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**WHAT IS THE ROLE OF INNOVATION
STRATEGIES? EVIDENCE FROM SPANISH
FIRMS**

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What is the role of innovation strategies? Evidence from Spanish firms

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Abstract:

This paper discusses the determinants of two alternative measures of innovative success/output by looking at firm's innovation strategies. These relationships are also discussed by distinguishing between firms belonging to manufacturing and services sectors. Our econometric analysis is based on an extensive sample of 3,919 firms taken from the Spanish Technological Innovation Panel (PITEC) for the period 2008–2012. Alongside the empirical analysis we applied a two-step procedure. We first identified a diverse range of innovation strategies by applying a principal component analysis (absence, mixed and oriented). Then, after controlling for positive skewness of the dependent variables, we used a generalized linear model (GLM) to examine the impact of these strategies. Our empirical results have some interesting aspects. Firstly, firms that do not design innovation strategies have a lower probability of being a successful innovative firm. Secondly, firms that design a strategy, but one that is not oriented on any specific direction, are prone to achieving lower success rates than firms with an oriented strategy. Finally, the results also show that there is a good fit between the oriented strategy pursued by a firm and its innovation success.

Keywords: innovation strategy, innovation success, innovation objectives, Spain, PITEC

JEL Classification Numbers: D21. O31. O32

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1. INTRODUCTION

It is well known that innovation is a decisive tool in ensuring the competitive position of firms in their markets. In fact, innovation is a process with high levels of uncertainty and a right innovation strategy can help firms to guide the process in order to enjoy a durable competitive advantage in dynamics environments (Cooper 1984b; Smith 2010). Hence, firms may dedicate efforts and time to design, ex ante which innovation strategies they wish to pursue to meet their objectives (Burgelman, Christensen, and Wheelwright 2004; Cooper and Edgett 2010). In this paper, we analyse empirically the role that innovation strategies play in achieving innovation outputs. In particular, we ask both which strategy has the greatest odds of improving innovation success and whether there is a fit between the innovation strategy pursued and innovation success measured in terms of product and process innovations.

In recent decades, empirical research has attempted to identify why some firms have been more innovative than others, and also how firms may improve their odds of successful innovation. Today, a large body of research exists on the determinants of innovation, as well as on the effects of innovation on firms¹. An agreement factor that emerges from these body of literature and enhances innovative success is an explicit innovation strategy because it provides a guideline for dealing with strategic issues, such as selecting the market to enter or developing new products (Ernst 2002; van der Panne, van Beers, and Kleinknecht 2003; Schroeder 2013). Hence, over the last few decades, the empirical literature has mainly discussed the role of innovation strategies using the concept of innovation input or output representing a subset of the various innovation strategies that firms have at their disposal. For instance, in relation to innovation output,

¹ The main model explored in this literature is the CDM model based on Crepon, Duguet, and Mairesse (1998) that links R&D expenditures, innovation output and productivity.

product, process, marketing and organisational strategies have been analysed (Hervas-Oliver, Sempere-Ripoll, and Boronat-Moll 2014; Jayaram, Oke, and Prajogo 2014; Karlsson and Tavassoli 2015; Tavassoli and Karlsson 2015), or according to R&D sources (innovation input) empirical literature has distinguished between internal strategy (to make), external strategy (to buy) and, more recently, cooperation strategy (Veugelers and Cassiman 1999; Vega-Jurado, Gutiérrez-Gracia, and Fernández-de-Lucio 2009; Goedhuys and Veugelers 2012; Mata and Woerter 2013; Love, Roper, and Vahter 2014).

However, this literature has hardly explored a broader and long term relationship between innovation strategies and innovation success, it has mainly focus solely on innovation inputs or output point of views. Our approach to addressing this gap is to take a step back compared to previous studies on innovation determinants, starting with the innovation objectives since these are found to be the starting point of the innovation process and provides a broader and long term vision of the process (OECD -Eurostat 2005; Cooper and Edgett 2010). To do this, our data comes from the Spanish Technological Innovation Panel (PITEC), a dataset that comprises the annual Spanish Community Innovation Survey (CIS) questionnaire and follows the methodological guidelines defined in the OECD's Oslo Manual. Using a broad sample of 3,919 Spanish manufacturing and services firms for the period 2008–2012, we carry out our empirical analysis in two stages. Firstly, we identify the different kind of innovation strategies that a firm can design. Applying a principal component analysis to thirteen innovation objectives listed in the innovation survey, we define the innovation strategies (absence, mixed and oriented towards quality, production, cost and environmental and regulatory) that firms may pursue to improve their odds of successful innovation. Then, we examine the impact on innovation success of these strategies and their degree of fit applying a GLM model to check for positive skewness in the dependent variables.

Our contribution differs from the previous literature in a number of ways. Firstly, we expand the scope of analysis of innovation strategies beyond only the field of input or output innovation only point of view in order to provide a much richer understanding of firms' choices of innovation strategies as well as of the effects of different strategies on innovation success. Secondly, given the current increasing importance of service firms in most industrialized countries and the distinct nature of the innovative processes between manufacturing and service firms (Segarra-Blasco 2010; Leiponen 2012) we consider it appropriate and relevant to explore and study in more depth the differences between manufacturing and service firms. This allows us to detect and quantify differences between sectors.

The remainder of the paper is structured as follows. Section 2 consists of a literature review. Section 3 presents the database, the variables and some descriptive statistics. Section 4 contains the econometric methodology. Section 5 shows our main findings. The last section presents our conclusions and the consequent policy implications.

2. INNOVATION STRATEGIES

The empirical literature has paid attention to specific classifications of innovation strategies. First, according to R&D sources or innovation input, three strategies have been distinguished, internal (or make), external (or buy) and cooperation (Oerlemans, Meeus, and Boekema 1998; Veugelers and Cassiman 1999; Goedhuys and Veugelers 2012; Love, Roper, and Vahter 2014). This research has found that a combination of internal and external knowledge sources is a key element of a successful innovation strategy instead of only undertake R&D in-house. Closely related to the role of networks, partnerships and linkages, a new growing body of literature investigate how resources allocation

strategies (measured as breadth of external search for new ideas) impact upon performance (Laursen and Salter 2006; Leiponen and Helfat 2010; Leiponen 2012). Their empirical results suggest that strategies based on allocation resources to a broader range of information sources is likely to affect innovation outcomes.

Second, related to the four type of innovations proposed by the Oslo Manual (3rd edition, 2005), some empirical papers have differentiated between technological strategies -product and process innovations- and non-technological strategies -marketing and organizational innovations- (Jayaram, Oke, and Prajogo 2014; Karlsson and Tavassoli 2015; Oh, Cho, and Kim 2015; Tavassoli and Karlsson 2015). For instance, Karlsson and Tavassoli (2015) for a sample of Swedish firms distinguished between sixteen strategies, which compose four type of innovation outputs from Oslo Manuals, i.e. product, process, marketing and organizational, called simple innovation strategies, plus various combinations of these four types, called complex innovation strategies. They found that complex innovation strategies are better off in terms of their future productivity as compared to those firms that choose simple innovation strategies. Although these are a useful classification, we think that these classifications are simplistic view of looking at innovation strategies of firms.

It is well known that innovation is a dynamic process subject to a complex sequence of decisions. Considering it as a process, from a temporal dimension, a firm's first strategic decision is whether to innovate or not. That is, take on new challenges in order to survive or grow in the markets or, on the contrary, opt for dynamic routines and keep doing the same thing as always, not taking into account changes in the environment and their consequences. When the decision to innovate has been taken, and innovation is a priority in the firm, the second step consists in deciding which innovation strategy to develop.

The main role of an innovation strategy is that guides the decisions on how resources are to be used to meet a firm's objectives for innovation and, consequently provides value and builds competitive advantage. Gilbert (1994) highlighted that innovation strategy designates to what degree and in what way a firm uses innovation to perform its business strategy and to enrich its performance. Hence, a planned and well-communicated innovation strategy is necessary in order to achieve maximal effectiveness and efficiency (Ramanujam and Mensch 1985; Ernst 2002; van der Panne, van Beers, and Kleinknecht 2003; Oke 2007).

Design a correct innovation strategy is an essential tool for a constant growth when the environment is dynamic, unpredictable, competitive and specially in difficult times. In addition, to obtain a successful innovations determination of a strategic orientation and top management team support are needed (Cooper 1984a; Cooper and Edgett 2010; Talke, Salomo, and Rost 2010). In addition, because in innovation activities require the acquisition of highly specialized assets (sunk costs), the presence of highly-educated and skilled employees (knowledge-related intangible assets), and involve a significant degree of uncertainty (Hall 2002) following a long-term horizons when a firm allocate their critical and scarce resources have been shown to be important for producing high-quality innovations and avoiding quick decisions (Akman and Yillmaz 2008; Talke, Salomo, and Rost 2010).

Although an innovation strategy provides a guideline for survival in today's competitive environment and is helpful to the firm's technological capabilities, according to Page (1993) and more recently to Dobni, Klassen and Nelson (2015), it does not seem to be common practice among firms. Clearly, one of the most important barriers to innovation is the absence of well-defined innovation goals and objectives that provide a

clear direction for the innovation process to follow (Oke 2007; Dobni, Klassen, and Nelson 2015).

Those firms that do not design a clear innovation strategy tend to have lower returns on R&D and innovation activities – this is because firms that wish to innovate in all areas may end by innovating in none, may innovate in areas not essential for the firm, may invest in innovation projects not aligned with the objectives of the firm, or their innovation efforts may just become a matter of chance. For instance Akman and Yillmaz (2008) highlighted that without a strategy for innovation, innovation success is harder and frequently not possible. This lead us to formulate the following hypothesis:

H1. Firms that do not design clear innovation strategies have lower odds of being a successful innovative firm.

When it comes to oriented strategies, the literature emphasises that an innovation strategy focus on specific innovation fields increases a firm performance. To build an oriented strategy implies the use of common resources between related objectives within an innovation field and has been found to increase innovation outcomes thanks to avoiding additional costs, coordinating resources or sharing learning processes (Salomo, Talke, and Strecker 2008; Bowonder et al. 2010; Leiponen 2012; Aniruddha 2013). Hence, firms with strong degree of focus may perform better than firms with an absence of focus that are more likely to fail.

However, that not all innovative orientations are suitable for a given environment and different innovation orientations are associated with differences innovation success (Manu and Sriram 1996). For example, product innovation outputs will primarily relate to innovations orientations towards competition, market and demand (e.g increasing market share, range of products) while process or organisational innovations will tend to relate to supply or new legislation orientations (e.g. reducing costs, improving production

capabilities, reducing environmental impacts) (Balachandra and Friar 1997; van der Panne, van Beers, and Kleinknecht 2003; Tidd, Bessant, and Pavitt 2005; Paulraj 2009; Hervas-Oliver, Sempere-Ripoll, and Boronat-Moll 2014; Jayaram, Oke, and Prajogo 2014). This lead us to test the fit between innovation strategy and formulate our second hypothesis:

H2. Firms that design oriented innovation strategies have higher odds of being a successful innovative firm.

Based on the “recombinant growth” expression, the recombination of different types of knowledge or different types of innovations, it is accepted that the probability of obtaining innovation success is higher when there is more variety to be recombined (Weitzman 1998). Here, variety is taken as diversity in innovation orientations, which is reflected in the breadth of fields in firm’s innovation objectives.

One of the questions that have significance relevant in the management studies is the effects of diversity on firm performance. Some authors showed that diversified technology base positively affects innovative potential of firm (Garcia-Vega 2006; Quintana-García and Benavides-Velasco 2008; Lin and Chang 2014). However, other studies find that the level of diversity matters and too much diversity cause high levels of coordination and integration costs and may lead to reduced opportunities for innovation (Leten, Belderbos, and Van Looy 2007). In the same line, Laursen and Salter (2006), Leiponen and Helfat (2010) and Leiponen (2012) investigate how resources allocation strategies (measured as breadth of external search for new ideas or pursuing multiple parallel objectives) impact upon performance. In general, their empirical results suggest that strategies based on allocation resources to a broader range of information sources or objectives are associated with successful innovation. Some particularities regarding the sector is found, for instance, (Leiponen 2012) showed that breadth in terms of pursuing

parallel innovation objectives appears to have a negative effect on innovation in service industries because some services firms may do not have enough accumulated managerial processes and capabilities to benefit from these strategies.

In summary, based on the above literature review and discussion, the last hypothesis is proposed:

H3. Firms that design mixed innovation strategies have higher odds of being a successful innovative firm.

3. DATABASE, VARIABLES AND DESCRIPTIVE STATISTICS

3.1 Database

This analysis is based on firm level data from the Technological Innovation Panel (PITEC). PITEC is a specific statistical instrument for studying the innovation activities of large sample of Spanish firms over time and it is jointly developed by the Spanish National Institute of Statistics (INE), the Spanish Foundation for Science and Technology (FECYT), and the Foundation for Technical Innovation (COTEC).

PITEC is designed as a panel survey, based on the Community Innovation Survey (CIS), one of the most used datasets in innovation studies.² These innovation surveys are collected following the general guidelines of the Oslo Manual (OECD–Eurostat, 2005).

The PITEC has two main advantages for this study³. First, and most importantly, this database has detailed information about firms' innovation objectives. Innovation

² See Vokoun (2015), Cainelli *et al.* (2015), and Hashi and Stojčić (2013) for recent examples of empirical work using the Community Innovation Survey dataset and Segarra-Blasco and Teruel (2014); Barge-Gil and López (2014); Costa-Campi *et al.* (2015) for recent examples of empirical work using the PITEC dataset.

³ However, PITEC data base is not free of limitations. One of the limitations of the innovation surveys like PITEC is the subjective nature of many of the questions addressed to the firm's management or those responsible for R&D departments. However, Mairesse and Mohnen (2005) provide evidence that the

surveys are constantly improving their quality and relevance and, from 2003 on, the innovation survey has been updated and new questions have been included, allowing researchers to pursue new lines of research in depth. Specifically, in 2008, Spanish firms were for the first time asked to indicate the importance of items in a list of innovation objectives when carrying out innovation activities⁴. Such information is essential to this study. Second, PITEC is characterized by its time dimension. It has panel data for the period 2003–2012 which facilitates researchers in dealing more accurately with innovative behaviour of Spanish firms longitudinally and also treat standard econometric issues, such as unobserved heterogeneity and simultaneity problems that are hard to detect in simple cross-sectional data or time series (Baltagi 2008). In such temporal panels, containing data on the firms' innovation performance, it is easier to control common endogeneity problems by introducing lagged explanatory variables in the empirical specification or by using new methods which take into account the initial conditions of the model's dependent variable and firms' individual-specific effects (Semykina and Wooldridge 2010).

Our final database selection was subject to a process of filtering. The main filters were as follows: 1) data referred the period 2008–2012, because objectives questions were not included in the survey until 2008; 2) only innovative firms were examined, that is,

subjective measures of innovation surveys tend to be consistent with more objective measures of innovation, such as the probability of holding a patent and the share in sales of products protected by patents.

⁴ In general, empirical research on innovation at the firm level has yet to incorporate the role of the objectives, in particular, in the studies of determinants of eco-innovation (Cainelli, De Marchi, and Grandinetti 2015; Costa-Campi, García-Quevedo, and Segarra-Blasco 2015; Jakobsen and Clausen 2015) and in the studies of how the breadth of innovation objectives impacts on innovation (Leiponen and Helfat 2010; Leiponen 2012).

firms that had introduced product or process innovations or firms with an intention of being innovative (i.e. firms that had taken an innovative project but later abandoned or it still remain to be completed);⁵ 3) firms from the manufacturing and service sectors were analysed;⁶ 4) firms that report confidentiality issues, mergers, employment incidents and so on were not incorporated in the sample.

After all filtering, our empirical analysis is based on a balanced panel of 19,595 observations for the period 2008–2012. At this point, the dataset included 3,919 Spanish innovative firms of which 2,850 firms belong to the manufacturing sector and 1,069 firms to the service sector.

3.2 Variables

We consider two types of dependent variables: product innovation (the introduction of a good or service that is new or significantly improved during t-2 to t) and process innovation (the implementation of a new or significantly improved production or delivery method during t-2 to t).

The key explanatory variables in our analysis represent the different innovation strategies that firms may design when engaging in innovation activities. In 2008, the Spanish CIS introduced a new question⁷ *“Innovation activities carried out in your firm could be oriented to different objectives, how important were each of the following*

⁵ For instance, we take into account those firms that may be pursuing a certain innovation strategy and yet fail to attain innovation outcomes in a given period. Excluding non-innovative firms is based on the reason that these firms are unlikely to have any aspiration to innovation, in line with other studies using innovation dataset (D’Este et al. 2012; Jakobsen and Clausen 2015).

⁶ See Appendix 1 for a detailed classification.

⁷ The question was modified by the INE. In 2008, the question regarding the effects of innovation was replaced by innovation objectives. While "objectives" relate to a firm's motives for innovating, "effects" concern the actual observed outcomes of innovations (OECD - Eurostat, 2005).

objectives⁸ for your innovation activities during the three last years⁹?.” Firms were asked to evaluate the importance of each innovation objective on a Likert scale of 1 to 4, where 1 represents "high importance", 2 represents "intermediate importance", 3 represents "low importance" and 4 represents "factor not experienced". For each objective, listed in Table 1,¹⁰ we assign a binary value depending on its survey response. These dummy variables are equal to 1 when firm considers the innovative objective to have high importance and 0 when the importance is intermediate, low or not experienced.

First, we distinguished between these firms that innovation process is guided by an innovation strategy and those that do not design a strategy. Firms designing an innovation strategy also are divided into two groups: mixed and oriented strategy. The former strategy includes firms that have an innovation strategy but without any specific orientation (firms pursue some innovation objectives but not inter-related ones). The latter encompasses these firms with a clear innovation strategy oriented towards quality, production, costs or environmental and regulatory dimension.¹¹

In order to identify the oriented strategies, we group the thirteen innovation objectives by applying a multivariate statistical method. A principal component analysis (PCA) is undertaken on the thirteen innovation objectives reported from the innovation

⁸ See Table 1 for a detailed classification.

⁹ Some of qualitative questions in innovation surveys refer to a 3-year period, while quantitative ones refer to the actual year of the survey. In particular, questions on innovation objectives refer to a 3-year period.

¹⁰ In 2008, the innovation survey included thirteen innovation objectives. In addition, in 2009, three new objectives relating to employment such as the increase in total employment, the increase in skilled employment and the maintenance of employment were appended to the thirteen objectives added the previous year. Due to the lack of data for the full period under analysis, the latter objectives about employment are not considered in this study.

¹¹ The exact definition of these variables (in the way that we use them in our analysis) is presented in Appendix 2. See Appendix 2 for a detailed definition.

survey.¹² PCA analyses should be ideally applied to continuous variables or ordinal measures with broad enough scales. Hence, the categorical variables with relatively narrow scales (binary variables) are corrected for by using a tetrachoric correlation matrix as the input correlation matrix in the standard PCA, under the assumption that observed binary variables correspond to latent continuous variables.

Table 1
Component loadings after orthogonal rotation

Innovation objectives	Quality	Production	Cost	Environmental and regulatory
1. Increase range of goods or services	0.4982	-0.0393	-0.0648	-0.0072
2. Replace products being phased out	0.3115	0.0898	0.1152	-0.0665
3. Enter new markets	0.5118	-0.0862	0.0064	0.0131
4. Increase market share	0.5077	-0.0134	0.0312	-0.0154
5. Improve product quality	0.3662	0.1635	-0.0453	0.0732
6. Increase flexibility of production	-0.0132	0.6920	-0.0536	0.0139
7. Increase capacity of production	-0.0166	0.6509	0.0287	-0.0043
8. Reduce labour costs per unit output	0.0066	0.2003	0.4676	-0.0677
9. Reduce material costs per unit output	0.0027	-0.0560	0.6421	-0.0282
10. Reduce energy costs per unit output	-0.0182	-0.0628	0.5781	0.0846
11. Reduce environmental impacts	-0.0045	-0.0617	0.0919	0.5444
12. Improve health or safety of employees	-0.0038	0.0467	-0.0261	0.5808
13. Fulfil government regulation or standards requirements	0.0093	0.0189	-0.0379	0.5859
Cronbach's alphas	0.7270	0.7195	0.7634	0.8339

Note: Seventy percent of total variance was explained by the four components; principal components factoring with orthogonal varimax rotation. N=19,595. Larger components loadings appear in bold.

After the extraction of principal components, orthogonal rotation¹³ of retained components was applied in order to enhance interpretability (Kline 1994). The number of components to retain for rotation was subjective, based on the trade-off between

¹² The main interest in this study is to use PCA to identify patterns of association across innovation objectives.

¹³ Orthogonal rotation rotated components remain uncorrelated while oblique rotation allows for correlation between the rotated components. For additional robustness in analysing the patterns identified, we used oblique rather than orthogonal rotation, but the same patterns emerged.

simplicity (retaining as few as possible factors) and completeness (explaining most of the variation in the data). There are some standard recommendations in this area. Kaiser's rule, for example, recommends retaining only components with eigenvalues larger than one. Another common strategy is to examine the plot of the eigenvalues and determine whether there is a point beyond which the remaining factors explain considerably less variation. Taking these recommendations into account, four components were retained.

Cronbach's coefficient is also used to evaluate internal consistency for each component retained. The Cronbach alphas for the four components are greater than 0.70, generally indicating an acceptable level of internal consistency.

Table 1 shows the component loadings that emerged after having retained four components. According to the results, the objectives can be broadly categorized as quality strategy (competing with better and more products), production strategy (improving the capacity and flexibility of production), cost strategy (competing with lowering production costs) and environmental and regulatory strategy (being environmentally friendly and satisfying standard requirements).

In addition to our variables of interest, innovation strategies, following the economic literature on the determinants of innovation (Souitaris 2002; Galende and de la Fuente 2003; Becheikh, Landry, and Amara 2006; Vega-Jurado et al. 2008; Keupp, Palmié, and Gassmann 2012) a set of variables related to the firm's assets, competences and capabilities are also included as internal factors (size, group, export and training in innovation activities). Then, the firm's industry (high tech manufactures and high knowledge intensive services); technological opportunity (cooperation); appropriability conditions (legal mechanisms of protection) and government and public policies (subsidies) variables are included in the analyses as external factors. Appendix 2

summarises the list of variables and their definition, Appendix 3 descriptive statistics of variables included in the empirical analysis and Appendix 4 shows the correlation matrix.

3.3 Descriptive statistics

Based on an extensive sample of Spanish innovative firms, this section offers an overview of innovation strategies that can be designed. Table 2 lists the thirteen objectives that innovative firms can pursue in the course of their innovation activities, as well as the strategies proposed in this study. It can be seen that a large number of Spanish innovative firms have not designed an innovation strategy (24%). Some heterogeneity exists within the group of firms with an innovation strategy, in the sense that some firms have a mixed strategy (27%) and some firms specialize in a specific type of strategy. A quality strategy is the one most common across the sample. Nevertheless, if we compare strategies by sectors, this result changes slightly. A greater percentage of manufacturing firms pursue an environmental and regulatory strategy, while service firms are more interested in pursuing a production strategy. We also highlight that services firms have a higher percentage of mixed or, no strategy, than manufacturing firms.

Analysing the importance of the innovation objectives, over the 2008–2012 period, 55% of firms consider improving quality of goods or services to be their key innovation objective. Increasing the range of goods or services is indicated as the next most important objective (52%), and increased market share ranks third (42%); these results are in accord with the German ones, c.f. Aschhoff *et al.* (2013), and suggest that the main concern of most firms is their product and its characteristics.

Consequently, during the period analysed (2008–2012), Spanish firms try to keep their market position and survive by creating differentiated products and services and by distinguishing themselves from competitors. This is the opposite to Chinese firms, where

the main innovation objectives pursued relate to lowering production costs (Guan et al. 2009; Zheng 2014).

Table 2
Importance of different innovation objectives and strategies (mean score in the sample)

(% of firms)	All sample Obs=19,595 F=3,919	Manufactures Obs=14,250 F=2,850	Services Obs=5,345 F=1,069
1. Increase range of goods or services	0.5192 (0.4996)	0.5341 (0.4988)	0.4795 (0.4996)
2. Replace products being phased out	0.3399 (0.4737)	0.3473 (0.4761)	0.3202 (0.4666)
3. Enter new markets	0.4118 (0.4921)	0.4264 (0.4945)	0.3728 (0.4836)
4. Increase market share	0.4209 (0.4937)	0.4387 (0.4962)	0.3734 (0.4837)
5. Improve product quality	0.5492 (0.4975)	0.5349 (0.4987)	0.5874 (0.4923)
6. Increase flexibility of production	0.3371 (0.4727)	0.3280 (0.4695)	0.3614 (0.4804)
7. Increase capacity of production	0.3466 (0.4759)	0.3397 (0.4736)	0.3648 (0.4814)
8. Reduce labour costs per unit output	0.2715 (0.4447)	0.3040 (0.4600)	0.1848 (0.3882)
9. Reduce material costs per unit output	0.1695 (0.3752)	0.2032 (0.4024)	0.0798 (0.2711)
10. Reduce energy costs per unit output	0.1692 (0.3750)	0.1994 (0.3995)	0.0888 (0.2845)
11. Reduce environmental impacts	0.2546 (0.4356)	0.2870 (0.4523)	0.1683 (0.3742)
12. Improve health or safety of employees	0.2662 (0.4420)	0.3018 (0.4590)	0.1711 (0.3767)
13. Fulfil government regulation or standards requirements	0.3041 (0.4600)	0.3430 (0.4747)	0.2005 (0.4004)
Absence of strategy	0.2370 (0.4252)	0.2317 (0.4219)	0.2510 (0.4336)
Mixed strategy	0.2263 (0.4185)	0.2115 (0.4083)	0.2660 (0.4419)
Oriented strategy			
Quality	0.2733 (0.4457)	0.2865 (0.4521)	0.2381 (0.4260)
Production	0.2432 (0.4290)	0.2352 (0.4242)	0.2645 (0.4411)
Cost	0.1743 (0.3794)	0.2091 (0.4067)	0.081 (0.2734)
Environmental and regulatory	0.2643 (0.4409)	0.3016 (0.4589)	0.1650 (0.3712)

F: number of firms. Standard deviation in brackets.

Next to objectives related to competition, demand and market, firms also take into account increasing the capacity and flexibility of production (34%) and fulfilment of laws or regulations (30%) Only the increase in health security (26%), the reduction in

environmental impacts (25%), the reduction in labour costs (27%) and the reduction in material and energy unit costs (16%) seem to be less strongly pursued among the highly important objectives.

When we distinguish between manufacturing and services firms, the results show only small changes in the innovation objectives rankings. In the manufacturing and services sectors, the improvement of product/service quality and the increasing range of product or services still rank as the two most frequently stated objectives. Then, if we look at the increase in capacity and flexibility of production objectives, a greater percentage of services firms state that they pursue these objectives than is the case for manufacturing firms. However, the three objectives related to reducing costs are more followed by manufacturing firms than by service ones. Finally, the percentage of firms that state that environmental and regulatory objectives are an innovation objective of high importance is significant. For instance, in the manufacturing sector this percentage rises to 29 percent, however, in the services sector this percentage is much lower (17%). As Cainelli *et al.* (2015) remark, manufacturing firms are increasingly challenged to include environmental innovations in their business activities.

4. ECONOMETRIC METHODOLOGY

Generally, the economics analysis of the determinants of product or process innovation has been carried out using standard logit or probit models or bivariate models. However, binary logit and probit models assume that the numbers of dependent variable cases scored as one, and scored as zero, are fairly equal. When there is a significant disparity, as in our case (76% of firms have introduced product innovations and 73% of firms have introduced process innovations), generalized linear models (GLMs) with a binomial family and log-log link provide better estimations because of their asymmetric nature

(Hardin and Hilbe 2012). We choose to opt for GLMs models, as we prefer to prioritise the positive skewness of the dependent variables.

The GLMs also control for over-dispersion, which can be an important problem in models with binary responses, causing underestimation of the standard error of the estimated coefficient vector, and consequently non-significant variables can spuriously appear to have significant influences. In order to recognize possible over-dispersion, the GLMs provide the value of the Pearson χ^2 or the deviance divided by the degrees of freedom. A Pearson's statistic close to 1 indicates that the models are not over dispersed (they are well specified). The Huber-White Sandwich technique was used to correct for possible heteroscedasticity problems.

Specifically, the following equation is estimated:

$$y_{it} = \beta_0 + \beta_1 STRAT_{it-1} + \beta_2 X_{it-1} + \alpha_t + \delta_i + \varepsilon_{it} \quad (1)$$

being $i = 1, \dots, N$ firms and $t = 1, \dots, T$ years and where y_{it} is the binary outcome variable that distinguishes between product innovation and process innovation. Among the explanatory variables in Equation (1), $STRAT_{i,t-1}$ is a vector of explanatory variables containing information about innovation strategies that firms can pursue, $X_{i,t-1}$ includes a set of firm characteristics and β_0, β_1 and β_2 are unknown parameter vectors to be estimated. Additionally, a set of dummy variables related the temporal α_t and sector dimension δ_i are included in all of the regressions to control for cyclical effects and specific industry characteristics, respectively.

Innovation efforts need some time to impact on innovation outputs, for that reason, our data take into account a potential time lag between innovation efforts and new product or process innovations.¹⁴ Following Audretsch *et al.* (2014); Barge-Gil and López (2014)

¹⁴ Since we are working with a short panel, we decided to lag the independent variables by just one period of time, although further lags may be needed.

and Santamaría *et al.* (2012), in the regression analyses, the dependent variables refer to the year t while the explanatory variables refer to the year $t-1$. This time difference is used in order mitigate endogeneity problems arising from reverse causality.

Even though panel data is available, a pooled estimation has been carried out for the whole period. The period for which the dependent variable data is available is very short and most of the independent variables like strategies and R&D are highly persistent (Clausen *et al.* 2012) and there is very little variation over time.

In addition, in order to control for potential multicollinearity problems, the variance inflation factor (VIF) was calculated. The individual VIF values were substantially below the recommended cut-off point of 10, indicating that multicollinearity problems do not exist in any of the models (the mean VIF was 1.54).

5. RESULTS

The main results of the empirical analyses are presented in this section. Tables 3 and 4 report the results of the generalized linear model (GLM) for the whole sample, and for the manufacturing and services firms, respectively¹⁵. Both tables present two econometric models, first the baseline model, which includes the most common innovation determinants is presented, followed by the innovation-strategy model, where we analyse the effect of different innovation strategies. Pearson's statistics with respect to all of the models were close to one, indicating that the models were not over dispersed.

As we expected, for innovative firms, not designing an innovation strategy has a negative and significant impact on the likelihood of achieving successful innovation measured in terms of product or process innovations. Whereas firms that design an

¹⁵ The smaller values of Akaike's information criterion (AIC) in Models innovation strategy indicate that these models had improved explanatory power compared to the Baseline Model.

innovation strategy show mixed results, depending on the innovation strategy and the innovation success pursued (product and process innovation). Our results also indicate that, when innovation strategies are mixed, this increases the probability of innovation in products, while it decreases the probability of innovation in processes; however, the latter coefficient is not significant.

Regarding oriented strategy, our results seem to confirm that there is a good fit between the innovation strategy pursued, and the innovation output obtained. Firms that follow a quality strategy show a positive and significant impact on product innovation and negative but no significant impact on process innovation. In particular, those, firms that pursue a quality strategy would increase their likelihood of being successful innovative firms in product innovations by 11 percent. Comparing the marginal effects between mixed strategy and focus on quality strategy, the results show that the impact of oriented strategy on product innovation is about seven percent higher, as we expected. The results also show that production, cost and environmental and regulatory strategy have a positive and significant impact on process innovation and a negative impact on product innovation.

Table 3
Generalized linear models (GLMs, whole sample)

Variables	Product innovation				Process innovation			
	Baseline model		Innovation strategies		Baseline model		Innovation strategies	
	Coeff.	MEMs	Coeff.	MEMs	Coeff.	MEMs	Coeff.	MEMs
lSize _{<i>t-1</i>}	0.0815*** (0.014)	0.0159*** (0.003)	0.0882*** (0.014)	0.0168*** (0.003)	0.2128*** (0.015)	0.0457*** (0.003)	0.1962*** (0.015)	0.0405*** (0.003)
Group _{<i>t-1</i>}	-0.1001*** (0.038)	-0.0195*** (0.007)	-0.1045*** (0.038)	-0.0199*** (0.007)	-0.0253 (0.036)	-0.0054 (0.008)	-0.0595 (0.036)	-0.0123 (0.007)
Export _{<i>t-1</i>}	0.2325*** (0.035)	0.0453*** (0.007)	0.1970*** (0.035)	0.0375*** (0.007)	0.0562 (0.034)	0.0121 (0.007)	0.0473 (0.035)	0.0098 (0.007)
Human resources _{<i>t-1</i>}	0.4530*** (0.049)	0.0883*** (0.009)	0.4173*** (0.049)	0.0794*** (0.009)	0.8771*** (0.052)	0.1883*** (0.011)	0.8059*** (0.052)	0.1664*** (0.010)
Internal R&D _{<i>t-1</i>}	0.0795*** (0.005)	0.0155*** (0.001)	0.0669*** (0.005)	0.0127*** (0.001)	-0.0279*** (0.005)	-0.0060*** (0.001)	-0.0381*** (0.005)	-0.0079*** (0.001)
lExternal R&D _{<i>t-1</i>}	-0.0036 (0.005)	-0.0007 (0.001)	-0.0045 (0.005)	-0.0009 (0.001)	-0.0001 (0.005)	-0.0000 (0.001)	0.0013 (0.005)	0.0003 (0.001)
Cooperation _{<i>t-1</i>}	0.3848*** (0.039)	0.0750*** (0.008)	0.3529*** (0.040)	0.0671*** (0.007)	0.3267*** (0.036)	0.0702*** (0.008)	0.2769*** (0.036)	0.0572*** (0.007)
Subsidy _{<i>t-1</i>}	-0.0022 (0.038)	-0.0004 (0.007)	-0.0087 (0.039)	-0.0017 (0.007)	-0.1024*** (0.035)	-0.0220*** (0.008)	-0.0985*** (0.036)	-0.0203*** (0.007)
HT manuf. and HKIS _{<i>t-1</i>}	0.2826*** (0.034)	0.0551*** (0.007)	0.2697*** (0.034)	0.0513*** (0.006)	-0.3368*** (0.032)	-0.0723*** (0.007)	-0.3293*** (0.032)	-0.0680*** (0.007)
Absence strategy _{<i>t-1</i>}			-0.3234*** (0.060)	-0.0615*** (0.011)			-0.2954*** (0.061)	-0.0610*** (0.013)
Mixed strategy _{<i>t-1</i>}			0.2033*** (0.064)	0.0387*** (0.012)			-0.0309 (0.062)	-0.0064 (0.013)
Quality strategy _{<i>t-1</i>}			0.5855*** (0.050)	0.1114*** (0.009)			-0.0019 (0.051)	-0.0004 (0.010)
Production strategy _{<i>t-1</i>}			-0.1399*** (0.049)	-0.0266*** (0.009)			0.6601*** (0.052)	0.1363*** (0.011)
Cost strategy _{<i>t-1</i>}			-0.0755 (0.050)	-0.0144 (0.010)			0.2580*** (0.055)	0.0533*** (0.011)
Environ. and regulatory strategy _{<i>t-1</i>}			-0.0418 (0.049)	-0.0079 (0.009)			0.1418*** (0.050)	0.0293*** (0.010)
Constant	0.2410*** (0.073)		0.3381*** (0.089)		0.6401*** (0.076)		0.7462*** (0.094)	
(1/df) Pearson	0.9854		0.9761		0.9997		0.9935	
AIC	1.0313		1.0100		1.08688		1.0515	
BIC	-135,161.9		-135,448.7		-134,290.8		-134,799.1	
Log pseudolikelihood	-8,070.4		-7,898.0		-8,506.1		-8,222.8	
Observations				15,676				

Estimations control for time and industry dummies. Marginal effects calculated at their mean (MEMs). For dummy variables, change in probability for a discrete change of the dummy variable from 0 to 1. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Given the different nature of manufacturing and service sectors, we also focus on the differences that an innovation strategy may exert on the probability of innovating in

these two sectors (Table 4). In general, the lack of an innovation strategy to pursue has a significant and negative influence on innovation success in manufacturing and services firms. However, the effect of this variable is quite heterogeneous across both sectors. A service firm not having an innovation strategy is associated with a 13 percent decrease in the probability of being a successful innovative firm as measured in terms of process innovation, while manufacturing firms are associated with a four percent decrease. This reveals notable sectorial differences.

Then, regarding oriented strategies our results seem to confirm that there is also a good fit between the innovation strategy pursued, and the innovation output obtained by sectors. Again, firms that follow a quality strategy show a positive and significant impact on product innovation and negative but no significant impact on process innovation. While firms that design production, cost or environmental strategies show a positive and significant impact on process innovation. However, in services firms these results change slightly. The sign of the last innovation strategy (environmental and regulatory strategy) becomes negative and significant in respect to process innovation.

In addition, services firms that design an environmental and regulatory strategy would decrease by five percent the probability of being a successful innovative firm, as measured by process innovation, whereas manufacturing firms would increase the probability by three percent. The sizes of the effect of these three strategies (production, cost and environmental and regulatory) on process innovation success are quite different. Production strategy shows the strongest effect, followed by cost and environmental and regulatory strategy. In addition, the results also show sectorial differences. The likelihood of being a successful innovative firm, measured by process innovation, would increase by 15 percent when manufacturing firms follow a production strategy or but only by 11 percent for a service firm following the same strategy.

Table 4 GLMS by sector

Variables	Manufactures							
	Product innovation				Process innovation			
	Baseline model		Innovation strategies		Baseline model		Innovation strategies	
	Coeff.	MEMs	Coeff.	MEMs	Coeff.	MEMs	Coeff.	MEMs
ISize $t-1$	0.0939*** (0.020)	0.0171*** (0.004)	0.1065*** (0.020)	0.0189*** (0.004)	0.2054*** (0.020)	0.0420*** (0.004)	0.1974*** (0.020)	0.0386*** (0.004)
Group $t-1$	-0.0670 (0.048)	-0.0122 (0.009)	-0.0741 (0.048)	-0.0132 (0.009)	-0.0640 (0.045)	-0.0131 (0.009)	-0.1072** (0.045)	-0.0210** (0.009)
Export $t-1$	0.1170** (0.050)	0.0213** (0.009)	0.0811 (0.050)	0.0144 (0.009)	0.0507 (0.049)	0.0104 (0.010)	0.0604 (0.050)	0.0118 (0.010)
Human resources $t-1$	0.4853*** (0.066)	0.0885*** (0.012)	0.4761*** (0.066)	0.0847*** (0.012)	0.8141*** (0.066)	0.1664*** (0.013)	0.7396*** (0.066)	0.1447*** (0.013)
IInternal R&D $t-1$	0.0982*** (0.006)	0.0179*** (0.001)	0.0849*** (0.006)	0.0151*** (0.001)	-0.0207*** (0.006)	-0.0042*** (0.001)	-0.0299*** (0.006)	-0.0059*** (0.001)
IExternal R&D $t-1$	0.0004 (0.007)	0.0001 (0.001)	-0.0003 (0.007)	-0.0000 (0.001)	-0.0109* (0.006)	-0.0022* (0.001)	-0.0080 (0.006)	-0.0016 (0.001)
Cooperation $t-1$	0.3255*** (0.048)	0.0594*** (0.009)	0.2990*** (0.049)	0.0532*** (0.009)	0.3987*** (0.045)	0.0815*** (0.009)	0.3371*** (0.045)	0.0660*** (0.009)
Subsidy $t-1$	0.0541 (0.046)	0.0099 (0.008)	0.0350 (0.047)	0.0062 (0.008)	0.0075 (0.043)	0.0015 (0.009)	-0.0004 (0.043)	-0.0001 (0.008)
HT manufacture. $t-1$	0.3837 (0.346)	0.0700 (0.063)	0.4545 (0.339)	0.0809 (0.060)	0.2694 (0.301)	0.0551 (0.062)	0.1877 (0.310)	0.0367 (0.061)
Absence strategy $t-1$			-0.3119*** (0.071)	-0.0555*** (0.013)			-0.2085*** (0.072)	-0.0408*** (0.014)
Mixed strategy $t-1$			0.1877** (0.077)	0.0334** (0.014)			-0.0436 (0.073)	-0.0085 (0.014)
Quality strategy $t-1$			0.5704*** (0.058)	0.1015*** (0.010)			0.0147 (0.059)	0.0029 (0.012)
Production strategy $t-1$			-0.1726*** (0.057)	-0.0307*** (0.010)			0.7595*** (0.064)	0.1486*** (0.012)
Cost strategy $t-1$			-0.1257** (0.058)	-0.0224** (0.010)			0.2177*** (0.062)	0.0426*** (0.012)
Environ. Regul. Strategy $t-1$			-0.2810 (0.0575)	-0.0050 (0.010)			0.1464** (0.0585)	0.2865** (0.0114)
Constant	0.0232 (0.299)		0.0388 (0.300)		0.0806 (0.272)		0.1133 (0.290)	
(1/df) Pearson	0.9798		0.9737		0.9915		0.9867	
AIC	0.9934		0.9745		1.0599		1.0251	
BIC	-94,9230.5		-95,090.8		-94,165.68		-94,518.0	
Log pseudolikelihood	-5,629.8		-5,518.2		-6,008.8		-5,804.63	
Observations					11,400			

Table 4
GLMS by sector (continued)

Variables	Services							
	Product innovation				Process innovation			
	Baseline model		Innovation strategies		Baseline model		Innovation strategies	
	Coeff.	MEMs	Coeff.	MEMs	Coeff.	MEMs	Coeff.	MEMs
ISize _{<i>t-1</i>}	0.0720*** (0.023)	0.0152*** (0.005)	0.0707*** (0.024)	0.0147*** (0.005)	0.1872*** (0.024)	0.0434*** (0.006)	0.1742*** (0.025)	0.0393*** (0.005)
Group _{<i>t-1</i>}	-0.1023 (0.067)	-0.0217 (0.014)	-0.1194* (0.068)	-0.0249* (0.014)	-0.0062 (0.065)	-0.0014 (0.015)	-0.0093 (0.066)	-0.0021 (0.015)
Export _{<i>t-1</i>}	0.0996 (0.065)	0.0211 (0.014)	0.0747 (0.066)	0.0156 (0.014)	-0.1153** (0.059)	-0.0267** (0.014)	-0.1200** (0.060)	-0.0271** (0.013)
Human resources _{<i>t-1</i>}	0.4717*** (0.076)	0.0998*** (0.016)	0.4005*** (0.076)	0.0834*** (0.016)	0.9943*** (0.084)	0.2306*** (0.018)	0.9257*** (0.084)	0.2088*** (0.018)
IInternal R&D _{<i>t-1</i>}	0.0516*** (0.009)	0.0109*** (0.002)	0.0394*** (0.009)	0.0082*** (0.002)	-0.0293*** (0.010)	-0.0068*** (0.002)	-0.0442*** (0.010)	-0.0100*** (0.002)
IExternal R&D _{<i>t-1</i>}	0.0127 (0.009)	0.0027 (0.002)	0.0090 (0.009)	0.0019 (0.002)	0.0079 (0.008)	0.0018 (0.002)	0.0057 (0.008)	0.0013 (0.002)
Cooperation _{<i>t-1</i>}	0.6277*** (0.071)	0.1328*** (0.015)	0.5804*** (0.071)	0.1209*** (0.015)	0.2495*** (0.065)	0.0579*** (0.015)	0.2106*** (0.066)	0.0475*** (0.015)
Subsidy _{<i>t-1</i>}	0.0203 (0.075)	0.0043 (0.016)	0.0380 (0.075)	0.0079 (0.016)	-0.2494*** (0.071)	-0.0578*** (0.016)	-0.2106*** (0.072)	-0.0475*** (0.016)
HKIS _{<i>t-1</i>}	0.2109 (0.288)	0.0446 (0.061)	0.3808 (0.286)	0.0793 (0.060)	-0.5371 (0.528)	-0.1246 (0.122)	-0.4339 (0.531)	-0.0979 (0.120)
Absence strategy _{<i>t-1</i>}			-0.2408** (0.120)	-0.0502** (0.025)			-0.5903*** (0.122)	-0.1331*** (0.027)
Mixed strategy _{<i>t-1</i>}			0.2868** (0.125)	0.0597** (0.026)			-0.1352 (0.124)	-0.0305 (0.028)
Quality strategy _{<i>t-1</i>}			0.4801*** (0.105)	0.1000*** (0.022)			-0.0991 (0.104)	-0.0223 (0.023)
Production strategy _{<i>t-1</i>}			0.0085 (0.101)	0.0018 (0.021)			0.4707*** (0.098)	0.1062*** (0.022)
Cost strategy _{<i>t-1</i>}			0.0502 (0.121)	0.0104 (0.025)			0.2638** (0.132)	0.0595** (0.030)
Environ. Regul. Strategy _{<i>t-1</i>}			0.0597 (0.106)	0.0124 (0.022)			-0.2000* (0.109)	-0.0451* (0.025)
Constant	-0.2844 (0.295)		-0.3373 (0.308)		1.0617** (0.531)		1.3614** (0.544)	
(1/df) Pearson	0.9810		0.9776		1.0183		1.0143	
AIC	1.0675		1.0516		1.1258		1.0930	
BIC	-31,065.1		-31,094.9		-30,815.78		-30,917.87	
Log pseudolikelihood	-2,263.3		-2,223.6		-2,388.0		-2,311.8	
Observations					4,276			

Estimations control for time and industry dummies. Marginal effects calculated at their mean (MEMs). For dummy variables, change in probability for a discrete change of the dummy variable from 0 to 1. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Finally, with respect to the other variables extensively analysed, our results for the whole sample are in accordance with the literature (Becheikh, Landry, and Amara 2006; Mohnen, Mairesse, and Dagenais 2006; Ahuja, Lampert, and Tandon 2008; Hashi and Stojčić 2013). Regarding firm characteristics, size has positive and significant impact on both product and process innovation success. A wide range of empirical studies showed that larger firms have more capacity to generate innovations (Bhattacharya and Bloch 2004; Becheikh, Landry, and Amara 2006). In general, other characteristics of the firm such as belonging to a group or export activity are not significant in explaining the introduction of product or process innovation. For innovation success, firm competences are important. They show a positive and significant impact, regardless of the type of innovation, except for investment in internal R&D which shows a negative and significant impact on process innovation. For instance, if firms invest in training expenditure for innovation activities, this is associated with a 16 percent increase in the probability of being a successful innovative firm in process innovations; if firms invest in supporting the introduction of innovations into the market activities this is associated with a 30 percent increase in the probability of being a successful innovative firm in product innovations.

As regards external factors, we observe that, for the whole sample, firms that have cooperation agreements and firms that have mechanisms to protection their innovative activities have an increased probability of being a successful innovation firm. With respect to public subsidies, we observe that having access to public R&D subsidies has a negative and significant impact on process innovation, however, we find no relation with product innovation. It is also observed that high tech manufactures and highly knowledge-intensive services (KIS) have positive and significant impact on product innovation, but a negative impact on process innovation.

To confirm the robustness of our results, we conducted additional analyses. First, we tested our model introducing the thirteen innovation objectives (dummy variables identifying firms pursue each of the objectives with high importance). When considering the analysis of each innovation objective (see Table A.5 in Appendix 5), we find that the results are very similar to those presented before. Quality objectives are positively related to product innovation; in particular, we find that four of five objectives are positive and significant, so a strong positive relationship is found. Firms that pursue Objective 1, increase range of goods or services, show the highest likelihood of being a successful innovative firm in product innovation. Objectives related to efficiency, such as increase in flexibility and capacity of production and reduction in labour costs per unit output have a positive relationship to process innovation. Firms that pursue the Objective 7 (increase the capacity of production) would increase the probability of having process innovations success by 10 percent. However, we do not find any positive and significant relationship between reduction in material and energy costs objectives and process innovation. The objectives related to reduction in environmental impacts and improvement in health or safety of employees have a negative and significant impact on product innovation. While the objective related to fulfil governmental regulation or standard recruitments, shows a positive and significant impact on product innovation, i.e. in firms pursuing this latter objective increase the probability of product innovation success by four percent.

6. CONCLUDING REMARKS

This study examines the role played by innovation strategies, which refers to strategic decisions at firm level, on innovation success measured in terms of product and process innovation. The analysis was performed with data from the Technological Innovation Panel (PITEC) between 2008–2012 for a sample of 3,919 Spanish innovative firms in the

manufacturing and services sectors. Firstly, we identified the innovation strategies that innovative firms can design (absence, mixed, or oriented strategy towards quality, production, cost and environmental and regulatory) by applying a principal component analysis. Secondly, after controlling for positive skewness of the dependent variables, a generalized linear model was used to examine the impact of these innovation strategies.

Our econometrics results show that those firms that are able to design their innovation strategies tend to have a greater probability of being a successful innovative firm. Our results also show that there is a good fit between the strategies pursued by each firm and the innovation output obtained. Quality strategy orientation is positively related to product innovation success, whereas product, cost and environmental and regulatory strategy are positively related to process innovation success. Product innovation requires understanding both customers and technologies, and firms that carry out process innovation are enhancing the efficiency, effectiveness and flexibility of the firm.

To sum up, our results highlight that there are three classes of Spanish innovative firms: 1) a group of firms that do not have an explicit strategy and consequently perform worst; 2) a group of firms that pursue some objectives in the innovative field and want to innovate, but do not have enough capacity to focus their innovation and, finally, 3) a group of firms that have a capacity to design one or more oriented innovation strategy and experience greater innovation success.

These results are of great interest from the perspective of policy-makers and managers. They need to take into account a broader range of characteristics that may influence innovation success such as innovation strategy. It is crucial for management to realize the importance of innovation strategy as a fundamental key to the success of innovation in a highly dynamic environment. In terms of managerial implications, these results suggest that encouraging innovation beginning with a clear and precise innovation

strategy is likely to enhance innovative outcomes. For policy-makers, this study reveals a diverse range of strategic profiles in relation to innovation and emphasizes the importance and effects of innovation strategies in the manufacturing and services firms. From a public policy point of view, in order to develop appropriate innovation policies, it is currently very important for governments to understand how innovative firms define their innovation strategies. Many policies for supporting innovation would benefit from the identification of the main forces that drive firms' innovation activities. Thus, innovation policies should provide a series of tools to firms wishing to initiate internal reflection on their ability to innovate. In addition, evaluating and understanding the strategic orientation of innovative firms allows governments to develop appropriate innovation policies.

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APPENDIX

Appendix 1. Aggregations of manufacturing and services based on NACE Rev. 2

Firms are grouped depending on their technological intensity according to Eurostat, NACE Classification.

Table A.1

Aggregations of manufacturing and services based on NACE Rev. 2

Manufacturing industries	
<i>1. Industry: High Technology</i>	
Manufacture of basic pharmaceutical products and pharmaceutical preparations	21
Manufacture of computer, electronic and optical products	26
Manufacture of air and spacecraft and related machinery	30.3
<i>2. Industry: Medium High Technology</i>	
Manufacture of chemicals and chemical products	20
Manufacture of electrical equipment, Manufacture of machinery and equipment n.e.c., Manufacture of motor vehicles, trailers and semi-trailers	27-29
Manufacture of other transport equipment (excluding 30.1 Building of ships and boats, and 30.3 Manufacture of air and spacecraft and related machinery)	30 –(30.1+30.3)
<i>3. Industry: Medium Low Technology</i>	
Manufacture of coke and refined petroleum products	19
Manufacture of rubber and plastic products, Manufacture of other non-metallic mineral products, Manufacture of basic metals, Manufacture of fabricated metal products, except machinery and equipment	22-25
Building of ships and boats	30.1
Repair and installation of machinery and equipment	33
<i>4. Industry: Low Technology</i>	
Manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, Printing and reproductions of recorded media	10-18
Manufacture of furniture, Other manufacturing	31-32
Services industries	
<i>5. High-Tech Knowledge Intensive Services</i>	
Motion picture, video and television programme production, sound recording and music publishing activities, Programming and broadcasting activities, Telecommunications, Computer programming, consultancy and related activities, Information service activities	59-63
Scientific research and development	72
<i>6. Other Knowledge Intensive Services</i>	
Financial and insurance activities	64-66
Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis	69-71
Advertising and market research, Other professional, scientific and technical activities	73-74
Veterinary activities	75
Human health and social work activities	86-88
Arts, entertainment and recreation	90-93

Appendix 2. Variable definitions

Table A.2

Variable definitions

<i>Dependent variables</i>	
Product innovation	Dummy variable which takes the value 1 if the firm has introduced new or significantly improved products during t-2 to t; 0 if not
Process innovation	Dummy variable which takes the value 1 if the firm has introduced new or significantly improved production processes during t-2 to t; 0 if not
<i>Independent variables</i>	
<i>Firms' resources and capabilities</i>	
Absence of innovation strategy	Dummy variable which takes the value 1 if the firm pursues fewer than two objectives with high importance during t-2 to t; 0 if not
Mixed strategy	Dummy variable which takes the value 1 if the firm purses two or more objectives with high importance during t-2 to t without an orientation; 0 if not
Quality strategy	Dummy variable which takes the value 1 if the firm has a strategy oriented towards the quality. That means that firm considers at least four of the following objectives with high importance during t-2 to t: (1) increase range of goods or services, (2) replace products being phased out, (3) enter new markets, (4) increase market share and (5) improve product quality; 0 if not
Production strategy	Dummy variable which takes the value 1 if the firm has a strategy oriented towards the production. That means that firm considers two of the following objectives with high importance during t-2 to t: (1) increase flexibility of production, (2) increase capacity of production; 0 if not
Cost strategy	Dummy variable which takes the value 1 if the firm has a strategy oriented towards cost reduction. That means that firm considers at least two of the following objectives with high importance during t-2 to t: (1) reduce labour costs per unit output, (2) reduce material costs per unit output and (3) reduce energy costs per unit output objectives; 0 if not
Environment and regulatory strategy	Dummy variable which takes the value 1 if the firm has a strategy oriented towards environment and regulatory norms. That means that firm considers at least two of the following objectives with high importance during t-2 to t: (1) reduce environmental impacts, (2) improve health or safety of employees and (3) fulfil government regulation or standards requirements; 0 if not
Size	Log of the total number of firm's employees (in logs)
Group	Dummy variable that takes a value equal to 1 if the firm belongs to a group; 0 if not
Export	Dummy variable that takes a value equal to 1 if the firm exports; 0 if not
Internal R&D	Investment in internal R&D per worker (in logs)
External R&D	Investment in external R&D per worker (in logs)
Human resources	Dummy variable that takes a value equal to 1 if firm invests in training expenditure for innovation activities; 0 if not
High Tech manufacture and High KIS	Dummy variables which take the value equal 1 if the firm belongs to a high tech manufacturing sector or to a high knowledge intensive service; 0 if not
Cooperation	Dummy variable that takes a value equal to 1 if the firm cooperates with other agents during t-2 to t; 0 if not
Public subsidies	Dummy variable that takes a value equal to 1 if the firm received any public financial support for innovation activities during t-2 to t; 0 if not

Appendix 3. Descriptive statistics

Table A.3
Summary statistics of sample 2008-2012 (mean score in the sample)

Variable	Absence strategy Obs=4,645 F=929	Innovation strategy Obs=14,950 F=2,990	Mixed strategy Obs=4,436 F=887	Quality strategy Obs=5,357 F=1,072	Production strategy Obs=4,767 F=953	Cost strategy Obs=3,416 F=683	Environ. and regulatory strategy Obs=5,180 F=1,036
Size (workers)	231.32 (891.64)	290.93 (1156.10)	211.88 (898.97)	353.18 (1568.31)	387.46 (1388.32)	374.42 (1344.25)	363.7089 (1281.58)
Group ¹	0.4357 (0.4959)	0.4936 (0.4999)	0.4675 (0.4990)	0.4784 (0.4995)	0.5235 (0.4994)	0.5901 (0.4918)	0.5376 (0.4986)
Export by sales ¹	0.6822 (0.4656)	0.7305 (0.4437)	0.7044 (0.4563)	0.7731 (0.4188)	0.7082 (0.4546)	0.7854 (0.4105)	0.7698 (0.4209)
R&D training ¹	0.1138 (0.3177)	0.2134 (0.4097)	0.1832 (0.3869)	0.2251 (0.4177)	0.2494 (0.4327)	0.2330 (0.4228)	0.2438 (0.4294)
Internal R&D per worker (€)	6570.30 (28610.60)	8539.51 (32156.19)	9046.01 (48690.5)	8489.58 (17231.34)	7919.39 (25734.91)	7004.77 (16712.46)	8506.80 (18949.93)
External R&D per worker (€)	1443.42 (13977.46)	1706.74 (11187.17)	1445.14 (7024.45)	1655.79 (7358.225)	1627.46 (13468.46)	1491.96 (10136.31)	2034.50 (14958.37)
Cooperation ¹	0.3001 (0.4583)	0.4723 (0.4992)	0.4537 (0.4979)	0.4804 (0.4996)	0.4856 (0.4998)	0.4947 (0.5000)	0.4872 (0.4998)
Subsidy ¹	0.3608 (0.4802)	0.4922 (0.4999)	0.4862 (0.4998)	0.5070 (0.4999)	0.4740 (0.4993)	0.5014 (0.5000)	0.4996 (0.5000)
HT manuf. and HKIS ¹	0.4607 (0.4985)	0.5117 (0.4998)	0.5076 (0.4999)	0.5417 (0.4983)	0.4786 (0.4995)	0.4812 (0.4997)	0.5075 (0.4999)
Product innovation ¹	0.6206 (0.4852)	0.7983 (0.4012)	0.8016 (0.3988)	0.8579 (0.3491)	0.7734 (0.4186)	0.7827 (0.4124)	0.7949 (0.4037)
Process innovation ¹	0.6066 (0.4885)	0.7662 (0.4232)	0.6837 (0.4650)	0.7720 (0.4195)	0.8770 (0.3283)	0.85681 (0.3502)	0.8148 (0.3884)

Note: All monetary variables were deflated using the Price Index of the National Statistics Institute (INE, Spain). The Industrial Price Index was used for manufacturing firms and the Services Sector Price Index for services firms.

¹Percentage of firms.

F: number of firms.

Appendix 4. Correlation matrix

Table A.4
Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.Size	1																
2.Group	0.181*	1															
3.Export	-0.027*	0.077*	1														
4.Human resources	0.072*	0.031*	-0.005	1													
5.Internal R&D	-0.029*	-0.002	-0.025*	0.040*	1												
6.External R&D	-0.002	0.034*	-0.016*	0.032*	0.189*	1											
7.Cooperation	0.095*	0.132*	0.020*	0.149*	0.115*	0.086*	1										
8.Subsidy	0.029*	0.044*	0.050*	0.123*	0.151*	0.092*	0.367*	1									
9. HT manuf. HKIS	-0.040*	-0.009	0.062*	0.056*	0.124*	0.052*	0.044*	0.086*	1								
10. No strategy	-0.023*	-0.049*	-0.045*	-0.108*	-0.026*	-0.009	-0.147*	-0.112*	-0.045*	1							
11 Quality strategy	0.042*	-0.001	0.073*	0.052*	0.008	0.001	0.060*	0.056*	0.054*	-0.341*	1						
12. Production strategy	0.057*	0.049*	-0.013	0.086*	-0.002	-0.001	0.061*	0.014*	-0.036*	-0.316*	0.223*	1					
13. Cost strategy	0.040*	0.101*	0.067*	0.050*	-0.015*	-0.005	0.058*	0.037*	0.059*	-0.256*	0.199*	0.313*	1				
14. Environ. strategy	0.047*	0.069*	0.068*	0.082*	0.008	0.019*	0.067*	0.046*	0.095*	-0.334*	0.220*	0.239*	0.330*	1			
15.Unoriented strategy	-0.031*	-0.012	-0.017*	-0.009	0.016*	-0.009	0.024*	0.027*	-0.027*	-0.301*	-0.331*	-0.307*	-0.248*	-0.324*	1		
16.Product innovation	0.043*	0.014*	0.073*	0.105*	0.036*	0.002	0.153*	0.107*	0.090*	-0.176*	0.145*	0.022*	0.028*	0.054*	0.057*	1	
17.Process innovation	0.067*	0.074*	0.018*	0.163*	-0.021*	-0.021*	0.118*	0.023*	-0.057*	-0.152*	0.060*	0.189*	0.132*	0.116*	-0.054*	0.087*	1

* Significance at 5%

Appendix 5. Innovation objectives

Table A.5
GLMs. Innovation objectives (whole sample)

Variables	Product innovation		Process innovation	
	Coeff.	MEMs	Coeff.	MEMs
lSize $t-1$	0.0909*** (0.015)	0.0168*** (0.003)	0.1843*** (0.015)	0.0374*** (0.003)
Group $t-1$	-0.1098*** (0.038)	-0.0203*** (0.007)	-0.0604* (0.036)	-0.0123* (0.007)
Export $t-1$	0.1704*** (0.036)	0.0315*** (0.007)	0.0577* (0.035)	0.0117* (0.007)
Human resources $t-1$	0.4185*** (0.049)	0.0774*** (0.009)	0.7835*** (0.052)	0.1591*** (0.010)
lInternal R&D $t-1$	0.0594*** (0.005)	0.0110*** (0.001)	-0.0353*** (0.005)	-0.0072*** (0.001)
lExternal R&D $t-1$	-0.0034 (0.005)	-0.0006 (0.001)	0.0020 (0.005)	0.0004 (0.001)
Cooperation $t-1$	0.3229*** (0.040)	0.0597*** (0.007)	0.2694*** (0.036)	0.0547*** (0.007)
Subsidy $t-1$	-0.0185 (0.039)	-0.0034 (0.007)	-0.0959*** (0.036)	-0.0195*** (0.007)
HT manuf. and HKIS $t-1$	0.2405*** (0.034)	0.0445*** (0.006)	-0.3129*** (0.032)	-0.0635*** (0.007)
Objective 1 $t-1$	0.6440*** (0.039)	0.1191*** (0.007)	0.0154 (0.036)	0.0031 (0.007)
Objective 2 $t-1$	0.0518 (0.040)	0.0096 (0.007)	0.0319 (0.037)	0.0065 (0.008)
Objective 3 $t-1$	0.1829*** (0.043)	0.0338*** (0.008)	0.0115 (0.041)	0.0023 (0.008)
Objective 4 $t-1$	0.2449*** (0.044)	0.0453*** (0.008)	-0.0245 (0.041)	-0.0050 (0.008)
Objective 5 $t-1$	0.1246*** (0.038)	0.0230*** (0.007)	0.0092 (0.036)	0.0019 (0.007)
Objective 6 $t-1$	0.0096 (0.043)	0.0018 (0.008)	0.4400*** (0.044)	0.0894*** (0.009)
Objective 7 $t-1$	-0.1266*** (0.044)	-0.0234*** (0.008)	0.4947*** (0.045)	0.1005*** (0.009)
Objective 8 $t-1$	-0.0511 (0.048)	-0.0095 (0.009)	0.2327*** (0.049)	0.0473*** (0.010)
Objective 9 $t-1$	0.0804 (0.062)	0.0149 (0.012)	0.0287 (0.063)	0.0058 (0.013)
Objective 10 $t-1$	-0.1427** (0.061)	-0.0264** (0.011)	0.0853 (0.064)	0.0173 (0.013)
Objective 11 $t-1$	-0.1657*** (0.054)	-0.0306*** (0.010)	0.0974* (0.053)	0.0198* (0.011)
Objective 12 $t-1$	-0.1468** (0.058)	-0.0271** (0.011)	0.0228 (0.055)	0.0046 (0.011)
Objective 13 $t-1$	0.2303*** (0.054)	0.0426*** (0.010)	0.0777 (0.048)	0.0158 (0.010)
Constant	0.0259 (0.075)		0.4807*** (0.078)	
(1/df) Pearson	0.9718		0.9914	
AIC	0.9875		1.0373	
BIC	-135.748.3		-134.967.3	
Log pseudolikelihood	-7,714.4		-8,104.9	
Observations			15,676	

Estimations control for time and industry dummies. Marginal effects calculated at their mean (MEMs). For dummy variables, change in probability for a discrete change of the dummy variable from 0 to 1. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.



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(Desembre 2006)

CREAP2006-09

Segarra, A. (GRIT); **Teruel-Carrizosa, M.** (GRIT)

"Productivity growth and competition in spanish manufacturing firms:
What has happened in recent years?"
(Desembre 2006)

CREAP2006-10

Andonova, V.; **Díaz-Serrano, Luis.** (CREB)

"Political institutions and the development of telecommunications"
(Desembre 2006)

CREAP2006-11

Raymond, J.Ll.(GEAP); **Roig, J.Ll.** (GEAP)

"Capital humano: un análisis comparativo Catalunya-España"
(Desembre 2006)

CREAP2006-12

Rodríguez, M.(CREB); **Stoyanova, A.** (CREB)

"Changes in the demand for private medical insurance following a shift in tax incentives"
(Desembre 2006)

CREAP2006-13

Royuela, V. (AQR-IREA); **Lambiri, D.**; **Biagi, B.**

"Economía urbana y calidad de vida. Una revisión del estado del conocimiento en España"
(Desembre 2006)



CREAP2006-14

Camarero, M.; Carrion-i-Silvestre, J.LL. (AQR-IREA); Tamarit, C.

"New evidence of the real interest rate parity for OECD countries using panel unit root tests with breaks"
(Desembre 2006)

CREAP2006-15

Karanassou, M.; Sala, H. (GEAP); Snower, D. J.

"The macroeconomics of the labor market: Three fundamental views"
(Desembre 2006)

2007

XREAP2007-01

Castany, L. (AQR-IREA); López-Bazo, E. (AQR-IREA); Moreno, R. (AQR-IREA)

"Decomposing differences in total factor productivity across firm size"
(Març 2007)

XREAP2007-02

Raymond, J. Ll. (GEAP); Roig, J. Ll. (GEAP)

"Una propuesta de evaluación de las externalidades de capital humano en la empresa"
(Abril 2007)

XREAP2007-03

Durán, J. M. (IEB); Esteller, A. (IEB)

"An empirical analysis of wealth taxation: Equity vs. Tax compliance"
(Juny 2007)

XREAP2007-04

Matas, A. (GEAP); Raymond, J.Ll. (GEAP)

"Cross-section data, disequilibrium situations and estimated coefficients: evidence from car ownership demand"
(Juny 2007)

XREAP2007-05

Jofre-Montseny, J. (IEB); Solé-Ollé, A. (IEB)

"Tax differentials and agglomeration economies in intraregional firm location"
(Juny 2007)

XREAP2007-06

Álvarez-Albelo, C. (CREB); Hernández-Martín, R.

"Explaining high economic growth in small tourism countries with a dynamic general equilibrium model"
(Juliol 2007)

XREAP2007-07

Duch, N. (IEB); Montolio, D. (IEB); Mediavilla, M.

"Evaluating the impact of public subsidies on a firm's performance: a quasi-experimental approach"
(Juliol 2007)

XREAP2007-08

Segarra-Blasco, A. (GRIT)

"Innovation sources and productivity: a quantile regression analysis"
(Octubre 2007)

XREAP2007-09

Albalade, D. (PPRE-IREA)

"Shifting death to their Alternatives: The case of Toll Motorways"
(Octubre 2007)

XREAP2007-10

Segarra-Blasco, A. (GRIT); Garcia-Quevedo, J. (IEB); Teruel-Carrizosa, M. (GRIT)

"Barriers to innovation and public policy in catalonia"
(Novembre 2007)

XREAP2007-11

Bel, G. (PPRE-IREA); Foote, J.

"Comparison of recent toll road concession transactions in the United States and France"
(Novembre 2007)



XREAP2007-12

Segarra-Blasco, A. (GRIT);

“Innovation, R&D spillovers and productivity: the role of knowledge-intensive services”
(Novembre 2007)

XREAP2007-13

Bermúdez Morata, Ll. (RFA-IREA); **Guillén Estany, M.** (RFA-IREA), **Solé Auró, A.** (RFA-IREA)

“Impacto de la inmigración sobre la esperanza de vida en salud y en discapacidad de la población española”
(Novembre 2007)

XREAP2007-14

Calaeys, P. (AQR-IREA); **Ramos, R.** (AQR-IREA), **Suriñach, J.** (AQR-IREA)

“Fiscal sustainability across government tiers”
(Desembre 2007)

XREAP2007-15

Sánchez Hugalbe, A. (IEB)

“Influencia de la inmigración en la elección escolar”
(Desembre 2007)

2008

XREAP2008-01

Durán Weitkamp, C. (GRIT); **Martín Bofarull, M.** (GRIT) ; **Pablo Martí, F.**

“Economic effects of road accessibility in the Pyrenees: User perspective”
(Gener 2008)

XREAP2008-02

Díaz-Serrano, L.; **Stoyanova, A. P.** (CREB)

“The Causal Relationship between Individual’s Choice Behavior and Self-Reported Satisfaction: the Case of Residential Mobility in the EU”
(Març 2008)

XREAP2008-03

Matas, A. (GEAP); **Raymond, J. L.** (GEAP); **Roig, J. L.** (GEAP)

“Car ownership and access to jobs in Spain”
(Abril 2008)

XREAP2008-04

Bel, G. (PPRE-IREA) ; **Fageda, X.** (PPRE-IREA)

“Privatization and competition in the delivery of local services: An empirical examination of the dual market hypothesis”
(Abril 2008)

XREAP2008-05

Matas, A. (GEAP); **Raymond, J. L.** (GEAP); **Roig, J. L.** (GEAP)

“Job accessibility and employment probability”
(Maig 2008)

XREAP2008-06

Basher, S. A.; **Carrión, J. Ll.** (AQR-IREA)

Deconstructing Shocks and Persistence in OECD Real Exchange Rates
(Juny 2008)

XREAP2008-07

Sanromá, E. (IEB); **Ramos, R.** (AQR-IREA); **Simón, H.**

Portabilidad del capital humano y asimilación de los inmigrantes. Evidencia para España
(Juliol 2008)

XREAP2008-08

Basher, S. A.; **Carrión, J. Ll.** (AQR-IREA)

Price level convergence, purchasing power parity and multiple structural breaks: An application to US cities
(Juliol 2008)

XREAP2008-09

Bermúdez, Ll. (RFA-IREA)

A priori ratemaking using bivariate poisson regression models
(Juliol 2008)



XREAP2008-10

Solé-Ollé, A. (IEB), Hortas Rico, M. (IEB)

Does urban sprawl increase the costs of providing local public services? Evidence from Spanish municipalities
(Novembre 2008)

XREAP2008-11

Teruel-Carrizosa, M. (GRIT), Segarra-Blasco, A. (GRIT)

Immigration and Firm Growth: Evidence from Spanish cities
(Novembre 2008)

XREAP2008-12

Duch-Brown, N. (IEB), García-Quevedo, J. (IEB), Montolio, D. (IEB)

Assessing the assignation of public subsidies: Do the experts choose the most efficient R&D projects?
(Novembre 2008)

XREAP2008-13

Bilotkach, V., Fageda, X. (PPRE-IREA), Flores-Fillol, R.

Scheduled service versus personal transportation: the role of distance
(Desembre 2008)

XREAP2008-14

Albalate, D. (PPRE-IREA), Gel, G. (PPRE-IREA)

Tourism and urban transport: Holding demand pressure under supply constraints
(Desembre 2008)

2009

XREAP2009-01

Calonge, S. (CREB); Tejada, O.

“A theoretical and practical study on linear reforms of dual taxes”
(Febrer 2009)

XREAP2009-02

Albalate, D. (PPRE-IREA); Fernández-Villadangos, L. (PPRE-IREA)

“Exploring Determinants of Urban Motorcycle Accident Severity: The Case of Barcelona”
(Març 2009)

XREAP2009-03

Borrell, J. R. (PPRE-IREA); Fernández-Villadangos, L. (PPRE-IREA)

“Assessing excess profits from different entry regulations”
(Abril 2009)

XREAP2009-04

Sanromá, E. (IEB); Ramos, R. (AQR-IREA), Simon, H.

“Los salarios de los inmigrantes en el mercado de trabajo español. ¿Importa el origen del capital humano?”
(Abril 2009)

XREAP2009-05

Jiménez, J. L.; Perdiguero, J. (PPRE-IREA)

“(No)competition in the Spanish retailing gasoline market: a variance filter approach”
(Maig 2009)

XREAP2009-06

Álvarez-Albelo, C. D. (CREB), Manresa, A. (CREB), Pigem-Vigo, M. (CREB)

“International trade as the sole engine of growth for an economy”
(Juny 2009)

XREAP2009-07

Callejón, M. (PPRE-IREA), Ortún V, M.

“The Black Box of Business Dynamics”
(Setembre 2009)

XREAP2009-08

Lucena, A. (CREB)

“The antecedents and innovation consequences of organizational search: empirical evidence for Spain”
(Octubre 2009)



XREAP2009-09

Domènech Campmajó, L. (PPRE-IREA)

“Competition between TV Platforms”

(Octubre 2009)

XREAP2009-10

Solé-Auró, A. (RFA-IREA), **Guillén, M.** (RFA-IREA), **Crimmins, E. M.**

“Health care utilization among immigrants and native-born populations in 11 European countries. Results from the Survey of Health, Ageing and Retirement in Europe”

(Octubre 2009)

XREAP2009-11

Segarra, A. (GRIT), **Teruel, M.** (GRIT)

“Small firms, growth and financial constraints”

(Octubre 2009)

XREAP2009-12

Matas, A. (GEAP), **Raymond, J.Ll.** (GEAP), **Ruiz, A.** (GEAP)

“Traffic forecasts under uncertainty and capacity constraints”

(Novembre 2009)

XREAP2009-13

Sole-Ollé, A. (IEB)

“Inter-regional redistribution through infrastructure investment: tactical or programmatic?”

(Novembre 2009)

XREAP2009-14

Del Barrio-Castro, T., **García-Quevedo, J.** (IEB)

“The determinants of university patenting: Do incentives matter?”

(Novembre 2009)

XREAP2009-15

Ramos, R. (AQR-IREA), **Suriñach, J.** (AQR-IREA), **Artís, M.** (AQR-IREA)

“Human capital spillovers, productivity and regional convergence in Spain”

(Novembre 2009)

XREAP2009-16

Álvarez-Albelo, C. D. (CREB), **Hernández-Martín, R.**

“The commons and anti-commons problems in the tourism economy”

(Desembre 2009)

2010

XREAP2010-01

García-López, M. A. (GEAP)

“The Accessibility City. When Transport Infrastructure Matters in Urban Spatial Structure”

(Febrer 2010)

XREAP2010-02

García-Quevedo, J. (IEB), **Mas-Verdú, F.** (IEB), **Polo-Otero, J.** (IEB)

“Which firms want PhDs? The effect of the university-industry relationship on the PhD labour market”

(Març 2010)

XREAP2010-03

Pitt, D., **Guillén, M.** (RFA-IREA)

“An introduction to parametric and non-parametric models for bivariate positive insurance claim severity distributions”

(Març 2010)

XREAP2010-04

Bermúdez, Ll. (RFA-IREA), **Karlis, D.**

“Modelling dependence in a ratemaking procedure with multivariate Poisson regression models”

(Abril 2010)

XREAP2010-05

Di Paolo, A. (IEB)

“Parental education and family characteristics: educational opportunities across cohorts in Italy and Spain”

(Maig 2010)



XREAP2010-06

Simón, H. (IEB), **Ramos, R.** (AQR-IREA), **Sanromá, E.** (IEB)

“Movilidad ocupacional de los inmigrantes en una economía de bajas cualificaciones. El caso de España”
(Juny 2010)

XREAP2010-07

Di Paolo, A. (GEAP & IEB), **Raymond, J. Ll.** (GEAP & IEB)

“Language knowledge and earnings in Catalonia”
(Juliol 2010)

XREAP2010-08

Bolancé, C. (RFA-IREA), **Alemany, R.** (RFA-IREA), **Guillén, M.** (RFA-IREA)

“Prediction of the economic cost of individual long-term care in the Spanish population”
(Setembre 2010)

XREAP2010-09

Di Paolo, A. (GEAP & IEB)

“Knowledge of catalan, public/private sector choice and earnings: Evidence from a double sample selection model”
(Setembre 2010)

XREAP2010-10

Coad, A., Segarra, A. (GRIT), **Teruel, M.** (GRIT)

“Like milk or wine: Does firm performance improve with age?”
(Setembre 2010)

XREAP2010-11

Di Paolo, A. (GEAP & IEB), **Raymond, J. Ll.** (GEAP & IEB), **Calero, J.** (IEB)

“Exploring educational mobility in Europe”
(Octubre 2010)

XREAP2010-12

Borrell, A. (GiM-IREA), **Fernández-Villadangos, L.** (GiM-IREA)

“Clustering or scattering: the underlying reason for regulating distance among retail outlets”
(Desembre 2010)

XREAP2010-13

Di Paolo, A. (GEAP & IEB)

“School composition effects in Spain”
(Desembre 2010)

XREAP2010-14

Fageda, X. (GiM-IREA), **Flores-Fillol, R.**

“Technology, Business Models and Network Structure in the Airline Industry”
(Desembre 2010)

XREAP2010-15

Albalate, D. (GiM-IREA), **Bel, G.** (GiM-IREA), **Fageda, X.** (GiM-IREA)

“Is it Redistribution or Centralization? On the Determinants of Government Investment in Infrastructure”
(Desembre 2010)

XREAP2010-16

Oppedisano, V., Turati, G.

“What are the causes of educational inequalities and of their evolution over time in Europe? Evidence from PISA”
(Desembre 2010)

XREAP2010-17

Canova, L., Vaglio, A.

“Why do educated mothers matter? A model of parental help”
(Desembre 2010)

2011

XREAP2011-01

Fageda, X. (GiM-IREA), **Perdiguero, J.** (GiM-IREA)

“An empirical analysis of a merger between a network and low-cost airlines”
(Maig 2011)



XREAP2011-02

Moreno-Torres, I. (ACCO, CRES & GiM-IREA)

“What if there was a stronger pharmaceutical price competition in Spain? When regulation has a similar effect to collusion”
(Maig 2011)

XREAP2011-03

Miguélez, E. (AQR-IREA); **Gómez-Miguélez, I.**

“Singling out individual inventors from patent data”
(Maig 2011)

XREAP2011-04

Moreno-Torres, I. (ACCO, CRES & GiM-IREA)

“Generic drugs in Spain: price competition vs. moral hazard”
(Maig 2011)

XREAP2011-05

Nieto, S. (AQR-IREA), **Ramos, R.** (AQR-IREA)

“¿Afecta la sobreeducación de los padres al rendimiento académico de sus hijos?”
(Maig 2011)

XREAP2011-06

Pitt, D., Guillén, M. (RFA-IREA), **Bolancé, C.** (RFA-IREA)

“Estimation of Parametric and Nonparametric Models for Univariate Claim Severity Distributions - an approach using R”
(Juny 2011)

XREAP2011-07

Guillén, M. (RFA-IREA), **Comas-Herrera, A.**

“How much risk is mitigated by LTC Insurance? A case study of the public system in Spain”
(Juny 2011)

XREAP2011-08

Ayuso, M. (RFA-IREA), **Guillén, M.** (RFA-IREA), **Bolancé, C.** (RFA-IREA)

“Loss risk through fraud in car insurance”
(Juny 2011)

XREAP2011-09

Duch-Brown, N. (IEB), **García-Quevedo, J.** (IEB), **Montolio, D.** (IEB)

“The link between public support and private R&D effort: What is the optimal subsidy?”
(Juny 2011)

XREAP2011-10

Bermúdez, Ll. (RFA-IREA), **Karlis, D.**

“Mixture of bivariate Poisson regression models with an application to insurance”
(Juliol 2011)

XREAP2011-11

Varela-Irimia, X-L. (GRIT)

“Age effects, unobserved characteristics and hedonic price indexes: The Spanish car market in the 1990s”
(Agost 2011)

XREAP2011-12

Bermúdez, Ll. (RFA-IREA), **Ferri, A.** (RFA-IREA), **Guillén, M.** (RFA-IREA)

“A correlation sensitivity analysis of non-life underwriting risk in solvency capital requirement estimation”
(Setembre 2011)

XREAP2011-13

Guillén, M. (RFA-IREA), **Pérez-Marín, A.** (RFA-IREA), **Alcañiz, M.** (RFA-IREA)

“A logistic regression approach to estimating customer profit loss due to lapses in insurance”
(Octubre 2011)

XREAP2011-14

Jiménez, J. L., Perdiguero, J. (GiM-IREA), **García, C.**

“Evaluation of subsidies programs to sell green cars: Impact on prices, quantities and efficiency”
(Octubre 2011)



XREAP2011-15

Arespa, M. (CREB)

“A New Open Economy Macroeconomic Model with Endogenous Portfolio Diversification and Firms Entry”
(Octubre 2011)

XREAP2011-16

Matas, A. (GEAP), **Raymond, J. L.** (GEAP), **Roig, J.L.** (GEAP)

“The impact of agglomeration effects and accessibility on wages”
(Novembre 2011)

XREAP2011-17

Segarra, A. (GRIT)

“R&D cooperation between Spanish firms and scientific partners: what is the role of tertiary education?”
(Novembre 2011)

XREAP2011-18

García-Pérez, J. I.; Hidalgo-Hidalgo, M.; Robles-Zurita, J. A.

“Does grade retention affect achievement? Some evidence from PISA”
(Novembre 2011)

XREAP2011-19

Arespa, M. (CREB)

“Macroeconomics of extensive margins: a simple model”
(Novembre 2011)

XREAP2011-20

García-Quevedo, J. (IEB), **Pellegrino, G.** (IEB), **Vivarelli, M.**

“The determinants of YICs’ R&D activity”
(Desembre 2011)

XREAP2011-21

González-Val, R. (IEB), **Olmo, J.**

“Growth in a Cross-Section of Cities: Location, Increasing Returns or Random Growth?”
(Desembre 2011)

XREAP2011-22

Gombau, V. (GRIT), **Segarra, A.** (GRIT)

“The Innovation and Imitation Dichotomy in Spanish firms: do absorptive capacity and the technological frontier matter?”
(Desembre 2011)

2012

XREAP2012-01

Borrell, J. R. (GiM-IREA), **Jiménez, J. L.,** **García, C.**

“Evaluating Antitrust Leniency Programs”
(Gener 2012)

XREAP2012-02

Ferri, A. (RFA-IREA), **Guillén, M.** (RFA-IREA), **Bermúdez, Ll.** (RFA-IREA)

“Solvency capital estimation and risk measures”
(Gener 2012)

XREAP2012-03

Ferri, A. (RFA-IREA), **Bermúdez, Ll.** (RFA-IREA), **Guillén, M.** (RFA-IREA)

“How to use the standard model with own data”
(Febrer 2012)

XREAP2012-04

Perdiguero, J. (GiM-IREA), **Borrell, J.R.** (GiM-IREA)

“Driving competition in local gasoline markets”
(Març 2012)

XREAP2012-05

D’Amico, G., **Guillen, M.** (RFA-IREA), Manca, R.

“Discrete time Non-homogeneous Semi-Markov Processes applied to Models for Disability Insurance”
(Març 2012)



XREAP2012-06

Bové-Sans, M. A. (GRIT), Laguardo-Ramírez, R.
“Quantitative analysis of image factors in a cultural heritage tourist destination”
(Abril 2012)

XREAP2012-07

Tello, C. (AQR-IREA), **Ramos, R.** (AQR-IREA), **Artís, M.** (AQR-IREA)
“Changes in wage structure in Mexico going beyond the mean: An analysis of differences in distribution, 1987-2008”
(Maig 2012)

XREAP2012-08

Jofre-Monseny, J. (IEB), **Marín-López, R.** (IEB), **Viladecans-Marsal, E.** (IEB)
“What underlies localization and urbanization economies? Evidence from the location of new firms”
(Maig 2012)

XREAP2012-09

Muñiz, I. (GEAP), **Calatayud, D.**, **Dobaño, R.**
“Los límites de la compacidad urbana como instrumento a favor de la sostenibilidad. La hipótesis de la compensación en Barcelona medida a través de la huella ecológica de la movilidad y la vivienda”
(Maig 2012)

XREAP2012-10

Arqué-Castells, P. (GEAP), **Mohnen, P.**
“Sunk costs, extensive R&D subsidies and permanent inducement effects”
(Maig 2012)

XREAP2012-11

Boj, E. (CREB), **Delicado, P.**, **Fortiana, J.**, **Esteve, A.**, **Caballé, A.**
“Local Distance-Based Generalized Linear Models using the dbstats package for R”
(Maig 2012)

XREAP2012-12

Royuela, V. (AQR-IREA)
“What about people in European Regional Science?”
(Maig 2012)

XREAP2012-13

Osorio A. M. (RFA-IREA), **Bolancé, C.** (RFA-IREA), **Madise, N.**
“Intermediary and structural determinants of early childhood health in Colombia: exploring the role of communities”
(Juny 2012)

XREAP2012-14

Miguellez, E. (AQR-IREA), **Moreno, R.** (AQR-IREA)
“Do labour mobility and networks foster geographical knowledge diffusion? The case of European regions”
(Juliol 2012)

XREAP2012-15

Teixidó-Figueras, J. (GRIT), **Duró, J. A.** (GRIT)
“Ecological Footprint Inequality: A methodological review and some results”
(Setembre 2012)

XREAP2012-16

Varela-Irimia, X-L. (GRIT)
“Profitability, uncertainty and multi-product firm product proliferation: The Spanish car industry”
(Setembre 2012)

XREAP2012-17

Duró, J. A. (GRIT), **Teixidó-Figueras, J.** (GRIT)
“Ecological Footprint Inequality across countries: the role of environment intensity, income and interaction effects”
(Octubre 2012)

XREAP2012-18

Manresa, A. (CREB), **Sancho, F.**
“Leontief versus Ghosh: two faces of the same coin”
(Octubre 2012)



XREAP2012-19

Alemany, R. (RFA-IREA), **Bolancé, C.** (RFA-IREA), **Guillén, M.** (RFA-IREA)

“Nonparametric estimation of Value-at-Risk”

(Octubre 2012)

XREAP2012-20

Herrera-Idárraga, P. (AQR-IREA), **López-Bazo, E.** (AQR-IREA), **Motellón, E.** (AQR-IREA)

“Informality and overeducation in the labor market of a developing country”

(Novembre 2012)

XREAP2012-21

Di Paolo, A. (AQR-IREA)

“(Endogenous) occupational choices and job satisfaction among recent PhD recipients: evidence from Catalonia”

(Desembre 2012)

2013

XREAP2013-01

Segarra, A. (GRIT), **García-Quevedo, J.** (IEB), **Teruel, M.** (GRIT)

“Financial constraints and the failure of innovation projects”

(Març 2013)

XREAP2013-02

Osorio, A. M. (RFA-IREA), **Bolancé, C.** (RFA-IREA), **Madise, N.**, **Rathmann, K.**

“Social Determinants of Child Health in Colombia: Can Community Education Moderate the Effect of Family Characteristics?”

(Març 2013)

XREAP2013-03

Teixidó-Figueras, J. (GRIT), **Duró, J. A.** (GRIT)

“The building blocks of international ecological footprint inequality: a regression-based decomposition”

(Abril 2013)

XREAP2013-04

Salcedo-Sanz, S., **Carro-Calvo, L.**, **Claramunt, M.** (CREB), **Castañer, A.** (CREB), **Marmol, M.** (CREB)

“An Analysis of Black-box Optimization Problems in Reinsurance: Evolutionary-based Approaches”

(Maig 2013)

XREAP2013-05

Alcañiz, M. (RFA), **Guillén, M.** (RFA), **Sánchez-Moscona, D.** (RFA), **Santolino, M.** (RFA), **Llatje, O.**, **Ramon, Ll.**

“Prevalence of alcohol-impaired drivers based on random breath tests in a roadside survey”

(Juliol 2013)

XREAP2013-06

Matas, A. (GEAP & IEB), **Raymond, J. Ll.** (GEAP & IEB), **Roig, J. L.** (GEAP)

“How market access shapes human capital investment in a peripheral country”

(Octubre 2013)

XREAP2013-07

Di Paolo, A. (AQR-IREA), **Tansel, A.**

“Returns to Foreign Language Skills in a Developing Country: The Case of Turkey”

(Novembre 2013)

XREAP2013-08

Fernández Gual, V. (GRIT), **Segarra, A.** (GRIT)

“The Impact of Cooperation on R&D, Innovation and Productivity: an Analysis of Spanish Manufacturing and Services Firms”

(Novembre 2013)

XREAP2013-09

Bahraoui, Z. (RFA); **Bolancé, C.** (RFA); **Pérez-Marín, A. M.** (RFA)

“Testing extreme value copulas to estimate the quantile”

(Novembre 2013)

2014

XREAP2014-01

Solé-Auró, A. (RFA), **Alcañiz, M.** (RFA)

“Are we living longer but less healthy? Trends in mortality and morbidity in Catalonia (Spain), 1994-2011”

(Gener 2014)



XREAP2014-02

Teixidó-Figueres, J. (GRIT), **Duro, J. A.** (GRIT)
“Spatial Polarization of the Ecological Footprint distribution”
(Febrer 2014)

XREAP2014-03

Cristobal-Cebolla, A.; **Gil Lafuente, A. M.** (RFA), **Merigó Lindhal, J. M.** (RFA)
“La importancia del control de los costes de la no-calidad en la empresa”
(Febrer 2014)

XREAP2014-04

Castañer, A. (CREB); **Claramunt, M.M.** (CREB)
“Optimal stop-loss reinsurance: a dependence analysis”
(Abril 2014)

XREAP2014-05

Di Paolo, A. (AQR-IREA); **Matas, A.** (GEAP); **Raymond, J. Ll.** (GEAP)
“Job accessibility, employment and job-education mismatch in the metropolitan area of Barcelona”
(Maig 2014)

XREAP2014-06

Di Paolo, A. (AQR-IREA); **Mañé, F.**
“Are we wasting our talent? Overqualification and overskilling among PhD graduates”
(Juny 2014)

XREAP2014-07

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