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THE IMPACT OF PUBLIC AND PRIVATE INTERNAL R&D INVESTMENTS ON SPANISH BUSINESS PERFORMANCE DURING THE PERIOD OF CRISIS 2008-2012

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Abstract: The purpose of the paper is to analyze the relationship between the internal R&D investments and the performance of the Spanish companies, considering if the source of the investment is public or private in a context of austerity policies and financial crisis. We use the panel data approach procedures, covering 1.345 companies and 5 years (from 2008 to 2012) from the PITEC database. Results show that the investment of public resources in internal R&D does not impact on the sales of Spanish companies, but the investment of private resources has a positive impact on the turnover. The impact of the private R&D investment on sales depends on the size and sector of the companies and their capability of generating own resources to invest in internal R&D.
Keywords: Internal R&D Investment, Turnover, Own funds, Public funds, PITEC

1. Introduction

Investment in R&D in Spain has been falling since the beginning of the crisis of 2007-2009. In contrast 18 EU Member States (including the three largest European economies: Germany, France and the UK) were able to increase or maintain their investments in R&D in years marked by widespread heavy restrictions on public accounts. The Spanish R&D&I (Research and Development and Innovation) system at the end of 2014 was in seventeenth place among the 28 states that made up the European Union (Eurostat 2015). In 2014 the Research and Development Expenditure (% of GDP) for Spain was 1.23 % (COSCE, 2016). Spain can be considered as an "intermediate country" defined as relatively high income but low or medium level in R&D or innovative performance according to Garcia et al. (2016).

On the other hand, the crisis in Spain has highlighted the importance of R&D&I for the sustainability of the companies and the society. Companies that have innovated, when the crisis ends are expected to have a sustainable competitive advantage over those that have not, and this will allow them to be better positioned to meet new business challenges, adapting better to the new market needs (MINECO 2015).

Patterns of innovation of Spanish companies were exposed in studies by Buesa and Molero (1998), Fonfría (1999), Hidalgo (2003), Nieto and Santamaría (2007), Camacho and Rodríguez (2008) and Trigo and Vence (2011) among others.

The traditional argument for intervention in innovation is based on the theory of market failures. This theory believes that the market fails to provide an optimal level of R&D (Arrow, 1962). The existence of imperfections in systems of appropriability of the results of innovation and the difficulty of controlling the dissemination of knowledge created would justify the presence of some public intervention (David et al. 2000; David and Hall 2000; Salter and Martín 2001; Bönte 2004; Gong and Strobl 2007).

A large part of the studies dealing with the relationship between public funding and the innovative activity of companies have focused on analyzing the net effects of public support on private R&D (Sveikauskas 2007). The results obtained are very heterogeneous and do not solve the problem of the effectiveness of these instruments to encourage innovation in companies. On the other hand, numerous studies show a positive relationship between investment in R&D and productivity of the company (Griliches 1981; Griliches 1995; Hall and Mairesse 1995, Guangzhou 2001; Sougiannis 1994; Alarcón and Sánchez 2013). They also make a separation on the origin of the funds thus, these studies have focused on analyzing the impact of investment in R&D from public sources (Czarnitzki and Fier 2002; Lööf and Heshmati 2005) and/or private sources Griliches (1986), Lichtenberg (1987) and Kaiser (2004).

In today's economy, it is interesting to study to what extent a company depends on public funds and what impact the granting of state aid produces on the activity of the businesses. The aim of this study is to provide new empirical evidence on the impact of the investment of public and private funds in internal R&D in boosting business activity of the Spanish companies.

2. Literature Review

The combination of the concepts of research, development and innovation (R&D&I), completes a cycle of the research system that is seen as the most outstanding incentive for the knowledge creation within the structures of the modern business. Innovation activities consist of all steps: scientific, technological, organizational, financial and business, including investment in new knowledge, for the introduction of products (goods or services) or new processes significantly improved. R&D is only one of these activities, and can be carried out in different phases of the innovation process, not only as the original source of creative ideas, but also as a way of solving problems that may occur at any stage until its culmination (PITEC 2015).

Mainly, research to assess the impact that investment in R&D has on business results have been based on, on the one hand, case studies (Zedtwitz et al. 2004), and on the other, econometric estimation of production functions including a R&D variable (Griliches 1979). The case study is a valuable tool for collecting data and generating hypotheses, but the generalization of the results is questionable. For its part, the econometric approach has been basically oriented to prove the existence of a positive relationship between investment in R&D of the company and its profitability and productivity, measured through different variables.

2.1 Relationship between R&D and business productivity

The analysis of the relationship between R&D and business performance through the estimation of production functions or through multivariate models, presupposes the existence of a relationship, which is intended to be adjusted so that significant conclusions can be reached with respect to the variables with most weight in the model and greater explanatory power. However, several studies suggest that the relationship between R&D and productivity cannot be generalized but has to be analyzed within a context of company size and technological level of the sector in which the enterprise develops the activity (Odagiri and Iwata 1986; Luh and Chang 1997; Beneito 2001; Molero and Garcia 2008; Rodriguez et al. 2017). Consequently, one would expect that the results achieved by companies in different dimensions such as productivity, profitability or efficiency were different depending on the above mentioned variables.

The hypothesis of performance of R&D has an important theoretical guide in the R&D capital stock model proposed by Griliches (1979). This model considers the expenditure on R&D as an investment from which a stock of knowledge (or technological capital) is derived, which can be incorporated by the company as one more input in their production activity. The incorporation of this technological capital has a positive impact on the productivity of the company, so that productivity differentials between firms which begin to engage in R&D activities and those that never do them should increase after the start of activities R&D by the first group of companies. In addition, different studies have revealed the presence of a critical point from which the repayment of R&D starts decreasing for enterprises very intensive in R&D, Becker and Speltz (1983) which could be called "diminishing returns of R&D ", Bravo and Carmona (2010), Huang and Liu (2005) are in the same line.

Already since the 60s there are studies that have analyzed the possible differences in profitability and productivity among companies according to the level of intensity in R&D Griliches (1986 and 1998); Mansfield (1961 and 1965); Arrow (1962); Schmookler (1966); Hall and Mairesse (1995); Cohen and Klepper (1996); Sutton (1998); Loof and Heshmati (2006) among others. The firms need to search for the optimal governance (outsourcing versus internal development) and geographical location (offshoring versus domestic) of each of the activities or R&D services within their value chain (Martinez-Noyaa et al. 2012).

Cohen and Keppler (1996), Tsai and Wang (2005) and Kafouros (2008) obtained in their studies that the positive results of investment in R&D depend on variables such as the size of the company. Others maintain the importance in the sector in which the company is registered (Beneito 2001; Tsai and Wang 2005; Chia-Hung 2004; Kafouros 2008).

Reviewing the literature, we found that there is great heterogeneity among the relationships between profit and investment in R&D. Most of them say that investment in R&D generates profits with a time delay (Aboody and Lev 2000; Jefferson et al. 2006).

2.2 Types of internal expenses on R&D

Among the expenses of internal R&D of the companies, three types of funding can be distinguished: a) own funds, b) Public funds and c) Other funds (PITEC 2015). The analysis of the relationship between public financing and business activity in R&D has been addressed by numerous studies that have focused on the effects of state aid on R&D. Public subsidies in some cases, have shown that public funding of R&D produces a crowding-out effect (Griliches 1986, Lichtenberg 1987 and Kaiser 2004), which implies that subsidies and aids of all kinds that the administration grants are used to cover the costs of investments that would have been made anyway without the direct or indirect financing of public administration, which means that investment in R&D has not been increased. However, other studies give different results and demonstrate that public aid increases investment in R&D in a way that the total expenditure is financed by the private sector and public administration, companies using this increase to expand the research objectives (Czarnitzki and Fier 2002 and Loofand Heshmati 2005). Public contribution, in other cases, allows the realization of research projects that would not have been possible by the company without the aid. In reality, studies on the impact of public support for R&D in the companies contemplate different results.

Public Administrations, both at Spanish State as well as the EU level, are aware of the need that companies have of funding to support their research capacity, so they have developed tools designed to support and encourage the development of research in general and investment in innovation in particular, which have been implemented through subsidies, soft loans or tax deductions. However, the funding, undertaken by public or private institutions, are an instrument of general policies affecting research and innovation by third party interests that do not always coincide with those of the companies, not even with the markets. A system for knowing the priorities that the State has in providing the aids is the characteristics of the firms receiving the aid. This involves an analysis of external financing received by companies for R&D, in this case Spanish, and which are summed up generally in subsidies and grants, in order to reveal the characteristics that these companies have and up to what point a company depends on public funding to survive (Mate and Molero 2012). Competitive funds have become a preferred mechanism to allocate research funding, particularly in developing countries, to the point that they are the most important source of funds (Vera-Cruz et al. 2008)

3. Sample And Data

3.1 Sample

The database used in this study has been the Technological Innovation Panel (PITEC 2016). This is a statistical tool for monitoring the activities of technological innovation of Spanish companies, the result of a joint effort of the National Institute of Statistics (INE,2015), the Spanish Foundation for Science and Technology (FECYT) and the COTEC Foundation, together with the advice of a group of university researchers. The PITEC database, with data from 2003, offers more than 460 variables of about 12,000 companies, as from 2005, which allows building time series for the study of the evolution and impact of innovation in the business sector. PITEC comprises two samples according according to spending on internal R&D or not.

One of the problems that can be found when processing such a broad database and with many variables, is that the dispersion of such is very high, and on obtaining results these may show unrepresentative data, regardless of the good processing of them. A longitudinal sample of 1345 companies for the development of our research has been selected from the PITEC database. This selection of the sample unit has been carried out based on 2008, and subsequently the same companies have been kept for the successive years (2009, 2010, 2011, and 2012), to see the time period evolution on the same sample. Since the objective of the article is to analyze the impact of investment in the internal R&D of the companies, enterprises that have carried out internal expenditure on R&D in 2008-2012 have been selected from the sample of PITEC. According to the NACE (Statistical Classification of Economic Activities in the European Community, Rev. 2, 2008), and due to the Spanish business structure, a business classification is proposed as indicated in Table 1. In the PITEC database up to 56 branches of business activity are indicated. Of the study sample that this unit is composed of, these companies are clustered in 9 major group, as shown in Table 1. Companies are grouped according to their activity in accordance to the following group classification. 1) Agro-Business; 2) Chemistry; 3) Services; 4)

Materials / Intermediate products; 5) Other manufactured products of end production; 6) Construction; 7) Communication; 8) Financial and 9) Other.

3.2 Data

The objective of this article is to analyze the relationship between own investments in R&D and the improvement in the company's activity. So as to measure this improvement in the period 2008-2012, we analyzed the turnover of the companies, defined in the database of the PITEC as Total of the commercial sales of goods and services, including exports and taxes, except VAT. One of the indicators most used to assess the innovative effort of the Innovation intensity, that is, the percentage that Represent expenditure on innovation activities in relation to turnover. In our study we studied the relationship between turnover and the origin of expenditure on R&D.

Regarding the internal investment in R&D, the variable selected was GTIND (Internal expenses in R&D), in turn, the PITEC database details the funds which a company dedicates to finance internal expenses in R&D. These funds are broken down according to their origin and are tied to the variable. The internal expenses dedicated by a company to R&D are usually the merger of different funds: a) Own resources, b) public financing, c) funds coming from other companies and d) other funds (Table 2). In our study, the analysis has been focused on own resources and on public financing which, added together, makes an average of 98% of the internal expenses in R&D. In Figure 1 it is shown how the own funds brings about an average of 84% of the internal expenses in R&D and the funds proceeding from public financing a 14% for the companies analyzed, although these figures change slightly with the years and the group to which the company belongs.

Highlighting those funds in which this study is centered, their scope is described precisely:

a) Own resources: these are the funds from the company itself, including loans and installments of an institutional character. It is the use of own capital to fund research. Within the concept of own resources all the assets generated by the company are included. Even when this kind of financing does not at all exclude others, as for example the public aid programs of sunk costs or the tax deductions which are generally always requested.

b) Public funding: they are the public funds granted to the company to finance R&D (Table 2). The advantage of this type of financing is that it is usually the cheapest and within margins that grant more time to develop the project and repay the money. Besides being, also frequently, embodied in aids and sunk costs subsidies. In all countries there are public programs that help companies that, occasionally, may even overlap several others in a given project. The problem is that both the number of projects and the characteristics and requirements of these require a thorough study of all of them to decide which are the most convenient and interesting for the company. Additionally in Table 3, the average and statistical values descriptive of the variables which are considered in the model are shown.

In relation to the period, over the term from 2008 to 2012 Spain lived a financial and economic crisis. The recession in the Spanish economy showed a very marked adjustment in domestic demand. On the supply side, the recession had a virulent impact on construction and industrial activity (Ortega and Peñalosa 2012).

4. Methodology

A dynamic data model panel is proposed in which the impact of internal investment in R&D is analyzed with regards to the turnover, taking into consideration the origin of the funds invested in R&D: Own funds of the company invested in internal R&D (Own_RD) and Public Funds invested in internal R&D (Public_RD). Panel data covering a sample of 1345 companies over the time horizon of five years (2008-2012). The number of observations amounts to 4,729.

We run the Hausman test where the null hypothesis is that the preferred model is random effect versus the alternative the fixed effect (Green 2008). It tests whether the errors are correlated with the regressors. The null hypothesis is that they are not. The random effects results reflect cross-sectional differences among entities, as well as variations over time within entities. Random effects estimation may be biased because omitted variables are not controlled. To address this problem it is recommended to use country fixed effects regression in order to control the effects of time-invariant variables with time-invariant effects. One potentially significant limitation of fixed effects models is that they cannot be used to investigate time-invariant causes of the dependent variables. Technically, time-invariant characteristics of the entities are perfectly collinear with the entity dummies. Fixed-effects models are designed to study the causes of changes within an entity.

Furthermore, the standard errors from fixed effects models may be too large. Conversely, random effects models will often have smaller standard errors, but the trade-off is that their coefficients are more likely to be biased (Allison 2009). The Hausman test shows that fixed effects model fits better than random effects.

According to Cameron and Trivedi (2005), the short panel data controls the unobserved individual effects, avoiding the need of considering company-dummy variable in the model. Our panel data covers 1,345 entities in five years. Hence, we do not consider an entity fixed effect. We consider a fixed effect by activity group and size in the econometric model, assuming that our results may be exposed to potential omitted variable bias.

In order to collect the delayed effect of investment in R&D on turnover (Sougiannis 1994; Maté and Rodriguez 2002) and smooth the time series of investment in R&D, in the model the relationship between the moving average of public investment in R&D during the past two years and the turnover of the current year is analyzed.

Together with the explanatory variables of investment in R&D, control variables, whose significance has been proven in previous empirical studies (data not shown), are introduced into the model. These variables are the size of the company (Scherer 1965; González et al. 1999 and Huergo and Jaumendreu 2004) and the activity sector (Beneito 2001; Tsai and Wang 2005; Chia -Hung 2004; Kafouros 2008; Buesa and Molero 1998) given the existing correlation between turnover and the size of the company (ρ = 0.86), this last variable is introduced into the model categorically, according to the following classification: 1) fewer equal to 50 workers; 2) greater than 50 and fewer equal to 250 workers; 3) greater than 250 and fewer equal to 500 workers; and 4) more than 500 workers. The business group is introduced into the model as a categorical variable of 9 groups as discussed in the section on Data. The variables are introduced into the model transformed into logarithms.

The resulting model is specified below:

$$L\_Turnover_{it} = \alpha_0 + \alpha_1 L\_Own\_RD_{i(\frac{(t-2)+(t-1)}{2})} + \alpha_2 \mathrm{L\_Public\_RD}_{i(\frac{(t-2)+(t-1)}{2})} + \alpha_{3j} Size_j + \alpha_{4k} Sector_k + \varepsilon_{it} \quad [1]$$

Where,
i = 1, 2, …, 1,345 companies
j=1,...,4 categories according to number of workers,
k=1,.., 9 activity groups,
t = 1,2, …, 5 years (period 2008-2012),
$L\_Turnover_{i,t}$ = Logarithm of the turnover (millions of current Euros) of the company i in year t,
$L\_Own\_RD_{i,}\ (\frac{(t-2)+(t-1)}{2})$ = Logarithm of the investment of own funds in R&D (millions of current euros) of the company i, with a delay of two-year moving average.
$L\_Public\_RD_i\ (\frac{(t-2)+(t-1)}{2})$ = Logarithm of the investment of public funds in R&D (millions of current euros) of the country i, with a delay of the moving average of two previous years.
$Size_j$ = Size of the company categorized in j groups.
$Sector_k$ = Classification of the companies according to their activity in 9 group groups.

We have tested the robustness of the results by introducing two modifications in the model [1]: 1) in order to study more in depth the relationship between investment in internal R& D and the turnover of the companies, we run the model [1] avoiding the size of the companies; and 2) the model [1] is replicated on the sub-samples of companies commensurate with the size (4 sub-samples) and activity (9 sub-samples).

We apply the Wooldridge test (Wooldridge 2002) to identify serial correlation in the idiosyncratic error term of Equation [1]. In linear panel-data models, serial correlation biases the standard errors and causes the results to be less efficient. The Wooldridge test rejects the hypothesis of no serial correlation in our database. Another common problem is heteroscedasticity. To test for heteroscedasticity, we applied the Wald statistic for group wise heteroscedasticity (Fox 1997). This test rejects the null hypothesis of homoscedasticity. Thus, we use a panel-corrected standard errors with a correction for heteroscedasticity and autocorrelation (Beck and Katz 1995).

5. Results and Discussion

Table 4 presents the detail of the results obtained on the sample of companies and sub-samples defined according to the size.

As shown in the first column number (Table 4), the coefficient of the own investment in internal R&D has a positive and statistically significant coefficient (0.033) that shows that an increase of the investment in own funds in internal R&D of the companies has a positive impact in its turnover. Conversely, the coefficient of public investment is not statistically significant. This result is partly explained by considering the size variable in the model, which has a high correlation with the dependent variable. If we look at the second column, which shows the results of the model [1] without considering the companies' size, the coefficient of public investment in R&D is positive significant (0.025) , indicating that an increase in the investment of public funds in internal R&D of the companies is associated with an increase in turnover of the investing companies. Comparing the coefficients of investments in R&D by source, allows us to observe that the impact of own funds investment in internal R&D on sales is almost 6 times higher than that of public funds.

The lack of significance of public funds also may be explained by the crowding-out effect. According to this effect the subsidies and aid are used to cover the costs of investments that would have been made anyway without financing, whether direct or indirect, from the public administration. It does not add a significant effect of increased turnover, as it would have been done anyway with or without those funds (Griliches 1986; Lichtenberg 1987; Kaiser 2004). The crowding-out effect takes place primarily in medium-large companies that have the capacity to access to public funding programs. In other words, the aforementioned "crowding-out effect" occurs mainly in medium and large firms, while small firms experience difficulties to access to Public Funds Programs for R&D. This is due to the administrative and bureaucratic cost of those programs as an entry barrier for small firm. The bureaucracy and the cost of these programs become usually a barrier for small companies to access to R&D public funds. Indeed, we have to consider the period analyzed. In 2008 Spain fell into an economic and financial crisis that may be explained that public R&D investment did not contribute to boost the sales of the Spanish companies.

The size is a categorical variable that groups the companies in 4 categories: 1) less than five employees (its effect is in the intercept); 2) between 50 and 250 employees; 3) between 250 and 500 employees; and more than 500 employees. The coefficients of the size groups are all positive and statistically significant. It means that there are differences statistically significant between the groups of enterprises. These differences show that the four size levels proposed are relevant in the analysis of the impact of the R& D investments.

The results summarized in column 1 (Table 4) shows that the coefficients are higher as the size group is higher. It means that the impact of investments in R&D on the turnover is higher in larger companies than in smaller ones. Referring to group activity, we consider in the model 9 classifications. The coefficients of all the group activities are statistically significant. It means that group activity proposed is relevant to explain the relationship between investment of public funds in R&D and turnover. This result matches with previous studies that conclude that there is a statistically significant difference between activity sectors in the study of the impact of R&D investments on business performance (Sheder 1965; Evangelista et al. 1997; Gonzalez et al. 1999; Lopez et al. 2005). If we look at the coefficients of the different activities, we can see that the agro-business group (included in the intercept) has the highest coefficient. This group of activity is followed by chemistry classification (-0.107) and materials /intermediate products (-0.198). . Communication, finance and other show the lowest coefficients. The statistically significant differences between the coefficients show that the impact of R&D investment on sales depends on the activity and the classification proposed is useful to understand the relationship.

Columns number 3 through 6 (Table 4) shows the results of the model [1] applied on the 4 sub-samples according to their size. As can be seen, the own investment in internal R&D maintains the positive and significant coefficient in all business groups, except in the case of smaller companies. The volume of own investment in R&D of the companies with fewer than 50 workers does not exceed 0.3 million Euros/year on average in the period under review against 1.6 million Euros/year invested on average by the companies grouped in the other categories. If we compare the coefficients between the different size groups, we can see that group 4 (with the highest size) has the highest coefficient (0.108). As the size of the company is smaller the coefficient of the own R&D investment is lower. As indicated by the categorical variable of size in the results of column 1, the impact of own R&D investment on the turnover is higher in larger companies than smaller ones.

Referring to public R&D investment, the coefficient is not statistically significant. This result matches with that obtained in the model [1] applied on the whole sample of companies (column 1). It helps us to discuss that it is not easy to find the positive relationship between public RD investment and sales, unless a relevant explanatory variable is omitted.

The performance of the activity groups remains. The highest coefficient is that of agro-business activity, showing that the impact of investment on sales figure is higher in agro-business activity than on the rest of activities.

The explanatory capacity of the model applied to the sub-samples of the companies is lower mainly due to the non-inclusion of the size variable in the estimation.

The following Table 5 shows the results of the model [1] applied on sub-samples of companies generated according to their group activity.

As can be seen (Table 5), the coefficient of the investment of own funds maintains its positive and significant sign in most of the activity groups, which strengthens the result of the impact of these funds in boosting business. A comparison of the coefficients of the investment of funds in R&D allows us to observe that the groups in which the greater impact of investment in R&D on the sales figure is in the agro-business group (0.057), followed by the chemical group, manufacturing and construction (around 0.05). The coefficient of public investment remains not significant when explaining the evolution of the turnover of the companies with the exception of the agro-Business and construction groups. This result can be explained by the fact that agro-business and construction group showed, in our database, lower innovation intensity (measured as ratio between turnover and innovation expenses) than the rest of the groups. These two groups showed greater efficiency in the use of public funds as well as greater dependence on them. Regarding the companies size, we can see that the classification remains statistically significant in all the estimations. The companies with larger number of employees show a higher size coefficient. There are differences in the values of the size coefficients across groups, showing sectorial differences in size effects.

The results of this analysis are in line with those obtained by the analysis of the Ministry of Economy and Competitiveness (MICINN, 2014), where it was concluded that the system of research and innovation needs an increase in resources that should be associated with structural reforms to make the public investment more efficient. These requested resources must be used only to encourage reforms. Likewise, it is also necessary to increase the proportion of competitive funds. It is necessary that the public instruments (public funds) be suited to the real needs of the investigation, they must be of a broad spectrum and with sufficient versatility to be able to adapt to investigations based on results and experiences.

6. Conclusions

Internal R&D is a crucial component of innovation and a key factor in developing new competitive advantages in industry and technology sectors.

The aim of the article was to analyze how the internal R&D investment contributes to enhance the sales performance of the companies. The main contribution of the research comes through taking into consideration the analysis of the public and private sources of the internal R&D. This work broadens the knowledge of the effect of the investment in internal R&D (public and self-financing) on business performance and its implications on the R&D policies aimed at boosting a greater efficiency and competitiveness in Spanish companies.

We developed a panel data model to estimate the impact of R&D on sales. The results of running the regression models on sub-samples of entities grouped according to their size and activity group confirmed the findings of the regression models run on the whole sample.

With the logical cautions derived from a study based on a financial crisis period and focused on R&D expenditures and size, the results support four main conclusions. First, it can be concluded that the investment in internal R&D has a positive impact on sales of Spanish companies. The results of this analysis obtained on the whole sample of companies and sub-samples by size and group of activity confirm this relationship.

The results of the differentiated analysis of the impact of investment in internal R&D depending if the origin of the investment is private or public, leads to the second conclusion. The investment of own private funds of the companies in internal R&D boosts the sales of Spanish companies. Conversely, we are not able to conclude the positive impact of the investment of public funds in internal R&D on sales. Spain was in the midst of severe financial and economic crisis and public R&D effort was not capable to boost companies' turnover. Only those companies with capacity to generate own resources were able to invest in internal R&D to increase their sales. Greater public support than that provided over the crisis period (2008-2012), is needed to enhance the R&D effort of the Spanish SMEs companies and support the private initiative.

The relevance of the investment of own funds versus public funds in internal R&D is linked to the third conclusion of this article. According to the results obtained, the same investment in internal R&D in companies with more than 500 workers doubles that of in companies with fewer than 500 workers. The impact of investment in R&D in the sales figure depends on the size of the company and its capacity to generate own funds to invest in internal R&D. It highlights the importance of carrying out actions aimed at boosting investment in R&D by companies, above all among the smaller ones, which necessarily involves an effort from the public sphere in order to boost private effort.

Finally, the group activity should be considered to design the investment policies in internal R&D in companies. The impact of the internal R&D investment on the turnover varies depending on the activity of the company

Innovation policies should focus on the promotion of internal business capabilities, encouraging the development of internal activities of R&D driving the investment with own and public funds. In addition, it is important, to considerate the design of Public programs should be more accessible to SME as well as larger ones, with clear and simply working rules, reducing bureaucracy and "not time-consuming" for firms.

For further research, it would be interesting to consider the crowding-out effect and the relationship between private and public R&D investments. A larger period of time, considering pre and post-crisis, will contribute to further clarifying the impact of internal R&D investments of Spanish companies.

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List of Figures:

Figure 1. Public and Private Funds in percentages regarding internal expenses in R&D for the different groups studied.

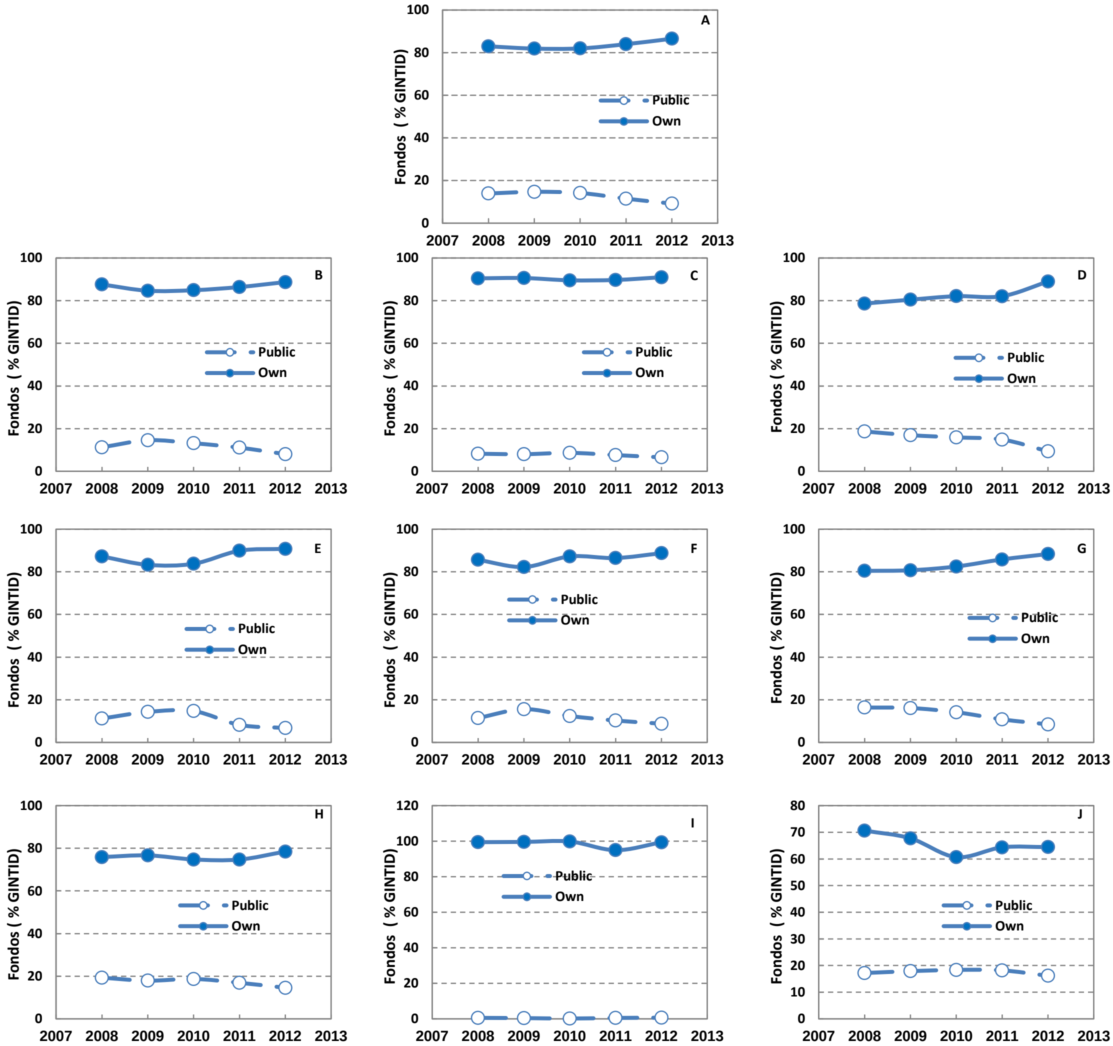

Figure 1. Public and Private Funds in percentages regarding internal expenses in R & D for the different groups studied. A) All; B) Agro-Business ; C) Chemistry; D) Services; E) Materials / Intermediate products; F) Other manufactured products of end production; G) Construction; H) Communication; I) Financial and J) Other.
Source: Own elaboration based on PITEC database

List of Tables

Table 1. Spanish Companies studied and grouped according to International Standard Industrial Classification code (ISIC , Rev. 4, 2008) in this study.

	Group	Code according to ISIC (International Standard Industrial Classification, Rev. 4, 2008)	Companies
1	Agro-Business	01; 02; 03; 10; 11; 12	146
2	Chemestry	20; 21	149
3	Services	46; 47; 49; 50; 51; 52; 53; 55; 56; 68; 85; 86; 87; 88	149
4	Material/Intermediate Products	05; 06; 07; 08; 09; 16; 17; 19;22; 23; 24; 24	253
5	Other Manufacted Product of end production	13; 26; 27; 28; 30; 31; 32	87
6	Construction	41; 42; 43	246
7	Communication	58; 59; 60; 61; 62; 63	195
8	Financial	64; 65; 66	35
9	Other	69; 70; 71; 72; 73; 74; 90; 91; 92; 93; 94 ; 99	85
Total			1345

Table 2. Origin of the different funds of Internal Expenses of R & D.

VARIABLE	CONCEPT
F Own	**Own Funds**
F 2	Funds from other Spanish companies of the group
F 3	Funds from other Spanish public companies
F 4	Funds from other private Spanish companies and
FONEMPR	**Funds from other companies (includes F2, F3, F4)**
F 5	Subsidies from the ACE[1]
F 6	Contracts with the ACE[1]
F 7	Subsidies from the Autonomous and Local Adm.
F 8	Contracts with the Autonomous and Local Adm.
FONPUBLI	**Public Funds (includes (F5, F6, F7 y F8)**
F 9	Funds from national universities
F 10	Funds from the national IPSFL[2]

F11	Funds from foreign companies of the same group
F12	Funds from other foreign companies
F13	Funds from EU programs
F14	Funds from foreign AAPP[3]
F15	Funds from foreign universities
F16	Funds from foreign IPSFL[2]
F17	Funds from other international organizations
FONOTR	**Other Funds (Includes F9,F10,F11,F12,F13,F14, F15, F16**

[1] ACE, Central government administration
[2]IPSFL, Non profitable private institutions
[3]AAPP, Public Administrations

Table 3. Measures and descriptive statistics for variables included in the model

Variable	Unit	Obs	Mean	Std. Dev.	Min	Max
Turnover	Million €	6,074	188.88	886.92	0.00	14,384
Own_RD	Million €	6,077	1.28	4.18	0.00	79
Public_RD	Million €	6,077	0.17	0.60	0.00	18
Size	Employees	6,077	575.90	2,284.96	1.00	41,168

Source: Own elaboration based on PITEC database.

Table 4 Results of the Model [1]. Sample and subsamples by size.

Dependet variable: Turnover

	Model [1]	Model [1] (1)	Model [1] Size 1	Model [1] Size 2	Model [1] Size 3	Model [1] Size 4
	1	2	3	4	5	6
Own_RD	0.033***	0.117***	0.016	0.027**	0.032**	0.108***
	(0.006)	(0.009)	(0.011)	(0.01)	(0.011)	(0.019)
Public_RD	0.004	0.025***	0.006	0.002	-0.01	0.01
	(0.003)	(0.005)	(0.07)	(0.004)	(0.005)	(0.009)
Size						
50<size=<250	1.823***					
	(0.045)					
250<Size<=500	2.859***					
	(0.051)					
Size>500	4.292***					
	(0.061)					
Sector						
Chemistry	-0.107°	-0.556***	-0.013	-0.222*	-0.047	-0.468***
	(0.058)	(0.087)	(0.151)	(0.092)	(0.096)	(0.127)
Services	-0.55***	-0.568***	-1.326***	-0.213	-0.337*	-0.014
	(0.079)	(0.126)	(0.176)	(0.127)	(0.142)	(0.153)
Materials/Intermediate products	-0.198***	-0.174	-0.463**	-0.32***	0.057	0.052
	(0.056)	(0.088)	(0.154)	(0.092)	(0.089)	(0.122)
Other Manufactured products of end production	-0.728***	-1.332***	-0.823***	-0.8891***	-0.321**	-0.998***
	(0.063)	(0.099)	(0.157)	(0.097)	(0.101)	(0.145)

Construction	-0.34***	-0.452***	-0.301*	-0.521***	-0.123	-0.263*
	(0.054)	(0.085)	(0.147)	(0.089)	(0.086)	(0.108)
Communication	-1.085***	-2.123***	-1.207***	-1.264***	-0.808***	-0.82***
	(0.067)	(0.095)	(0.143)	(0.117)	(0.112)	(0.164)
Finance	-1.147***	-0.935***	-1.777***	-0.604*	-0.942***	-1.198***
	(0.136)	(0.205)	(0.273)	(0.251)	(0.176)	(0.211)
Other	-1.886***	-3.158***	-2.213***	-1.953***	-0.542	-1.388***
	(0.123)	(0.166)	(0.281)	(0.252)	(0.321)	(0.092)
Intercept (*)	15.151***	16.14***	15.496***	17.113***	17.881***	18.195***
	(0.093)	(0.13)	(0.176)	(0.139)	(0.149)	(0.243)
N	4,729	4,729	1,319	1,971	693	746
R^2	0.66	0.2	0.18	0.16	0.11	0.15

(1) Without considering the size of the company

(*)Agro-Business sector, size lower than 50 employees

º, *, **, *** denotes level of significance of 10%, 5%, 1% and 0.1% .

Source: Own elaboration