

Insert table 1 and 2

In this way, the size of the company has been fundamental for the decision and capacity of the company to embark on innovative activities. Is innovation spending also contingent on the size of the company? As can be seen in table 2, innovation spending on innovative firms also declined during the economic crisis, being more marked in micro and small firms. Yet, spending on medium and large companies, although slightly lower, remained. This may mean that innovative firms, especially larger ones, keep their spending on innovation even in times of economic crisis. One of the items of expenditure that represents greater outlay for the companies is the acquisition of machines, equipment and software for innovation. Again, we found that large companies expend more in this item than smaller ones. However, the decreasing during the crisis was similar and not clearly associated with company size. Finally, the percentage of sales of new products for the company or the market due to product innovation also remained constant throughout the period, except for micro and small firms in which there was a slighting tendency to a decrease.

Analysing our second variable of interest in Table 3, we see that innovative firms had a slightly higher level of firm's sale growth than non-innovative ones. These differences remained constant for the period analysed. Likewise, companies with export capacity maintained a higher level of firm's sales growth during the period of crisis –not in macroeconomic expansion period- compared to the rest for the whole period analysed. Focusing on size, figure 1 portrays the sales variation by size and year. In year 2008, there was a big decline in the firm growth (but still positive) coinciding with the beginning of the crisis in late 2008. The firm´s growth turned to negative in 2009 and kept lower level of variation since them.

Insert table 3

Insert Figure 1

4. MODEL SPECIFICATION

The analysis in this paper is based on a structural model (often called CDM) consisting of four stages (Crepon et al., 1998): the decision of firms to innovate; their decision about the amount of innovation expenditure; the production of innovation output; and, the impact of innovation output on productivity (or growth). The model is calculated sequentially, assuming causality between the decision to innovate and the firm growth, but also allowing the inverse causality. Each of these stages includes determinant factors, such as firm's characteristics as well as, environmental and institutional characteristics. The first two stages estimations –decision and investment in innovation- are reported in appendix A for space limitations.

The use of a panel of data allows us to solve some of the limitations of previous studies based on CIS. On the one hand, the innovation is carried out over several years and different costs are allocated depending on the development phase of the innovation. We correct for this fact imputing the average expenditure on innovation by firm in period *t* to *t-2*. On the other hand, the output of innovation is not immediate, so having a data panel allows us to introduce delays in the explanatory variables by increasing the robustness of our model. Finally, with this panel from 2005 to 2013.

Similarly to the studies such as Hashi and Stojčić (2013) and (Lööf & Heshmati, 2002, 2006), the decision to innovate and the decision on how much to invest in innovation are linked to their determinants in the first two stages of the innovation process. Then, the third stage is a knowledge production function linking innovation input and output. Thus, the innovation output, included in the third equation depend on the decision to innovate (first) and how much to invest in innovation (second equation). Finally, in the fourth stage the productivity of a firm is related to the innovation output.

The literature on innovation and firm performance identifies two major problems with the econometric specification of this relationship, namely simultaneity and selectivity biases (Hashi & Stojčić, 2013; Mairesse & Robin, 2017). The first one arises because some factors influence in chorus on firm's decision to innovate, how much spent, and its final performance. Selectivity bias arises from the fact that not all firms are engaged in innovation and some innovations are not successful.

This sequential structural model approach includes the predicted value of one endogenous variable that enters in the estimation of the next equation. The inclusion of a correction factor for potential selection bias relaxes the original CDM model assumption that errors should not be correlated.

4.1 General Specification of the Model

Similar to the CDM, we use a four-equation structural model in our sensitivity analysis:

Let i=1,…N index firms, and t=1…9 index year time from 2005 to 2013. The first equation account for firms' decision to innovate in the period t to t-2; the second one account for firms' innovate effort in the period t to t-2. Being $d^*_{i(t;t-2)}$ and $g^*_{i(t;t-2)}$ two unobserved (latent) variables of the decision to innovate and of the level of the firm's investment in innovation respectively, we can define:

$$d_{i(t;t-2)} = \beta_0 x^0_{i(t;t-2)} + u^0_{i(t;t-2)} \quad (1)$$

$d_{i(t;t-2)} = 1$ if $d^*_{i(t;t-2)} > 0$, otherwise $d_{i(t;t-2)} = 0$

And

$$g_{i(t;t-2)} \mid d_{i(t;t-2)} = \beta_1 x^1_{i(t;t-2)} + u^1_{i(t;t-2)} \quad (2)$$

$g_{i(t;t-2)} = g_{i(t;t-2)}$ if $g^*_{i(t;t-2)} > 0$, otherwise $g_{i(t;t-2)} = 0$

Where $d_{i(t;t-2)}$ is an observable variable of firm's decision to innovate in t to t-2 and $g_{i(t;t-2)}$ is the observable level of the average firm's investment in innovation in the period t to t-2. Then, x^0_{it}, x^1_{it}, β_0, β_1 are independent variables and their corresponding parameters which reflect the impact of different determinants on the firm's decision to invest in innovation and on the level of expenditure on innovation. u^0_{it}, u^1_{it} are random error terms with zero mean, constant variances and not correlated with the explanatory variables.

The third equation are the innovation production function (innovation output) presented as follow:

$$k_{it} = a^2_g \hat{g}_{i(t;t-2)} + \beta_2 x^2_{it^*} + u^2_{it} \quad (3)$$

Where k_{it} represents the innovation output of firm in year t, $\hat{g}_{i(t;t-2)}$ represents estimates of innovation input from Equation (2) and a^2_g is the corresponding vector of unknown parameters. x^2_{it} is the vector of other explanatory variables which includes among others inverse Mill's ratio estimates from Eq. (1) and performance from the

fourth stage to control for selection bias and feedback effect. Finally, β_2, are the coefficients of the explanatory variables while u_{it}^2 is the random error term with mean zero and constant variance not correlated with explanatory variables. By using its predicted value, we also instrument the innovative effort $d^*_{i(t;t-2)}$ and take care that it is possibly endogenous to the innovation production function (Griffith et al, 2006).

Finally, the last equation of the model relates the innovation output and other factors with the firm's performance (growth). We used a log transformed function similar than a Cobb-Douglas production function as follow:

$$q_{it} = \alpha \hat{k}_{it} + \beta_3 x^3_{it^*} + u^3_{it} \qquad (4)$$

with q_{it} as the dependent variable indicating the firm's rate of growth in year t; $\hat{k}_{it}$ representing estimates of innovation output from Eq. (3), where α the elasticity of production with respect to changes in innovation output. The vector $x^3_{it^*}$ is a vector of input variables with include among other one lag of the dependent variable, β_3 is the correspondent unknown parameters and u^3_{it} being the error term which is assumed to be uncorrelated with explanatory variables.

4.2 Econometric technique

As we said before, the first two equations are estimated jointly through a double hurdle model (Cragg, 1971) in which observations on both innovative and non-innovative firms are included. This methodology separates the decision to innovate in two process. The first hurdle corresponds to factors affecting the decision to innovate (participation) and the second to the decision of level of expenditure. A different latent variable is used to model each decision process. This model is closer to the firm reality where some companies do not want to innovate, and some other, do not have the enough resources and capabilities to do it. Thus, the first hurdle needs to be crossed to be a potential innovator. Given that the firm is a potential innovator, it current circumstances dictate whether innovate—this is the second hurdle (Engel & Moffatt, 2014).

Two main advantage emerges using a double hurdle model: First, the probability of a positive value (first stage) and the actual value, given that it is positive (second stage), can be determined by different underlying process (i.e., different parameters) overcoming the limitations of the Tobit model (Burke, 2009; Engel & Moffatt, 2014).

Second, the double hurdle model can be interpreted as a flexible version of the Heckman model. In the Heckman model, zero observations arise due to nonparticipation solely whereas the double hurdle model relaxes this assumption and allows zero observations to arise in both the participation hurdle and expenditure hurdle. (Eakins, 2016). Therefore, the double hurdle model features both the selection mechanism of the Heckman model (which is not a feature of the Tobit model) and the censoring mechanism of the Tobit model -which is not a feature of the Heckman model- (Eakins, 2016).

However, is reasonable to think that the decision to innovate (participation) and how much to spent (expenditure) are related decisions, but it may be driven by different variables. The Double Hurdle model assumes that there is no correlation between the error terms in the two hurdles (Cragg, 1971), so we relaxed this assumption included the inverse Mills ratio from the first component as explanatory for the second component (Burke, 2009; Heckman, 1979; Wooldridge, 2010). Thus, we assumed that there is a correlation between the decision to innovate (participation), and how much to spend in innovation (expenditure). Finally, we correct for autocorrelation using cluster- robust standard error.

The third and fourth stages are estimated as a system in a 3SLS simultaneous equation where the endogenous innovation output variable is limited only to strictly positive values in the last step. In the production function model illustrated by equations (2) to (4), the innovation input g in equation (2) is an explanatory variable in the innovation output equation (3), and innovation output, k, is an explanatory variable in the productivity equation (4). Because of the endogeneity of these variables, we cannot assume that the explanatory variables and the disturbances are uncorrelated. Thus, similarly than Lööf and Heshmati (2002, 2006), van Van Leeuwen and Klomp (2006) and Hashi and Stojčić (2013), we relaxed the full correlation between the error terms of the fourth equations with one of partial correlation between disturbance terms. It is assumed that the disturbance terms from the first two stages of the innovation process are correlated with each other because of unobservable characteristics of firms. As noted by Griffith, Huergo, Mairesse, and Peters (2006) such procedure controls for the possibility of potential endogeneity of innovation input to the innovation output. Similarly, the third and fourth stages are estimated jointly as a system in a reduced form of the model.

4.3 Definition of variables

In this subsection, we describe the variables used for each stage of the model. Information about how is measured each of the variables is available in Appendix A.

Decision to innovate

A firm decision to innovate is considered (dependent variable in Equation 1) as long as it reported a positive value for innovation expenditure in the period t to t-2. Similar that Hashi and Stojčić (2013) or Peters, Roberts, and Vuong (2017), I broader the innovation definition included R&D expenditure and expenditure on machinery, equipment, software, patents, know-how and training of staff for innovation activities (Oslo Manual, 2005). Most studies have adopted the practice of including the same variables as determinants of the decision to innovate and how much invest in innovation. However, in the explanatory variables of Equation (1) we included only variable available for the whole sample (innovative and not innovative firms) to avoid spurious correlations. Variables such us organizational and marketing innovations, objectives of innovations should be avoided since this variables are only answers by innovative firms.

Among the factors that are usually included in the decision to innovate as well as how much to spend on innovation are the size of the company, the export capacity, types of cooperation, source of financing, company structure, sector and previous experience.

We divided the exploratory variables of the decision to innovate in firms' characteristics, and market characteristics. Firms characteristics includes, the size of firm, belong to a group, foreign ownership participation, firm age, capacity to invest, internationalization, experience in innovation and firm localization in a technological park.

Firm size is measured by logarithms of firm's employees. Two dummy variable identified if the firm belong to a group of enterprises being the parent or subsidiary. Then a dummy variable if firm is private and with foreign participation. The firm age is measured in logarithm, whereas a categorical variable of the firm degree of internationalization (abroad UE border) in the year t-2 identified export capacity. The firm capacity of investment is measured by the logarithm of the firm average gross investment in tangible assets in the period t to t-2. Innovation experience is imputed if

the firm was able to introduce a successful innovation previously (in t-3), or in the first year that the firm was included in the sample. Finally, a dummy identified if the firm is established in a technological park.

In relation with the market characteristics, we included factors hampering innovation (cost, knowledge and market); Spanish representative sector dummies; and a dummy variable of the economic crisis period started in 2009 (in the late 2008).

Innovation investment

In the second stage, Innovation input was defined as the natural logarithm of the average amount spent per year in the period t to t-2 on innovations divided by the average employees per year in the same period. This definition measures the innovation expenditure intensity and it is widely used in the field. However, imputed the value of three years represents a huge advantage with respect other research. One of the limitations of the analysis based on CIS databases is that it can only allocate the expenditure on innovation of year t. Yet, just as the process of innovation takes place over several years, innovation expenditures are also imputed over more than one period or year. In many cases, innovation expenses are paid in several years, (e.g. through a financial agreement), or the innovation process has different phases that require diverse levels of expenditure. Impute only the year t may bias the innovation input data and its effect on innovation output (Archibugi, Filippetti, & Frenz, 2013a). Further, defined this way, the variable encompasses spending on all innovation activities mentioned earlier (intramural and extramural R&D expenditure, investment in machinery, equipment and software and other acquisitions of external knowledge).

The exploratory variables of Equation (2) includes the same exploratory variables of Equation (1) except the dummy variable if the firm was able to introduce a successful innovation previously. Further, we also included variables that may affect the investment in innovation. as dummies identifying highly important sources of information about innovation (internal sources, market sources, institutional sources); firm access to subsidies thought a dummy if the firm receives any public financial support from national or EU institutions; a dummy variable if the firm is involved in continuous activities of intramural R&D; a dummy variable if the firm invest in external R&D; breakdown of expenditure on innovation as percentage of total

innovation expenditure in the period t to t-2 on acquisition of machines, equipment and software; three dummies variable if the firm cooperate on innovations with: (1) other abroad enterprises or institutions, (2) public institutions and research centre (3) competitors and other firms in the same main market segment (coopetition) in the period t to t-2.

Innovation output

In Equation (3) innovation output is measured by the natural logarithm of the share of sales of new products and services (new to a firm and new to the firm's market) of the firm. As Oslo Manual (2005), we considered "new" as entirely new, or substantially improved good of service. Thus, it is the percentage in logarithm of total sales in year *t* due to products or services launched in the period t to t-2. Unfortunately, for the other types of innovation – process, organizational and marketing- the only innovation measures available are dichotomous measures. The sale of new products is considered as the most robust measure since the introduction of new products or services includes the whole process of innovation and allows quantifying the commercial success of innovation (Mohnen & Hall, 2013).

The explanatory variables in this equation are also divided in firm and environment characteristics. Firm characteristics included innovation investment intensity measured by innovation input from the second stage; a dummy variable if the firm was able to introduce a successful innovation previously (in t-3); a dummy variable if the firm is involved in continuous activities of intramural R&D in the previous year; a dummy variable if the firm invest in external R&D in the previous year; two dummies if the firm was able to introduce process or non-technological innovation (organizational and marketing) in the same period (t to t-2) respectively. We included two dummies representing firms whose objective is explorative or accumulative innovation (see Appendix A); three dummies for cooperation with abroad firm or institutions, public institution, or with competitors respectively in the period t to t-2. Further, two dummies if the firm received any public financial support from national or EU institutions, etc. in the previous year. We also include the natural logarithm of firm growth from the Equation (4); firm size; a proxy of the firm environment though a dummy if the firm is established in a technological park; the percentage of employees with high education; two dummies variable if the firm operates in high manufacture or

high services sector. Environment characteristics includes sector dummies and economic crisis dummy.

Finally, to correct the sample selection of select only companies with positive values of innovation output, we included two inverse Mills ratio: one from the first stage controlling selection bias of the decision to innovate, and another one controlling for the fact that firms may introduce other types of innovations that do not change the dependent variable of the Equation (3). In other words, companies can innovate with goals far from the introduction of new products for the market or the company. For example, innovations aimed at adapting to new regulations, those that seek to improve the quality and welfare of employees, process innovations that reduce the environmental impact of a particular product or process, non-technological innovations[3].

Firm growth

Finally, we defined the dependent variables of four stage in Equation (4) as firm growth measured through the variation of turnover. Since this variable is in logarithms, we built an index variable with base in 2005. Firm growth variable is frequently used in the innovation-performance analysis mainly due to the anonymization that innovation surveys have. They do not include accounting variables and the company name is not display (e.g. Audretsch, Segarra, et al., 2014; Raymond, Mohnen, Palm, & Loeff, 2010).

As mentioned above, the equation (4) includes the predicted values of innovation output from the previous stage, one year lag of the dependent variables which was instrumented with a two year lag of the same variable. The independent variables included are firm size; firm age (in logarithm); a proxy of the firm capacity of investment, firm internationalization, foreign ownership participation, other types of innovations, as well as sector and a dummy for the period of economic crisis. Firm size and firm age is calculated in the same way as described before. We calculated the firm capacity of investment by the logarithm of the firm average gross investment in tangible assets in the period t to t-2. Firm internationalization is measured by the

[3] We run an additional regression where the dependent variable is a dummy that takes the value 1 if a firm successfully introduced process or non-technological innovations in the period t to t-2 but not product innovation. The exploratory variables are the same ones introduced for equations 3 (innovation output).

percentage of overseas sales outside the UE. A dummy variable for being part of group of enterprises and a dummy variable if firm is private and with foreign participation is used for firm structure. We included a dummy if the firm was able to introduced a non-technological innovation (organizational and marketing) in the same period (t to t-2), We included We added four main sectors: trade, hospitality, services, construction, and finance. Finally, we included a dummy for the period of economic crisis started in 2009.

5. RESULTS

We present the results of the determinants of innovation output –third stage- and the effect of innovation output on firm performance –fourth stage-. The determinants of the decision to innovate and how much to invest in innovation are reported in appendix C because space limitation. In the descriptive analysis in the previous section, we found clear differences in depending on size and economic period. For this reason, in the next tables, we included pre-crisis and crisis economic period, and the differences between small (including micro) firms and large (including medium) ones.

5.1 Innovation output

The third stage consists only on firms that have reported a positive amount of innovation output measured by the share of sales coming from the introduction of new product or services to the firm or market. Two inverse Mill's ratio was included to control for potential selectivity bias. One comes from the first equation and another one for an auxiliary regression of the equation 3. The results of the estimation are presented in table 4. The inverse Mill's ratio from the first equation is insignificant but not the inverse Mill's ratio from the auxiliary regression suggesting the appropriateness of correcting for selection bias.

Insert table 4

Starting by the determinants of the innovation output, we found differences between pre crisis and crisis period. The coefficients of innovation input yields a positive relationship with innovation output in the whole sample (0,244). Nevertheless, the elasticity is higher in micro and small (SM) firms than in medium and large (ML). There is also a decrease in the elasticity during period of economic crisis compared

with period of expansion. There are three likely explanation: One is that in period of economic crisis, the objectives of innovation activities changes from product into process or non-technological. Another explanation is that the demand change in period of crisis, diluting the potential positive effect of new product or services. However, as we could analyse in table 1, the average share of innovative products and services launched remained similar in period of crisis. Thus, there are not clear demand factors as changes in consumer's preferences. Finally, it is also likely that companies prefer to defend their position in the market exploiting the existing technology and knowledge, which may lead to an inefficient investment in innovation in period of crisis (Auh & Menguc, 2005; March, 1991).

In period of economic crisis, other factors become important to generate innovation output. Firms involved in continuous R&D lead to an increase in the innovation output. The coefficient is higher in period of economic crisis. Further, continuous R&D generates higher innovation output in ML firms than in MS. This means that those companies that have an established research department, for which they carry out innovation activities on an ongoing basis, obtain greater innovation output than those companies that innovate on an occasional basis. This is also related to what we find in the previous section where ML seek exploratory innovations.

Furthermore, previous experience in innovation positively affects innovation output. Again, the positive effect is higher in periods of economic crisis. Those companies that had already introduced innovations in previous periods (t-3) have a greater capacity to readapt to the new adverse macroeconomic conditions, and obtain greater innovation performance in terms of introducing and sell new products or services. This variable is not relevant for ML firms in period of expansion but becomes significant in period of crisis. For MS firms, previous experience is essential for successful innovation, especially in downturns. Again, the learning process and experiences are relevant in period of downturn.

However, extramural R&D does not influence positively the innovation performance in any kind of period. Therefore, the same conclusion arises: investment in innovation is a necessary condition, but other key factor can enhances innovation output in periods of crisis. This investment must be accompanied by previous experience and knowledge.

Combine product and process innovation increase the innovation output. Both strategies are related since the introduction of a new product and services usually requires new processes. The coefficient of non-technological innovation yields the same results for period of crisis than expansion. When the company is able to innovate in several types of innovation increases the innovation output.

Further, those companies that have a clear objective of exploratory and cumulative innovation increase the innovation output in period of economic crisis. The positive effect of cumulative innovation is twice as much as exploratory innovation. This can mean two things: First, is that because Spain is a "follower" country in terms of technology, cumulative innovation causes a greater increase in the share of sales of new goods and services. Second, is that in periods of crisis, changes in demand preferences (e.g. more focus on price and basic needs) causes cumulative innovations to perform better than the exploratory ones in terms of percentage of new products or services in relation to their total sales.

The cooperation with other foreign institutions or firms influences the innovation output positively in the whole period. The cooperation with abroad institution is significant for MS firms but not for ML. This means that MS firms take advantages of this type of cooperation to generate new product or services. Nevertheless, cooperation with public institutions and competitors impact negatively in the innovation output. The last result not imply that cooperation with public institution is not effective, if not that cooperation with public institution may not have the objective to introduce new product or services (e.g. focus in process or environmental issues). Finally, the subsidies of Spanish public institutions allow, in times of crisis, to achieve greater innovation output, especially for MS firms.

Analysing the firm’s internal characteristics, the effects of firm’s growth on innovation output is positive in the whole period, without difference between MS and ML firms. Firms with higher growth also gather higher innovation output in a feedback effect. Finally, the environment is also contingent to the innovation performance. In period of economic expansion, technology parks are positively related with innovation output. Knowledge spillover in science parks produces a positive impact on firms that are located together in terms of performance and efficiency (Audretsch & Feldman, 2004). Thus, firms are able to assimilate knowledge spill over for their neighbours.

However, this relationship disappear in period of economic crisis. One likely explanation is that in period of crisis, the free share of information and knowledge is smaller which can reduce the advantages of technology park.

5.2 Firm growth determinants

In this fourth stage, we analysed firm growth, which is determined by the innovation output, as well as other control variables available in the database. Table 5 contains the estimation output by 3SLS.

Insert table 5

The results indicate that innovation output significantly increases firm growth. Again, we find differences between the pre-crisis and crisis period and between micro and small firms (MS) vs medium and large (ML). Whereas the elasticity of firm growth-innovation output is 0.256 in period of expansion, it decreases to 0.112 in in period of economic crisis. Thus, the effect of innovation output on firm growth is half in period of economic downturns. There are also differences taking into account company size. Whereas in MS firms, innovation output leads to increase firm growth, it is not the case for ML firms where the positive effect disappears in period of crisis. Further, the elasticity is higher in MS firms than in ML. For MS innovation is a clear strategy to become a competitive firm.

Similarly, the introduction of process and not technological innovation does not enhance firm's growth in period of economic crisis. The non-significance of process and non-technological innovation dummies is frequent once the intensity of product innovation is introduced as a continuous variable (Lee et al., 2003; Criscuolo, 2009).

The coefficient of the lag of firm growth is statistically significant and positive, indicating the persistence of the changes implemented by the company to improve its productivity and growth. Firm size is positively related with firm growth. One likely explanation is that the stronger benefits derived from dominance position, access to internal and external financing of bigger firms leads then to increase their size.

Export and invest capacity increase firm growth, but its elasticity is relatively small compared to the other variables. Export becomes relevant in period of economic crisis. Those companies present in international markets can offset the decline in

domestic markets demand. Contrary, company age and be part of a group reduces firm growth. Finally, the period of economic crisis reduces the firm growth.

6. DISCUSSION AND CONCLUSION

The economic crisis of 2008 changed the environment conditions, which affects the decision to innovate and the total investment in innovation (e.g. Archibugi et al., 2013b; Paunov, 2012). Similarly, the macroeconomic environment may also determine the performance of these innovations and their final effect on firm performance, and growth. In contractive environments, uncertainty, liquidity and demand constraints may limit the benefits achieved from its innovation strategies. The objective of the article has been (i) to analyze the determinants of innovation performance and (ii) to examine how these outputs determine the company's growth, during the expansionary and contractionary periods of the economy. With this aim, we have obtained information from Spanish companies (one of the countries most affected during the crisis of 2008) and we estimated a sequential model based on four stages: decision to innovate, how much to innovate, the performance of innovation and finally the effect of these innovation output in firm growth.

Effect of the economic crisis: The size of the company in the input and output of the innovation.

This study corroborates that the crisis has reduced the number of companies that decide to innovate in Spain, which decreases the total investment in innovation. This result is in line previous studies for European and OECD countries (OECD, 2012). Thus, the percentage of firms that have introduced innovations in the crisis period has been reduced drastically, especially in the micro and small enterprises. In times of crisis, under the mix of uncertainty and risk, it makes difficult for small firms to access external capital markets to finance innovation projects (B. H. Hall, Moncada-Paternò-Castello, Montresor, & Vezzani, 2016; Lee, Sameen, & Cowling, 2015). Yet, for firms that decide to innovate, the crisis does not diminish the intensity in innovation spending (especially medium and large companies). Therefore, size becomes a key variable for understanding the decision and how much to spend on innovation.

Previous studies show a mix of results on the effects of size in the decision to innovate and how much to invest (e.g. Lööf & Heshmati, 2006). In this research, we found that the size of the firm reduces the probability of investing in innovation in pre-crisis periods, but not in contractionary periods. This implies that small firms have greater difficulty in embarking on innovation activities in the face of uncertain scenarios such as periods of crisis. On the other hand, the larger the size of the company, the lower the intensity of innovation costs, regardless of the macroeconomic conditions. However, in our results, the size is not related to the outputs of the innovation. One possible explanation is that the measure of innovation output used (the share of sales of new products or services for the company or market) underestimates the share when total sales are high, as in large companies. Another is that in medium and larger firm transaction and bureaucratic costs can reduce the efficiency of innovations.

Experience and persistence in innovation to generate "innovation output" in periods of crisis.

One of the main results of the study is that the economic crisis has not only negatively affected the probability of innovation, but also (1) innovation performance and (2) the effect of these outputs have on company growth.

Although the relationship between innovation input (innovation investment) and innovation output remains positive in both pre-crisis and crisis periods, the relationship returns are slightly lower in periods of crisis. In this period, investing more in innovation has associated a smaller increase of the performance of this innovation than in pre-crisis periods. One possible explanation is the reduction of expenditures on equipment and machinery for innovation, a variable that some studies have found to be "crucial" to generate innovation output (Love & Roper, 2015; Pellegrino, Piva, & Vivarelli, 2012). Another explanation is that liquidity and financing constraints in times of crisis force the firm to keep only innovation projects that preserve their relative position in the market compared to the competitors in terms of technology and knowledge (Auh and Menguc, 2005; March, 1991).

However, in our study, two factors are important to generate innovation output in contractive periods: previous experience in innovation and persistence in R&D. The positive effect of experience is higher in times of crisis than in expansion. Experience

in related projects can create internal capabilities within the organization, learning economies, and "internal spillovers" that reduce the negative side effects of the economic crisis on innovation performance (Phene & Almeida, 2008; Teece, 2014). This result is in line with Amore (2015) who obtained that companies with experience in innovation during previous economic crises obtain greater yield of the innovation in new crises.

With respect to persistence in the knowledge created, continuous R&D is creative work carried out within the enterprise, which is undertaken systematically in order to increase the volume of knowledge to conceive new applications, such as goods or services and new or significantly improved processes. In our study, we find that companies that carry out R&D on a continuous basis obtain greater performance from their innovations than those companies that buy R&D or simply do it on an occasional basis. This positive effect is most evident in times of crisis. These results imply that those companies with a continuous innovation strategy (which is also related to the size of the company), are capable of generating higher levels of introduction of new products in periods of economic crisis. Under the evolutionary perspective, firms that carry out R&D activities on a continuous basis accumulate knowledge and extract technology and technological trajectories that help them to improve innovation performance (Raymond et al., 2010). This continued learning is especially relevant in times of crisis, where the company does not have the same capacity to adapt to technological changes. The companies that innovate continually have the capacity to adapt to the new circumstances of the environment and can obtain greater yields of their innovation. Yet, the purchase of R&D is not enough to generate innovation output in times of crisis. Internal and external R&D is one of the most studied variables in the field of innovation with a positive relationship in innovation output (e.g. Crepon et al, 1998; Love et al. 2009; Roper et al. 2008).

Therefore, companies that do not have previous experience on innovations or are involved in innovation in an occasional basis must re-evaluate the performance of their innovations in times of crisis so as not to fall into inefficiencies and sunk costs.

Firm growth: The role of the innovation outputs.

Apart from the negative effect of the period of crisis on firm growth, the results show that the economic crisis limits the return of innovation. Innovation output positively

influences the growth of the company, but in periods of crisis the positive effect of innovation output is reduced by half. This implies that a greater share of sales due to the introduction of new products or services for the company or market does not entail a clear increase in the firm growth. One possible explanation is that in crisis there are adjustments in demand. Consumers have greater budget constraints, which may limit the demand for innovative products. Another is that the innovations introduced are not radical enough to generate a competitive advantage in times of crisis. These recessive periods force firms to keep only the innovation projects that allow them to maintain their relative position in the market compared to the competitors, in terms of technology and knowledge (Auh & Menguc, 2005; March, 1991).

Is innovation recommendable in times of crisis? The answer is yes, innovation helps the growth of the company through sales, but the firm must be aware that the performance of innovation is lower than in expansive periods. Therefore, companies should: First, recalculate the opportunity cost of innovation, second invest in projects with previous experience, or to cooperate with companies experienced in innovation, and third to focus efforts on continued R&D activities. All this together helps companies in contractive periods to reduce risk and to take positive externalities of the characteristics of the company on innovation.

The role of public funding in innovation.

Another main question is whether public funds earmarked for firm innovation are effective in times of crisis. According to the results, public aid increases the investment in innovation of firms significantly, regardless of the period considered. In addition, public funds increase innovation output in times of crisis, but not in pre-crisis periods. Specifically, public funds from Spanish administrations have a positive effect on the introduction of new products and services in times of economic crisis. This relationship is not seen in expansive periods or funds coming from the EU. One explanation is that many of the EU funds are based on very long-term innovation projects, with a fundamental objective of expanding the boundaries of knowledge and generating positive externalities for society, thus its positive effect cannot be captured with this model. In any case, public subsidies allow firms to increase their spending on innovation and generate greater outputs of this investment in times of

crisis, especially in small and micro enterprises, which ends up influencing the growth of the company. However, cooperation with public entities (e.g. Universities, or state research centers), while increasing investment in innovation, decreases the share of new products and services in the enterprise market (output) in times of crisis. Again, one possible explanation is that innovations developed in cooperation with public entities may be directed towards other types of innovation, such as process innovations rather than products.

Despite the interest of these results, it is important to mention that this study was subject to several limitations. First, the indicators used to measure firm growth at the firm level are not neutral with respect to empirical results (Audretsch, Segarra, et al., 2014). For comparability, we selected the variable most frequently used in this field, but results may be different with other performance variables. Second, although we corrected in the model for selection bias and omitted variables, firm growth, as well as innovation output, it is also associated with specific unobservable firm's capabilities, such as managerial capacity, entrepreneurship, ownership or firm diversification. In that sense, we cannot use other firm's accounting measures relevant to calculate firm growth due to firm's anonymization of the sample. Finally, the study is conducted in Spain, which may not represent other countries or specific sectors.

APPENDIX A

Table A.1. Explanation of variables.

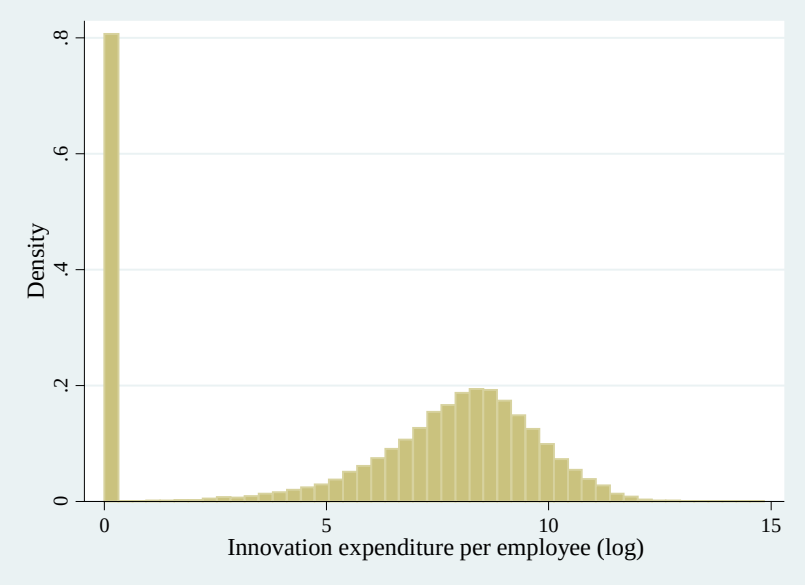
Dependent variables	Abbreviation	Definition
Eq. (1): Decision to innovate		Dummy variable; 1 if firm, in years t to t-2, engaged in any type of innovation expenditures follow Oslo Manual 2005 definition. Thus is in intramural or extramural R&D, purchased new machinery, equipment, software or other external knowledge, engaged in training of personnel, market research or did any other preparations to implement new or significantly improved products and processes, or new or significantly improved organization or distribution methods.
Eq. (2): Innovation input (natural logarithm)	Inno. input	Innovation intensity: Amount (in euro) of average expenditure on innovation in year t to t-2 divided by the average employees in the period t to t-2 (Innovation expenditure: Oslo Manual 2005 definition).
Eq. (3): Innovation output (natural logarithm)	Inno. output	Percent of firm's turnover in year t coming from goods or services that were new to market or to the firm in years t to t-2.
Eq. (4): Firm growth (natural logarithm)	Sales growth	Sales growth: Index number with base in firm's turnover in 2005
Independent variables		
Firm size (natural logarithm)	Firm size	Number of employees in year t
Private company with foreign participation	PRIV	Dummy variable; 1 if firm is private and with foreign participation in year t.
Company age (natural logarithm)	Age	Number of years since the set-up of the firm
Gross investment (natural logarithm)	GITA	Gross investment (in euros) in tangible assets in year t
Part of a group	Part. group	Dummy variable; 1 if firm is part of an enterprise in year t.
Part of a group being the parent	Parent	Dummy variable; 1 if firm is part of an enterprise group being the parent company in year t.
Part of a group being the subsidiary	Subsidiary	Dummy variable; 1 if firm is part of an enterprise group being a subsidiary company in year t.
High degree employees	High degree	Percent of employees in the firm with University studies.
Location in a Scientific or Technological Park	Tech. park	Dummy variable; 1 if firm is located in a Scientific or Technological Park in year t
Exporter abroad UE	Export.	Categorical variable: 1 if firm export outside the UE less than 20% of the turnover; 2 if firm export in range 20% to 50%; 3 if firm export more than 50%; 0 in other cases (in year t).
Exporter in t-3	Exp. t-2	Dummy variable; 1 if firm sold goods or services outside the UE in year t-2
Innovation characteristics		
Intramural R&D	Intra. R&D	Dummy variable; 1 if firm is involved in-house R&D in year's t to t-2.
Continuous R&D	Cont. R&D	Dummy variable; 1 if firm is involved in continuous in-house R&D in year t. (lagged in equation 3) Survey question: "Has your company carried out internal R&D activities in *year t*? Continuously or occasionally?"
Extramural R&D	Entra. R&D	Dummy variable; 1 if firm bought R&D from other enterprise or research organization in years t. (lagged in equation 3)
Process innovation	Proc. inno	Dummy variable; 1 if firm introduced process innovation in year's t to t-2
Non-technological innovation	N-T. inn	Dummy variable; 1 if firm in years t to t-2, introduced organizational or marketing innovations follow Oslo Manual 2005 definition.
Explorative innovation	Expl. Inn.	Dummy variable; 1 if firm considered as highly important factor in their decision to innovate (t; t-2) at least two of the following: (i) increase range of goods or services; (ii) entering new markets; (iii) increased market share

Accumulative innovation	Accum. Inn.	Dummy variable; 1 if firm considered as highly important factor in their decision to innovate (t; t-2) at least half of the following: (i) Replace old products and process; (ii) Improving quality of goods or services; (iii) Improving flexibility for producing goods or services; (iv) Increasing capacity for producing goods or services; (v) Reducing costs per unit produced; (vi) Less energy per unit produced; (vii) Less materials per unit produced
Expenses in equipment and software (natural logarithm)	Soft.	Percentage of total innovation expenditure in t, on acquisition of machines, equipment and software (not included in R&D).
Experience in innovation	Inno. in t-3	Dummy variable; 1 if firm was able to introduce an innovation in t-3.
Hampering innovation		
Cost factors	Cost f.	Dummy variable; 1 if firm perceives the lack of funds, finance from sources outside the enterprise and high costs of innovation as highly important factors hampering its innovation activities, projects or decision to innovate (years t to t-2).
Knowledge factors	Know. F.	Dummy variable; 1 if firm perceives the lack of qualified personnel, information on technology or markets or difficulties in finding cooperation partners for innovation as highly important factors hampering its innovation activities, projects or decision to innovate (years t to t-2).
Market factors	Market f.	Dummy variable; 1 if firm perceives the domination over market by established enterprises or the uncertainty of demand for innovation goods and services as highly important factors hampering its innovation activities, projects or decision to innovate (years t to t-2).
Public support		
Public financial support	Public fund	Dummy variable; 1 if firm received financial support for innovation activities from local/regional, central government or EU authorities (loans, grants, subsidies ...) in year t to t-2
National subsidies	Spa. funds	Dummy variable; 1 if firm in years t to t-2 received financial support for innovation activities from central government. (with 1 lag in Equation 3)
EU subsidies	UE funds	Dummy variable; 1 if firm in years t to t-2 received financial support for innovation activities from EU authorities (with 1 lag in Equation 3)
Sources of innovation about technological innovations		
Internal sources	Internal S.	Dummy variable; 1 if firm perceives sources of information within enterprise or group as highly important sources of information on innovation (t; t-2).
Market sources	Market S.	Dummy variable; 1 if firm perceives suppliers, customers, competitors, consultants or R&D labs as highly important sources of information on innovation (t; t-2).
Institutional sources	Inst. S.	Dummy variable; 1 if firm perceives universities or government as highly important sources of information on innovation (t; t-2).
Cooperation		
Cooperation with abroad countries	Coop. abr.	Dummy variable; 1 if firm cooperated on innovations with other overseas enterprises or institutions in years t to t-2
Cooperation with competitors	Competitors	Dummy variable; 1 if firm cooperated on innovations with other competitors enterprises or enterprises in the same main sector in years t to t-2 prior to survey
Cooperation with public institutions	Coop. Public	Dummy variable; 1 if firm cooperated on innovations with public institutions in years t to t-2 prior to survey
Firm main sector		
Food, beverages and tobacco	Food	Dummy variable; 1 if firm operates in manufacture of food, beverages and tobacco products.
Textile	Textile	Dummy variable; 1 if firm operates in manufacture of textiles
Chemical	Chemical	Dummy variable; 1 if firm operates in manufacture of chemicals and chemical products.

Textile		Dummy variable; 1 if firm operates in manufacture of textiles
Water and energy	W&E	Dummy variable; 1 if firm operates in electricity, gas, steam, air conditioning supply, water supply; sewerage; waste management and remediation activities (Group D and E NACE2009)
High Tech Manufactures	HT manu.	Dummy variable; 1 if firm operates in High Technology manufacture sector (OCDE Definition)
High Tech Services	HT serv.	Dummy variable; 1 if firm operates in High Technology service sector (OCDE Definition)
Construction	Const.	Dummy variable; 1 if firm operates in construction. (Group F)
Hospitality	Hospitality	Dummy variable; 1 if firm operates in accommodation and food service activities (Group I)
Finance	Finance	Dummy variable; 1 if firm operates in financial and insurance sector (Group K)
Health	Health	Dummy variable; 1 if firm operates in human health and social work activities (Group Q)
Controls		
IMR equation 1	IM.1	Inverse Mill's ratio from selection equation
IMR auxiliary equation 3	IM.3	Inverse Mill's ratio from auxiliary equation of innovation output with dependent variable Dummy variable be 1 if firm in year t to t-2, introduced process, organizational or marketing innovations but not product innovation.
Period of crisis		Dummy variable; 1 in the period 2009 to 2013

APPENDIX B

Figure B.1. Histogram of the ratio of innovation expenditure per employee (in logarithms).



APPENDIX C

Table C1. Results of the selection equation.

	Total firms sample			Micro and small firms sample			Medium and large firms sample		
	Total	Pre-crisis	Crisis	Total	Pre-crisis	Crisis	Total	Pre-crisis	Crisis
Factors hampering innovation									
Cost f.[a]	0.297***	0.362***	0.267***	0.227***	0.326***	0.179***	0.403***	0.450***	0.387***
	(0.0208)	(0.0313)	(0.0265)	(0.028)	(0.043)	(0.033)	(0.032)	(0.047)	(0.038)
Know. F[a]	-0.0183	-0.0108	-0.0419	-0.048	-0.063	-0.044	0.010	0.055	-0.031
	(0.0276)	(0.0395)	(0.0359)	(0.035)	(0.051)	(0.041)	(0.043)	(0.061)	(0.054)
Market f.[a]	0.0475**	0.0218	0.0651**	0.007	0.013	0.003	0.119***	0.075	0.145***
	(0.0230)	(0.0338)	(0.0295)	(0.030)	(0.045)	(0.035)	(0.036)	(0.051)	(0.044)
Previous experiences in innovation									
Inno. in t-3[a]	1.162***	1.253***	1.105***	0.988***	1.013***	0.976***	1.318***	1.520***	1.155***
	(0.0229)	(0.0312)	(0.0308)	(0.033)	(0.046)	(0.038)	(0.032)	(0.043)	(0.042)
Firms characteristics									
Firm size[b]	-0.0690***	-0.184***	0.0150						
	(0.00935)	(0.0127)	(0.0119)						
Company age[b]	-0.0855***	-0.0636**	-0.0763**	-0.212***	-0.232***	-0.195***	-0.001	-0.013	0.012
	(0.0222)	(0.0267)	(0.0302)	(0.031)	(0.038)	(0.039)	(0.030)	(0.035)	(0.038)
GITA[b]	0.0569***	0.0533***	0.0592***	0.065***	0.059***	0.068***	0.044***	0.038***	0.049***
	(0.00171)	(0.00239)	(0.00226)	(0.002)	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)
Type of company									
PRIV [a]	0.00672	0.0144	-0.0291	-0.077	-0.316***	-0.004	-0.001	0.049	-0.027
	(0.0385)	(0.0549)	(0.0464)	(0.075)	(0.119)	(0.081)	(0.045)	(0.062)	(0.054)
Parent[a]	0.251***	0.314***	0.217***	0.148*	0.112	0.158*	0.247***	0.251***	0.261***
	(0.0466)	(0.0679)	(0.0570)	(0.082)	(0.128)	(0.087)	(0.055)	(0.077)	(0.067)
Subsidiary[a]	0.0463	0.0574	0.0308	0.011	0.192**	-0.053	0.038	-0.057	0.108**
	(0.0314)	(0.0430)	(0.0380)	(0.053)	(0.085)	(0.059)	(0.038)	(0.051)	(0.046)
Firm environment									
Tech. park[a]	0.605***	0.617***	0.635***	0.525***	0.593***	0.508***	0.714***	0.619***	0.753***
	(0.0742)	(0.117)	(0.0893)	(0.093)	(0.145)	(0.105)	(0.123)	(0.187)	(0.149)
Export in t-2[a]	0.280***	0.314***	0.263***	0.233***	0.276***	0.218***	0.335***	0.341***	0.336***
	(0.0176)	(0.0272)	(0.0208)	(0.023)	(0.041)	(0.025)	(0.026)	(0.036)	(0.031)

(continued)	Total firms sample			Micro and small firms sample			Medium and high firms sample		
	Total	Pre-crisis	Crisis	Total	Pre-crisis	Crisis	Total	Pre-crisis	Crisis
Crisis[a]	-0.520***			-0.676***			-0.337***		
	(0.0182)			(0.025)			(0.027)		
Firm main sector									
Construction[a]	-0.232***	-0.171**	-0.247***	-0.470***	-0.425***	-0.481***	-0.117*	-0.108	-0.126
	(0.0585)	(0.0791)	(0.0740)	(0.095)	(0.128)	(0.105)	(0.070)	(0.098)	(0.089)
Health[a]	-0.0565	0.00958	-0.167*	0.134	0.224*	0.035	-0.156**	-0.135	-0.169*
	(0.0602)	(0.0692)	(0.0907)	(0.108)	(0.121)	(0.165)	(0.072)	(0.089)	(0.096)
W&E[a]	0.153*	0.198	0.112	0.025	0.025	0.027	0.219*	0.319*	0.182
	(0.0895)	(0.148)	(0.114)	(0.145)	(0.229)	(0.153)	(0.117)	(0.192)	(0.138)
Hospitality[a]	-1.072***	-1.203***	-0.928***	-1.104***	-0.900***	-1.303***	-1.014***	-1.274***	-0.831***
	(0.0997)	(0.140)	(0.133)	(0.215)	(0.244)	(0.370)	(0.113)	(0.177)	(0.133)
Food[a]	-0.0166	0.125*	-0.120**	-0.229***	-0.065	-0.316***	0.196***	0.328***	0.124
	(0.0444)	(0.0644)	(0.0573)	(0.062)	(0.091)	(0.074)	(0.065)	(0.090)	(0.084)
Textile[a]	0.119	0.249*	0.0405	-0.070	0.007	-0.112	0.466***	0.672***	0.343**
	(0.0874)	(0.138)	(0.103)	(0.109)	(0.165)	(0.122)	(0.162)	(0.261)	(0.168)
HT manu.[a]	0.612***	0.511***	0.703***	0.510***	0.441***	0.557***	0.903***	0.727***	1.156***
	(0.0757)	(0.110)	(0.0953)	(0.088)	(0.127)	(0.100)	(0.152)	(0.205)	(0.269)
HT serv.[a]	0.448***	0.675***	0.393***	0.567***	1.071***	0.489***	0.311***	0.508**	0.244**
	(0.0723)	(0.146)	(0.0805)	(0.094)	(0.207)	(0.098)	(0.109)	(0.204)	(0.119)
Constant[b]	-0.0161	0.350***	-0.883***	0.440***	0.429***	-0.247*	-0.830***	-0.803***	-1.162***
	(0.0687)	(0.0861)	(0.0968)	(0.098)	(0.119)	(0.128)	(0.100)	(0.121)	(0.134)
Sample size	59,949	26,644	26,644	30,436	13,289	17,147	29,513	13,355	16,158
Number of firms	6661	6661	6661	3758	3489	3648	3658	3518	3464

Note: a: Dummy variable; b: Continuous variable in logarithmic; c: Ordered categorical variable. Cluster-Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See Appendix A for variable details.

Table C2. Results of the innovation investment equation.

	Total firms sample				Micro and small firms sample				Medium and large firms sample			
	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.
Highly important sources of information about innovation												
Internal s.[a]	0.208***	0.215***	0.193***	0.169***	0.166***	0.180***	0.147***	0.137***	0.225***	0.234***	0.206***	0.182***
	(0.020)	(0.024)	(0.025)	(0.025)	(0.025)	(0.031)	(0.032)	(0.032)	(0.034)	(0.042)	(0.042)	(0.043)
Market s.[a]	0.143***	0.145***	0.140***	0.114***	0.116***	0.089***	0.137***	0.124***	0.165***	0.182***	0.149***	0.127***
	(0.019)	(0.024)	(0.024)	(0.024)	(0.024)	(0.030)	(0.030)	(0.030)	(0.033)	(0.041)	(0.040)	(0.040)
Inst. S.[a]	0.078***	0.063**	0.091***	0.087***	0.088**	0.079*	0.099**	0.097**	0.121***	0.112**	0.120**	0.117**
	(0.027)	(0.032)	(0.032)	(0.033)	(0.035)	(0.043)	(0.043)	(0.043)	(0.044)	(0.055)	(0.051)	(0.051)
Factors hampering innovation												
Cost factors[a]	-0.033*	-0.004	-0.056**	-0.062**	0.017	0.052	-0.014	-0.017	-0.073**	-0.033	-0.099**	-0.101**
	(0.020)	(0.025)	(0.026)	(0.026)	(0.026)	(0.032)	(0.034)	(0.034)	(0.033)	(0.042)	(0.041)	(0.041)
Know. F. [a]	-0.074***	-0.084***	-0.066**	-0.072**	-0.076**	-0.095**	-0.060	-0.065*	-0.039	-0.033	-0.051	-0.054
	(0.024)	(0.028)	(0.031)	(0.031)	(0.030)	(0.037)	(0.039)	(0.039)	(0.044)	(0.052)	(0.058)	(0.058)
Market factors[a]	-0.079***	-0.091***	-0.071***	-0.077***	-0.078***	-0.063*	-0.091***	-0.092***	0.007	-0.031	0.034	0.027
	(0.020)	(0.025)	(0.025)	(0.025)	(0.026)	(0.033)	(0.032)	(0.032)	(0.035)	(0.045)	(0.044)	(0.044)
Type of innovation												
Intramural R&D[a]	0.923***	0.842***	0.998***	0.983***	0.837***	0.770***	0.908***	0.903***	0.989***	0.893***	1.068***	1.053***
	(0.024)	(0.027)	(0.030)	(0.030)	(0.029)	(0.035)	(0.037)	(0.037)	(0.041)	(0.048)	(0.053)	(0.053)
Extramural R&D[a]	0.472***	0.471***	0.471***	0.469***	0.356***	0.344***	0.368***	0.368***	0.511***	0.515***	0.502***	0.500***
	(0.022)	(0.027)	(0.028)	(0.028)	(0.028)	(0.033)	(0.036)	(0.036)	(0.036)	(0.044)	(0.043)	(0.043)
Soft.[c]	0.195***	0.487***	-0.049	-0.057	0.132**	0.457***	-0.131*	-0.139*	0.177**	0.470***	-0.085	-0.083
	(0.047)	(0.060)	(0.058)	(0.058)	(0.060)	(0.082)	(0.074)	(0.074)	(0.075)	(0.091)	(0.093)	(0.093)
Expl. Inn.[a]				0.097***				0.012				0.176***
				(0.028)				(0.036)				(0.045)
Accum. Inn.[a]				0.121***				0.091**				0.028
				(0.029)				(0.038)				(0.043)
Cooperation with:												
Coop. Abr.[a]	0.299***	0.334***	0.311***	0.308***	0.172***	0.208***	0.163***	0.162***	0.195***	0.169***	0.257***	0.255***
	(0.032)	(0.043)	(0.036)	(0.036)	(0.044)	(0.055)	(0.053)	(0.053)	(0.044)	(0.061)	(0.048)	(0.048)

Coop. Public [a]	0.111***	0.053*	0.149***	0.152***	0.136***	0.094**	0.163***	0.164***	0.048	0.028	0.057	0.059
	(0.025)	(0.031)	(0.030)	(0.030)	(0.033)	(0.040)	(0.042)	(0.042)	(0.038)	(0.050)	(0.045)	(0.045)
Competitors[a]	0.277***	0.176***	0.332***	0.330***	0.162***	0.138**	0.172***	0.172***	0.235***	0.124*	0.297***	0.292***
	(0.035)	(0.045)	(0.040)	(0.040)	(0.042)	(0.058)	(0.049)	(0.049)	(0.053)	(0.070)	(0.060)	(0.060)
Access to subsidies												
Public funds[a]	0.633***	0.626***	0.616***	0.617***	0.642***	0.623***	0.630***	0.633***	0.583***	0.572***	0.578***	0.577***
	(0.021)	(0.025)	(0.027)	(0.027)	(0.028)	(0.033)	(0.037)	(0.037)	(0.033)	(0.043)	(0.041)	(0.041)
Type of company												
PRIV[a]	0.200***	0.188***	0.201***	0.202***	0.083	-0.022	0.131**	0.137**	0.055	0.069	0.046	0.043
	(0.042)	(0.053)	(0.046)	(0.046)	(0.061)	(0.085)	(0.065)	(0.066)	(0.052)	(0.063)	(0.059)	(0.059)
Parent[a]	0.257***	0.300***	0.215***	0.216***	0.083	0.109	0.062	0.064	-0.104*	-0.089	-0.120*	-0.122*
	(0.044)	(0.055)	(0.050)	(0.050)	(0.072)	(0.092)	(0.079)	(0.079)	(0.061)	(0.074)	(0.069)	(0.069)
Subsidiary[a]	0.288***	0.353***	0.231***	0.229***	-0.020	0.073	-0.085	-0.088	0.122***	0.133**	0.109**	0.106**
	(0.032)	(0.041)	(0.037)	(0.037)	(0.050)	(0.064)	(0.057)	(0.057)	(0.045)	(0.055)	(0.052)	(0.052)
(continued)		Total firms simple				Micro and small firms sample				Medium and large firms sample		
	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.
Firms characteristics and environment												
Firm size[b]		-		-								
	-0.581***	0.607***	-0.558***	0.560***								
	(0.013)	(0.014)	(0.015)	(0.015)								
Export [c]	0.053***	0.060***	0.045***	0.042***	-0.014	-0.016	-0.019	-0.019	0.124***	0.101***	0.143***	0.137***
	(0.013)	(0.015)	(0.016)	(0.016)	(0.018)	(0.022)	(0.021)	(0.021)	(0.021)	(0.024)	(0.026)	(0.026)
Company age[b]	-0.027	-0.026	-0.024	-0.024	- 0.398***	- 0.372***	- 0.453***	- 0.452***	-0.009	-0.010	-0.002	-0.000
	(0.024)	(0.025)	(0.031)	(0.031)	(0.030)	(0.031)	(0.039)	(0.039)	(0.035)	(0.037)	(0.043)	(0.043)
GITA[b]									-		-	
	0.018***	0.020***	0.015***	0.015***	0.005*	0.009**	0.001	0.001	0.015***	-0.014***	0.017***	-0.017***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.005)
Tech. park[a]	0.373***	0.420***	0.334***	0.336***	0.330***	0.374***	0.295***	0.297***	0.421***	0.585***	0.311***	0.306***
	(0.052)	(0.069)	(0.056)	(0.056)	(0.064)	(0.086)	(0.069)	(0.069)	(0.095)	(0.128)	(0.098)	(0.098)
Crisis[a]	0.095***				0.150***				0.154***			
	(0.017)				(0.023)				(0.027)			
Firm main sector												
Const.[a]		-		-	-	-	-	-	-		-	
	-0.425***	0.389***	-0.489***	0.479***	0.394***	0.333***	0.481***	0.478***	0.612***	-0.630***	0.634***	-0.621***
	(0.078)	(0.094)	(0.095)	(0.094)	(0.104)	(0.128)	(0.141)	(0.141)	(0.126)	(0.150)	(0.142)	(0.141)
Health[a]	-0.263***	-0.206**	-0.371***	-	0.316***	0.427***	-0.046	-0.042	-	-0.952***	-	-0.720***

				0.357***					0.848***		0.732***	
	(0.083)	(0.091)	(0.116)	(0.116)	(0.109)	(0.119)	(0.180)	(0.180)	(0.132)	(0.148)	(0.162)	(0.162)
W&E[a]	0.052	0.259**	-0.078	-0.069	0.179	0.360*	0.096	0.092	-0.201	-0.018	-0.307*	-0.283*
	(0.108)	(0.128)	(0.127)	(0.127)	(0.194)	(0.204)	(0.253)	(0.252)	(0.146)	(0.176)	(0.170)	(0.170)
Hospitality[a]		-		-	-	-	-	-	-		-	
	-1.094***	1.154***	-1.041***	1.046***	1.645***	1.822***	1.337***	1.336***	0.911***	-0.900**	0.893***	-0.898***
	(0.214)	(0.327)	(0.237)	(0.234)	(0.227)	(0.292)	(0.167)	(0.164)	(0.261)	(0.360)	(0.299)	(0.296)
Food[a]		-		-	-		-	-				
	-0.178***	0.185***	-0.190***	0.190***	0.233***	-0.180**	0.310***	0.310***	-0.102	-0.145*	-0.076	-0.076
	(0.048)	(0.054)	(0.058)	(0.058)	(0.069)	(0.085)	(0.082)	(0.081)	(0.071)	(0.079)	(0.084)	(0.084)
Textile[a]	-0.189**	-0.159**	-0.233**	-0.233**	-0.110	-0.070	-0.153	-0.151	-0.051	-0.001	-0.118	-0.117
	(0.074)	(0.076)	(0.093)	(0.092)	(0.108)	(0.115)	(0.139)	(0.139)	(0.109)	(0.114)	(0.138)	(0.137)
HT. Manu.[a]	0.441***	0.388***	0.514***	0.517***	0.304***	0.262***	0.378***	0.379***	0.660***	0.667***	0.666***	0.671***
	(0.051)	(0.055)	(0.060)	(0.060)	(0.054)	(0.063)	(0.065)	(0.065)	(0.077)	(0.083)	(0.093)	(0.093)
H.T. Serv. [a]	0.910***	1.034***	0.844***	0.862***	0.853***	0.962***	0.775***	0.780***	1.219***	1.377***	1.158***	1.181***
	(0.059)	(0.080)	(0.061)	(0.061)	(0.065)	(0.084)	(0.069)	(0.069)	(0.129)	(0.201)	(0.125)	(0.126)
IM.1		-		-	-		-	-	-		-	
	-0.523***	0.488***	-0.521***	0.510***	0.276***	-0.194**	0.305***	0.302***	1.127***	-1.202***	1.055***	-1.049***
	(0.048)	(0.071)	(0.057)	(0.056)	(0.064)	(0.098)	(0.074)	(0.074)	(0.083)	(0.123)	(0.098)	(0.098)
Constant	9.005***	9.031***	9.068***	9.070***	8.562***	8.387***	8.965***	8.962***	6.447***	6.433***	6.598***	6.588***
	(0.073)	(0.079)	(0.101)	(0.101)	(0.097)	(0.107)	(0.139)	(0.139)	(0.134)	(0.147)	(0.180)	(0.180)
Sample size	59,949	26,644	26,644	26,644	30,436	13,289	17,147	17,147	29,513	13,355	16,158	16,158
Number of firms	6661	6661	6661	6661	3758	3489	3648	3648	3658	3518	3464	3464

Note: a: Dummy variable; b: Continuous variable in logarithmic; c: Ordered categorical variable. IMR: Inverse Mills Ration. Cluster-Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See Appendix A for variable details.

REFERENCES

Aghion, P., Askenazy, P., Berman, N., Cette, G., & Eymard, L. (2012). Credit Constraints and the cyclicality of R&D investment: Evidence from France. *Journal of the European Economic Association, 10*(5), 1001-1024. doi:10.1111/j.1542-4774.2012.01093.x

Amore, M. D. (2015). Companies learning to innovate in recessions. *Research Policy, 44*(8), 1574-1583. doi:https://doi.org/10.1016/j.respol.2015.05.006

Antonioli, D., Bianchi, A., Mazzanti, M., Montresor, S., & Pini, P. (2013). Innovation strategies and economic crisis: Evidence from firm-level Italian data. *Economia politica, 30*(1), 33-68.

Archibugi, D., Filippetti, A., & Frenz, M. (2013a). Economic crisis and innovation: Is destruction prevailing over accumulation? *Research Policy, 42*(2), 303-314. doi:https://doi.org/10.1016/j.respol.2012.07.002

Archibugi, D., Filippetti, A., & Frenz, M. (2013b). The impact of the economic crisis on innovation: Evidence from Europe. *Technological Forecasting and Social Change, 80*(7), 1247-1260. doi:https://doi.org/10.1016/j.techfore.2013.05.005

Arrow, K. J. (1962). The Economic Implications of Learning by Doing. *The Review of Economic Studies, 29*(3), 155-173. doi:10.2307/2295952

Audretsch, D. B., Coad, A., & Segarra, A. (2014). Firm growth and innovation. *Small Business Economics, 43*(4), 743-749. doi:10.1007/s11187-014-9560-x

Audretsch, D. B., & Feldman, M. P. (2004). Chapter 61 - Knowledge Spillovers and the Geography of Innovation. In J. V. Henderson & T. Jacques-François (Eds.), *Handbook of Regional and Urban Economics* (Vol. Volume 4, pp. 2713-2739): Elsevier.

Audretsch, D. B., Segarra, A., & Teruel, M. (2014). Why don't all young firms invest in R&D? *Small Business Economics, 43*(4), 751-766. doi:10.1007/s11187-014-9561-9

Auh, S., & Menguc, B. (2005). Balancing exploration and exploitation: The moderating role of competitive intensity. *Journal of Business Research, 58*(12), 1652-1661. doi:https://doi.org/10.1016/j.jbusres.2004.11.007

Barlevy, G. (2007). On the cyclicality of research and development. *The American Economic Review, 97*(4), 1131-1164.

Bayus, B. L., Erickson, G., & Jacobson, R. (2003). The Financial Rewards of New Product Introductions in the Personal Computer Industry. *Management Science, 49*(2), 197-210. doi:10.1287/mnsc.49.2.197.12741

Bessler, W., & Bittelmeyer, C. (2008). Patents and the performance of technology firms: Evidence from initial public offerings in Germany. *Financial Markets and Portfolio Management, 22*(4), 323-356. doi:10.1007/s11408-008-0089-3

Bovha Padilla, S., Damijan, J. P., & Konings, J. (2009). Financial Constraints and the Cyclicality of R&D investment: Evidence from Slovenia.

Breschi, S., Malerba, F., & Orsenigo, L. (2000). Technological regimes and Schumpeterian patterns of innovation. *The Economic Journal, 110*(463), 388-410.

Burke, W. J. (2009). Fitting and interpreting Cragg's tobit alternative using Stata. *Stata Journal, 9*(4), 584.

Choi, S. B., & Williams, C. (2014). The impact of innovation intensity, scope, and spillovers on sales growth in Chinese firms. *Asia Pacific Journal of Management, 31*(1), 25-46. doi:10.1007/s10490-012-9329-1

Coad, A., & Rao, R. (2010). Firm growth and R&D expenditure. *Economics of Innovation and New Technology, 19*(2), 127-145. doi:10.1080/10438590802472531

Coad, A., Segarra, A., & Teruel, M. (2016). Innovation and firm growth: Does firm age play a role? *Research Policy, 45*(2), 387-400. doi:http://dx.doi.org/10.1016/j.respol.2015.10.015

Cohen, W. M., & Klepper, S. (1996). A Reprise of Size and R&D. *The Economic Journal, 106*(437), 925-951. doi:10.2307/2235365

Cragg, J. G. (1971). Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods. *Econometrica, 39*(5), 829-844. doi:10.2307/1909582

Crepon, B., Duguet, E., & Mairessec, J. (1998). Research, Innovation And Productivity: An Econometric Analysis at The Firm Level. *Economics of Innovation and New Technology, 7*(2), 115-158. doi:10.1080/10438599800000031

Dachs, B., & Peters, B. (2014). Innovation, employment growth, and foreign ownership of firms: A European perspective. *Research Policy, 43*(1), 214-232. doi:https://doi.org/10.1016/j.respol.2013.08.001

Eakins, J. (2016). An application of the double hurdle model to petrol and diesel household expenditures in Ireland. *Transport Policy, 47*, 84-93. doi:https://doi.org/10.1016/j.tranpol.2016.01.005

Engel, C., & Moffatt, P. G. (2014). dhreg, xtdhreg, and bootdhreg: Commands to implement double-hurdle regression. *Stata Journal, 14*(4), 778-797.

Filippetti, A., & Archibugi, D. (2011). Innovation in times of crisis: National Systems of Innovation, structure, and demand. *Research Policy, 40*(2), 179-192. doi:https://doi.org/10.1016/j.respol.2010.09.001

Freeman, C. (1994). The economics of technical change. *Cambridge Journal of Economics, 18*(5), 463-514.

Griffith, R., Huergo, E., Mairesse, J., & Peters, B. (2006). Innovation and Productivity Across Four European Countries. *Oxford Review of Economic Policy, 22*(4), 483-498. doi:10.1093/oxrep/grj028

Griliches, Z. (1986). Productivity, R and D, and Basic Research at the Firm Level in the 1970's. *The American Economic Review, 76*(1), 141-154.

Hall, B. H., Mairesse, J., & Mohnen, P. (2010). Chapter 24 - Measuring the Returns to R&D. In H. H. Bronwyn & R. Nathan (Eds.), *Handbook of the Economics of Innovation* (Vol. Volume 2, pp. 1033-1082): North-Holland.

Hall, B. H., Moncada-Paternò-Castello, P., Montresor, S., & Vezzani, A. (2016). Financing constraints, R&D investments and innovative performances: new empirical evidence at the firm level for Europe. *Economics of Innovation and New Technology, 25*(3), 183-196. doi:10.1080/10438599.2015.1076194

Hall, B. H., & Sena, V. (2017). Appropriability mechanisms, innovation, and productivity: evidence from the UK. *Economics of Innovation and New Technology, 26*(1-2), 42-62. doi:10.1080/10438599.2016.1202513

Hall, R. E. (1991). Recessions as reorganizations. *NBER macroeconomics annual*, 17-47.

Harrison, R., Jaumandreu, J., Mairesse, J., & Peters, B. (2014). Does innovation stimulate employment? A firm-level analysis using comparable micro-data from four European countries. *International Journal of Industrial Organization, 35*, 29-43. doi:https://doi.org/10.1016/j.ijindorg.2014.06.001

Hashi, I., & Stojčić, N. (2013). The impact of innovation activities on firm performance using a multi-stage model: Evidence from the Community Innovation Survey 4.

Research Policy, 42(2), 353-366. doi:https://doi.org/10.1016/j.respol.2012.09.011

Hausman, A., & Johnston, W. J. (2014). The role of innovation in driving the economy: Lessons from the global financial crisis. *Journal of Business Research, 67*(1), 2720-2726. doi:http://dx.doi.org/10.1016/j.jbusres.2013.03.021

Heckman, J. J. (1979). Sample Selection Bias as a Specification Error. *Econometrica, 47*(1), 153-161. doi:10.2307/1912352

Klomp, L., & Van Leeuwen, G. (2001). Linking Innovation and Firm Performance: A New Approach. *International Journal of the Economics of Business, 8*(3), 343-364. doi:10.1080/13571510110079612

Lee, N., Sameen, H., & Cowling, M. (2015). Access to finance for innovative SMEs since the financial crisis. *Research Policy, 44*(2), 370-380. doi:https://doi.org/10.1016/j.respol.2014.09.008

Li, H., & Atuahene-Gima, K. (2001). Product Innovation Strategy and the Performance of New Technology Ventures in China. *Academy of Management Journal, 44*(6), 1123-1134. doi:10.2307/3069392

Lööf, H., & Heshmati, A. (2002). Knowledge capital and performance heterogeneity: A firm-level innovation study. *International Journal of Production Economics, 76*(1), 61-85. doi:https://doi.org/10.1016/S0925-5273(01)00147-5

Lööf, H., & Heshmati, A. (2006). On the relationship between innovation and performance: A sensitivity analysis. *Economics of Innovation and New Technology, 15*(4-5), 317-344. doi:10.1080/10438590500512810

Love, J. H., & Roper, S. (2015). SME innovation, exporting and growth: A review of existing evidence. *International Small Business Journal, 33*(1), 28-48. doi:doi:10.1177/0266242614550190

Mairesse, J., & Robin, S. (2017). Assessing measurement errors in the CDM research–innovation–productivity relationships. *Economics of Innovation and New Technology, 26*(1-2), 93-107. doi:10.1080/10438599.2016.1210771

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71-87.

Miller, D. J. (2006). Technological diversity, related diversification, and firm performance. *Strategic Management Journal, 27*(7), 601-619. doi:10.1002/smj.533

Mohnen, P., & Hall, B. H. (2013). Innovation and Productivity: An Update. *Eurasian Business Review, 3*(1), 47-65. doi:10.14208/bf03353817

OECD. (2005). *The Measurement of Scientific and Technological Activities: Guidelines for Collecting and Interpreting Innovation Data: Oslo Manual*.

OECD. (2009). *Policy Responses to the Economic Crisis: Investing in Innovation for Long-Term Growth*. Retrieved from

OECD. (2012). *Innovation in the Crisis and Beyond.* Retrieved from Paris:

OECD. (2015). *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development.* Retrieved from

Ouyang, M. (2011). On the Cyclicality of R&D. *The Review of Economics and Statistics, 93*(2), 542-553. doi:10.1162/REST_a_00076

Paunov, C. (2012). The global crisis and firms' investments in innovation. *Research Policy, 41*(1), 24-35. doi:https://doi.org/10.1016/j.respol.2011.07.007

Pellegrino, G., Piva, M., & Vivarelli, M. (2012). Young firms and innovation: A microeconometric analysis. *Structural Change and Economic Dynamics, 23*(4), 329-340. doi:https://doi.org/10.1016/j.strueco.2011.10.003

Peters, B., Roberts, M. J., & Vuong, V. A. (2017). Dynamic R&D choice and the impact of the firm's financial strength. *Economics of Innovation and New Technology, 26*(1-2), 134-149. doi:10.1080/10438599.2016.1202516

Phene, A., & Almeida, P. (2008). Innovation in multinational subsidiaries: The role of knowledge assimilation and subsidiary capabilities. *Journal of International Business Studies, 39*(5), 901-919. doi:10.1057/palgrave.jibs.8400383

Rafferty, M., & Funk, M. (2008). Asymmetric effects of the business cycle on firm-financed R&D. *Economics of Innovation and New Technology, 17*(5), 497-510. doi:http://dx.doi.org/10.1080/10438590701407232

Raymond, W., Mohnen, P., Palm, F., & Loeff, S. S. v. d. (2010). Persistence of Innovation in Dutch Manufacturing: Is It Spurious? *The Review of Economics and Statistics, 92*(3), 495-504. doi:10.1162/REST_a_00004

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5, Part 2), S71-S102.

Segarra, A., & Teruel, M. (2014). High-growth firms and innovation: an empirical analysis for Spanish firms. *Small Business Economics, 43*(4), 805-821. doi:10.1007/s11187-014-9563-7

Stiglitz, J. E. (1993a). *Endogenous growth and cycles*. Retrieved from

Stiglitz, J. E. (1993b). The role of the state in financial markets. *The World Bank Economic Review, 7*(suppl 1), 19-52.

Teece, D. J. (2014). A dynamic capabilities-based entrepreneurial theory of the multinational enterprise. *Journal of International Business Studies, 45*(1), 8-37. doi:10.1057/jibs.2013.54

Van Leeuwen, G., & Klomp, L. (2006). On the contribution of innovation to multi-factor productivity growth. *Economics of Innovation and New Technology, 15*(4-5), 367-390.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed. ed.). Cambridge: MIT press.

TABLES

Table 1. Descriptive statistics on the decision to innovate during the period 2005 to 2013.

	Pre-crisis				Crisis				
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Percentage of innovative firms in:									
Product	55.16	54.30	52.15	53.63	55.58	56.31	44.12	39.38	37.71
Process	55.01	56.37	53.24	55.41	57.68	58.88	45.97	39.63	36.63
Organization and marketing	n.a	n.a	n.a	50.82	49.38	47.46	46.16	46.18	44.41
Total	72.51	72.51	70.45	76.49	77.74	78.56	68.34	65.35	63.31
Percentage of innovative firms by size:									
Micro firms	74.81	70.19	69.72	73.13	71.73	71.32	55.79	52.20	47.42
Small firms	79.49	79.04	75.19	80.65	83.03	82.99	71.34	67.16	65.06
Medium firms	76.75	78.06	75.21	81.18	82.81	83.99	75.84	73.83	73.39
Large firms	55.66	60.00	59.32	69.06	71.47	74.63	70.43	69.27	69.94

N.a: Not available;

Table 2. Descriptive statistics of innovation expenditure and output during the period 2005 to 2013.

	Pre-crisis				Crisis				
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Average and median expenses in innovation (in logarithms) of the innovative firms:									
Micro firms	10.33	9.32	9.06	8.41	7.86	7.26	7.78	7.45	7.16
	11.27	11.11	11.10	10.98	10.60	10.41	10.57	10.34	10.21
Small firms	10.83	10.26	10.06	9.59	9.13	8.71	9.00	8.96	8.93
	11.70	11.67	11.72	11.55	11.43	11.38	11.45	11.42	11.50
Medium firms	11.55	11.06	10.84	10.36	10.39	10.03	10.52	10.10	10.00
	12.37	12.34	12.44	12.39	12.37	12.32	12.49	12.43	12.44
Large firms	11.54	11.27	11.38	10.66	10.29	9.96	10.36	10.21	9.88
	13.37	13.21	13.35	13.05	13.04	12.88	12.94	12.88	12.77
Percentage of expenditure on innovation for the acquisition of machines, equipment and software.									
Micro firms	18.59	19.40	17.70	15.26	15.92	14.00	14.52	9.36	10.11
Small firms	22.40	18.40	19.02	17.59	15.62	13.65	12.84	11.68	12.31
Medium firms	22.84	21.12	19.27	18.11	16.77	15.06	15.27	12.91	11.83
Large firms	28.54	24.96	24.37	23.21	27.15	22.49	21.48	19.71	18.06
Percentage of firm's turnover in year t coming from goods or services that were new to market or to enterprise (only for companies that report product innovation):									
Micro firms	48.28	45.96	46.58	48.62	46.80	44.61	44.60	39.91	39.26
Small firms	41.60	41.57	40.87	44.47	41.62	41.85	41.72	39.64	40.50
Medium firms	38.75	38.27	36.43	37.74	37.16	36.64	39.52	38.84	39.31
Large firms	34.19	31.02	34.20	35.22	35.63	35.62	37.89	36.25	37.15

Table 3. Average and median firm growth (percentage) in different groups of firms in the database.

	Pre-crisis			Crisis				
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Innovative firm vs non-innovative firm. (Average and median)									
Non-Innovative		16.02	11.91	2.98	-8.79	3.16	3.32	-3.77	-1.88
		6.89	6.87	0.01	-10.15	0.18	0.08	-4.71	-2.97
Innovative		17.03	16.14	7.27	-8.85	6.40	6.19	-2.48	0.64
		8.77	8.58	1.59	-11.12	2.30	2.57	-3.71	-1.06
Exporter abroad UE vs non-exporter									
Non exporter		18.13	16.34	7.15	-7.11	2.86	3.69	-4.37	-2.36
		8.14	8.18	2.05	-8.23	0.18	0.14	-4.73	-3.52
Exporter		14.75	12.67	4.77	-11.56	9.75	7.42	-1.14	2.23
		8.18	7.72	-0.18	-14.66	5.01	3.76	-2.95	0.29

Table 4. Results of the innovation output equation.

	Total firms sample				Micro and small firms sample				Medium and large firms sample			
	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.
Innovation Characteristics												
Inno. input[b]	0.244***	0.256***	0.234***	0.230***	0.220***	0.260***	0.196***	0.202***	0.133***	0.193***	0.114***	0.122***
	(0.034)	(0.054)	(0.043)	(0.043)	(0.031)	(0.051)	(0.040)	(0.040)	(0.029)	(0.052)	(0.035)	(0.035)
Cont. R&D[a]	0.228***	0.189**	0.253***	0.255***	0.152**	0.140	0.168*	0.183**	0.228***	0.305**	0.218**	0.218**
	(0.059)	(0.091)	(0.075)	(0.075)	(0.067)	(0.106)	(0.086)	(0.086)	(0.075)	(0.130)	(0.093)	(0.092)
Ext.. R&D[a]	-0.043**	-0.038	-0.045*	-0.043*	-0.034	-0.025	-0.041	-0.042	-0.022	-0.011	-0.017	-0.020
	(0.018)	(0.028)	(0.023)	(0.023)	(0.026)	(0.042)	(0.034)	(0.034)	(0.028)	(0.050)	(0.034)	(0.034)
Proc. inno.[a]	0.066***	0.079***	0.060***	0.037	0.097***	0.084**	0.105***	0.076**	0.037	0.103*	0.010	-0.022
	(0.017)	(0.028)	(0.022)	(0.024)	(0.023)	(0.038)	(0.029)	(0.032)	(0.030)	(0.053)	(0.036)	(0.038)
N-T. inn.[a]				0.041*				0.071**				-0.006
				(0.024)				(0.032)				(0.036)
Expl. inn.[a]				0.044*				0.021				0.065*
				(0.023)				(0.033)				(0.035)
Accum. inn.[a]				0.109***				0.100***				0.135***
				(0.0258)				(0.037)				(0.034)
Inno. in t-3 [a]	0.264***	0.189**	0.355***	0.368***	0.290***	0.248**	0.357***	0.385***	0.126	0.124	0.184*	0.198*
	(0.060)	(0.088)	(0.082)	(0.081)	(0.070)	(0.109)	(0.095)	(0.096)	(0.078)	(0.129)	(0.103)	(0.102)
Cooperation												
Abroad inst.[a]	0.098***	0.087	0.111**	0.117**	0.180***	0.174**	0.175**	0.190***	0.053	0.090	0.054	0.055
	(0.037)	(0.057)	(0.047)	(0.047)	(0.056)	(0.088)	(0.073)	(0.073)	(0.050)	(0.090)	(0.061)	(0.060)
Public inst.[a]	-0.060***	-0.025	-0.081***	-0.079***	-0.050	0.028	-0.091**	-0.090**	-0.092***	-0.088	-0.095**	-0.090**
	(0.022)	(0.034)	(0.027)	(0.027)	(0.031)	(0.050)	(0.040)	(0.040)	(0.034)	(0.061)	(0.041)	(0.040)
Competitors[a]	-0.076***	-0.065	-0.077**	-0.079**	-0.128***	-0.113	-0.136**	-0.142**	-0.010	-0.021	-0.003	-0.008
	(0.029)	(0.047)	(0.036)	(0.035)	(0.044)	(0.074)	(0.055)	(0.055)	(0.042)	(0.078)	(0.050)	(0.049)
Access to subsidies												
Spa. funds[a]	0.052**	0.021	0.069***	0.075***	0.086***	0.040	0.109***	0.122***	0.021	-0.005	0.033	0.036
	(0.021)	(0.032)	(0.026)	(0.026)	(0.031)	(0.049)	(0.039)	(0.039)	(0.032)	(0.056)	(0.039)	(0.038)
UE funds[a]	-0.035	0.028	-0.058	-0.056	0.013	0.029	0.019	0.007	-0.064	-0.008	-0.095	-0.081
Feedback effect												
	(0.038)	(0.062)	(0.047)	(0.047)	(0.055)	(0.096)	(0.068)	(0.068)	(0.054)	(0.100)	(0.064)	(0.063)
Sales growth[b]	0.110***	0.135*	0.116***	0.117***	0.072***	0.117	0.078***	0.077***	0.138***	-0.014	0.161***	0.167***
	(0.020)	(0.072)	(0.022)	(0.022)	(0.026)	(0.088)	(0.027)	(0.027)	(0.033)	(0.123)	(0.035)	(0.035)

(Continuation)	Total firms sample				Micro and small firms sample				Medium and high firms sample			
Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total
Firm and environment characteristics												
Firm size [b]	-0.007	-0.026	-0.002	-0.009								
	(0.015)	(0.024)	(0.018)	(0.018)								
High degree [b]	0.000	0.013	-0.007	-0.007	-0.008	-0.003	-0.012	-0.012	-0.007	0.013	-0.016	-0.014
	(0.007)	(0.011)	(0.008)	(0.008)	(0.009)	(0.015)	(0.012)	(0.012)	(0.010)	(0.019)	(0.012)	(0.012)
Tech. park [a]	0.026	0.175**	-0.027	-0.025	0.026	0.169*	-0.033	-0.037	0.152**	0.301**	0.112	0.093
	(0.042)	(0.070)	(0.052)	(0.052)	(0.053)	(0.093)	(0.066)	(0.066)	(0.064)	(0.122)	(0.076)	(0.074)
Crisis [a]	-0.071***				-0.123***				-0.009			
	(0.021)				(0.030)				(0.032)			
HT manu. [a]	-0.006	-0.073	0.049	0.052	0.055	-0.042	0.128**	0.130**	0.015	-0.035	0.040	0.040
	(0.034)	(0.050)	(0.043)	(0.043)	(0.044)	(0.068)	(0.058)	(0.058)	(0.055)	(0.093)	(0.068)	(0.067)
HT serv. [a]	-0.175**	-0.250**	-0.122	-0.114	-0.094	-0.251**	-0.008	-0.015	0.050	0.101	0.069	0.043
	(0.070)	(0.114)	(0.087)	(0.087)	(0.073)	(0.122)	(0.092)	(0.091)	(0.094)	(0.191)	(0.111)	(0.109)
MR.1 [c]	0.102	0.053	0.156	0.167*	0.369	0.490	0.321	0.432	0.112	-0.064	0.167	0.183
	(0.080)	(0.156)	(0.097)	(0.096)	(0.263)	(0.424)	(0.335)	(0.336)	(0.113)	(0.244)	(0.132)	(0.130)
MR.3 [c]	0.786***	0.841**	0.767**	0.808**	0.191*	0.183	0.230*	0.234*	0.405	1.002*	0.262	0.341
	(0.259)	(0.410)	(0.330)	(0.329)	(0.110)	(0.218)	(0.133)	(0.132)	(0.289)	(0.516)	(0.352)	(0.349)
Constant	-0.198	-0.319	-0.323	-0.351	0.420	-0.165	0.425	0.228	0.771*	0.620	0.853	0.669
	(0.510)	(0.826)	(0.657)	(0.653)	(0.457)	(0.779)	(0.584)	(0.586)	(0.456)	(0.957)	(0.551)	(0.546)
Sample size	22,573	7,046	15,527	15,527	11,264	3,660	7,604	7,604	11,309	3,386	7,923	7,923

Note: a: Dummy variable; b: Continuous variable in logarithmic; c: Ordered categorical variable. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See Appendix A for description of the variables.

Table 5. Outputs of the growth equation.

	Total firms sample				Micro and small firms sample				Medium and large firms sample			
VARIABLES	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.	Total	Pre-crisis	Crisis	Crisis a.
Inn. Output.[b]	0.152***	0.241***	0.112***	0.108***	0.133***	0.201***	0.092***	0.090***	0.049**	0.075**	0.034	0.047**
	(0.017)	(0.034)	(0.018)	(0.019)	(0.021)	(0.039)	(0.024)	(0.025)	(0.021)	(0.032)	(0.025)	(0.022)
Proc. Inn.[a]				-0.003				-0.004				0.008
				(0.006)				(0.009)				(0.008)
Non-tech. inn.[a]				-0.002				0.004				0.001
				(0.006)				(0.009)				(0.008)
Crisis[a]	-0.114***				-0.128***				-0.100***			
	(0.005)				(0.008)				(0.006)			
Sales Growth (t-1)[b]	0.965***	0.913***	0.974***	0.975***	0.972***	0.939***	0.979***	0.979***	0.973***	0.919***	0.981***	0.978***
	(0.006)	(0.025)	(0.006)	(0.006)	(0.008)	(0.032)	(0.008)	(0.008)	(0.008)	(0.028)	(0.008)	(0.008)
Firms size.[b]	0.025***	0.035***	0.022***	0.023***								
	(0.002)	(0.005)	(0.003)	(0.003)								
Export. [c]	0.014***	-0.010	0.025***	0.025***	0.029***	0.004	0.040***	0.040***	0.006	-0.012	0.013***	0.013***
	(0.003)	(0.006)	(0.003)	(0.003)	(0.004)	(0.009)	(0.005)	(0.005)	(0.004)	(0.008)	(0.005)	(0.005)
GITA[b]	0.004***	0.003***	0.005***	0.005***	0.007***	0.004***	0.008***	0.008***	0.003***	0.002**	0.004***	0.004***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Company age[b]	-0.035***	-0.040***	-0.029***	-0.030***	-0.045***	-0.071***	-0.024**	-0.025**	-0.018***	-0.012	-0.020**	-0.021***
	(0.006)	(0.010)	(0.006)	(0.006)	(0.009)	(0.016)	(0.010)	(0.010)	(0.006)	(0.010)	(0.008)	(0.008)
Part. group[a]	-0.026***	-0.030***	-0.024***	-0.025***	-0.017*	-0.025	-0.015	-0.015	-0.014**	-0.014	-0.012*	-0.014*
	(0.005)	(0.010)	(0.006)	(0.006)	(0.009)	(0.017)	(0.010)	(0.010)	(0.006)	(0.012)	(0.007)	(0.007)
PRIV[a]	-0.002	-0.009	-0.001	-0.000	0.029*	0.054	0.023	0.024	-0.006	-0.020	-0.001	-0.001
	(0.007)	(0.014)	(0.007)	(0.007)	(0.015)	(0.033)	(0.017)	(0.017)	(0.007)	(0.015)	(0.008)	(0.008)
Trade[a]	0.008	0.005	0.006	0.006	0.006	0.012	0.002	0.001	-0.001	-0.017	0.002	0.003
	(0.010)	(0.020)	(0.012)	(0.012)	(0.015)	(0.029)	(0.018)	(0.018)	(0.014)	(0.028)	(0.016)	(0.016)
Hospitality[a]	0.021***	0.035***	0.011*	0.011*	0.016*	0.015	0.015	0.015	0.027***	0.062***	0.012	0.013
	(0.006)	(0.011)	(0.006)	(0.006)	(0.009)	(0.017)	(0.010)	(0.010)	(0.007)	(0.015)	(0.009)	(0.009)
Construction[a]	-0.034**	0.042	-0.071***	-0.073***	-0.039	0.010	-0.065*	-0.068*	-0.047**	0.047	-0.084***	-0.083***

	(0.018)	(0.033)	(0.021)	(0.020)	(0.033)	(0.059)	(0.040)	(0.040)	(0.019)	(0.037)	(0.023)	(0.022)
Finance[a]	0.051**	0.041	0.056**	0.053**	0.104*	0.080	0.112	0.112	0.014	-0.023	0.032	0.030
	(0.020)	(0.040)	(0.023)	(0.023)	(0.060)	(0.104)	(0.073)	(0.073)	(0.020)	(0.040)	(0.023)	(0.023)
Constant	-0.277***	-0.312**	-0.319***	-0.306***	-0.167*	-0.140	-0.264***	-0.255***	0.067	0.239	-0.022	-0.043
	(0.065)	(0.158)	(0.069)	(0.069)	(0.087)	(0.198)	(0.093)	(0.096)	(0.075)	(0.168)	(0.087)	(0.081)
Observations	22,573	7,046	15,527	15,527	11,264	3,660	7,604	7,604	11,309	3,386	7,923	7,923
R-squared	0.608	0.334	0.718	0.721	0.638	0.307	0.730	0.731	0.705	0.397	0.772	0.767

Note: a: Dummy variable; b: Continuous variable in logarithmic; c: Ordered categorical variable. GITA: Gross investment in tangible assets; PRIV: Private with foreign participation. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See Appendix A for further information about the variables

FIGURE

Figure 1. Average firm's sales growth by size.