INNOVATION AND R&D IN SPANISH FIRMS

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Degree in Economics
Group A
2015/2016

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Abstract: This study investigates the determinants of the Spanish firm in their innovation, looking for the effects of the different types of innovation that are produced by the firms. The analysis is based on a sample of more than 12,800 firms during the years 2006 to 2012. The results suggest that a good inversion of R&D inside the company is better than the purchase of R&D to Spanish firms or to foreign companies. Although a good investment in those cases, the purchase of R&D to Spanish or to foreign, are also very important to produce an innovation or a significantly improvement. We must be borne in mind that that these factors are important, but they need other internal or external factors in order to make a major innovation

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1. INTRODUCTION

Nowadays, the global economy is characterised by a strong competition, where knowledge is one of the most important intangible resources that firms have. Since achieving and sustaining competitive advantage of the companies not explained just by the position of the market, but because of the difficulty for reply their knowledge assets and the figure that there are develop to make value (Diaz et al., 2006). Also these authors remarked the difficulty that there are in the identification and the valuation of the knowledge assets, and therefore, in their paperwork.

During the last years, it has increase the preoccupation on the measure of the measuring of the results obtained in the assets inversions of knowledge, these produce a necessity of measure the activities produced for take an innovation.

Some studies like Oerlemans et al. (1998) and by Feel (2003), showed that the internal resources of a firm make the principal factor of their innovative performance, the establishment of a networking with external agents apply a limited effect. But other authors, for example, Vega-Jurado et al. (2009) recognise the value of the external agents like sources of innovative ideas and many times depends of the ability to build strong links with the external agents. This value can became by the cooperation with other companies or with the firms of the same group, or buying the de technological knowledge to another companies, Spanish ones or foreign.

Some researchers had warned the risk of overestimate the paper of the external sources of knowledge and stand out the effort innovative that the firms produce and also they develop inside of their companies, in the departments of R&D or production. We can tell that the companies has three strategies to develop an innovation: make, buy and cooperate.

On the contrary, some works point out that the external and internal knowledge acquisition can be complementary activities in the firm's innovation strategy. The authors maintain that the effect of external knowledge sources depends on the internal capabilities of the firm. Also they must have a well organization prepared and open to external ideas, and has skilled scientific and technical staff (Rothwell, 1992).

An innovative company, is a firm that has introduced an innovation for a given period of time. The innovative firms can be classified depending of their politics and investigate

needs. These classifications are used to obtain dates, for example, the percentage of firms that use one or various types of innovation at the same period. In most of these classifications it can be include more additional information, like who develop the innovation, the own firm or it can be acquired by an external firm.

The nature of innovative activities vary from one company to another. Some firms can engage in innovative projects such as the development and introduction of a new product, while others are dedicated to the continuous improvement of its products, process and operations. Both types of companies will make innovations, one producing a big significant change in innovation and other firm will produce small changes put they are also significant changes.

The innovative activities are all tasks, scientific, technological, organizational, financial and commercial, including investment in new knowledge, which lead actual or potentially to the implementation of innovations. Some activities can be innovative in themselves, while others will be needed to set up innovations. Innovative activities include also those R&D which cannot be directly attributed to the evolution of a specific innovation (Oslo Manual, 2005).

The firms can have innovative activities but have not introduced any innovation, so there are three types of innovation companies: successful, in process and abandoned. The successful company resulted in putting up an innovation. The firm in process, still has not obtained results of the implementation up to innovation. The abandoned company is which has dismissed before putting up innovation. A company active in innovation is one that has been innovative activities during a period analysed, including activities in process and abandoned (Oslo Manual, 2005)

Knowing these, this study will attempt to advance in two objectives. The first one is analyse if firms innovate depending on the source of innovation used, namely R&D and taking into account different sources of R&D, and the second objective is analyse if this different sources of R&D have different impact on the four types of innovation, classified following the Oslo Manual (2005).

The analysis is produced by a sample of Spanish companies compiled through a sample of Technological Innovation (PITEC). The panel database is available from 2003 to 2012, but we use only from 2006 to 2012 for the technological innovation and from 2008 to 2012 of the non-technological innovation. The raison is due to the fact that non technological innovation is only available since 2008, and because PITEC dataset is updated with 3000 new firms in 2006, for this reason despite that data are available from

2003, we consider that use data from 2006 have more advantages. We have used these with the economic program Stata and we estimated the probit model to make the empirical study. After the estimation we saw that the specific independent variables, producing the R&D and the bought of R&D are important when the firm is going to produce an innovation. Also it is important for the innovation that a firm exports their product to external companies.

To achieve the objectives, this work is structured as follows. Section 2 resumes the theory of the model and a review of the literature. Section 3 presents the data used for this study. Section 4 presents the methodological aspects of the empirical study and the measurements of the variables and the econometric specifications evaluated. Section 5 presents the results and Section 6 presents the main conclusions.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Nowadays, there are many sudden changes in technology, the customer and the competitor are forcing companies in a continuous renovation to survive, these changes go through search new ways of doing the activities, between them we can find the innovation.

One part of the process to innovate is the external sources of knowledge. Exits an evidence that shows the utilization of these external sources of knowledge represents a growing phenomenon. In most of the countries of the OECD, the expenses in external R&D have demonstrated a considerable increase, even more than the displayed by total expenditures in R&D or in the innovation (Vega-Jurado et al., 2009).

Traditionally, the study of the innovation parted of the premise that the producers of products triggered of these proceedings of innovation. The new investigators of the technological and organizational changes have been demonstrated that if the producer is the only source of innovation will limit the process innovative (Hippel, 1988). With this in mind, it is recognise the importance that has for innovate activity have sources of innovation and knowledge outside the firm.

Alfred Marshall in 1925 was the first one to contemplated that the base of internal knowledge with the external sources, highlighting in his work the importance that has for the economic progress firms develop positive externalities thought a market-based organization (Marshall, 1925). These external sources can be firms of the same group, suppliers, consulting companies, universities, technological centre or institutions of R&D.

Like that any department of R&D in any company form part of the only source of innovative activity, the sources of innovation can be divided in two groups, internal or external. The first one make reference to the group of innovative activities that are produced in the company, in special in de department of R&D, marketing or production. The second group can be divided in three parts, the first are the sources coming from the market (like competitors), buying the technology, customer or consumers, suppliers of materials, equipment or software, technological centre, etc. The second group can be learning centre, public or private institutes of investigation or universities, and the third group is the general information available of patens, conferences or specific magazine.

The search and acquisition of the technological knowledge has been a key aspect inside the business innovation strategy. The firms not only have to decide between produce the internal knowledge or acquire external sources, but also they have to select the better

mechanism to get these knowledge (Vega-Jurado et al., 2009). These mechanism are called innovation strategies or technological strategies. The companies have three different options to acquire the technological knowledge to produce the innovation.

The first strategy is create the knowledge, through the internal development of the activities in R&D and the confidence with the own enterprise capabilities, this strategy is known as the decision of make. The second strategy is acquire by a technological externally, by market transactions. The firm has two options, acquire the technological knowledge incorporate in goods or services, or acquire the technological knowledge not incorporate in any intangible elements (for example, outsourcing R&D or taken patent licenses), this decision of strategy is buy. The last strategy is take part and develop the technology with collaborate agreements with other companies or organizations, this strategy is cooperate (Vega-Jurado et al., 2009).

While the first strategy is based with the use of the internal knowledge, the other ones are related whit the utilization of external sources. The difference between buy and cooperate is that in the buying they develop a unilateral relationship while in the cooperation each part contribute in a relationship providing their knowledge (Croisier, 1998).

A continuation an explanation of the definitions of innovation, their types of innovation, the R&D and their activities are included.

The innovation is the introduction of a product or process, new or significantly improved, or an introduction of a new method of commercialization or organizational applied to business practices, in the work organization or in external relationships (Oslo Manual, 2005).

There are two types of innovation: technological innovation and non-technological innovation. Inside of the technological innovation we can find the product innovation and the process innovation, while in the non-technological innovation we can find the commercial innovation and the organizational innovation.

Product innovation is the entrance of a good or services as either new or improved characteristics or its possible uses. Within of this type of innovation, they should enter the improvements in technical specifications, components or materials, software or other functional characteristics.

When speaking about innovation product we have to keep in mind that it includes goods and services, therefore, includes the introduction of new goods and services such as

improving their functional characteristics. The new products are differed from previous by the new characteristics and their new uses.

The design is a very important part of the innovations, but changes in it do not constitute a significant change in the characteristics of the product by what does not imply a product innovation. For example the routine software updates are not a product innovation.

Process innovation is the introduction of a new method of production or distribution or significantly improved. It includes technical improvements of equipment and software. The objective of this type of innovation is the decrease in unit costs of production or distributions, increasing the quality of the product, producing or distributing new or improved products. The production methods incorporate techniques, equipment and software used to produce goods and services.

The distribution affects to the logistics of the company including equipment, software and techniques of supply of inputs that will influence in the inventories of the firm and in the distributions of the final product. Services can be incorporated in new methods or methods significantly improved for the creation and production of them. There may be changes in equipment or software used for innovation in procedures and techniques used by companies.

Concerning the non-technological innovation, commercial innovation is defined when a firm use new methods of marketing significant improvements in the design or in the presentation of the product, its positioning, its promotion or its price. The objective of this innovation is to cover the needs of the customers, the opening of new markets, or the replacement of a product of the company to increase its sales in the market.

The distinguishing feature is the introduction of a new commercial method ever used by the company. Commercial innovations must be part of a new idea or commercial strategy that means a change with respect to the methods used previously. They can be developed by the innovator as adopted following the instructions of other companies or organizations. These methods will affect to the existing products and for the new creations.

When we talk about business innovation can say that it is similar to the "4 Ps" (product, price, promotion and positioning) of the theory of the Marketing Mix, i.e. the study of the behaviour of the consumer and the needs for these search.

Commercial innovations includes being part of a new commercial strategy product design changes. These innovations relate to changes in the shape and appearance of

the product rather than its functions or applications. We can include the presentation of products such as drinks, detergents where the main change will be the outside of the product, i.e. their appearance as innovation.

The positioning of the product implies the development of new sales channels. These sales channels are methods used to sell products and services to customers, and not the logistics methods that can be used to deliver the product.

The promotion product is the use of new ideas to present the goods and services of the company. The innovations in the price involve the use of new pricing policies to sell the goods and services of the company.

Organisational innovation introduce a new method of organization applied to the business practices, the organisation of work or the external relations of the company. The objective of this type of innovation is to improve business results by reducing administrative cost or transaction, improving the job satisfaction, get access to non-marketable assets or reducing supply costs. The feature that startles is the implementation of a new organizational method that has not been used previously in the company and which is the result of the strategic managerial decisions.

In implementing organizational innovations in business, they involve the application of new methods of the organization of the routines and procedures of work, introducing new systems to improve the learning and dissemination of knowledge in the enterprise. This innovation in the organization of the work are used to apply new methods in the distribution of responsibilities and autonomy in decision making of employees and for the division of work between the different parts of the company.

In the external relationships of the company involve the application of new methods of organizing relations with other companies or with the same group, clients or suppliers, outsourcing business activities relating to the production, supply, distributions, etc.

It will not be considered as innovation all those organizational methods previously used in the enterprise, but if it is used for the first time can be considered as an innovation. The fusion and acquisitions of other companies are not considered organizational innovations, although this is the first time that the company makes it. Organisational innovation may be considered if such fusion or acquisitions develops or adopts new organizational methods in the course of the same.

So it is considered as innovation, this product, process, commercial method or organizational method must be new in the company or significantly improved. We ca

include those processes, products and methods that the company has been able to adopt and which have been developed by others companies or group previously.

Now, we are going to define what is research and experimental development (R&D), comprise creative and systematic work undertaken in order to increase the stock of knowledge, including knowledge of humankind, culture and society, and to devise new applications of available knowledge (Frascati Manual, 2015).

The concept of R&D contains three activities: basic research, applied research and experimental development. Regarding basic research is to obtain new knowledge about phenomena and observable facts, without thinking of giving them any application or a particular use. It is a stage of discoveries. Applied research is to male new original works with a specific objective, these results likely to be patented, this stage is the invention. Finally, the experimental development takes advantages of existing knowledge that had been obtained from research and/or practical experience, directing it to the production of new products, processes, commercial methods and organizational methods, or improving existing ones. At this stage the firm has obtained the "Know How" knowledge and develops prototypes.

On the basis of the definitions described above we can say that the innovation process occurs thanks to the process of R&D, where the companies invest in R&D or acquire R&D of foreign companies, whether they are domestic or foreign. If the results of the prototypes are effective and viable, companies make investments to produce large quantities and sell them to the market, if this product or service is accepted by the market, will become innovation.

 Gomez, Vargas (2014) said in their paper that the Spanish companies have 4 strategies to produce an innovation, the first one in not doing anything, not patents and not innovation in R&D. The second one is the make, that match with our first regression in the model, the making in the investment productions. And the third one, is buying, in our model it match with our two second regressions, buying inside Spain and the buying outside Spain. Also they think that a combination with make and buy, would be good to the innovation process for the firms. Very similar we can find some papers of Vega-Jurado, 2008, they shows also with the same two initial variables make and buy, but these authors though that cooperate with other companies they will also be better.

These authors arrive to the same conclusion, the internal expenses of the R&D to the department of R&D is a good strategy to make an innovation. Gomez et al. also demonstrated that the strategy of making and buying in the strategies for produce an

innovation. In the other hand, Vega-Jurado et al., (2009) demonstrated that the cooperation is a good strategy to make an innovation.

With this study, we want to presents what happened when depending of the expenses of R&D, the firm will arrive to a type of innovation or to another. In our study, we have seen four types of innovation and three different regressions, estimating the model we will arrive to know if the firm will produce an innovation or not.

3. DATA

The data used for the empirical study have been achieved from the Technological Innovation Panel (PITEC), executed by the Spanish Observatory of R&D (ICONO) of the Spain's Science and Technology Foundation (FECYT) and by the National Statistics Institute (INE). PITEC is a panel database that allows the analysis of technological and non-technological innovation of Spanish companies.

PITEC is a tool for the analysis of the development of business at national level activities. Being composed of panel data, this will allow us to perform repetitive observations throughout the time of the economic units, and to develop a more estimates accurate of the evolution of enterprises (expenditure on innovation, R&D resources, etc.). Also for determine the impact of innovation (productivity effects) to identify the strategies employed by the companies in implementing their innovations, such as the internal or external expenditure of R&D.

The panel database is available from 2003 to 2015, nevertheless we use only data from 2006 to 2012 due to the fact, that in 2006, the PITEC added 2,000 companies more, and the sample has a better stability because in the three first years there are many gaps. From this year, there is only information about technological innovation, product and process, because organizational and commercial innovation were not consider types of innovation. In 2008, these types of innovation were consider like non-technological innovation, there are commercial and organizational innovations. The number of observation of this non-technological innovation is less than the technological innovation because the sample is from 2008 to 2012. We finish the period in 2012, because we have only free access until 2012 data. The PITEC offered more than 460 variables about 12.800 companies. The target population of this survey are small, medium and big companies, with a minimum of 10 workers. They are included industrial and services sectors, but the surveys are answer by private enterprises. The survey is based on the Oslo Manual; it provides information about the behaviour of the Spanish companies. The number of companies will be large enough to ensure the representativeness of the target population and its characteristics.

Table 1 shows the number of enterprises that during the years 2006-2012, made a new product or an improvement seen in the product or services. As the date's shows, the product and process innovation are preferred by the firms. It is possible that commercial and organizational innovations are not yet known by the firms. Also we can see a descent number of firms that make and innovation in the last years.

Table 1. Number of firms by type of innovation, (percentage in brackets)

	2006	2007	2008	2009	2010	2011	2012
Product							
Yes	4,443 (9.36)	4,201 (8.85)	4,268 (8.99)	4,248 (8,95)	4,151 (8,75)	3,099 (6.53)	2,659 (5.60)
No	2,769 (5.83)	2,964 (6.25)	2,884 (6,08)	2,642 (5.57)	2,464 (5.19)	3,249 (6.85)	3,415 (7.20)
Process							
Yes	4,418 (9.31)	4,147 (8.74)	4,247 (8,95)	4,262 (8.98)	4,143 (8.73)	3,012 (6.35)	2,540 (5.35)
No	2,794 (5.89)	3,018 (6.36)	2,905 (6.12)	2,628 (5,54)	2,472 (5.21)	3,336 (7.03)	3,534 (7.45)
Commercial							
Yes			2,177 (6.58)	2,079 (6.28)	1,945 (5.88)	1,873 (5.66)	1,849 (5.59)
No			4,975 (15.04)	4,811 (14.54)	4,670 (14.12)	4,475 (13.53)	4,225 (12.77)
Organizational							
Yes			3,374 (10.20)	3,070 (9,28)	2,831 (8.56)	2,662 (5.66)	2,480 (7.50)
No			3,778 (11.42)	3,820 (11.55)	3,784 (11.44)	3,686 (11.14)	3,594 (10.86)
Total	14,424	14,330	28,608	27,560	26,460	25,392	24,296

Source: Own elaboration.

The product innovation had more firms producing innovation in 2006, during the years this quantity is decrease. One of the factors that can be produced this is the economic recession that Spain had since 2008 to the actually. In spite of this, there are more firms that has produced a product innovation. In the process innovation, there is similar to the product innovation, we can see a decrease in 2007, but in 2008 and 2009 there is an increase in the development of the process innovation, since then there is a decrease during the next years.

In the non-technological innovation, the commercial innovation also had a decreasing in during the years, but in this case we have only data during the economic recession. And for the organizational innovation we have a decrease in the number of firms that produce the innovation.

Table 2, exposes the number of companies that develop an innovation during the years 2006-2012, in the different four types following the Oslo Manual (2005) classification. There are three types of who has done the development of the innovation, the first one is the same company, the second one is the firm with other companies or institutions including companies of the same group or consulting companies. The last one, is other companies or institutions where the firm buy the development of the innovation.

Many companies prefer made their own innovation, here there are included the enterprises of the same group. In the second type, there are the collaborations with other companies, this mean that the innovation is produce by the two enterprises. At last, in the third case all the innovation is from the other company or institutions like universities.

Table 2. who develop the innovation by type of innovation, (percentage in brackets)

	2006	2007	2008	2009	2010	2011	2012
Product							
Company or group	3,726 (15.26)	3,535 (14.48)	3,567 (14.61)	3,548 (14.54)	3,470 (14.22)	2,598 (10.64)	
Company in collaboration with others	584 (2,39)	526 (2.15)	565 (2.31)	559 (2.29)	549 (2.25)	429 (1.76)	
Other companies or institutions	133 (0.54)	140 (0.57)	136 (0.56)	141 (0.58)	132 (0.54)	72 (0.29)	
Process							
Company or group	3,321 (13.71)	3,119 (12.87)	3,194 (13.18)	3,231 (13.34)	3,123 (12.89)	2,258 (9.32)	
Company in collaboration with others	754 (3.11)	633 (2.61)	660 (2.72)	642 (2.65)	636 (2.62)	477 (1.97)	
Other companies or institutions	343 (1.42)	395 (1.63)	393 (1.62)	389 (1.61)	384 (1.578)	277 (1.14)	
Commercial							
Company or group			1,874 (18.89)	1,794 (18.08)	1,684 (16.97)	1,621 (16.34)	1,592 (16.04)
Company in collaboration with others			274 (2.76)	260 (2.62)	242 (2.44)	236 (2.37)	238 (2.40)
Other companies or institutions			29 (0.29)	25 (0.25)	19 (0.19)	17 (0.17)	19 (0.19)
Organizational							
Company or group			2,575 (17.86)	2,350 (16.30)	2,170 (15.05)	2,047 (14.20)	1,941 (13.46)
Company in collaboration with others			714 (4.95)	655 (4.54)	611 (4.24)	562 (3.90)	494 (3.43)
Other companies or institutions			85 (0.59)	65 (0.45)	50 (0.35)	53 (0.37)	45 (0.31)

Source: Own elaboration.

We are going to make a comparison of the types of innovation during the year 2009. As we can see in all the types of innovation the number of firms that made an innovation decrease. In the product innovation, we can see that made and innovation had increased respect the other years. But in the other types of innovation there is a general decrease.

The most part of the innovative effort it is not produce for the same firms but also develops inside of them. The internal resources are the main determinant of its innovative performance, and the establishment of networks with external agents has a limited effect (Vega-Jurado et all, 2008). A majority of companies make a big investment in R&D to develop a new product or to get better a product that they have in their product portfolio. The enterprises that innovate with the process innovation are the ones that have a higher percentage acquiring R&D from external companies. These could be the most difficult type of innovation and it is possible that those companies how innovate in process need more help in the development of the process.

The results shows that the firms reduced their innovation because they reduce their inversion so they reduced the innovation like the consequences of the crisis. Also concluded, when the firms has a support for public funding, they have a better experience or when focus on the market home they are less likely to reduce their innovative effort (Gomez et al., 2014).

4. METODOLOGY

4.1 Econometric specifications

The objective of this study is to analyse the probability to innovate using different sources of R&D. For the estimation, we use a probit model in two stages, where the dependent variable is a dummy variable taking the value of 1 if the firm innovate and 0 otherwise.

The proposed equation for the regression estimation is;

$$p(innovation_t = 1) = \beta_1 \, lage_{i,t-1} + \beta_2 \, lsize_{i,t-1} + \beta_3 exp_{i,t-1} + \beta_4 group_{i,t-1} + \beta_5 lgtinnmean_{i,t-1} + \partial_t + \delta_i + \varepsilon_{i,t} \tag{1}$$

We propose three specification of the equation distinguish three different sources of R&D.

$$p(innovation_t = 1) = \beta_1 \, lage_{i,t-1} + \beta_2 \, lsize_{i,t-1} + \beta_3 exp_{i,t-1} + \beta_4 group_{i,t-1} + \beta_5 lgintidmean_{i,t-1} + \partial_t + \delta_i + \varepsilon_{i,t} \tag{2}$$

$$p(innovation_t = 1) = \beta_1 \, lage_{i,t-1} + \beta_2 \, lsize_{i,t-1} + \beta_3 exp_{i,t-1} + \beta_4 group_{i,t-1} + \beta_5 lidespmean_{i,t-1} + \partial_t + \delta_i + \varepsilon_{i,t} \tag{3}$$

$$p(innovation_t = 1) = \beta_1 \, lage_{i,t-1} + \beta_2 \, lsize_{i,t-1} + \beta_3 exp_{i,t-1} + \beta_4 group_{i,t-1} + \beta_5 lidextmean_{i,t-1} + \partial_t + \delta_i + \varepsilon_{i,t} \tag{4}$$

This econometric model is estimate by the different types of innovation: product, process, commercial and organizational. In this way, we obtain 12 logic equations, which, based on the dichotomy of the dependent variables, were estimated using binary probit regressions.

The binary probit model is a non-lineal model of regression specific designed for dependent binary variables. It is adopting a nonlinear formulation requiring that the estimated values to be between 0 and 1 because, as we have seen, the regression with binary dependent variable models the probability that the firm introduce an innovation is 1.

In this project, it is consider four dichotomous dependent variables, all of them related with the innovation, the product innovation ($inoprod_{i,t}$), the process innovation ($inoproc_{i,t}$), the commercial innovation ($inocom_{i,t}$) and the last one the organizational innovation ($inorg_{i,t}$). All of them will only take two values, 0 and 1, when they do not produce any innovation in the enterprise will take 0 and when they make an innovation will take 1.

We consider innovation product when the firm introduce an innovation in goods and services. An innovation in goods is when they made a new product or doing a significant improvement, we do not consider an innovation a resale or an aesthetic improvement. Respect the services, we consider an innovation when they make new services or a significant improvement of them.

For the process innovation we consider that the firm introduce an innovation when they used a new methods of manufacture or producing goods and services, or making a significant improvement. Also when the firms have a new logistics systems, new delivery methods or a new method of distribution or improved significantly those that they have for their inputs, goods or services. In addition, we can consider an innovation when they have support activities for processes such as maintenance of systems or computer operations, buying or accounting, new or improved significantly.

We consider innovation commercial when the firm make significantly modification in the design of the product or in the packaging of the goods or services. They introduce new techniques or channels distributions for the promotion of the product, for example a new advertising channel for a new mark. Also we consider an innovation when the firm use news methods for the positioning of the product in the market or the sales channels. As well, a new method to establish de prices of the goods and services, for example, the first use of a new variable system of prices in function of the demand or a discount system.

For the last type of innovation, organizational innovation, we consider that a firm produce an innovation when they use a new business practices in work organization or company procedures, like the supply chain management, efficient production or quality management. A new methods of organization of the workplaces in the company with the objective of a better distribution of responsibilities and decision-making is also consider an organizational innovation. The last consideration of innovation is the new methods of managing external relations with other companies or public institutions, for example, the creation for the first time of alliances, partnerships, outsourcing or subcontracting.

For these regressions we have consider three important variables to make each regression. First of all, we consider the total internal expenses in R&D, especially in the development in the department of R&D, marketing or production. The second variable, is the purchase of R&D to Spanish firms, here we can also include the cooperation with other firms.   The last important variable to this regression is the purchase to foreign companies, here we can include the buy to international institutions, firms or universities. For technological innovation, the database used is the type panels from 2006 to 2012.

In addition, for non-technological innovation, the database is from 2008 to 2012, because before 2008 there is not any information about these types of innovation.

4 .2 Independent variables

The control variables of this study have been selected considering the variables common used in other empirical works.

$lage_{i,t-1}$, is the difference between the years that they answer the survey with the year of the creation of the company. The size of the company is represented by $lsize_{i,t-1}$, this variable identify how many workers have the firm, the minimum of workers are 10 that is that all the firms have at least 10 workers. For these two variables, we have taken logarithms and there are in a year delay.

The variable $group_{i,t-1}$ is a dummy variable that take the value 1 if the firm belong to a group and 0 otherwise. The last of these four variables is $exp_{i,t-1}$, it is a dichotomous variable that take 1 of the firm made any delivery exportations less intra-Community and 0 otherwise. All those variables have a year delay in our database.

Now we are going to see the three specific explanatory variables of interest, $lgintidmean_{i,t-1}$, $lidespmean_{i,t-1}$ and $lidextmean_{i,t-1}$. These variables are the different source of R&D used by firms. The first variable $lgintidmean_{i,t-1}$ is the internal expanses in R&D from the company, in the model (2). To create this one, first we have divided the original variable between the size of the company, after that we have said to stata that it has to replace 0.0000001 when $lgintidmean_{i,t-1}$ is equal to 0. Then we have taken logarithms and applied of delay. This variable shows how much money has the company's expenses in internal R&D for make an innovation or improve a product.

In model (3), we must to generate the variable $lidespmean_{i,t-1}$, we have made a new variable adding some variables of the survey, these ones are the buying services to Spanish companies, like other companies, universities or research partnerships. Later we have divided by the size of the companies. We said to Stata that he has to replace 0.0000001 when $lidespmean_{i,t-1}$ is equal to 0. Then we have taken logarithms and applied of delay. This variable is the amount of expenses that a firm paid the R&D to produce the innovation or the improvement of their products.

To generate the variable to model (4), the $lidextmean_{i,t-1}$ variable, we have also do an adding of variables from the survey, now these variables are the buying services from foreign companies, like universities, other firms or international organizations. After that,

we have divided by the size of the firms. We said to Stata that he has to replace 0.0000001 when $lidextmean_{i,t-1}$ is equal to 0. Then we have taken logarithms and applied of delay. This one is the expenses in R&D to foreign enterprises to make an innovation or an improvement of their products portfolio.

Finally, also temporal dummies, (∂_t) and industry dummies (δ_i). are included in the equation, to control for these unobserved factor that are industry specific and these unobserved factors that varied by time.

5. RESULTS

The objective of this study is know if some factors are important to produce an innovation, as we known the dependent variables are dichotomous, i.e. we only know if it is significantly or not to produce the innovation. If it is significantly we will know if the sign is positive or negative when they are going to produce an innovation.

Table 3 presents the results of the general regression, the first stage, as we can see the results there are three significate variables that have many influence upon to produce an innovation. The size of the company is one of the important variables that is when the company decided to make an innovation it does not matter if the company is small or big. The exportations to another countries is also important to produce an innovation, but for the process innovation is not important. The last variable important in this model (1) is the investment in R&D, here we include de internal investment and the external investment. Comparing the effect of the exportations when the firms are going to develop an innovation, those who develop a commercial innovation has a 5.50% of possibilities to produce it, is the highest of the four types of innovations. We can see a similar case in the total expenses of R&D, that those companies that produce commercial innovation has a better possibility to produce the innovation

Table 3: Results from *probit* estimation using $lgtinnmean$

Variables	Types of innovation			
	$inoprod_{i,t}$	$inoproc_{i,t}$	$inocom_{i,t}$	$inorg_{i,t}$
$lage_{i,t-1}$	0.008	0.041	0.010	-0.043
	(0.0422)	(0.0434)	(0.0434)	(0.0516)
$lsize_{i,t-1}$	0.217	0.366	0.242	0.448
	(0.0206)***	(0.0219)***	(0.0269)***	(0.0269)***
$group_{i,t-1}$	-0.028	0.027	-0.081	0.110
	(0.0551)	(0.0560)	(0.0705)	(0.0643)*
$exp_{i,t-1}$	0.363	0.036	0.224	0.181
	(0.0466)***	(0.0469)	(0.0550)***	(0.0511)***
$lgtinnmean_{i,t-1}$	0.084	0.075	0.050	0.045
	(0.00202)***	(0.00207)***	(0.00235)***	(0.00211)***
∂_t	Yes	Yes	Yes	Yes
δ_t	Yes	Yes	Yes	Yes
Observations	18,689	18,689	18,689	18,689
Pseudo R2	0.701	0.724	0.826	0.800
chi2_c	2328	2789	4486	4358

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

In the second stage, we have divided the investment of R&D in three sections, one is the internal investment, the second one is the buying of services in Spanish companies and the last one in the buying of R&D in foreign companies. Like that we have three equations and four types of innovation, the results are that we have to analyse twelve equation in this part of the model. It means that for each type of innovation we have three equations. To simplify the table of the results, we have divided in two tables, one there are the technological innovations (table 4) and the other one there are the non-technological innovation (table 5). Table 4 and table 5 show the results of de probit model about 460 variables of 1200 companies with which we analyse the determinants of the selection of the strategy of acquisition of technological knowledge utilized by the company. Like that we will do easier the interpretation of the results, the two tables shows the marginal effects of the variables about the probability to choice each strategy. These marginal effects are calculated for the average value of all the variables, they must be interpreted like the variation of the probability of carrying out each of the strategies as a results of a unit change in the variables, we only will know if a firm will produce or not.

Table 4 shows the results of the regressions for product and process innovation. The size of the company is important to introduce an innovation, it is important for the two types of innovation. Respect the exportations are important for the three regressions for the product innovation, but for the process innovation is only important when the buy the services to another firm, it does not matter if it is to Spanish companies or to foreign companies. The internal investment of R&D is so important to both types of innovation to produce an innovation. Also the buying services to Spanish companies and to foreign companies are significant in both types of innovation.

As we can see in the results in table 4, to have an internal department of R&D or buying to foreign companies have a greater effect in the firms that develop a new innovation with process innovation. However, the companies that invest in the purchase of R&D in Spanish companies have a greater effect producing an innovation with the production innovation. Also the firms that export their products producing product process have a one small percentage higher with respect to companies that have process innovation.

Table 5 presents the results for the non-technological innovation, commercial and organizational innovation. Here is also important the size of the company to produce the innovation, in the both types of innovation. The exportations are important for the firms to introduce the innovation in their companies. The three important variables of each regression are significant for the organizational innovation, but for the commercial

innovation there are only two of them important, the internal investment of R&D and buying of services in Spanish companies.

In the results of the table of the non-technological innovation, we can see that in the commercial innovation the expenses of the internal department of R&D have a higher percentage than the organizational innovation when they are going to produce an innovation. However, in the organizational innovation has a higher percentage in the purchase of R&D in Spanish companies, when they are going to develop an innovation or a significant improvement. And also the purchase of foreign companies is more significant than in the commercial innovation. In the case of the commercial innovation, the firms that have a greater number of exports will improve more in this type of innovation for develop a new product or process.

Table 4: Results from *probit* estimations using technological innovation as dependent variable

	Technological Innovation					
	Product Innovation			Process Innovation		
Variables	$inoprod_{i,t}(2)$	$inoprod_{i,t}(3)$	$inoprod_{i,t}$ (4)	$inoproc_{i,t}(2)$	$inoproc_{i,t}$ (3)	$inoproc_{i,t}$ (4)
$lage_{i,t-1}$	0.024 (0.044)	0.019 (0.052)	0.007 (0.055)	0.04206 (0.047)	0.0345 (0.050)	0.0252 (0.051)
$lsize_{i,t-1}$	0.298 (0.021)***	0.428 (0.025)***	0.462 (0.027)***	0.462 (0.024)***	0.533 (0.025)***	0.565 (0.026)***
$group_{i,t-1}$	0.00793 (0.057)	-0.0195 (0.066)	-0.00410 (0.068)	0.0638 (0.060)	0.0363 (0.062)	0.0412 (0.064)
$exp_{i,t-1}$	0.369 (0.048)***	0.551 (0.052)***	0.591 (0.053)***	0.0932 (0.049)*	0.214 (0.050)***	0.238 (0.050)***
$lgintidmean_{i,t-1}$	0.113 (0.003)***			0.0798 (0.003)***		
$lidespmean_{i,t-1}$		0.0516 (0.003)***			0.0389 (0.003)***	
$lidextmean_{i,t-1}$			0.0323 (0.006)***			0.0364 (0.006)***
∂_t	Yes	Yes	Yes	Yes	Yes	Yes
δ_t	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,689	18,689	18,689	18,689	18,689	18,689
Pseudo R2	0.728	0.808	0.827	0.766	0.791	0.803
chi2_c	2778	4235	4715	3621	4142	4418

Standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Results from *probit* estimations using non-technological innovation as dependent variable

	Non-technological Innovation					
	Commercial Innovation			Organizational Innovation		
Variables	$inocom_{i,t}(2)$	$inocom_{i,t}$ (3)	$inocom_{i,t}$ (4)	$inorg_{i,t}(2)$	$inorg_{i,t}$ (3)	$inorg_{i,t}$ (4)
$lage_{i,t-1}$	0.018 (0.058)	0.013 (0.061)	0.009 (0.063)	-0.040 (0.053)	-0.046 (0.056)	-0.055 (0.058)
$lsize_{i,t-1}$	0.289 (0.027)***	0.350 (0.028)***	0.368 (0.029)***	0.496 (0.026)***	0.557 (0.027)***	0.598 (0.028)***
$group_{i,t-1}$	-0.064 (0.071)	-0.080 (0.075)	-0.071 (0.077)	0.127 (0.066)*	0.112 (0.069)	0.116 (0.070)*
$exp_{i,t-1}$	0.222 (0.056)***	0.311 (0.057)***	0.330 (0.058)***	0.188 (0.052)***	0.268 (0.053)***	0.286 (0.054)***
$lgintidmean_{i,t-1}$	0.069 (0.003)***			0.0610 (0.003)***		
$lidespmean_{i,t-1}$		0.0284 (0.003)***			0.0341 (0.003)***	
$lidextmean_{i,t-1}.$			0.0164 (0.006)**			0.0425 (0.006)***
∂_t	Yes	Yes	Yes	Yes	Yes	Yes
δ_t	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,689	18,689	18,689	18,689	18,689	18,689
Pseudo R2	0.834	0.856	0.865	0.809	0.828	0.839
chi2_c	4697	5150	5429	4604	5040	5353

Standard errors in brackets.
*** p<0.01, ** p<0.05, * p<0.1

6. CONCLUSIONS

During the economic recession the Spanish companies had a repercussion in the general economic context. In situations like that, the firms are pressured to find new opportunities of business and improve the efficiency of their activities. One option to get these two objectives is the innovation. But in this context, it also generated some difficulties for develop the necessary activities. The problems are the lack of resources and the short view to the short and medium term reducing the innovative in activities.

The blockage to the innovation has been increased during the years, the lack of resources can reduce force the budget destined to R&D activities and the innovation. The temporal horizon of these inversions tends to be in the large term, and their uncertainty results. The uncertainly of the real demand of the products and services results of an innovative activities that can produce the firm about the innovative effect.

This study has analysed the effect when a firm is going to produce or not an innovation using different purchases for produce an innovation in the Spanish manufacturing firms, looking for a new product, process development or a significant improvement about the value creation.

During this work, we have seen that the external sources of knowledge are important while the firm is going to make an innovation, they are represented in the purchase of R&D to external companies, whether Spanish companies or foreign companies. This purchase has a good result in our analysis, since both options were important to the innovation for the firm.

In the tables of the results, we can see that the exportations and the expenses in R&D are so important for produce an innovation or for produce a significate improvement. The model that we have estimated our regressions, binary probit model, give us only positive results. But we know for other papiers like, Vega-Jurado et all, 2008, that the purchase to external companies it is no so very important to produce innovations. We can progress this model using *margins*, for these regressions, this could be a future paper or a thesis of the innovation in Spanish firms.

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8. APPENDIX

Appendix A: Description of the variables

	Variable	Description	Scale of measurement
Dependent variables	$inoprod_{i,t}$	Product innovation	Dummy variable: 1 if the firm developed or introduced new or improve products into the market, and 0 otherwise
	$inoproc_{i,t}$	Process innovation	Dummy variable: 1 if the firm developed or introduced new or improve process into the market, and 0 otherwise
	$inocom_{i,t}$	Commercial innovation	Dummy variable: 1 if the firm developed or introduced new or improve a commercial product into the market, and 0 otherwise
	$inorg_{i,t}$	Organizational innovation	Dummy variable: 1 if the firm developed or introduced new or improve an organizational type into the market, and 0 otherwise
Explicative variables	$lage_{i,t-1}$	Number of years of the company	Logarithm of the years that has the company
	$lsize_{i,t-1}$	Firm's size	Number of workers in the firm
	$group_{i,t-1}$	The firm belong to a group	Dummy variable: 1 if the firm belongs to a group, and 0 otherwise
	$exp_{i,t-1}$	Export intensity	Sales from exports/total sales
	$lgintidmean_{i,t-1}$	Internal expense of R&D	Logarithm of the expense of R&D
	$lidespmean_{i,t-1}$	Purchase of R&D in Spain	Logarithm of the expense buying the R&D in Spain
	$lidextmean_{i,t-1}$	Foreign purchase of R&D	Logarithm of foreign expense of R&D
	$lgtinnmean_{i,t-1}$	Total expense in R&D	Logarithm of the total expense of R&D