UNIVERSITAT POLITÈCNICA DE VALÈNCIA

ADE

FACULTAD DE ADMINISTRACIÓN Y DIRECCIÓN DE EMPRESAS. UPV

ANALYSIS OF THE CORRELATION BETWEEN SECTORS AND BARRIERS TO INNOVATION

MÁSTER EN GESTIÓN DE EMPRESAS, PRODUCTOS Y SERVICIOS

ALUMNA: CONSTANZA TROIANO PUIG
TUTOR: JOSÉ LUIS HERVÁS OLIVER

6 JULIO 2017

ABSTRACT

Innovation is becoming more popular in the last years and as a consequence, the population starts to be more aware about its effect. Innovation is surrounding us, is the future, something that add value, something that allow companies to be more competitive. Every time, more firms are interested on performing innovation activities in order to achieve some of their objectives such as increase turnover, reduce costs, increase their performance, etc. This concept, is also associated to economic growth, business survival, employment growth, social welfare and competitiveness. Thus, innovation is essential in this world in constant change and improvement.

Because of that, it is unavoidable to find research that deal with this topic. Analyze innovation and its effect over companies is crucial to understand better this phenomenon which is taking more relevance. However, it has been observed that there exist some constraints that hamper innovation. As this last topic is not widely studied by economic sectors, this research is focus on determine barriers' impact over Spanish firms while an evaluation of innovation activities is performed.

Findings about which are those sectors who innovate more and which are the ones who must deal with a larger number of barriers is provided at the end of this project.

Table of contents

List of graphics and tables

Graphics

Tables

1 Introduction

Nowadays, it can be observed that companies bet strongly for innovation. This concept, recently more frequent in business strategies, it is synonymous of offering a higher competitive advantage in a current market which is every time more complex and competitive. From higher Research and Development (R&D) expenditure, new technologies, highly skilled personnel, etc., companies aim to achieve a better positioning and differentiate themselves from their competitors. Therefore, innovation is crucial for economic growth, business survival, employment growth, social welfare and competitiveness (Buesa et al. 2010; Yasar et al. 2015).

The benefits from carrying out innovation activities are unlimited since it can provide an improvement of everything surrounding us such as an improvement of a product, the increase of the performance of a business model or provide solutions for complex problems. Therefore, this phenomenon not only must concern companies in their effort to increase their profit margins, it should also concern governments and public entities, and the whole society should be aware of the power of innovation since affect all our lives.

Due to the relevance of innovations and the increasing interest of our society on this, I found attractive the idea to perform a project about this topic. This allowed me to have a better knowledge of what innovation really is and its effect in companies. In addition, I established some goals before starting about what I wanted to figure out along my analysis. Specifically, I tried to focus on how innovation barriers affect companies' performance, and which are those economic sectors that innovate more and which of them innovate in a lower degree. The first topic has been widely studied in the last years and incorporated in questionnaires about innovation by recognized organisms. Despite that, its study on how affect the different economic sectors has not been of interest for most scholars and thus, little efforts have been employed in its study. Evidence of how barriers have an impact over innovation and the effect they have in the different economic sectors will be provided.

Different literature sources have been used for writing this project. Results provided by the INE and CIS questionnaires have been useful in the methodology section since they represent a wide range of real and trustable data about innovation and the actors involved.

The structure of this thesis consists on an explanation of the different objectives which were intended to achieve followed by a theoretical framework in which different topics have been addressed. Types of innovation, why is important to analyze innovation, which advantages have innovation on firms' performance, current situation in Spain and which kind of indicators allow a numerical evaluation of innovation are some of the points analyzed. Then, it was proceeded to a numerical study using the information offered by the questionnaires mentioned in the previous paragraph and the program SPSS. The results obtained have been evaluated in more detail and through them, different conclusions have been extracted and expose at the end of this project.

2 Objectives

The first aim of this project is to analyze and compare the innovation capacity and performance of companies in different sectors. The difference between these sectors on how they deal with innovations in the current scenario, it will be subjected to further study.

As it will be seen among this essay, there are different actors taking part in the innovation process and factors that can inhibit or enhance innovation. Because their important role in the innovation field of a company, they will be also analyzed.

In addition, it is intended to identify which are those sectors which present more barriers to innovation and therefore they must try harder for being innovative. The relationship between barriers and innovation will be studied and will be demonstrated their correlation. Through analyzing a set of data provided by different entities such as Eurostat, it will be possible to determine which are the current barriers that these sectors must face and the impact degree. Therefore, different research tools will be employed including a multivariate cluster technique with the aim to compare the interaction between companies and the analyzed barriers.

3 Theoretical framework

3.1 Concept of innovation

The concept of innovation goes back up to a century ago when Schumpeter (1934) described it as "doing new things or doing things that are already done, in a new way." It is a process that he called "constructive destruction" in which new technologies replaced the old ones. On the other hand, according to this distinguished economist, there are 5 types of innovation:

- Introduction of new products
- Introduction of new production methods
- Opening of new markets
- Development of new supply sources of raw materials or other inputs
- Creation of new market structures in an industry.

Likewise, several are the definitions of the word innovation that have been given since then. Perhaps one of the most relevant is the one provided by the Organization for Economic Co-operation and Development (OECD 2005), which states that an innovation is the implementation of a new or improved product or process, a new marketing method, or a new organizational method in business practices, the organization of the workplace or external relations.

It is also interesting the definition provided by COTEC (2016) in which innovation is understood as every change (not only technological) based on knowledge (not only scientific) that generates value (not only economic).

3.2 Types of innovation

3.2.1 Technological and non-technological innovation

The term innovation it is often attributed only to product innovation. However, there exist other types of innovation such as process innovation. Activities that imply somehow a change in the company, are classified in four different categories (OECD 2005) within two groups: technological innovation and non-technological innovation. Product and process innovation belongs to the first

group mentioned, which consists on a new technological development based on the acquisition of knowledge or the development of existing technologies. Oppositely, non-technological innovation refers to the need of changing the procedures of the firm or introducing new or improved market systems without necessarily imply a change or adoption of a new technology (Pérez 2015). This group englobes organizational and marketing innovation.

In more detail, product innovation involves the introduction to the market of a new or significantly improved good or service which is differentiated from the existing product because its characteristics or uses. This can take place using new knowledge or technologies, or a combination of existing knowledge and technology. Usually, teams involved in a product innovation are composed by a cross-functional membership which helps firms to acquire information diversity and amplify the knowledge leading to an improvement of the innovation process (Guo et al. 2017). It is essential that employees have the ability to produce and present new ideas in the company which will be the base for following development of product or service innovation. For that reason, leaders must provide a path that employees can follow to exploit their idea generation ability, and make the best use of the available resources. Therefore, managers must be able to guide the idea generation towards the achievement of a particular goal (Perkins et al. 2017).

It is clear that company's aim is to be successful when a new product is launched to the market. For analyzing this fact, indicators such as obtain a product advantage, meet customer needs and market potential (Harbor et al. 2017), are used to identify if this objective has been fulfilled.

Secondly, process innovation is defined by the OECD (2005) as the implementation of a new or significantly improved production or delivery method. This includes changes in techniques, equipment and/or software. Generally, the main interests that companies have for developing a process innovation are to enhance the quality, decrease production or delivery costs and to produce or deliver a new or improved product.

An organizational innovation is understood as "the implementation of a new organizational method in the firm's business practices, workplace organization or

external relation" (OECD 2005). Two types of organizational innovation can be distinguished: intra-organizational innovation and inter-organizational innovation. The former, involves those new methods used within a company while the latter is referred to new structures or procedures outside the boundaries established around the firm (Camisón et al. 2014).

On the other side, it can be considered a marketing innovation "the implementation of a new marketing method involving significant changes in product design or packaging product placement, product promotion or pricing" (OECD, 2005). The objective of carrying out marketing innovation activities are to open new markets or positioned a new product on the market, among others.

3.2.2 Radical innovation vs Incremental innovation

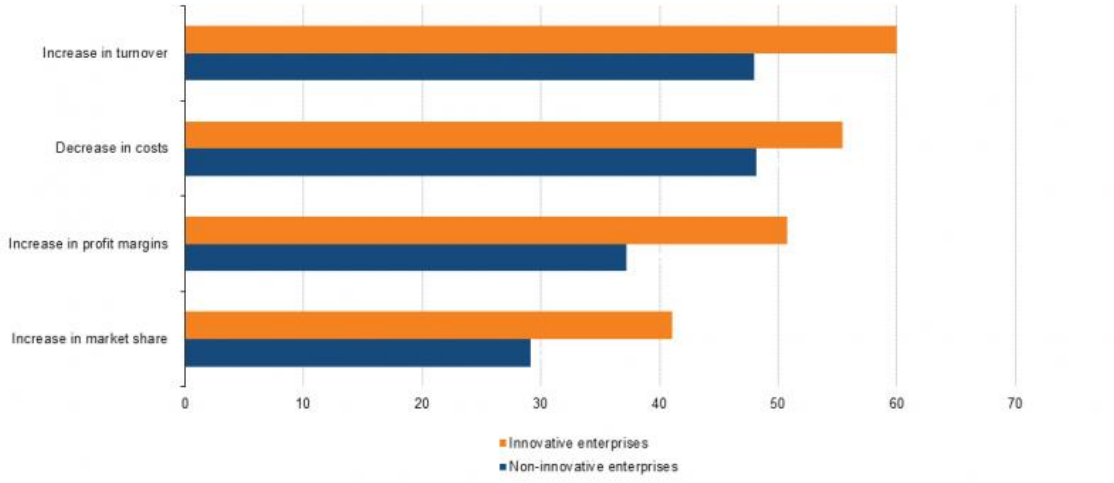
On the other side, other distinctions can be done regarding types of innovation. An example of this, is the one provided by several authors who distinguish between radical and incremental innovations. Many terms are associated to the former such as discontinuous innovation, disruptive innovation, really new product, major innovation or breakthrough innovation. This term, is defined as radically different technology or as something considerably new to the firm and the market which brings pronounced change. The process involved behind a radical innovation starts with an ideation phase followed of the translation to a tangible object which is successfully exploited, i.e., a nonlinear cycle characterized by divergent and contingent activities (Sandberg et al., 2014). Meanwhile incremental innovation refers to an existing service, product or method which has been considerably improved. Other definition is the one provided by Geiger and Finch (2016) who consider that incremental innovation is born when using established resources, producers and users identify new services or products or even adapt existing ones, solving current problems on that.

3.3 Relevance of innovation

It is important to understand the reason why companies are interested in innovating. Many authors agreed that a common reason is to increase turnover, however, there are several reasons that explain why companies are stimulated

to perform innovative activities. Regarding product innovation (and in many cases in marketing), the objectives are stimulated by competition, demand and markets. In this way, innovation can have an impact on the productivity and efficiency of a company, it can affect market share or the quality of the product or service offered or help to reduce costs.

Graphic 3.3.1 Goals for innovative and non-innovative enterprises



(*) Excluding the Czech Republic, Denmark, Ireland, Spain, France, Luxembourg, Finland and the United Kingdom. The survey reference period covers the three years from 2010 to 2012.

Source: Eurostat, 2017

On the other hand, the Statistics National Institute (2015), identify the following statements as objectives of the company for carrying out innovative activities:

- Product based objectives
  - Wider range of goods or services
  - Replacement of outdated products or processes
  - Entry in new markets
  - Increase market share
  - Increase the quality of goods or services
- Process based objectives
  - Increase flexibility in production
  - Increase the capacity of production
  - Lower labor costs for unit produced
  - Less materials for unit produced
  - Less energy for unit produced
- Work based objectives

- Increase total employment
- Increase of qualified employment
- Job maintenance

Other objectives

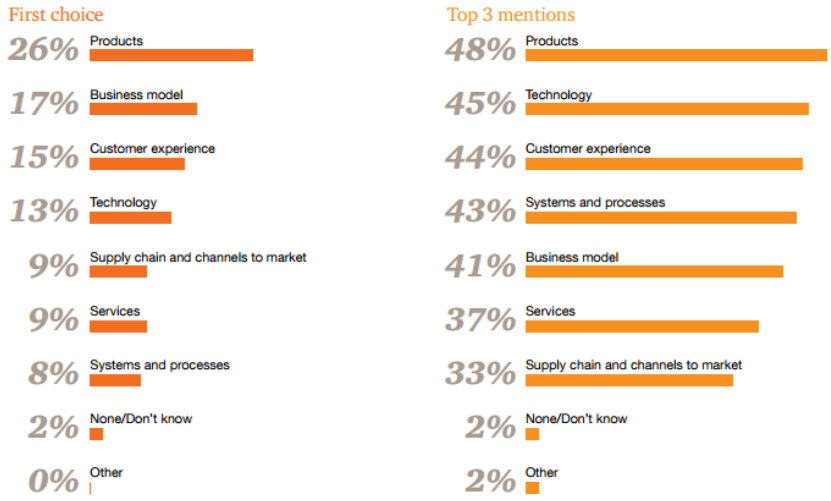
- Lower environmental impact
- Improve employees' health and safety
- Accomplishment of regulatory requirements: environmental, health or safety

In addition, not because companies perform innovative activities necessarily means that they are going to be always successful in their efforts to achieve their objectives. Likewise, it may happen that the implementation of an innovation has other effects than those that led to its first motivation. About the first statement mentioned, Pellegrino and Savona (2017) made a distinction between firms considering their willingness and need to innovate. They found that those firms considered potential innovators, i.e., companies with a desire to perform innovation activities, may not be able to perform correctly the introduction of new products or processes and be a failure's victim. This group is known as failure innovator. Nevertheless, some of those potential innovators could achieve satisfactorily this purpose and for that reason they received the name of innovators. Meanwhile, there exist enterprises who do not innovate (non-innovative oriented). This could be because, not long ago, they performed an innovation, so they do not have yet a necessity of carrying out innovation activities, or simply they are not interested.

It should be highlighted that nowadays, companies are not only focused on improving a product or range of products, in fact they are more interested in finding new ways of increasing their profit. They intend to go further and try to convert what they sell and the way they sell it. Thus, it is more evident the growing interest in innovation. According to a survey conducted by PwC (2013) in which 246 CEOs from around the world formed part, the 51% of them said that innovation is one of their priorities for their company, the 36% of them find valuable to innovate, 10% considers that innovation is its main focus, and only the 3% acknowledged not having innovation as a priority. Additionally, the 26% of the survey respondent, consider that a strong visionary business leadership is

the key factor for achieving a successful innovation. Similarly, other 26% think that the most important aspect is to have an adequate culture to support and encourage innovation. Regarding which areas aim to innovate in the three following years (from the time that the survey was performed), the results are shown in the image below.

Graphic 3.3.1 Areas to innovate inside a company



Source: PwC, 2013

According to statistics provided by Eurostat (2017), more than 6 of 10 innovative product and / or process companies of the European Union, to achieve one of their objectives, gain an advantage over their competitors, reduced waiting time between initiation and Implementation of its innovations. Practically the same proportion, 60.6% of companies use the complexity of goods and services with the aim of increase their competitiveness.

Furthermore, it has been demonstrated that an innovation involvement is linked to a higher increase in turnover in the firm. Therefore, it has been revealed that the 79% of European firms which introduced one or more innovations since 2011 until 2014, were witnesses of an increase higher of the 25% of their turnover by the end of that period (European Commission 2015). In the period 2010-2012 the 48.9% of the companies belonging to the European Union show activities of innovative character (Eurostat 2017). Germany is the country that leads this ranking, since 66.9% of all companies reported such activities. It is followed by Luxembourg with 66.1%, Ireland with 58.75% and Italy with 56.1%. At the

opposite side of the list, Bulgaria, Poland and Romania stand out for having fewer innovative companies with 27.4%, 23% and 20.7% respectively.

Table 3.3.3 Participation of innovative companies by type of implementation

	Process innovative enterprises (% of all enterprises)	Enterprises that developed process innovation by introducing new or improved logistics, delivery or distribution methods (% of all process innovative enterprises)	Enterprises that developed process innovation by introducing new or improved methods to manufacture or produce goods or services (% of all process innovative enterprises)	Enterprises that developed process innovation by introducing new or improved supporting activities for processes (% of all process innovative enterprises)
EU-28 (²)	21.4	34.9	65.5	58.9
Belgium	31.1	35.2	60.3	53.3
Bulgaria	9.3	28.1	61.7	48.7
Czech Republic	24.0	39.6	68.0	59.2
Denmark	22.9	37.7	41.9	77.8
Germany	25.5	44.1	74.9	53.3
Estonia	23.8	25.4	65.9	48.4
Ireland	25.9	40.5	59.9	70.0
Greece	25.6	28.3	59.7	63.3
Spain	15.1	20.3	61.8	56.1
France	24.1	35.9	72.4	48.0
Croatia	19.0	40.8	65.3	69.0
Italy	30.4	31.3	61.3	66.8
Cyprus	28.2	95.7	57.8	84.7
Latvia	12.7	32.6	71.9	42.3
Lithuania	13.1	25.4	70.1	58.3
Luxembourg	32.8	41.7	59.1	64.9
Hungary	8.3	19.6	58.9	55.1
Malta	26.4	52.4	57.8	74.8
Netherlands	25.9	32.7	62.1	55.4
Austria	28.7	32.5	55.4	72.8
Poland	11.0	29.2	61.7	54.1
Portugal	33.5	37.2	60.7	72.2
Romania	4.6	31.6	69.3	34.9
Slovenia	22.5	34.1	68.2	66.6
Slovakia	13.5	38.6	62.9	64.4
Finland	29.3	33.9	64.0	62.9
Sweden	23.9	32.0	57.2	61.2
United Kingdom	14.1	:	:	:
Norway	11.9	25.4	60.8	47.4
Serbia	22.0	40.9	49.9	74.8
Turkey	20.4	45.3	79.9	58.4

(¹) The survey reference period covers the three years from 2010 to 2012.
(²) Excluding the United Kingdom for the specific types of implementation.

Source: Eurostat, 2017

Furthermore, Pellegrino et al. (2017) pointed that larger firms who are operating in an international environment and applying organizational changes and companies that count with highly skilled personnel, have a higher probability of bringing new innovative products or processes to the market. In contrast with other studies, the authors found that this positive relationship also corresponds with the case of younger firms.

3.4 Current innovation scenario

3.4.1 Spanish situation: comparison with Europe

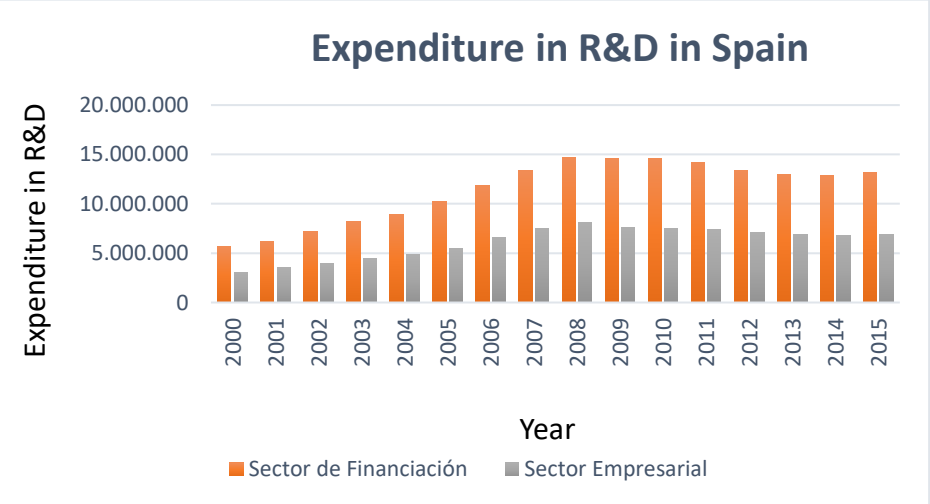
During many years, the Spanish Innovation System had a misconception of what imply thinking just for thinking. Invest resources on that was a nonsense. Instead, investigation has been see as a way to try to figure real applications to real problems, which lead to the acquisition of benefits. Therefore, basic research which provides new knowledge without clear application wasn't perceived as a way for generating value for companies until the eighties. From that time, it

started to circulate between some academics the idea that there is a link between basic research and product innovation, where the output obtained from carry this research can be used for developing new products (Martínez et al. 2013). Because this private research, companies can acquire new skills and be more prepare for innovate trough the exploitation of external knowledge. On that sense, companies increase their absorption capacity which is the "ability to recognize the value of new information, assimilate it and apply it to commercial ends" (Cohen et al. 1990).

Knowledge is cumulative and may lead to companies reinvesting in R&D using the benefits gained from previous successful innovation processes. Because this will increase the likelihood of the company to remain innovative, one might think that companies will bet on investing more in research. However, although it has been demonstrated that research is essential for being more innovative, investment in R&D in Spain has dealt one of the most difficult periods on the lasts years, dropping significantly since 2009. The crisis has supposed a decrease of the 9% of the investment in innovation, leaving Spain below the European mean.

Although this fact took place, a report presented by INE (2016) point hopeful data about innovation in Spain. During the year 2015, the expenditure in technological innovation was increased a 5,5% which means that a total of 13.674 million euros were invested, as it can be observed in graphic 3.4.1.

Graphic 3.4.1.1 Expenditure in R&D in Spain by sectors

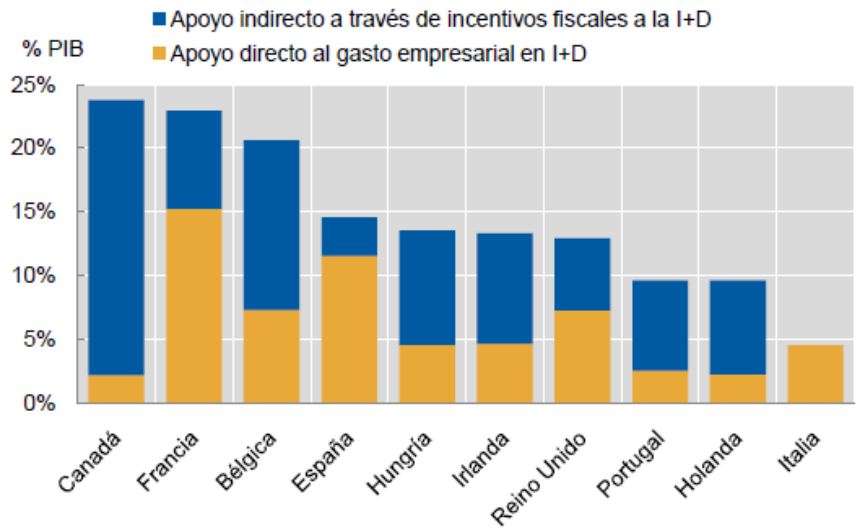


Source: own from https://icono.fecyt.es/indicadores/Paginas/default.aspx?ind=134&idPanel=1

In addition, during the period 2013-2015, 12,8% of Spanish companies with 10 or more employees performed a technological innovation whereas 23,7% of the Spanish firms were non-technological innovators. This happens because SMEs, which is formed by the 99,88% of the total of Spanish companies (Ministerio de Economía, Industria y Competitividad 2016), does not count with the technological capacity needed and do not perform enough R&D activities. Therefore, they must rely in other kind of activities such as new marketing, design or organizational exercises to be successful in innovation (Hervas et al. 2016).

To motivate and support enterprises R&D, the government applies some measures which help them in their effort for being innovative (Ministerio de Ciencia e Innovación 2011). This can be observed in the graphic below in GDP terms. It differentiates between direct support i.e. grants and loans and indirect support which are fiscal incentives. However, the data used belongs to 2008 and 2007 for Spain, Ireland and Holland, i.e., this information shows the situation before the crisis when the direct support predominantly prevailed and stood out between European countries.

Graphic 3.4.1.2 Direct and indirect support to R&D



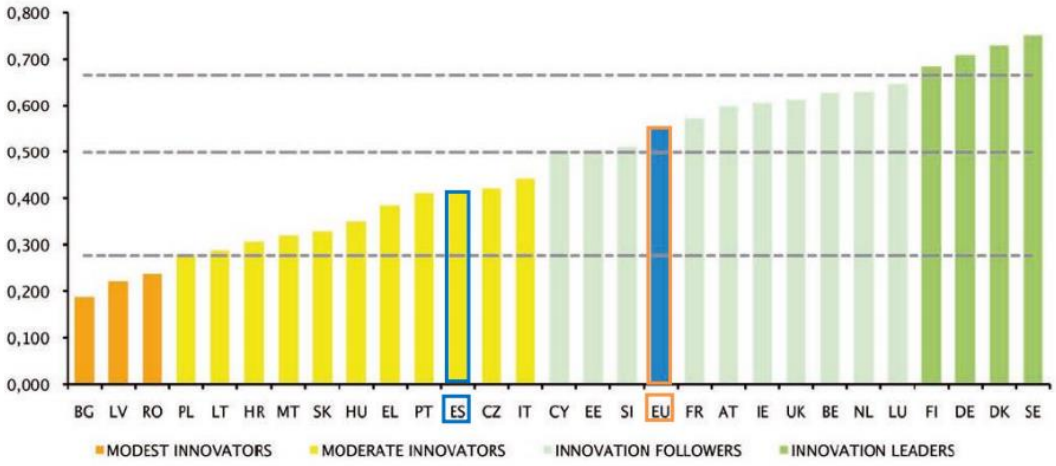
Source: Ministerio de Ciencia e Innovación 2011

On the other side, from the use of a synthetic indicator, the Spanish Foundation for Science and Technology (FECYT) (Ministerio de Economía, Industria y competitividad 2014) separates the member states of the European Union into 4 country categories. These are:

- Modest innovators
- Followers in innovation
- Moderate innovators
- Modest innovators

With a synthetic value of 75% of the value of the Union, Spain is placed in the 17th position of the ranking. Consequently, Spain is considered a moderate innovator together with Italy, Czech Republic, Portugal, Greece, Hungary, Slovakia, Malta, Croatia, Lithuania and Poland, which are in the same group.

Graphic 3.4.1.3 Countries of the European Union classified by the synthetic number



Source: Ministerio de Economía, Industria y competitividad, 2014

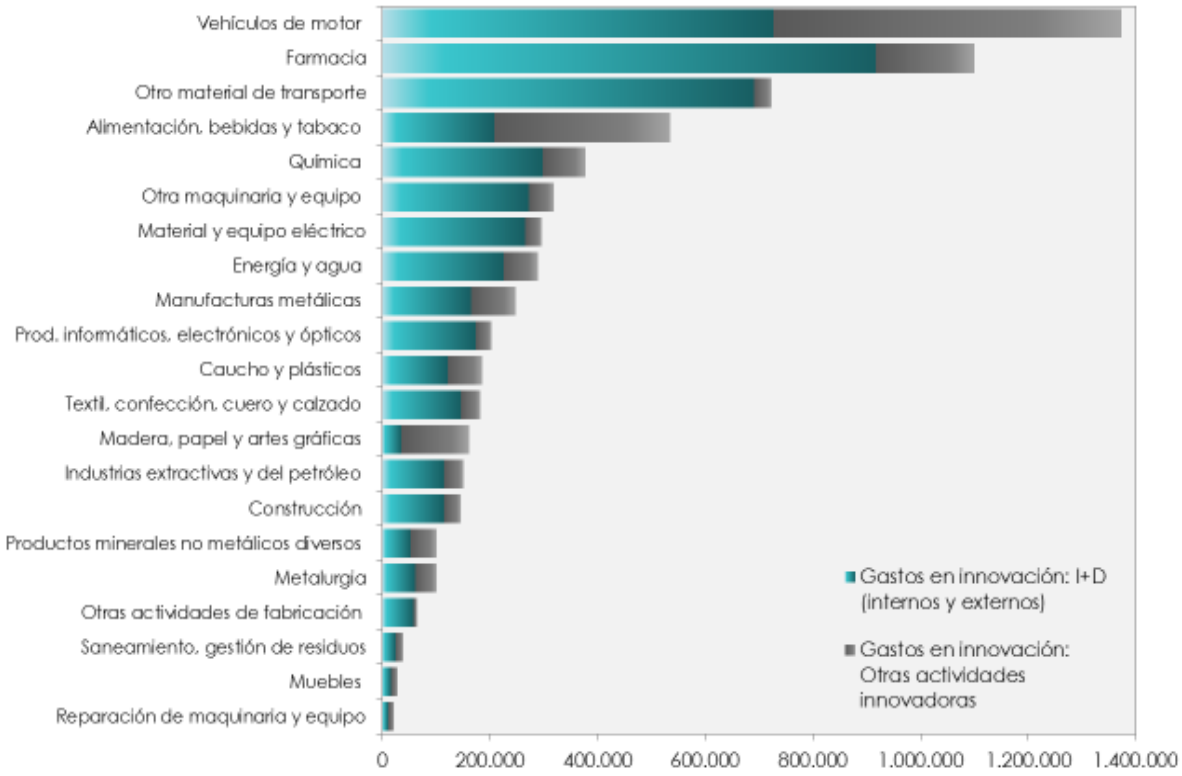
What makes Spain to be in position 17th in the ranking, could be an interesting question. In general, it can be stated that Spain have some strengths when talking about innovation. One of them is its competitiveness in basic research i.e., it has an attractive and open research systems. Their excellence in this sector is caused by three factors: to have many scientific publications with international cooperation, these publications correspond to the 10% of publications most cited in the world and it has a high number of students from non-EU countries. Another strength that characterized Spain is a high ability to bring innovations from the firm to the market. On that sense, the country highlights because the exportations of medium and high technology products and the sales of new products as a percentage of turnover.

However, which moves Spain back in the queue are its expenditure in business innovation and the capacity to innovate of PYMES. Because of that, Spain should

try harder and invest more in R&D and in acquisition of machinery, software and hardware.

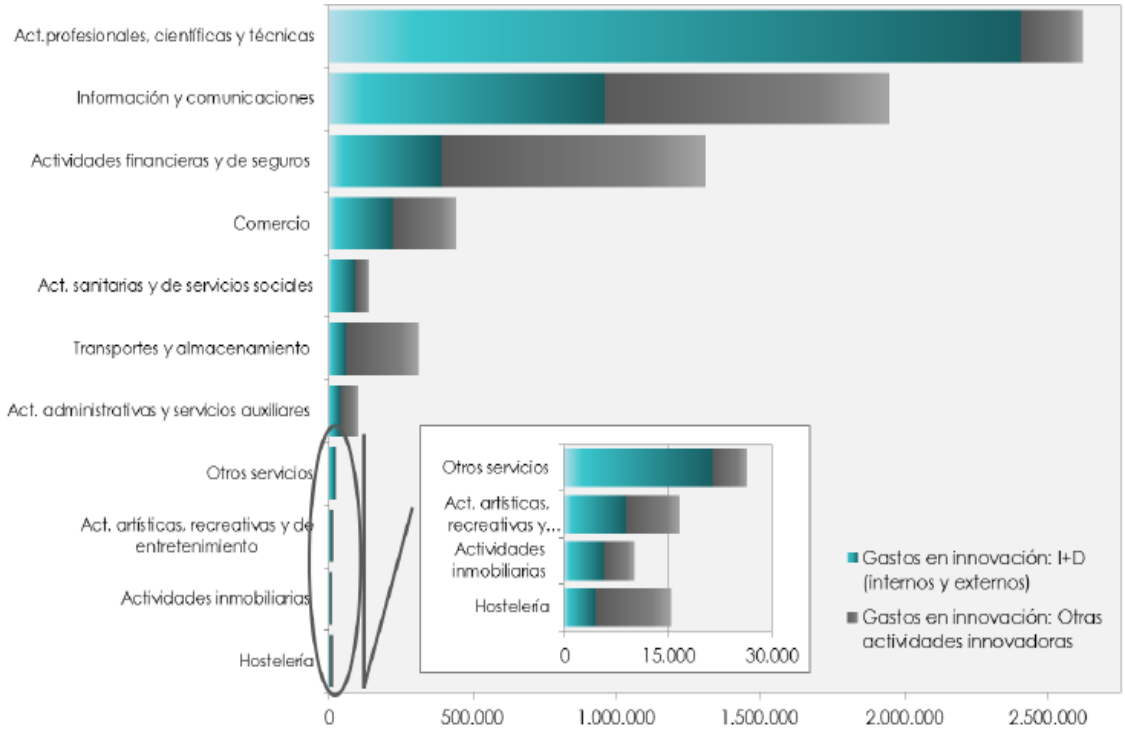
In regard to the last point mentioned, most of the innovation expenditure goes directly to services and industry, a 51 and 48% respectively for technological innovations, while it is quite insignificant in agriculture, ranching, forestry and fishing. It results interesting to observe how, at the same time, these economical resources are divided within the sector as it is show in the graphic below for the case of the industry and service sectors.

Graphic 3.4.1.4 Structure of the innovation expenditure within the industry in 2015



Source: Ministerio de Economía, Industria y competitividad, 2017

Graphic 3.4.1.5 Structure of the innovation expenditure within the services sector in 2015

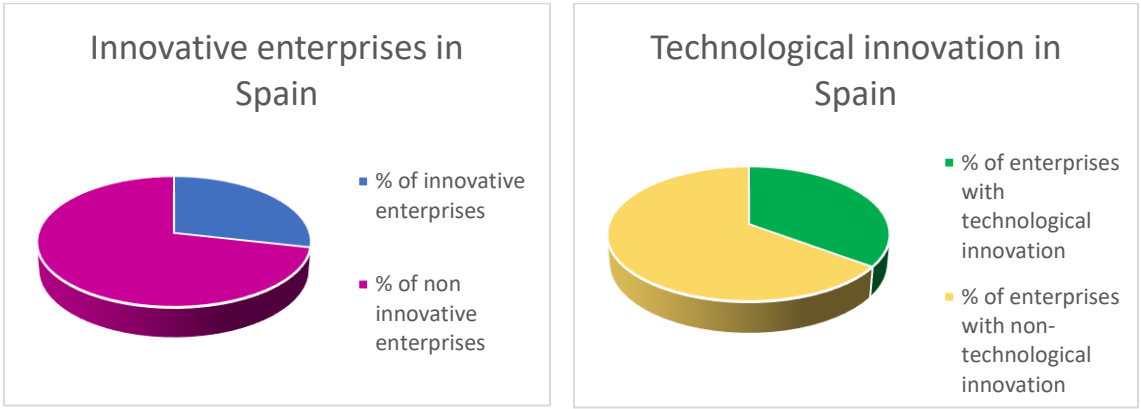


Source: Ministerio de Economía, Industria y competitividad, 2017

For non-technological innovations, the expenditure percentage increase considerably in the services sector and reaches a value of 71%. On the other hand, the industry represents a 26% of the expenditure while in agriculture, ranching, forestry and fishing only a 3%.

In the graphic below, information about the number of enterprises in Spain which develop technological and non-technological innovations is appreciated.

Graphic 3.4.1.6 Innovative enterprises in Spain (Period 2013-2015)

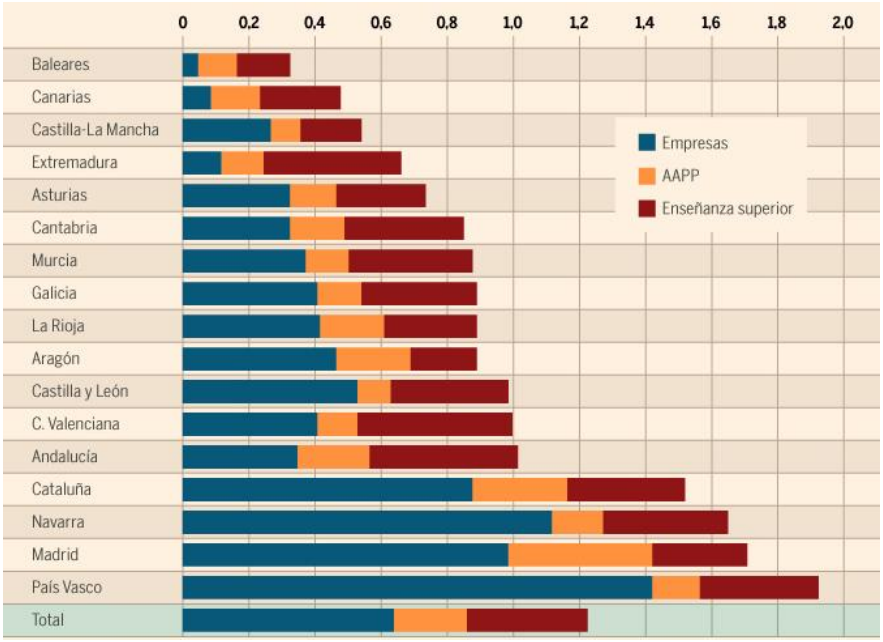


Source: own from http://www.ine.es/dyngs/INEbase/es/

3.4.2 Innovation by regions

Moreover, the Foundation BBVA – IVIE (Fundación BBVA – IVIE 2016) made a regional analysis of the innovative situation in Spain using the investment in R&D as innovation indicative parameter. In addition, the investment in R&D can be linked to the social welfare of the economy i.e. the gross domestic product per capita. Thus, a decrease of the ratio R&D/GDP can be observed between the Spanish regions, being Murcia the only exception. This has been especially remarkable in Cantabria and Asturias where this ratio has fallen from 1.16 to 0.85% and 0.99 to 0.73% respectively. This ratio corresponding to each autonomous community can be observed in the image below.

Graphic 3.4.2.1 Ratio R&D/GDP of the Spanish Autonomous Communities in 2015



Source: Fundación BBVA-IVIE, 2017

Furthermore, the decrease on the expenditure in R&D has affect both, the public and private sector. In this scenario, companies play a great role being responsible of the 53% of the total investment in R&D in 2015 (Fundación BBVA – IVIE 2016). On the other hand, the 47% remaining of the total expenditure in R&D is associated to the effort carried by public administrations in cooperation with higher education. The distribution of expenditure according to public and private sector differs significantly between one community and another. The Basque Country and Navarra are those regions where the private sector has a greater

relevance since it is responsible of the 75 and 69% respectively of the total expenditure. Likewise, in Baleares Islands and Canarias the private sector only contributes with the 14% and 19% of the total investment (COTEC 2016).

3.5 Innovation barriers

As innovation means change, the future can be unclear and the resources available to afford these innovative activities can be limited. The firm can find itself trying to face a situation caused by the appearance of restrictions in any part of the process which may lead to failure. As it can be seen, this topic has a high relevance since the removal or decrease of barriers impact has the power of encourage people to be innovative and may increase the performance of those who already innovate. Thus, analyze possible constraints to innovation may be helpful for identifying any obstacle which limits innovation activities and therefore find a path to overcome them.

First of all, the word barriers can be understood as “an issue that either prevents or hamper innovative activities in the firm” (Sandberg et al., 2014:1294). Several terms are associated to it and used in literature like: bottlenecks, constraints, challenges, concerns, dangers, difficulties, obstacles and problems. Literature also point that barriers inhibit, hinder, complicate or impede innovation which can leads to a failure in the innovative activities.

Even when it is clear, that research is essential for having a better understanding about factors delimiting innovation, reality is not along the same lines. Pellegrino et al. (2017) noticed that mostly the literature is focus on the factors that enhance innovation success rather than those that trigger an innovation failure within the company. Research on that, should also make a distinction between the different periods of the innovation cycle which take place during the decision to perform innovation activities, the moment when the firm is engaged in innovation and when the company introduce a new product/process.

3.5.1 Types of barriers

3.5.1.1 Revealed barriers vs deterring barriers

In the literature, different ways of classification of the innovation barriers can be found. An example of that is the one provided by D'Este et al. (2012), who distinguish between two groups. The first one is characterized by a distinction of the policy perspective where acquires relevance those entities responsible for making policies. They should try to create policies that fit the current situation and enhance firms to engage in innovation activities. In addition, they must identify why companies fail on being innovative and what is the scope of it. The second type belongs to innovation management, where is needed to identify those barriers that firms must face when they are developing innovative activities. Belonging to these types, D'este et al. (2012) also distinguishes two main barriers to innovation. The first one, revealed barriers, makes mention to the obstacles that arise when a firm is engaged in innovation activities and its consciousness about them. The second, deterring barriers, refers to these barriers that seems impossible to overcome.

3.5.1.2 Internal and external barriers

Otherwise, Hözl et al. (2011) and Sandberg et al. (2014) mentioned internal and external barriers to innovation. While the former is related to the organization, management and competences of a firm, the later refers to the obstacles caused by the market, the government and the system and arise from the interaction with other companies or institutions. Furthermore, external barriers are separated into two categories, one corresponding to obstacles which result from the behavior of a particular actor and those related with the macro environment. For example, customer resistance and government are considered to form part of the first group while undeveloped network and ecosystem, technological turbulence and inappropriate system are considered as obstacles in the macro environment. It could be stated that SMEs are more affected by external finance while large firms are more influenced by customer resistance. In addition, undeveloped network and ecosystem influences both. Regarding internal barriers, these are classified in issues relating to mindset, resources, organizational structure and competences. The latter, is also divided into discovery, incubation and acceleration and commercialization competences. It has been observed that a

restrictive mindset is the predominant barrier in SMEs and large firms, followed by the lack of discovery competences (in the case of large firms) and lack of incubation competences (in the case of SMEs).

The table below shows some interesting data extracted from Sandberg' et al. (2014) article. The main external and internal barriers regarding the different target markets, size of the company and activities among the innovation process are specified.

Table 3.5.1.2.1 Main barriers in function of the size of the company, the target markets and activities

		Innovation barriers	
		Main external barriers	Main internal barriers
Size of the company	SMEs	Undeveloped network and ecosystem	Restrictive mindset Competences
		Paucity of external finance	Lack of incubation
			Insufficient resources
	Large firms	Customer resistance	Restrictive mindset competences
		Undeveloped network and ecosystem	Lack of discovery
		Technologies turbulence	Unsupportive organizational structure
Target markets	B to C	Customer resistance	Lack of discovery competences
		Undeveloped network and ecosystem	Restrictive mindset
	B to B	Undeveloped network and ecosystem	Restrictive mindset
		Unsupportive government	Lack of incubation competences
Activities in the innovation process	Ideation	Customer resistance	Insufficient resources
			Restrictive mindset
	R&D	Customer resistance	Restrictive mindset

		Technological turbulence	Unsupportive organizational structure
			Insufficient resources
	Commercialization	Customer resistance	Lack of acceleration and commercialization competences
		Undeveloped network and ecosystem	

Source: Sandberg et al. 2014

3.5.1.3 Adoption barriers and risk barriers

Furthermore, Hözl and Junger (2011) made a distinction of the types of obstacles that may face those companies which are large and well established. Firstly, they find that adoption barriers can arise. This can limit firms' capability to explore new disruptive innovation leading to an increase of excessive bureaucracy. Secondly, they differentiated mindset barriers which are linked whit the fact that companies sometimes are stuck in the old way of how products and markets work letting go potential opportunities. Besides, when a company maintains their routines and is excessively confident with them and the experience, can face risk barriers and deal with the threat caused by disruptive innovations. In the last place, nascent barriers are those thinking and management limitations that arise during the innovation process when the firm is not able to think beyond.

3.5.1.4 Barriers associated to innovator and non-innovator enterprises

Moreover, there exist other type of distinction based on if the firm is considered innovator or non-innovator and if it been dealt adopters and non-adopters of advanced technologies. It has been observed that those who reported more constraints for being innovative are innovator firms and adopters of advanced technologies rather than those who present a minor innovation behavior (D'Este et al. 2012). Pellegrino et al. (2017) found that the investment in innovation is considerably higher in innovators in comparison with failed innovators which may indicate why some firms fail in their chance to be innovative. Furthermore, innovative companies are more focus on export, perform organizational changes and have more skilled personnel. In addition, financial obstacles are presented with force to the companies as it is reflected in the table shown below which indicates that 66% of the companies somehow experienced this obstacle. Also, the authors consider that companies who are not involved in any innovation

activity don not present innovation barriers which leads to a result of zero in the table.

Table 3.5.1.4.1 Statistics about firms' constraints and basic information

	Total Sample		Pot. Innovators		Failed Innov.		Innovators		Non Inno. Or.	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Explanatory variables										
ln(Age)	2.88	0.67	2.89	0.66	2.90	0.66	2.88	0.65	2.87	0.70
Ln(Age sq.)	8.75	3.41	8.76	3.38	8.83	3.39	8.71	3.37	8.70	3.50
Exporter	0.38	0.49	0.43	0.49	0.31	0.46	0.53	0.50	0.23	0.42
Higher Education	15.81	25.89	17.57	26.72	13.42	24.01	21.07	28.34	10.21	22.12
Innovation expenditure (turn)	0.75	1.06	0.91	1.12	0.53	0.85	1.24	1.21	0.24	0.61
Organization	0.25	0.43	0.30	0.46	0.18	0.39	0.39	0.49	0.08	0.27
ln (Size)	4.15	1.49	4.21	1.49	4.08	1.45	4.31	1.52	3.99	1.46
Obstacles to innovation										
Financial obstacles	0.66	0.47	0.87	0.34	0.87	0.33	0.86	0.34	0	0
Knowledge obstacles	0.60	0.49	0.79	0.41	0.78	0.42	0.81	0.40	0	0
Market obstacles	0.61	0.49	0.81	0.40	0.80	0.40	0.81	0.40	0	0
Regulation barriers	0.49	0.50	0.64	0.48	0.65	0.48	0.64	0.48	0	0
N. of Observation	37,732		28,673		13,097		15,576		9059	

Source: Pellegrino et al. 2017

3.5.1.5 Functional and psychological barriers

Another way to classify barriers consists on separate them into functional barriers and psychological barriers (Lian et al. 2013). The first type englobes:

- Usage barrier: the customer needs longer time to integrate the innovation because it is not accordant with its past experiences, values or requirements.
- Value barrier: unless the new product is clearly better that the existing one, the customer will not be willing to buy the innovation because it does not recognize its value.
- Risk barrier: this takes place when the customer does not understand the innovative product and will refuse to buy.

On the other hand, psychological barriers involve image barriers which arise when the customer has a bad impression of the country of origin, the brand, industry or other factors related to the innovation and traditional barrier which changes the customer's culture generating a conflict.

3.5.2 Barriers overview

In general, several scholars agree that the set of barriers to innovation is composed by some of the barriers mentioned below. Primarily financial barriers are seen as one of the main constraints against innovation. This term involves under capitalization, short term liquidity problems, insufficient working capital, insufficient start-up capital and poor financing management (Larsen and Lewis, 2007). Count with an economic support is crucial for being successful on developing and introducing a new product or service. However, Cassamata (2003) assures that despite it is essential for firms to count with an external finance source, this will not guarantee their success in innovation. Research shows that the effect of this barrier is higher in small firms and in high-tech sectors. Meanwhile, large companies are less affected by this constraint and this fact enhance the probabilities of the firm to be involved in an innovation activity and exploit economies of scale. Furthermore, when two companies count with the same funds, the one with better innovation capabilities will face easily financial constraints. According to Pellegrino's et al. (2017), financial obstacles reduce in 7% the possibility of the firm to introduce an innovative product/process whereas it is reduced until 4.7% when the company must face market constraints and by 2.6% when regulatory obstacles arise.

Furthermore, knowledge barriers are relevant because they refer to the lack of availability of qualified labor, the lack of scientific and technological knowledge and the lack of information regarding the markets which can lead to the unknowledge of market opportunities for innovation and uncertainty of the demand.

Additionally, another barrier is the arduousness that sometimes firms have when they are trying to find partners to cooperate in innovation issues.

In addition, companies may confront legal barriers related to regulations, taxes, governmental standards, etc. On that way, Brüggemann et al. (2016) found that intellectual property rights also hamper innovation and reduce the total welfare by 20-30%. One of the reasons provided by them to explain this fact is that sometimes, with the aim to avoid paying license fees, some innovation opportunities are missed. In industries with constant innovation development

such as pharmaceutical, bioengineering or software firms, IP rights decrease the innovation rate. Moreover, Blind et al. (2017) discovered that in low uncertainty markets, standards affect companies' innovation effectiveness whereas regulations have a positive opposite effect. However, in the case of markets with high uncertainty, it occurs the contrary and deal with regulations can be translated in a limitation of companies' freedom. Thus, formal standards can be used against rivals in a strategic way and create market entry barriers but at the same time they can affect the technological infrastructure of a market.

Likewise, the Community Innovation Survey (CIS, 2012) collect, in a survey carried out by them, the following obstacles that may affect firms:

- Strong price competition
- Strong competition on product quality, reputation or brand
- Lack of demand
- Innovations by competitors
- Dominant market share held by competitors
- Lack of qualified personnel
- Lack of adequate finance
- High cost of access to new markets
- High cost of meeting government regulations or legal requirements

3.5.3 Technological frontier and firms' innovative behavior

Werner Hözl et al. (2011) also discussed the innovative behavior of firms regarding the approach of countries to a technological frontier, understanding this term as "the highest level reached upon a technological pathwidth respect to the relevant technological and economic dimensions". Can be highlighted that a major number of innovative companies is present in those countries close to this frontier. Therefore, they have more probabilities to face knowledge barriers such as skill barriers. Oppositely, countries which are allocated far from this technological frontier are characterized by a higher number of non-innovative companies which have no concern in innovation. Thus, financial barriers are more

relevant for the firms placed in these countries since their strategies used to be cost and investment based. In addition, evidence show that for this group is more useful to make use of technology which has been developed in another place instead of creating it by themselves.

3.5.4 Firms perception about barriers

Another factor that may affect firms in innovate are not only the barrier itself it is also the perception they have about them. This perception can be responsible for limiting the engagement that firms have with innovation activities. For example, barriers change in function of the size of the company and industrial affiliation. In that way, large firms used to be more concerned about commercial failure, uncertainty related to costs and internal obstacles while small firms are aware about financial constraints and market structure, feeling that these barriers have a greater impact on them. Another factor which has influence on barriers is the industry. As higher is the competition in the sector and R&D intensity, greater barriers are perceived. For example, legal impediments have an impact over telecommunications meanwhile banking sector is affected by internal resistance to change (Sandberg et al. 2014).

In addition, in the case of multinationals they normally have a lower perception of lack of technological and market knowledge as something that can affect their innovative activities.

There is evidence available which shows that barriers' perception also differs with the age. In the case of novel firms, on average they show a lower concern about having skilled personnel when they are starting to perform innovation activities. Instead, it has a greater impact on them when they are already stablished in those activities (Pellegrino, 2014).

3.5.5 Evidence on how companies deal with barriers

Finally, it could be expected that when companies must face innovation barriers they would consider different scenarios and therefore different ways of acting against these obstacles. Nevertheless, in the study carried out by Larsen and Lewis (2007), they discovered a reality contrary to their assumptions. They found that SMEs opt for ignore the problem or act as if they were solved using weak

solutions, as it is shown in table 3.4.2. They also realized that companies were more concerned about solving one crisis per time instead of preventing them from the very beginning.

The table which appears below summarized some of the main results obtained from the authors. It is about eight firms subjected to study and explains the barriers they found and the paths followed by the firms to overcome them.

Table 3.5.5.1 Barriers and ways to overcome them between some SMEs

	Firm's product	Barriers	Ways to overcome barriers
Medical Supplies Ltd	Equipment for keeping medicine cold	Financial barrier	Use of personal funds and bank finance
		Location	First, relocation in its own house. Finally, dismissal of all the employees excepting three.
Medical Products Ltd	Form of human implant	Financial barrier	Eventual selling of the business
		Global distribution	They didn't opt for a strategic alliance. Instead they prefer the politics do-it-yourself
		Lack of skilled staff	Make a team with people with complementary skills
		Research management	Sponsor research at a university hospital
Environmental Products Co-operative	Flow meter	Competitors copy their products	Ignore the problem and offer a consultancy service
		Staff leaves the company when they gain experience	Find replacements
		Market analysis	Assign a marketing manager
Sensor Equipment Ltd	Low cost gas detector	Design and manufacture of a key functional element of the product	Process of design and test a prototype in conjunction with a specialist manufacturer
		Financial barrier	Request of an innovation grant from regional government
		Overstretch finances	Close eventually the business and work as a consultant
Textile Equipment Ltd	Piece of textile fabrication equipment	Lack of working capital	Simplification of the manufacturing process and hire unskilled staff

		Financial barrier	The firm could not guarantee one requisite for achieving a governmental grant
		Time	Adoption of a *stop and go* strategy*
		Stress	Creation of a separate design consultancy and manufacture and assembly the product externally.
Marine Products Ltd	Boats and marine accessories	Knowledge barrier	Stablish a relationship with a local agency who have knowledge in NPD
		Financial barrier	Applied for a loan and a venture capital which were denied. The firm cut costs and use own funds.
		Marketing	Creation of a web site
		Skill shortages	Subcontract of an engineering company
Architectural Structures Partnership	Design of new structures	Skill shortages	Train and educate the partnership
		Finance for training	Join an SME innovation network
		Marketing	Increase the number of contacts through word of mouth or because the spin-offs from previous projects
Textile Materials Ltd	Holographic cloth	Find a specialist manufacturer	Find an employee in the company who was working in other project
		Finance	Adoption of a *stop and go* strategy
		Marketing	The firm built a list of potential customers

*Stop and go strategy: The product innovation process stops when there are no financial resources and is restarted when there are funds available.

Source: own from Larsen et al. (2007) article

3.6 Entities interested in the study of innovation

The increasing interest on innovation has led to the fact that several organisms are focused on its study. Every time there is a higher awareness about the relevance of innovation and the need of analyzing it. For that reason, entities such as Instituto Nacional de Estadística (INE, Spain), Eurostat (Europe), Institut für angewandte Sozialwissenschaft GmbH (INFAS, Germany), Economic and Social Research Council (ESRC, UK) and Community Innovation Survey (CIS, Europe),

among others, apply some resources in understanding the current innovation situation.

As it will be seen in section 4 (methodology), data extracted from the CIS questionnaire and INE will be used to determine which are those sectors who innovate more and are engaged in a higher number of innovative activities at the same time that an analysis of the innovation barriers is performed.

3.6.1 Community Innovation Survey

Nowadays, the results obtained from the Community Innovation Survey (CIS), are used widely because provide reliable innovation data. This survey, it is performed every two years and counts with a large sample from many countries (countries from the European Union, some EFTA countries and EU candidate countries). It is a voluntary survey which means that from one survey to another not necessarily participate all the same countries. It provides statistics about innovation activity in which companies are engaged and other aspects related to innovation. In addition, Eurostat is carrying out a standard questionnaire in harmony with CIS3 data collection. Concepts appearing on this survey are extracted from the Oslo Manual.

Must be mentioned, that in the survey companies are classified by country, size class, type of innovation activity and economic activity (NACE). The latter, whose name comes from the French “Nomenclature statistique des activités économiques dans la Communauté européenne” and is also known as Statistical classification of economic activities in the European Community, provides statistical data from different economic fields such as national accounts, employment and production, among others.

3.6.2 Instituto Nacional de Estadística

The National Statistics Institute, is an autonomous organism linked to the Ministry of Economy, Industry and Competitiveness. It is responsible of generating national statistics in a widely variety of topics such as demographic and economic censuses, national accounts, demographic and social statistics, economic and social indicators, coordination and maintenance of business directories, formation of the Electoral Census, etc.

There is an innovation survey carried out by the INE in which data about the innovation process of enterprises is provided. In this survey topics such as economic impact, innovation activities and innovation expenditure, among others, are analyzed (INE 2016).

3.7 Innovation indicators

As it has been observed among this project, it is important to evaluate companies' innovation degree by sectors and/or countries. To measure the innovative performance, it is important to establish some indicators which helps to understand how innovative are the firms submitted to study and are also useful for firms for determining their competitive strategies. Until now, several studies affirm that there exists a positive relationship between innovation and performance where innovation has been measure mainly as R&D expenditure (Hashi et al. 2013). However, for a better study, R&D cannot be used as the only parameter for evaluate innovation since is just one of several innovation inputs. For example, some non-R&D indicators (but considered an innovation variable) are product design, trial production, market analysis, employees' training or investment in fixed assets related to innovation (Kleinknecht et al. 2002). Furthermore, several authors distinguish between input indicators (causes) and output indicators (consequences). In their article, Saraceni et al. (2015) consider the following innovation indicators:

Table 3.7.1 Input and output innovation indicators

Input indicators	Output indicators
Human Resources dedicated to R&D	Number of innovation projects
Financial investment in R&D	Percentage of revenue obtained with new products and services
Type of investment	Cost economy with new products and services
Organizational configuration favorable to innovation	Selling of technology to others
Physical structure destined to R&D	Number of patents required/ceded

Organizational culture aimed to innovation	Prizes received because of innovations
Maturity in innovation process	
Technology and Innovation Management Practices	

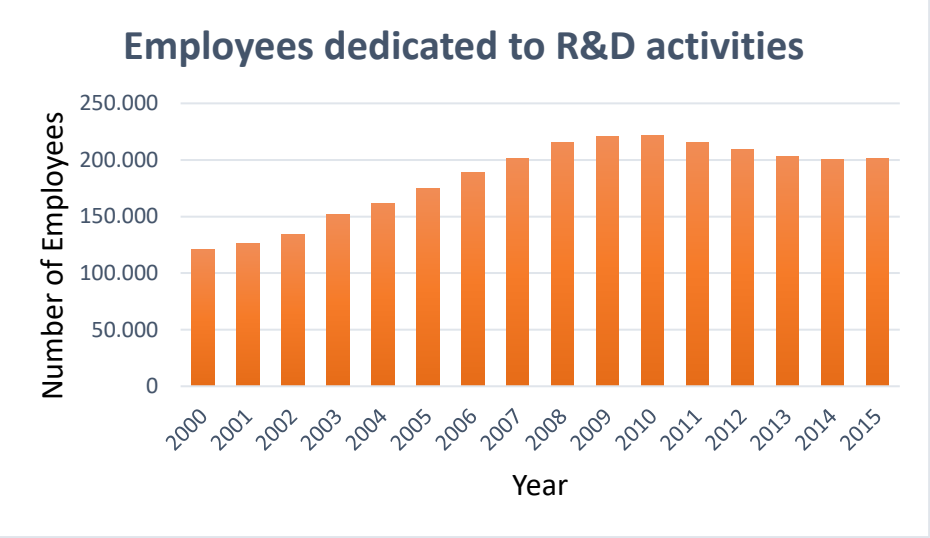
Source: Saraceni et al. 2015

In the following sections, some relevant indicators are explained in more detail with the aim to provide a better understanding of them and the reasons of why are they useful.

3.7.1 Human resources

It is understood, as human resources, the set of employees who work in an organization contributing value and competitiveness to the environment. Because within the company there are employees focused on research or performing other R&D activities, several indicators can be used for evaluating innovation. The number of employees dedicated to R&D activities or the resources destined to employees' training are just some examples of it.

Graphic 3.7.1.1 Employees dedicated to R&D activities by years



Source: own from https://icono.fecyt.es/indicadores/Paginas/default.aspx?ind=34&idPanel=1

In regard to the last statement, companies must develop their employees' skills and capacity to get and understand new knowledge in order to guarantee change inside the company and build innovative capacity. It has been verified that highly

skilled people may be more innovative in their jobs and can introduce changes on them. In addition, for these people used to be easier to transfer the skills gained from one job to another (CEDEFOP, 2012). García et al. (2016) recommends that innovation policies which support training for R&D personnel must be designed. While large companies tend to invest on training for employees, in Spain only the 30% of the SME's provide extra education to their employees.

For all these reasons, companies are interested in investing in training for their personnel. Thus, the expenditure on that becomes essential for evaluating innovation.

On the other side, the number of employees dedicated to R&D activities is analyzed in the CIS and the INE questionnaire and is considered a relevant innovation indicator. A total of 200.865,8 employees performed R&D activities during the year 2015, which represents a 0,3% more than the previous year. In the graphic below, the personnel dedicated to R&D by occupation and gender is represented.

Table 3.7.1.2 Personnel dedicated to R&D activities by occupation and gender in 2015

Personal empleado en I+D por sector de ejecución según ocupación y sexo. Año 2015

En equivalencia a jornada completa

Sector Ejecución	Personal total			Investigadores		
	Total	Tasa de variación (%) 2014-2015	% Mujeres	Total	Tasa de variación (%) 2014-2015	% Mujeres
TOTAL	**200.865,8**	**0,3**	**40,5**	**122.437,0**	**0,2**	**39,0**
Admón. Pública	39.677,8	2,4	51,1	19.961,8	-1,1	46,8
Enseñanza Superior	73.326,9	-0,1	45,5	57.106,5	-0,1	42,5
Empresas	87.431,5	-0,2	31,4	45.151,0	1,0	31,0
IPSFL	429,6	7,8	52,2	217,7	3,6	53,7

Source: INE 2015

3.7.2 Research and Development (R&D)

As it has been reported through this project, especially in section 3.4, R&D is a crucial factor which determines the innovation degree inside the company. This term, refers to those studies related with technological advance and research focused on improve social welfare. The applications that R&D studies contribute to firms are unlimited since allow them to create new technologies or products,

adapt excisting ones from other countries, acquire knowledge, improve process performance, etc.

Thus, indicators related with R&D such as acquisition of external R&D, expenditure in internal R&D or personnel dedicated to R&D activities, are widely used by researchers for analyzing innovation.

3.7.3 Acquisition of machinery, equipment, hardware and software

The acquisition of machinery, equipment, hardware and software is considered a non-R&D activity which contributes to innovation within a firm. The development and diffusion plays an important role since it provides external knowledge to the firm. Thus, it results interesting to analyze the introduction of a new or improve machinery, equipment, hardware or software as well as the proportion of them in its total stock, including future purchases (OECD 2005).

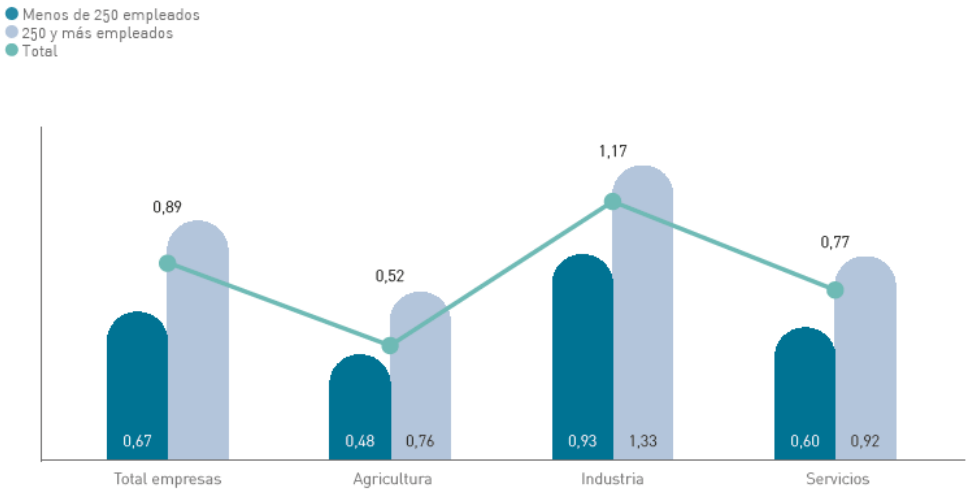
3.7.4 Innovation intensity

Nowadays, innovation is essential to firms for surviving. Thus, a constant flow of successful innovation must follow firms' trajectory if they want to achieve their objectives, like increase profit and growth, since it has been observed that high innovative enterprises perform better than lower intensity enterprises.

The size of the enterprise is also a key determinant in innovation intensity, and therefore, large companies used to present a higher innovation activity than those who are smaller according to several studies.

The next graphics show the intensity in technological innovation by sectors and by years expressed as a percentage of turnover destined to the expenditure for technological innovation activities.

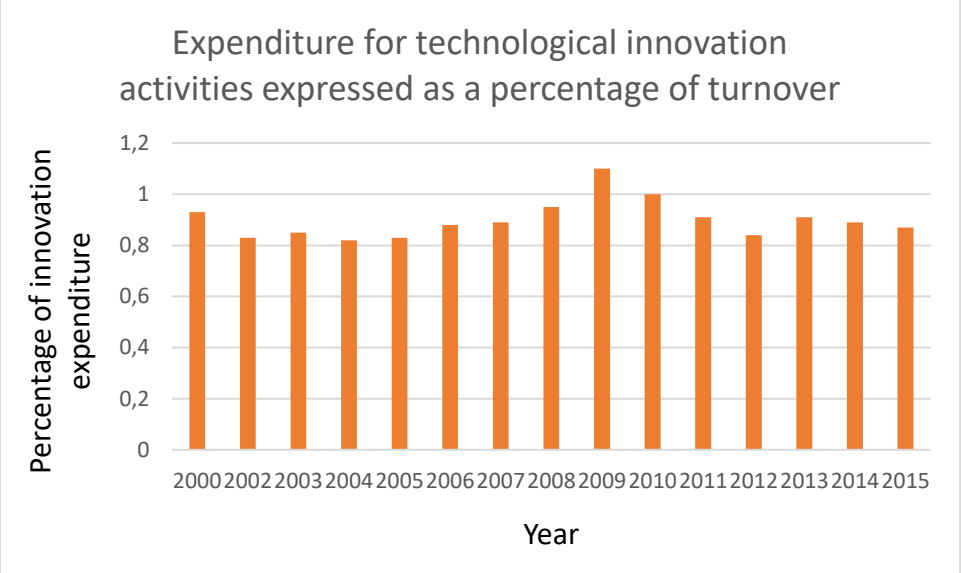
Graphic 3.7.4.1 Intensity in technological innovation of companies in 2014



Note: (innovative activity expenses / turnover) x 100

Source: INE

Graphic 3.7.4.2 Technological innovation intensity by years



Source: own from https://icono.fecyt.es/indicadores/Paginas/default.aspx?ind=141&idPanel=1

3.7.5 Cooperation with other partners and acquisition of external knowledge

To face alone the increasing difficulties which will appear during the innovation process could be critical for companies' survival, especially when they do not count with enough resources. Thus, having partners with whom information transfer is made and next to which new products and services can be developed, is an attractive idea which can make the difference. This may be the key for a

company to gain a competitive advantage over their competitors. Furthermore, many of this information is of public domain and it is in the firm's hands to be able of transforming it in useful knowledge and take advantage of it.

Large companies have it easier on that sense, since they tend to use a wider variety of information sources and therefore, is more common in those cases to have cooperation partners (Finland statistics 2014).

4 Methodology

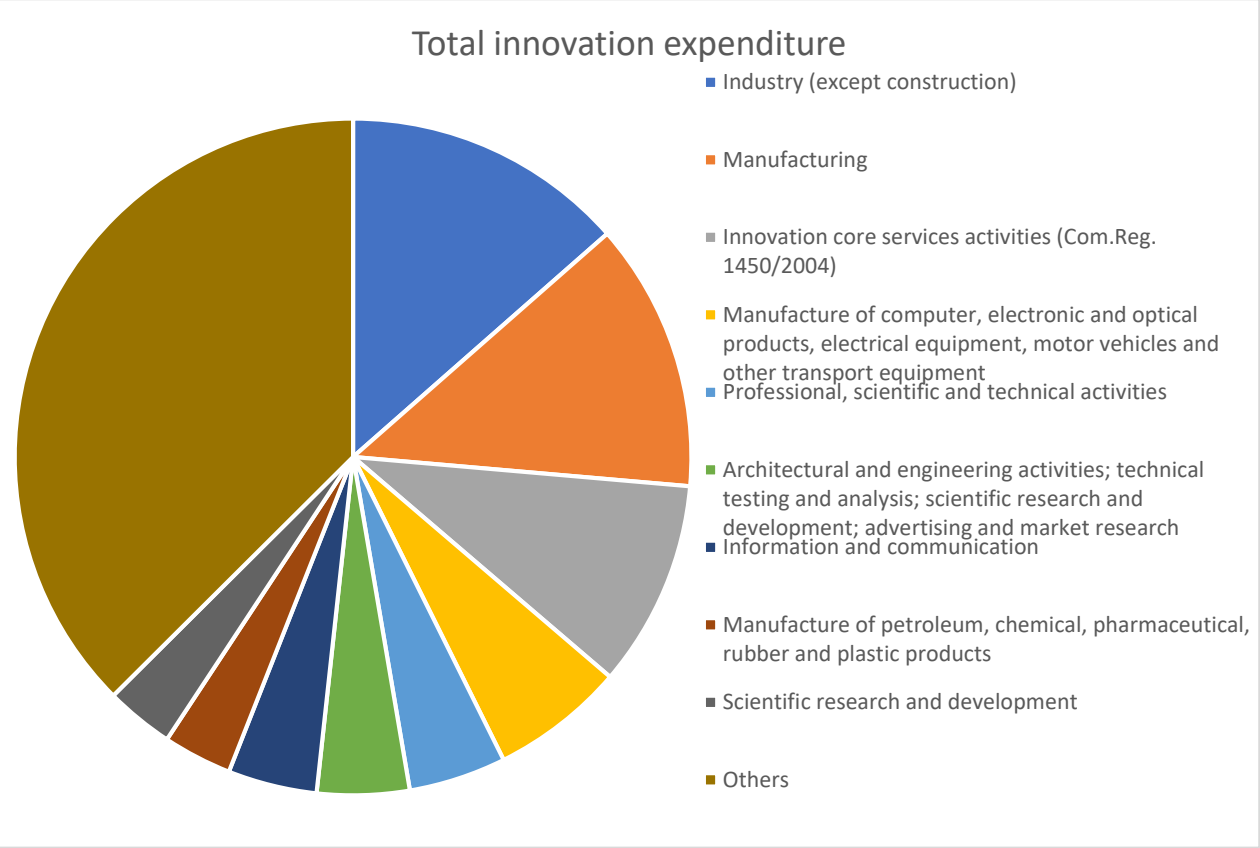
4.1 Analysis of the innovation degree of the different economic sectors

As it has been mentioned at the beginning of this project, one of the main objectives of this research is to determine which are the sectors, classified by type of economic activity, that must face more barriers in their attempt to develop innovation activities. Also, it results interesting to determine how much do companies invest in innovation and in which kind of activities are they involved. To evaluate that, different tools can be useful for analyzing innovation parameters, which allow a better understanding of the current scenario.

Firstly, it has been used data provided by Eurostat about the CIS questionnaire in regard with innovation constraints and engagement in innovation activities. Unfortunately, data corresponding to hampered innovation activities in Spain is not available in the CIS questionnaire of 2012 and 2014 and the sample available is not representative in the case of sectors' activity engagement and expenditure. For that reason, in this project it was analyzed the information provided in the seventh Community Innovation Survey (CIS 2010) in which 31 countries participated during the period 2008-2010. From the information published by Eurostat, the data corresponding to Spain was extracted with the aim of being studied. Specifically, it was analyzed information about innovation activities in which sectors are engaged and how much invest on them. Must be mentioned, that those sectors in which this information was not provided, were discarded during the analysis.

Therefore, the first innovation indicator evaluated in this project has been the total innovation expenditure by sectors since it provides a great knowledge of the innovation degree because involves many inputs related to the innovation process. With the aim to show the tenth sectors which invest more in innovation, the graphic placed below was performed.

Graphic 4.1.1 Total innovation expenditure by sectors

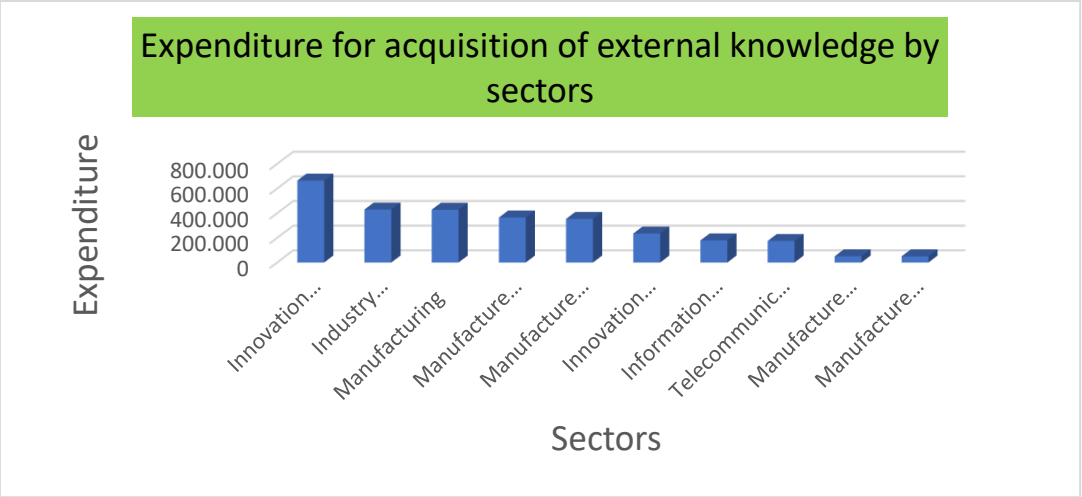


Source: http://ec.europa.eu/eurostat/web/science-technology-innovation/data

If the graphic 4.1.1 is compared with graphics 4.1.2 and 4.1.3 it can be observed that the following list of sectors which invest more in innovation coincides with sectors which show a higher expenditure for acquisition of machinery, equipment and software and a major expenditure for acquisition of external knowledge.

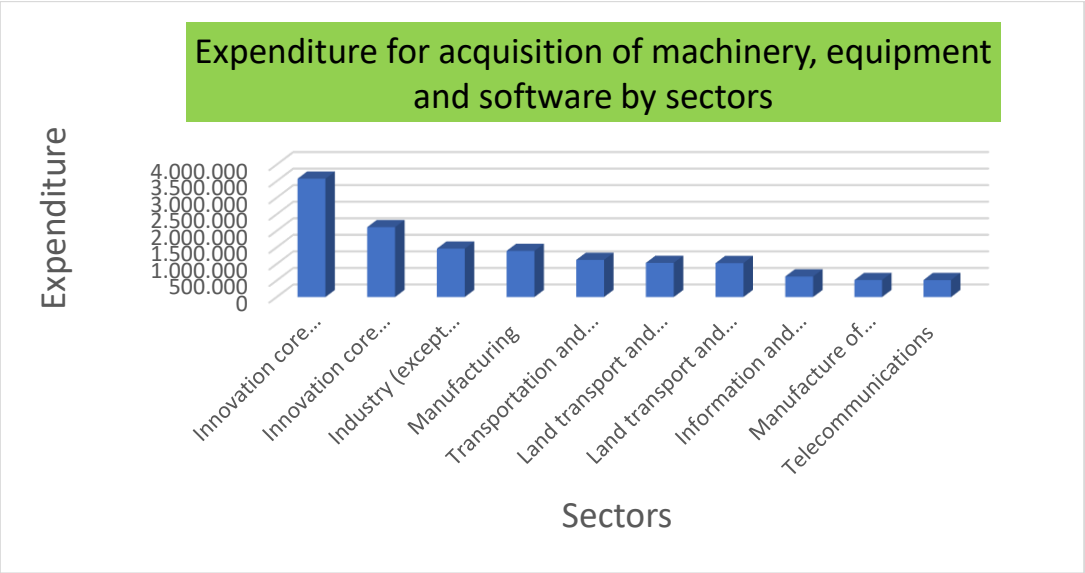
- Innovation core activities
- Industry (except construction)
- Manufacturing
- Innovation core services activities
- Manufacture of computer, electronic and optical products, electrical equipment, motor vehicles and other transport equipment
- Information and communication

Graphic 4.1.2 Expenditure for acquisition of external knowledge by sectors



Source: http://ec.europa.eu/eurostat/web/science-technology-innovation/data

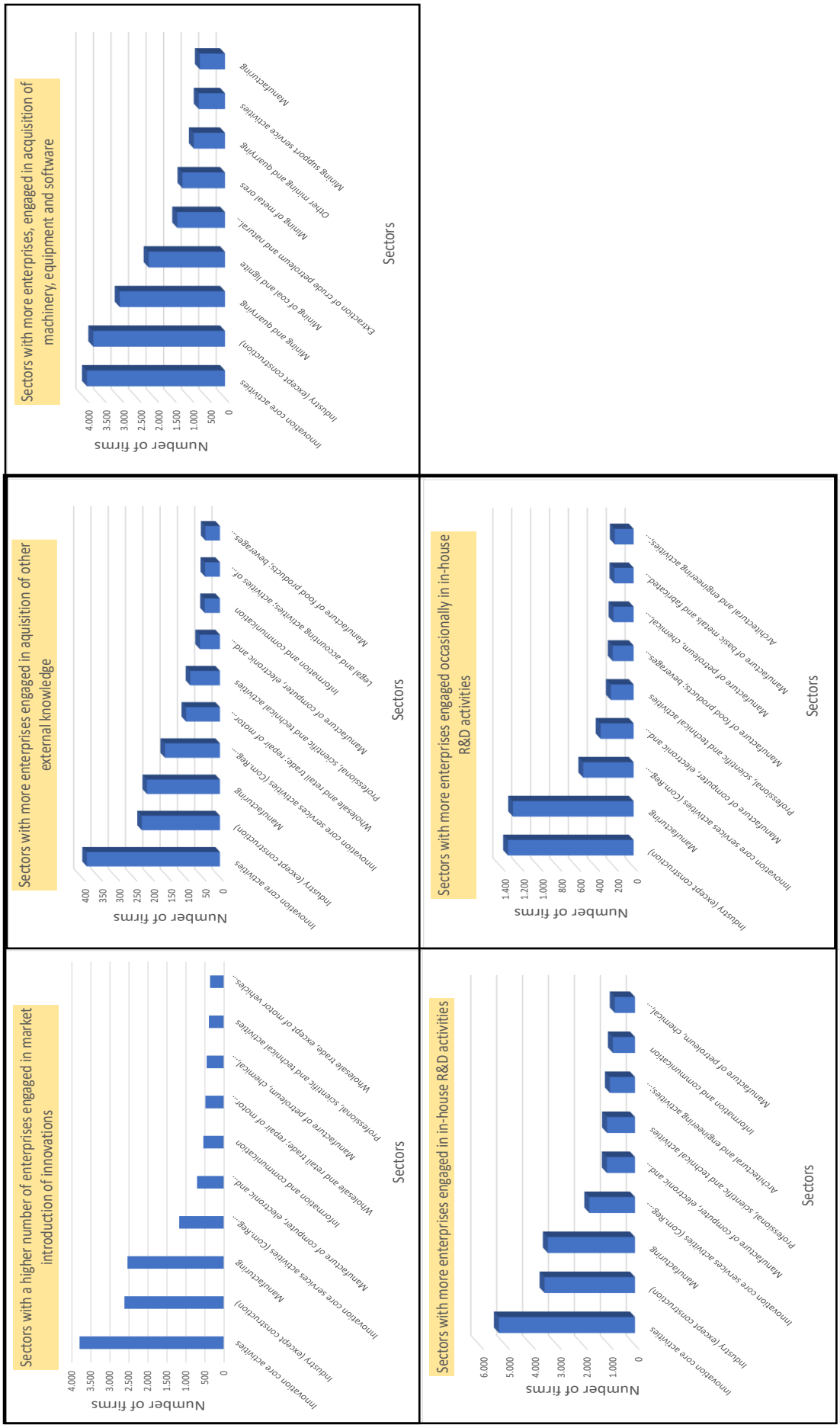
Graphic 4.1.3 Expenditure for acquisition of machinery, equipment and software by sectors



Source: http://ec.europa.eu/eurostat/web/science-technology-innovation/data

At the same time, it can be stated that in general those sectors which invest more in innovation present a larger number of firms engaged in innovation activities such as R&D activities, introduction of innovations to the market, acquisition of external knowledge and acquisition of machinery, equipment and software, among others. In the graphics below are represented those sectors which have a higher number of enterprises engaged in the activities mentioned. As it can be observed, many of them coincides with the sectors shown in graphic 4.1.1, 4.1.2 and 4.1.3.

Graphic 4.1.4 Sectors with more enterprises engage in innovation activities



Source: http://ec.europa.eu/eurostat/web/science-technology-innovation/data

The second part of the methodology is focused on determining the innovation degree of the different economic sectors. To evaluate that, innovation indicators mentioned in section 3.6 have been used in conjunction with the information extracted from the PITEC data base. In addition, the program SPSS for statistics has been employed for obtaining the desired results.

In more detail, it was proceeded to perform a cluster analysis using the K-means method in which the economic sectors were classified into four categories. Basically, this multivariate technic allows the classification of objects in conglomerates (clusters) with a high internal homogeneity degree and external heterogeneity. The results provided by this technic cannot be considered unique since they depend on the variables and the cluster method used. The advantage in that case of using the K-means cluster, in which the association of cases is based on the distance between them in a set of variables, is that it is possible to select the number of conglomerates in which the objects (sectors in this case) will be grouped. It was considered the next four categories or clusters:

- Innovation leaders: this group involves those sectors which perform many innovation activities and serve as an example of high innovative sector.
- Innovation followers: the degree of innovation of these sectors is over the mean but do not reach the level of innovation of the followers.
- Moderate innovators: this group is under the mean in innovation. They perform innovative activities but in a lower degree than the previous two groups.
- Modest innovators: despite the sectors who belong to this category carry out innovative activities, the amount of them is lower than the other groups.

It is also needed to identify relevant variables which will be employed for evaluating the similarities between objects. All those variables which are not relevant can cause errors in the results. For that reason, is essential to consider only those indicators which add value to the study. In this project, were employed the next innovation activities as innovation parameters:

- Internal R&D
- Acquisition of external R&D

- Acquisition of machinery, equipment and hardware or advanced software and buildings
- Acquisition of other external knowledge for innovation
- Training for innovation activities
- Introduction of innovations to the market
- Design, other preparations for production and/or production

Information regarding these variables was found in INE (2015) questionnaires which provide the total number of companies who develop any of the innovation activities specified above by sectors together with the number of companies of each sector who participated in the questionnaire. Relative variables were used i.e. the values used during the study corresponds to the percentage obtained when the number of companies performing a concrete innovation activity is divided by the total number of companies of this sector and multiplied by 100. Concretely, along this section, it was used the data collected during the year 2015.

Once the variables, the objects and the number of conglomerates desired are established, it starts the procedure of conglomeration in which first the objects more distant between them are selected. Lower distance between objects implies a better affinity. Distances are calculated through a simple Euclidean distance using the next equation:

$$D_{jk} = \sqrt{\sum_{i=1}^{n}(x_{ij} - x_{ik})^2}$$

Equation 4.1.1

where x_{ij} refers to the value of the object *i* in the sample *j*, x_{ik} the value of the object *i* in the sample *k* and *n* the total number of objects that are being compared.

The next step consists on a sequential lecture of the data file where each sector is designated to the nearest center. The value of these centers changes as new sectors are included. Once all the economic have been assigned to one of the conglomerates, an iterative process is initiated in order to calculate the final centers.

As the iterations go on, the displacement of the centers becomes smaller until no displacement is observed.

Table 4.2.1 shows the initial centers of the conglomerates, i.e., the value associated to the objects which have been chosen as respective centers. These values correspond to the mean of each variable within the initial conglomerate. In addition, the program SPSS select cases which are different and use their values to establish the initial conglomerates.

Table 4.2 1 Centers of initial clusters

	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4
Intern R&D	88,51	75,00	77,09	22,63
Acquisition of external R&D	55,17	25,00	23,07	10,22
Acquisition of machinery, equipment, hardware, software and buildings	26,44	50,00	20,64	56,93
Acquisition of external knowledge	1,72	12,50	1,82	0,00
Training activities for employees	21,84	37,50	20,49	51,09
Introduction of innovations to the market	27,01	12,50	20,79	14,60
Design, other preparations for production and/or production	7,47	25,00	9,86	6,57

Source: own

As it has been mentioned above, the rest of the objects are assigned to the corresponding cluster in function of their distance to the new center through an algorithm. This process is repeat until ten iterations take place or until no displacement is appreciated. On that case, iterations stop when performed the maximum number of iterations is performed.

Table 4.2.2 shows the distance between centers of final clusters where the values correspond to the means of each variable in the final conglomerate. This is obtained when the process of iterative updating is done.

Table 4.2 2 Centres of final clusters

	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4
Intern R&D	82,78	75,00	59,38	33,48
Acquisition of external R&D	36,05	25,00	23,90	14,10
Acquisition of machinery, equipment, hardware, software and buildings	24,73	50,00	39,04	54,70
Acquisition of external knowledge	2,33	12,50	2,89	0,69
Training activities for employees	18,95	37,50	29,34	37,80
Introduction of innovations to the market	25,02	12,50	22,34	12,86
Design, other preparations for production and/or production	9,0475,00	25,00	10,54	11,30

Source: own

Table 4.2 3 Distance between centres of final clusters

Cluster	1	2	3	4
1		40,988	31,898	65,735
2	40,988		28,813	46,824
3	31,898	23,813		34,337
4	65,735	46,824	34,337	

Source: own

Table 4.2.3 shows the Euclidean distances between the centers of the final conglomerates. Therefore, it can be appreciated that there is a higher distance between the conglomerates 1 and 4 while conglomerates 2 and 3 are closer.

After this process, the cluster to which each sector belongs is obtained. The results show that 22 sectors were valid for the cluster analysis while any of them was discarded. From all these valid objects, 7 sectors were grouped in cluster 1, 1 in cluster 2, 9 in cluster 3 and 5 in cluster 4.

In addition, from the use of the SPSS program, F statistics of the variance analysis can be obtained. The ANOVA table provides information about the contribution of each variable to the separation of groups. Those variables which present higher values of F will contribute to a greater separation between conglomerates. Therefore, it can observe that the highest F belongs to the variable internal R&D with a value of 60,975, while the lowest value of F, which is 3,518, corresponds to the variable design, other preparations for production and/or production.

Table 4.2 4 Table ANOVA

	Clúster		Error			
	Media cuadrática	gl	Media cuadrática	gl	F	Sig.
Intern R&D	2438,992	3	40,000	18	60,975	,000
External R&D	483,982	3	65,977	18	7,336	,002
Acquisition of machinery	924,489	3	19,121	18	48,348	,000
Acquisition of external knowledge	39,182	3	1,629	18	24,048	,000
Innovation training	386,049	3	54,729	18	7,054	,002
Introduction of new innovations	176,400	3	21,835	18	8,079	,001
Design innovation	74,962	3	21,309	18	3,518	,036

Source: own

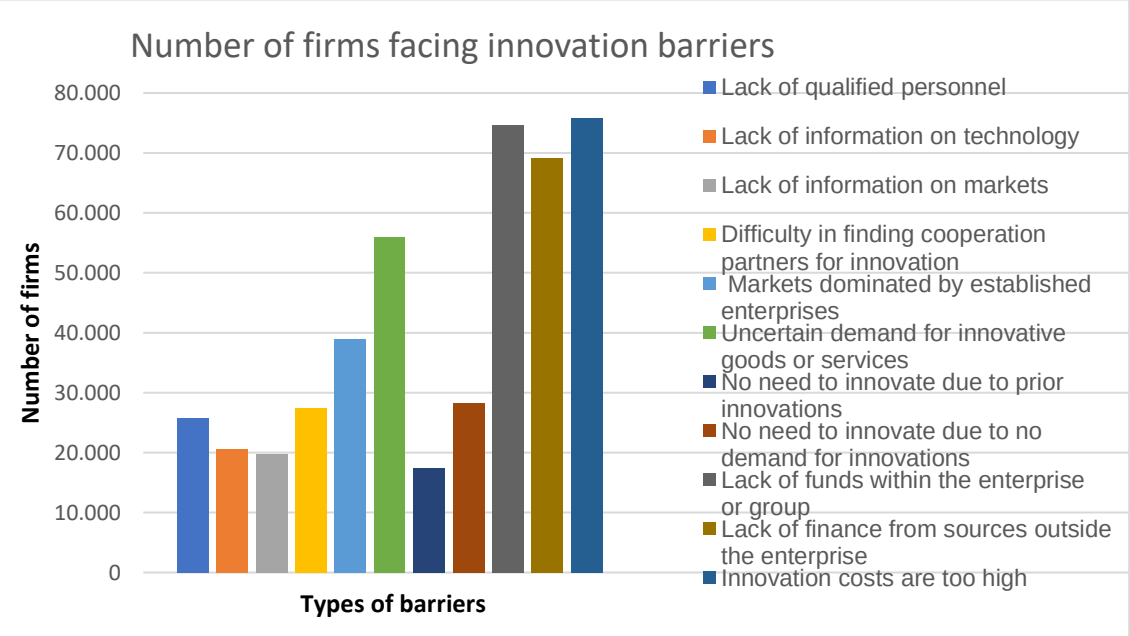
4.2 Analysis of innovation barriers

On the other side, factors hampering innovation activities were also studied. The constraints considered by the CIS questionnaire were:

- Lack of qualified personnel
- Lack of information on technology
- Lack of information on markets
- Difficulty in finding cooperation partners for innovation
- Markets dominated by established enterprises
- Uncertain demand for innovative goods or services
- No need to innovate due to previous innovations
- No need to innovate due to no demand for innovations
- Lack of funds within the enterprise or group
- Lack of finance from sources outside the enterprise
- Innovation costs are too high

Thus, it was obtained the number of enterprises which were affected during the period 2008-2010 by these constraints as it can be seen in the graphic 4.1.

Graphic 4.2.1 Number of firms facing innovation barriers



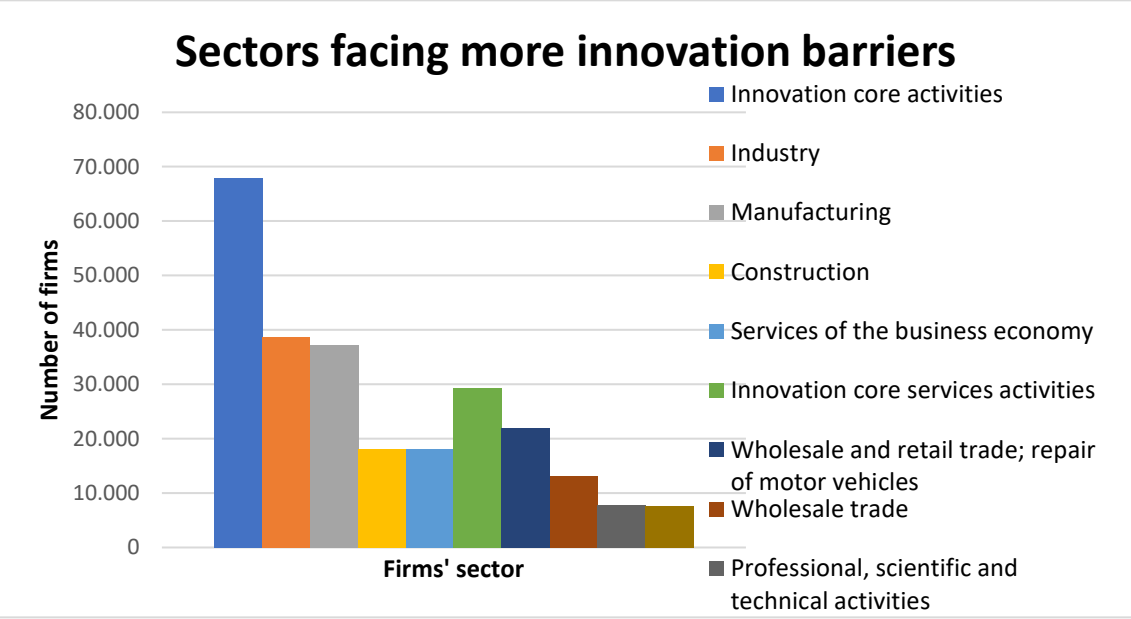
Source: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=inn_cis7_ham&lang=en

From the graphic above, it can be observed that innovation costs, lack of funds within the enterprise or group and lack of finance from sources outside the

enterprise are the most current barriers to which companies deal with. This is correlated with the literature analyzed where financial barriers were pointed as one of the most concerning factors hampering innovation (Hözl et al. 2001; Larsen et al. 2007; Pellegrino et al. 2017; Sandberg et al. 2014).

Furthermore, the information was analyzed by sectors. This allowed the obtaining of a list of those economic sectors which present a larger number of firms affected in their innovation activities and those sectors which are affected in a lower degree. The graphic below is a representation of this, where the sectors with a higher number of firms confronting barriers are shown. These sectors are: innovation core activities, industry, services of the business economy, manufacturing, construction, innovation core services activities, wholesale and retail trade and professional, scientific and technical activities. The first three sectors mentioned are the ones, who according to the data obtained, must deal with more barriers as it is seen in the graphic 4.2.

Graphic 4.2.2 Number of enterprises of the sectors that are more affected by innovation barriers



Source: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=inn_cis7_ham&lang=en

Further study was made to compare both type of sectors. For that reason, it was performed a table showing the 10th sectors where innovation barriers have a greater impact and the 10th sectors where this effect is lower. The table, shows the number of enterprises by sector to which somehow the factors analyzed hamper innovation.

Table 4.2.1 Comparison between the 10th economic sectors more and less affected by innovation barriers

Sectors	Barriers to Innovation											
	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services	No need to innovate due to prior innovations	No need to innovate due to no demand for innovations	Lack of funds within the enterprise or group	Lack of finance from sources outside the enterprise	Innovation costs are too high	Number of firms which find barriers to innovation
Innovation core activities	3.729	2.997	2.822	4.024	5.829	8.746	2.336	3.890	11.350	10.646	11.570	67.939
Services of the business economy	3.624	2.722	2.637	3.692	4.732	6.399	2.684	4.529	9.152	8.313	9.082	57.566
Industry (except construction)	2.080	1.636	1.579	2.161	3.315	5.180	1.168	1.687	6.788	6.283	6.832	38.709
Manufacturing	2.015	1.580	1.537	2.089	3.215	5.032	1.093	1.586	6.533	6.017	6.609	37.306
Innovation core services activities (Com.Reg. 1450/2004)	1.649	1.361	1.243	1.863	2.514	3.566	1.168	2.203	4.562	4.364	4.738	29.231
Wholesale and retail trade; repair of motor vehicles and motorcycles	1.306	1.168	954	1.226	1.847	2.583	1.099	2.053	3.147	3.032	3.498	21.913
Construction	736	1.067	914	1.036	2.112	2.477	726	1.505	2.385	2.312	2.893	18.163
Wholesale trade, except of motor vehicles and motorcycles	739	732	551	812	1.030	1.610	596	1.315	1.777	1.784	2.115	13.061
Professional, scientific and technical activities	387	262	320	626	677	860	368	424	1.390	1.284	1.275	7.873
Administrative and support service activities	597	453	477	603	626	802	311	643	1.152	978	1.063	7.705
Information service activities	22	5	14	38	40	47	5	10	63	58	37	339
Employment activities	32	13	6	11	21	20	36	25	66	51	57	338
Financial service activities, except insurance and pension funding	16	14	2	20	16	21	14	32	58	42	71	306
Water collection, treatment and supply	9	8	5	10	18	12	23	14	36	41	33	209
Insurance, reinsurance and pension funding, except compulsory social security	3	4	3	1	17	6	23	7	18	16	31	129
Electricity, gas, steam and air conditioning supply	6	8	8	5	3	9	3	12	17	27	24	122
Mining of coal and lignite	1	2	0	0	0	3	0	2	4	3	2	17
Manufacture of coke and refined petroleum products	0	1	0	0	0	0	0	0	1	2	1	5
Mining of metal ores	0	0	0	0	0	0	1	1	0	1	0	3
Extraction of crude petroleum and natural gas	0	0	0	0	0	0	0	0	0	0	0	0

Source: own from http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=inn_cis7_ham&lang=en

Therefore, from these graphics it can be observed that the three main barriers shown in graphic 4.1 which are basically financial barriers, coincide with the three principal obstacles that the sectors mentioned in table 4.1 must confront. The only exception is the insurance, reinsurance and pension funding sector in which no need to innovate because prior innovation is the second most concerning barrier.

As well as section 4.1, for analyzing barriers a cluster analysis was performed. Thus, the same procedure was followed and the sectors were classified within four conglomerates in function of their impact on the different sectors. The data was also obtained from the INE data base in which the information is display as the percentage of companies, by sector, which consider of high relevance a concrete barrier. The barriers of which information was available and thus, were used in this project, are:

- Cost barriers
- Knowledge barriers
- Market barriers
- Do not have reasons for innovating because previous innovations or simply because there is no demand of innovations.

After defining that, it was proceeded to introduce the different values in the SPSS program in order to obtain the cluster to which belong each sector. Clusters ranged from 1 to 4 in which 1 represents that conglomerate which encompasses those sectors that find more factors that hamper innovation or influence their decision of not innovating.

Below can be observed those graphics described in section 4.1 but with the values for the barriers' case.

From the graphic corresponding to distance between centers of final clusters, can be perceived that a higher distance is given between clusters 2 and 3 while clusters 1 and 4 present a lower Euclidean distance.

Table 4.2.2 Centers of initial clusters

	Cluster			
	1	2	3	4
Cost barriers	40,60	58,63	25,65	29,44
Knowledge barriers	25,48	33,40	17,70	12,60
Market barriers	29,60	36,86	15,14	21,02
Do not have reasons to innovate	34,97	26,26	43,07	21,79

Source: own

Table 4.2.3 Centers of final clusters

	Cluster			
	1	2	3	4
Cost barriers	41,81	58,63	29,03	44,77
Knowledge barriers	23,20	33,40	16,52	17,23
Market barriers	27,81	36,86	18,01	31,14
Do not have reasons to innovate	26,06	26,26	33,80	9,55

Source: own

Table 4.2.4 Distance between centers of final clusters

Cluster	1	2	3	4
1		21,656	19,068	18,118
2	21,656		39,659	27,670
3	19,068	39,659		31,757
4	18,118	27,670	31,757	

Source: own

Table 4.2.5 Table ANOVA

	Clúster		Error			
	Media cuadrática	gl	Media cuadrática	gl	F	Sig.
Cost barriers	612,160	3	20,428	29	29,967	,000
Knowledge barriers	172,021	3	9,961	29	17,269	,000
Market barriers	344,225	3	11,241	29	30,623	,000
Do not have reasons to innovate	692,900	3	38,121	29	18,176	,000

Source: own

5 Results

The cluster to which each sector belongs, in function of the number of companies in this sector performing technological innovation activities, was identified. Because the reliability of the results, finally only were studied those sectors of the CNAE ranging from 10 to 33, i.e., manufacture sectors. In the table below, these sectors and their respective clusters are represented:

Table 5.1 Cluster to which belongs each sector

SECTORS	CLUSTER
3. Food, drinks and tobacco (CNAE 10, 11, 12)	3
4.1. Textile (CNAE 13)	3
4.2. Confeccion (CNAE 14)	4
4.3. Leather and footwear (CNAE 15)	4
5.1. Wood and cork (CNAE 16)	4
5.2. Cardboard and paper (CNAE 17)	4
5.3. Graphic arts and reproduction (CNAE 18)	4
2.2. Oil industries (CNAE 19)	2
6. Chemistry (CNAE 20)	1
7. Pharmacy (CNAE 21)	1
8. Rubber and plastics (CNAE 22)	3
9. Miscellaneous non-metallic mineral products (CNAE 23)	3
10. Metallurgy (CNAE 24)	1
11. Metal manufacturers (CNAE 25)	3
12. Computer, electronic and optical products (CNAE 26)	1
13. Electrical equipment and material (CNAE 27)	1
14. Other machinery and equipment (CNAE 28)	1
15. Motor vehicles (CNAE 29)	3
16. Other transport materials (CNAE 30)	1
17. Furniture (CNAE 31)	3
18. Other manufacturing activities (CNAE 32)	3
19. Repair and installation of machinery and equipment (CNAE 33)	3

Source: own

According to the results obtained, those sectors which present a higher percentage of companies performing innovation activities are:

- Chemistry
- Pharmacy

- Computer, electronic and optical products
- Metallurgy
- Other machinery and equipment
- Other transport materials

This match with the data that appears in INE where is mentioned that in the 3 sectors first mentioned the percentage of companies with innovation activities in 2015 over the total of companies is above the 50% (53,96%, 75,68% and 56,74% respectively). That means, that in these sectors there are a higher number of companies which perform technological innovation activities than those who do not participate in this kind of activities. In addition, these results have sense since these sectors are well known for investing in R&D and constantly bet for innovation. Specifically, during the year 2015 the 8,6% of the expenditure of R&D in Spain is associated to the pharmaceutical sector, according to INE press release (INE 2015). In addition, 3,3% of the expenditure in R&D was concentrated in the chemical sector and 8,4% in computer activities.

Otherwise, metallurgy, electrical equipment and material, other machinery and equipment and other transport materials are reported to be the manufacture sectors with a lower percentage of companies developing innovations.

Furthermore, an analysis of the effect of barriers among Spanish firms was performed. The first part of this study was focused on carefully analyze the data obtained from CIS questionnaires in which it was found that financial constraints are the most frequent barriers that companies must face. More detailed, the financial barriers involve innovation costs, lack of funds within the enterprise or group and lack of finance. These results are closely related with the statements of many scholars who declare that financial barriers affect widely the firms and are a concerning fact.

In addition, it was determined which are those sectors that present a higher number of companies facing the barriers submitted to study. Discoveries show that innovation core activities, industry, services of the business economy and manufacturing are the sectors which face a large number of barriers. Results also show that those sectors which invest more in R&D are at the same time the ones that are affected by more obstacles.

A cluster analysis was also useful in this section for analyzing the effect of barriers. This tool allows the classification of the data sample in conglomerates. It was determined which are those sectors that are more concerned about cost, market and financial barriers and which are concerned in a lower degree. Finally, it was concluded that the sectors more affected by the presence of barriers are: chemistry, pharmacy, computer, electronic and optical products, motor vehicles and other transport materials. Most of them coincide with the sectors which previously were assign to the group of sectors developing more innovation activities. This discovery fits with findings in literature where some scholars discuss the fact that those companies or sectors who innovate more are also the sectors who must face a large number of constraints to innovation

Table 5.2 Clusters by sectors: barriers

SECTORS	CLUSTER
1. Agriculture, livestock, frestry and fishing	1
2. Extractive and oil industries (CNAE 05, 06, 07, 08, 09, 19)	1
3. Food, drinks and tobacco (CNAE 10, 11, 12)	1
4. Textile, confection, leather and footwear (CNAE 13, 14, 15)	1
5. Wood, paper and graphic arts (CNAE 16, 17, 18)	1
6. Chemistry (CNAE 20)	4
7. Pharmacy(CNAE 21)	4
8.Rubber and plastics (CNAE 22)	1
9. Miscellaneous non-metallic mineral products (CNAE 23)	1
10. Metallurgy (CNAE 24)	1
11. Metal manufacturers (CNAE 25)	1
12. Computer, electronic and optical products (CNAE 26)	4
13. Electrical material and equipment (CNAE 27)	1
14. Other machinery and equipment (CNAE 28)	1
15. Motor vehicles (CNAE 29)	4
16. Other transport material (CNAE 30)	4
17. Furniture (CNAE 31)	2
18. Other manufacturer activities (CNAE 32)	1
19. Repair and installation of machinery and equipment (CNAE 33)	3
20. Energie and water (CNAE 35, 36)	3
21. Sanitation, waste management and decontamination (CNAE 37, 38, 39)	3
22. Construccion (CNAE 41, 42, 43)	1
23. Comemerce (CNAE 45, 46, 47)	3
24. Transport and storage (CNAE 49, 50, 51, 52, 53)	3
25. Hostelry (CNAE 55, 56)	3
26. Information and communication (CNAE 58, 59, 60, 61, 62, 63)	1
27. Finance and inssurance activities(CNAE 64, 65, 66)	3

28. Real state activities (CNAE 68)	**3**
29. Professional, scientifical activities (CNAE 69, 70, 71, 72, 73, 74, 75)	**3**
30. Administrative and auxiliary services (CNAE 77, 78, 79, 80, 81, 82)	**3**
31. Health and social services activities (CNAE 86, 87, 88)	**3**
32. Artistic, recreational and entertainment activities (CNAE 90, 91, 92, 93)	**3**
33. Other services(CNAE 85-854, 94, 95, 96)	**1**

Source: own

6 Conclusions

To sum up, from a literature review, it can be concluded the following points about innovation and what implies for companies and countries and their development:

- Innovation expenditure in Spain has decreased considerably in the lasts years because the crisis. Therefore, the country is considered to be a moderate innovator which is located under the European mean.
- Oppositely to the fact mentioned above, global interest on innovation has increased significantly. Nowadays, people is more aware about the important role that innovation plays improving social welfare in the developed world. This have lead that more organizations are focused in obtaining and processing data about innovation from different companies.
- Some of the most common reasons which encourage enterprises for being innovative are to increase the turnover, decrease costs, increase market share and increase profit margin, among others.
- Not all the firms want to innovate. This fact takes place due to a previous innovation which leads firms to not have necessity or simply because they are not interested.
- The literature also remarks that close to the technological frontier, it is found a higher quantity of innovative companies.
- There are different ways to classify barriers depending on the perspective in which they are observed. Clearly, these constraints have a negative effect over innovation but they do not affect the different types of companies equally. An example could be that many authors distinguish two types of companies in function of the size, large firms and SMEs.
- Large firms are characterized for presenting a higher innovation activity than SMEs and use a wider range of knowledge sources. In addition, it has been observed that they have more facility for finding partners whit who they can cooperate along the innovation process. On the other side, this kind of enterprises are more affected by customer resistance and a restrictive mindset, which is related.
- SMEs constitute the 99,88% of the total number of Spanish companies i.e. most of the firms in Spain are englobed in this category. This implies that

a special attention must be done, when studying innovation, in this kind of companies. Furthermore, it has been shown that SMEs are more affected by financial issues, being this a critical factor, which can delimit the innovation capacity of these firms since they decrease firms' possibilities of becoming successful in innovation. Studies have pointed that there are different paths that companies follow in their efforts to address this obstacle such as ask for a loan, request a grant to the government, use own funds, close the company temporary, etc. As well as large companies, SMEs are also affected by a restrictive mindset.

- Furthermore, the age of the firm is another factor that influence firms. Theory pointed that novel firms present a lower concerning about having skilled employees whereas companies which are well established have demonstrated that having skilled personnel which is in constant learning is beneficial for the company and thus, something to keep in mind.
- Another point to highlight, is the fact that studies support the theory that innovators must deal with more constraints than non-innovators and they invest more in innovation. At the same time, innovators have shown a major focus on export, perform organizational changes and have high skilled employees.

Otherwise, it was performed a numerical study which reflect some interesting facts about topics covered throughout this project. To summarize, the next statements show the findings of this research:

- Motor vehicles, pharmacy and other transport material are those industry sectors which present a higher expenditure in innovation while in the services field highlight professional, scientific and technological activities, information and communication and finance and insurance as the ones that require higher investment.
- Chemistry, pharmacy and computer, electronic and optical products are those economic sectors which count with a larger number of companies developing innovations, if it is considered the number of companies in the sector performing innovation activities by the total of companies of that sector. Meanwhile, metallurgy, electrical equipment and material, other

machinery and equipment and other transport materials are located on the opposite side of the scale.

- In general, it was observed that those companies who invest more in R&D are at the same time enterprises that confront a high number of constraints hampering innovation.
- The most concerning barriers, or at least those barriers which are more widely spread over companies, are innovation costs, lack of funds within the enterprise or group and lack of finance from sources outside the enterprise.
- Sectors such as innovation core activities, industry, services of the business economy and manufacturing must deal with a large number of barriers.

Further research focused on the sectorial analysis of innovation and barriers should be done since it is an issue that really affects companies and their performance. Know by first hand which are those barriers that affect each sector and in which degree, can be helpful for companies for looking ways to address them efficiently. In this project it was determined which are those sectors that are located in each extreme of the innovation barometer. Once this is known, actions for increase and promote innovation should be taken.

Innovation affect every sector, even those who have a lower need for innovating. Because its relevance, it should be promoted by competent organisms such as the government or within the company itself, to look for how to be more innovative especially in those sectors which innovate less. All sectors can be benefited from carrying out innovative activities in many of their fields since it can reduce process cost and time, increase turnover, to give the opportunity to address new markets, etc.

In addition, as it was observed, the main barrier to innovation is based on finance, thus it should be analyzed with more detail how to confront this constraint. It has been shown that some companies address this through the request of loans, personal funds, stop and go strategy, request innovation grants to local government, etc. Therefore, it will be useful to analyze which solution fits better for each scenario i.e. what works better for companies based in their

characteristics such as the size of the company, activities they perform, etc. An exhaustive analysis on that could help governmental entities to divide better and select a more tight budget when they decide how innovation expenditure will be distributed.

7 References

BLIND, K., PETERSEN, S.S., and RIILLO, C.A., 2017. The impact of standards and regulation on innovation in uncertain markets. Research Policy [online], 46, pp. 249 – 264. DOI: 10.1016/j.respol.2016.11.003 [Accessed 10 May 2017].

BRÜGGEMANN, J., CROSETTO, O., MEUB, L., and BIZER, K., 2016. Intellectual property rights hinder sequential innovation. Experimental evidence. Research Policy [online], 45, pp. 2054 – 2068. DOI: 10.1016/j.respol.2016.07.008 [Accessed 11 May 2017].

BUESA, M., HEIJS, J., and BAUMERT, T., 2010. The determinants of regional innovation in Europe: A combined factorial and regression knowledge production function approach. Research Policy [online], 39, pp. 722-735 [Accessed 11 April 2017].

CAMISÓN, C., and VILLAR-LÓPEZ, A., 2014. Organizational innovation as an enabler of technological innovation capabilities and firm performance. Journal of Business Research [online], 67, pp. 2891-2902. DOI: 10.1016/j.jbusres.2012.06.004 [Accessed 3 April 2017].

CASSAMATTA, C., 2003. Financing and advising: optimal financial contracts with venture capitalists. The Journal of Finance [online], 58 (5), pp. 2059-2085. DOI: 10.1111/1540-6261.00597 [Accessed 18 April 2017].

COHEN, W.M., and LEVINTHAL, D.A., 1990. Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly [online], 35(1), pp.128-152. Available via: JSTOR [Accessed 6 May 2017].

CORNELL UNIVERSITY, INSEAD, and WIPO, 2016. The Global Innovation Index 2016: Winning with Global Innovation. Cornell University, INSEAD and WIPO, Ithaca, Fontainebleau, and Geneva.

COTEC, 2016. Informe COTEC 2016: Innovación en España. Fundación COTEC para la Innovación, Madrid.

D'ESTE, P., LAMMARINO, S., SAVONA, M., and TUNZELMANN, N., 2012. What hampers innovation? Revealed barriers versus deterring barriers. Research

Policy, 41, pp. 482-488. DOI:10.1016/j.respol.2011.09.008 [Accessed 27 April 2017].

ESPAÑA. Ministerio de Ciencia e Innovación, 2011. Análisis comparativo sobre el diseño, configuración y aplicabilidad de Incentivos Fiscales a la Innovación empresarial. Madrid: Alma Consulting Group.

ESPAÑA. Ministerio de Economía, Industria y competitividad, 2014. La innovación en España según el Cuadro de Indicadores de la Unión por la Innovación de 2013. Madrid: FECYT e ICONO.

ESPAÑA. Ministerio de Economía, Industria y competitividad, 2017. Análisis ICONO: Encuesta de innovación 2015. Madrid: FECYT e ICONO.

ESPAÑA. Ministerio de Economía, Industria y competitividad, 2016. Retrato de la PYME. Madrid: Ministerio de Economía, Industria y competitividad.

EUROPEAN UNION. European Centre for the Development of Vocational Training (CEDEFOP), 2012. Future skills supply and demand in Europe. Luxembourg: Publications Office of the European Union.

EUROPEAN UNION. European Commission, 2015. Innobarometer 2015 – The innovation trends at EU enterprises. European Union.

EUROSTAT, 2017. Innovation statistics [online]. Available via: Eurostat Statistics Explained [Accessed 3 April 2017].

FUNDACIÓN BBVA – IVIE, 2017. Las diferencias regionales en esfuerzo inversor en I+D se reducen un 9% durante los años de crisis, pero en lo que llevamos de siglo han aumentado casi un 40% [online]. Esenciales Fundación BBVA – Ivie. Available at: http://estaticos.expansion.com/opinion/documentosWeb/2017/03/17/FBBVA_Esenciales_14_tcm269-643402%20(1).pdf [Accessed 10 May 2017].

GALLEGO, J., RUBALCABA, L., and SUÁREZ, L., 2013. Knowledge for innovation in Europe: The role of external knowledge on firms' cooperation strategies. Journal of Business Research [online], 66, pp. 2034-2041. DOI: 10.1016/j.jbusres.2013.02.029 [Accessed 11 April 2017].

GARCÍA, G., SERRANO, A.M., and CONCEPCIÓN, M., 2016. Sector innovation capacity determinants: modelling and empirical evidence from Spain. R&D Management [online], 46 (1), pp. 80 – 95. DOI: 10.1111/radm.12125.

GEIGER, S., and FINCH, J., 2016. Making incremental innovation tradable in industrial service settings. Journal of Business Research [online], 66, pp. 2463-24700. DOI: 10.1016/j.jbusres.2016.02.015 [Accessed 17 June 2017].

GUO, J., SU, Q. and ZHANG, Q., 2017. Individual creativity during the ideation phase of product innovation: an interactional perspective. Creativity and Innovation Management [online], 26(1), pp. 31-48. DOI: 10.1111/caim.12205 [Accessed 17 May 2017].

HARBO, M. and PRAEST, M., 2017. From creative ideas to innovation performance. John Wiley & Sons Ltd. [online], 26(1), pp. 60-74. DOI: 10.1111/caim.12204 [Accessed 2 April 2017].

HASHI, I. and STOJCI, N., 2013. The impact of innovation activities on firm performance using multi-stage model: Evidence from the Community Innovation Survey 4. Research Policy [online], 42, pp. 353-366. DOI: 10.1016/j.respol.2012.09.011 [Accessed 24 June 2017].

HÖLZL, W., and JANGER, J., 2011. Innovation barriers across firm types and countries. Procedings of the DIME Final Conference, 6-8 April 2011, Maastricht. WIFO.

INSTITUTO NACIONAL DE ESTADÍSTICAS, 2016. Encuesta sobre innovación en las empresas [online]. Available via: INEbase [Accessed 25 June 2017].

KLEINLNECHT, A., VAN MONTFORT, K. and BROUWER, E, 2002. The non-trivial choice between innovation indicators. Economics of Innovation and New Technology [online], 11(2), pp. 109-121. DOI: 10.1080/10438590210899 [Accessed 24 June 2017].

LARSEN, P., and LEWIS, A., 2007. How award-winning SMEs manage the barriers to Innovation. Blackwell Publishing [online], 16(2), pp. 142 – 151. DOI:10.1111/j.1467-8691.2007.00428.x [Accessed 12 May 2017].

LIAN, J.W., and YEN, D.C., 2013. To buy or not to buy experience goods online: Perspective of innovation adoption barriers. Computers in Human Behavior [online], 29, pp. 665-672. DOI: 10.1016/j.chb.2012.10.009 [Accessed 11 May 2017].

MARTÍNEZ, A.I., QUINTÁS, M.A., SARTAL, A., and VÁZQUEZ, X.H., 2013. ¿Es rentable <<pensar por pensar>>? Evidencia sobre innovación en España. Cuadernos de Economía y Dirección de la Empresa [online], 16, pp. 142-153. DOI: http://dx.doi.org/10.1016/j.cede.2012.08.001 [Accessed 6 May 2017].

OECD, 2005. Oslo Manual: Guidelines for collecting and interpreting innovation data. Committee for Scientific and Technological Policy, OECD-OCDE, Paris.

PELLEGRINO, G., and SAVONA, M., 2017. No money, no honey? Financial versus knowledge and demand constraints to innovation. Research Policy [online], 46, pp.510-521. DOI: 10.1016/j.respol.2017.01.001 [Accessed 15 May 2017].

PELLEGRINO, G., 2014. Essays on Determinants and Effects of Barriers to Innovation. Ph.D. thesis, Universitat de Barcelona.

PÉREZ, J., 2015. Innovación Empresarial. Características, factores y determinante. Un análisis en base a la encuesta de innovación del INE. M.A. thesis, Universitat Politècnica de València.

PERKINS, G., LEAN, J., and NEWBERY, R., 2017. The role of organizational vision in guiding idea generation within SME contexts. John Wiley & Sons Ltd. [online], 26(1), pp. 75-90. DOI: 10.1111/caim.12206 [Accessed 2 April 2017].

PwC, 2013. Unleashing the power of innovation [online]. PwC. Available at: http://www.pwc.es/es/publicaciones/gestion-empresarial/assets/global-ceo-pulse-survey-innovation.pdf [Accessed 27 March 2017].

SANDBERG, B., and AARIKKA-STENROOS, 2014. What makes it so difficult? A systematic review on barriers to radical innovation. Industrial Marketing Management [online], 43(8), pp. 1293-1305. DOI: 10.1016/j.indmarman.2014.08.003 [Accessed 20 April 2017].

SARACENI, A.V., MARTINS DE RESENDE, L.M., SERPE, L.F. and ANDRADE, P.P., 2015. A comparative analysis between clustered and nonclustered companies using innovation indicators. IFAC-Papers [online], 48(3), pp. 155-160. DOI: 10.1016/j.ifacol.2015.06.074 [Accessed 25 June 2017].

SCHUMPETER, J., 1934. The Theory of Economic Development. Massachusetts: Harvard University Press.

STATISTICS FINLAND, 2014. Innovation activity 2012. [online]. Available via: Statistics Finland [Accessed 30 March 2017].

THE COMMUNITY INNOVATION SURVEY, 2012. The harmonized survey questionnaire.

YASAR, B., and SISMANOGLU, E., 2015. Innovation and the effect of research and development (R&D) expenditure on growth in some developing and developed countries. Procedia – Social and Behavioral Sciences [online], 195, pp. 768 – 775. DOI: 10.1016/j.sbspro.2015.06.474 [Accessed 1 April 2017].