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# Innovation success: What is the role of innovation strategies?

Elisenda Jové-Llopis (*), Agustí Segarra Blasco (*)

**Abstract:**

The objective of this paper is to explore the role played by firms' strategies during innovation process and its effects on innovation success. We argue that firm's innovative decisions not only concern how much innovation effort to make but, more especially, what kind of innovation objectives to pursue, which refer to strategic decisions taken at the level of the firm. Our econometric analysis is based on a sample of 3,919 manufacturing and services firms taken from the Spanish Technological Innovation Panel (PITEC) for the period 2008–2012. Firstly, applying a principal component analysis we identified a diverse range of innovation strategies (no strategy, unfocused, market, production, cost and environmental and regulatory strategy). Secondly, after controlling positive skewness of the dependent variables a generalized linear model is used to exanimate the impact of these innovation strategies. Our empirical results reveal some relevant aspects. Firstly, firms that do not have a well-defined innovation strategy experience fewer probability of being a successful innovative firm. Secondly, firms that do have an innovation strategy, but not focused on any specific orientation, have enhanced innovation success, but less than that of firms with an oriented strategy. Finally, the results also show that there is a good fit between an oriented strategy pursued by firms and their innovation success.

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

**JEL Classification Numbers**: D21. O31. O32

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## 1. Introduction

Innovation has been recognized as a vital source of competitive advantage for firms. 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, there is a large body of research on the determinants of innovation as well as the effects of innovation on firms. Especially economic and management innovation literature has distinguished a wide range of factors such as size, age, technological competences, technological opportunities, appropriability conditions, and so on that can determine and influence firm innovation success (Ahuja et al., 2008; Becheikh et al., 2006; Bhattacharya and Bloch, 2004; Cohen, 2010; Hall and Mairesse, 2006). However, in this literature little is known about strategic orientation of innovative firms' in innovation success. The design of innovation strategy provides a clear direction that innovation process should follow and focuses the efforts of the firm on a common innovation goal (Oke, 2007). Surprisingly, we rarely know what determinants of designing an innovation strategy are, what innovation strategy improve more the odds of successful innovation or whether there is a fit between innovation strategy pursued and innovation success. Therefore, we analyse whether firm that are able to design innovative strategies can improve the odds of successful innovation.

Before starting their projects, and in order to clarify and prioritize requisite tasks during innovative activities—which include, among others, intramural R&D, cooperative R&D activities and acquisition of external knowledge—innovative firms must design a strategy with pre-defined innovation objectives. Inter alia, the lack of an innovation strategy increases the dispersion of R&D resources, reduces coordination between investments and negatively affects the expected results in the field of production, marketing or human resources. In short, the absence of clear innovation objectives that determine innovation strategy to follow reduce the effectiveness and efficiency of the resources invested and worsens the firm's results.

Therefore, it is currently very important for governments to evaluate and understand the strategic orientation of innovative firms to allow them develop appropriate innovation policy. According to Guan et al. (2009) and OECD–Eurostat (2005), many policies for supporting innovation would benefit from the identification of the main forces that drive firms' innovation activities, that is their innovation objectives. Nevertheless, analysis of innovation objectives and their impact on innovation success has rarely been undertaken—this is largely due to the lack of available data.

Consequently, given the importance of designing an innovation strategy, the main purpose of this paper is to integrate innovation strategy as a key factor in the ability of firms to improve their odds of successful innovation measured in terms of product and process innovations. In 2008, for the first time, Spanish firms were asked to indicate both what objectives led their innovation activity, and the importance of each innovation objective. Using a sample from PITEC of Spanish innovative firms between 2008 and 2012, firstly, we identified the main innovation strategies that a firm can design. Through thirteen innovation objectives listed in the innovation survey and applying a principal component analysis we define the innovation strategies that firms may pursue (no strategy, unfocused, market, production, cost and environmental and regulatory strategy) in order to improve their odds of successful innovation. And, secondly, we examine the impact of these innovation strategies and their degree of fit on the innovation success.

Our contribution differs from the previous literature in a number of ways. Firstly, we show that innovation success is a function, not only of resources allocated by the firm, but more especially, of the ability of the innovative firm to design in a timely manner the innovation strategy to pursue through the innovation objectives. Secondly, we propose a new classification of innovation strategies by means of the innovation objectives pursued by firms. Thirdly, despite the increasing importance of service activities in modern economies, the empirical literature has traditionally focused on specific manufacturing industries; we add evidence for firms belonging to services industries. Hence, we distinguish between both sectors to detect differences between them.

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

## 2. Review of the relevant literature

Innovation is a dynamic process subject to a complex sequence of decisions. Considering it as a process, a firm's first strategic decision is whether to innovate or not. Should they take on new challenges in order to survive or grow in the markets or, on the contrary, should they 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, that means identifying what motivates performance and where firm would like to reach; typically top management is involved in this stage. A planned and well-communicated innovation strategy is necessary in order to achieve maximal effectiveness and efficiency (Oke, 2007; Ramanujam and Mensch, 1985). Not having an innovation strategy can create problems. These include a firm wishing to innovate in all areas and finally innovating in none, their innovating in areas not essential for the firm, investing in innovation projects not aligned with the strategic objectives of the firm, or innovation becoming just a matter of chance.

The strategy adopted by each firm will depend on what motivates the firm to innovate and will influence each stage of the innovation process. According to Ramanujam and Mensch (1985) a firm's innovation strategy consists of three pillars, the determination of innovation objectives, the acquisition and allocation of resources to innovative activities, and timing and internal consistency aspects. In addition, Tidd (2001) emphasizes that strategic management of innovation, understood as the use of appropriate strategic management techniques and measures to augment the impact of the firm's innovation activities on firm growth and performance, is fundamental for firms to achieve competitive advantage. However, although many firms may have the intention of being innovative, the majority of them do not have an explicit strategy (Dobni et al., 2015).

Then, innovation objectives, which refer to strategic decision at the firm level, may be defined. Defining innovation objectives is not an easy task for firms because they are required to allocate more resources to some projects or areas and less to the others. Furthermore, firms' resources are scarce and limited, and innovation activities are highly risky. Innovation activities require the acquisition of highly specialized assets (sunk costs), the presence of highly-educated and skilled employees (intangible assets related to the knowledge), and involve a significant degree of uncertainty (Hall, 2002).

Firms can engage in innovation activities for a number of reasons. For instance, strengthen the value added, differentiate their products from those of their competitors, frequently replace products with better versions (especially in a world of shortening product life cycles), increase market share or enter new markets. These objectives oriented toward market, demand and competition, the economic literature has positively associated with product innovations (Jayaram et al., 2014). Moreover, firms can also undertake new innovative projects in order to increase their flexibility or capacity, it means, implementing production or cost innovation strategy to increase the success of process innovations. These innovations have an advantage over product innovations, as they usually materialize internally (within the company), which makes them difficult to imitate by competitors. At the same time, companies can use process innovations as tools to increase the barriers to entry for competitors.

In addition, due to new legislation, firms may open up new pathways or close down others—for example, new innovative projects may be motivated by increasing the requirement for environmentally friendly products (Tidd et al., 2005) or adapting to changes imposed by new legislative demands and quality standards like regulations in the food sector such as use of specific technologies, ingredient or labelling requirements (Bigliardi and Dormio, 2009). Usually these sets of objectives related to the improvement of quality standards and environmental issues have been positively associated with process innovations (Batterink et al., 2006).

In recent times, companies have begun to realize the key role of human resources to improve their business growth. For this reason, maintain and motivate workers is one of the main problems in high-tech companies and knowledge-based. Also, enrich the skills of its employees has become one of the essential objectives of the companies to improve their innovation success.

In short, every goal of innovation can be identified in a manner favourable or unfavourable to a particular innovation strategy (Aniruddha, 2013).

The empirical literature has defined innovation strategies from different approaches. Firstly, depending on how the technology used is generated, it has studied the impact of three strategies on innovative results: internal strategy or make, external strategy or buy and cooperation strategy (Goedhuys and Veugelers, 2012; Love et al., 2014; Veugelers and Cassiman, 1999). And, secondly, by type of innovations proposed by the Oslo Manual, technology strategies (product and process innovations) and non-technological strategies (marketing and organizational innovations) are analyzed (Jayaram et al., 2014; Tavassoli and Karlsson, 2015). In line with the literature of simple and complex strategies, Karlsson and Tavassoli (2015), trough Manual Oslo four type of innovations show that firms that choose a complex innovation strategy are better off in terms of their future productivity in compare with those firms that choose simple innovation strategies.

Despite the great importance of innovation objectives in the design of a firm's strategy, few empirical works have analysed their role in innovation success. In line with the aims of this paper, we propose a typology of the innovative strategies designed by firms when carrying out innovation activities through their innovation objectives. Based on their ability to design strategies, innovative firms may be in one of the following three situations:

- Absence of strategy (null): firms that do not design a clear strategy in terms of innovation, it means that firms do not have clear innovation objectives to pursue.
- Unfocused strategy: firms that do design one, but without any orientation, it means that firms pursue some innovation objectives but not related.
- Focused strategy: firms able to establish clear and focused strategies in one or more of the market, production, cost, and environmental/regulatory fields. It means that firms pursue some related innovation objectives.

Previously, to the best of our knowledge, empirical research that has included innovation objectives has focused on studying how the breadth of innovation objectives impacts on innovation (simple and complex strategies). Leiponen and Helfat (2010) analyse how the breath of innovation objectives (in terms of achieving objectives of parallel innovation) and knowledge sources seems to have positive effects on manufacturing and detrimental effects on innovation in the service industries (the latter significantly mitigated by regular activities R&D). Thus, companies that pursue multiple objectives ahead a difficult and complex task, as it not only requires the correct allocation of resources, but also the coordination of resources to these objectives through innovation.

In addition, Batterink et al. (2006) and Dormio Bigliardi (2009) in order to identified technological innovation determinants for firms operating in the context of Dutch agrifood industry and northern Italian food industry, respectively, they include the innovation objectives in their analysis without identifying each innovation objective to a particular innovation strategy for very specific sectors and territories and for a short span of time. In terms of innovation objectives, their studies have had no clear results, indeed, in some cases, the results are even contradictory, which has given rise to debate.

Based on the above discussion, this study tests the following hypotheses:

- Firms that do not design clear innovation strategies have fewer possibilities of being a successful innovative firm.
- Firms that design an innovation strategy, but without any orientation, have fewer possibilities of a successful innovative success firm than firms with an oriented innovation strategy.
- Fit between oriented innovation strategy and innovation success:
    - Market innovation strategy is positively related to product innovative success, but negatively related to process innovative success.
    - Production innovation strategy is positively related to process innovative success, but negatively related to product innovative success.

- Cost innovation strategy is positively related to process innovative success, but negatively related to product innovative success.
- Environment/regulatory innovation strategy is positively related to process innovative success, but negatively related to product innovative success.

## 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 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.[1] These innovation surveys are collected following the general guidelines of the Oslo Manual (OECD–Eurostat, 2005).

The PITEC has two main advantages for this study. First, and most importantly, this database has detailed information about firms' innovation objectives. Innovation 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 how important a list of innovation objectives were when they carried out innovation activities. 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 allows accounting for standard econometric issues, such as reverse causality endogeneity problems (by lagging explanatory variables).

Our final database selection was subject to a cleaning process. The main filters were as follows: 1) data refers the period 2008–2012, because objectives questions are not included in the survey until 2008; 2) only innovative firms are examined, that is, firms that have introduced product or process innovations or have taken an innovative project

[1] See Cainelli et al. (2015) and Hashi and Stojčić (2013) for recent examples of empirical work using the CIS dataset and (Barge-Gil and López, 2014; Costa-Campi et al., 2015; Segarra and Teruel, 2014) for recent examples of empirical work using the PITEC dataset.

(later abandoned or still to be completed);[2] 3) firms from the manufacturing and service sectors are analysed;[3] 4) firms with less than 10 workers on average are dropped; and finally, 5) firms that have involved in a merger or takeover are 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

#### 3.2.1 Dependent variables

Innovation success can be captured by more than one measure. A wide range of options and numerous debates about innovation success indicators are still current (Becheikh et al., 2006; Kemp et al., 2003; Mairesse and Mohnen, 2010). We utilize two binary variables from the innovation survey to measure innovation success. Two types of innovation success are distinguished: product innovation (the introduction of a good or service that is new or significantly improved) and process innovation (the implementation of a new or significantly improved production or delivery method).

#### 3.2.2 Independent variables

The key explanatory variables in our analysis represent the different innovation objectives and strategies that firms pursue when engaging in innovation activities. The innovation survey is constantly updated and old questions, now considered less relevant, make space for new questions in order to facilitate research on new lines of investigations. Specifically, in 2008, the Spanish CIS introduced the question[4] *"Innovation activities carried out in your firm could be oriented to different objectives, how important were each of the following objectives[5] for your innovation activities during the three last years[6]?."* Firms were asked to evaluate the importance of each innovation objective on a

[2] This filter is caused by the design of the survey itself, because only innovative firms have to answer the full questionnaire, including these inquiries related to innovation objectives (Mairesse and Mohnen, 2010).

[3] See Appendix I for a detailed classification.

[4] The question was modified by the INE. In 2008 the question of effects of innovation was replaced by innovation objectives. While objectives relate firms motives for innovating, effects concern the actual observed outcomes of innovations (OECD -Eurostat, 2005).

[5] See Table 1 for a detailed classification.

[6] 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.

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,[7] 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.

With the aim of obtaining a more intrinsic firm view and match each innovation objective to a particular innovation strategy, we propose a new classification of firm strategy based on the innovation objectives pursued. First, we distinguished between firms that do not have an innovation strategy and those that do have one. Firms having an innovation strategy also are divided into two groups: unfocused strategy and focused strategy. The former strategy includes firms that have an innovation strategy but without any specific orientation (firms pursue some innovation objectives but not related). The latter encompasses these firms with a clear innovation strategy oriented towards market, production, costs or environmental and regulatory dimension.[8]

In order to identify the oriented innovation strategies, we group the thirteen innovation objectives by applying a multivariate statistical method. A principal component analysis (henceforth, PCA) is undertaken on the thirteen innovation objectives reported from the innovation survey.[9] PCA analyses should be ideally applied on 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.

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[7] 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 to the previous year. The latter objectives about employment are not considered in this study due to the lack of data for the whole period analysed.

[8] See Appendix II for a detailed definition.

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

After the extraction of principal components, orthogonal rotation[10] 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 simplicity (retaining as few as possible factors) and completeness (explaining most of the variation in the data). However, some recommended rules exist. Kaiser's rule 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 explained considerably less variation. Taking these rules into account, four components were retained.

**Table 1**
**Component loadings after orthogonal rotation**

| Innovation objectives | Market | 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.Fulfill government regulation or standards requirements | 0.0093 | 0.0189 | -0.0379 | **0.5859** |
| Cronbach's alphas | 0.7270 | 0.7195 | 0.7634 | 0.8339 |

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.

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 market strategy (competing with better and more products), environmental and regulatory strategy (being environmentally friendly and satisfying standard requirements), cost

[10] 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.

strategy (competing with lowering production costs) and production strategy (improving the capacity and flexibility of production).

In addition to our variables of interest (strategies and innovation objectives) and following the economic literature on the determinants of innovation (Becheikh et al., 2006; Galende and de la Fuente, 2003; Keupp et al., 2012; Souitaris, 2002; Vega-Jurado et al., 2008), a set of variables related to the firm's assets, competences and capabilities are also included as internal factors (age, size, group, export, training in innovation activities, investment to support innovation into the market). Then, the firm's industry (high tech manufacture and high knowledge intensive services); technological opportunity (cooperation and external R&D); appropriability conditions (legal mechanisms of protection) and government and public policies (subsidies) variables are included in the analyses as external factors. Additionally, a set of dummy variables related the temporal and sector dimension are included in all of the regressions to control for cyclical effects and specific industry characteristics, respectively. Appendix II summarises the list of variables and their definition, Appendix III descriptive statistics of variables included in the empirical analysis and Appendix IV shows the correlation matrix.

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.[11] Following Audretsch et al. (2014); Barge-Gil and López (2014) and Santamaría et al. (2012), in the regression analysis, in the regression analysis, 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.

### 3.2.3. Econometric methodology

Traditionally, the economics analysis of the determinants of product or process innovation has been carried out using logit or probit models. However, binary logit and probit models assume that the dependent variable comprises fairly equal number of cases scored as one compared with zeros. 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-

[11] Since we are working with a short panel, we decided to lag the variable by just one period of time, although more lags might be needed.

log link provide better estimations because of their asymmetric nature (Hardin and Hilbe, 2012).

The GLMs also control for overdispersion, which can be an important problem in models with binary responses, as cause underestimation of standard errors of estimated coefficient vector, and consequently non significant variables can be appear to be significant influences when it is not. In order to recognize possible overdispersion GLMs provide the value of the Pearson $\chi 2$ or the deviance divided by the degrees of freedom. A Pearson's statistic close to 1 indicates that the models are not overdispersed (they are well specified). The Huber-White Sandwich technique was used to correct for possible heteroskedasticity problems.

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).

## 4. Descriptive statistics

Table 2 lists the thirteen objectives that innovative firms can pursue in the course of their innovation activities, as well as the innovation strategies proposed in this study. It can be seen that a large number of Spanish innovative firms have not designed an innovation strategy (24%). Within the group of firms with an innovation strategy, some heterogeneity exists, in the sense that some firms have an unfocused strategy (27%) and some firms specialize in a specific type of strategy. A market 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 unfocused 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, see Aschhoff et al. (2013) and suggest that the main concern of most firms is their product and its characteristics.

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

| (% of firms) | All sample Obs=19,595 F=3,910 | Manufactures Obs=14,250 F=2,850 | Services Obs=5,345 F=1,069 |
|---|---|---|---|
| 1.Increase range of goods or services | 0.5192 | 0.5341 | 0.4795 |
| | (0.4996) | (0.4988) | (0.4996) |
| 2.Replace products being phased out | 0.3399 | 0.3473 | 0.3202 |
| | (0.4737) | (0.4761) | (0.4666) |
| 3.Enter new markets | 0.4118 | 0.4264 | 0.3728 |
| | (0.4921) | (0.4945) | (0.4836) |
| 4.Increase market share | 0.4209 | 0.4387 | 0.3734 |
| | (0.4937) | (0.4962) | (0.4837) |
| 5.Improve product quality | 0.5492 | 0.5349 | 0.5874 |
| | (0.4975) | (0.4987) | (0.4923) |
| 6.Increase flexibility of production | 0.3371 | 0.3280 | 0.3614 |
| | (0.4727) | (0.4695) | (0.4804) |
| 7.Increase capacity of production | 0.3466 | 0.3397 | 0.3648 |
| | (0.4759) | (0.4736) | (0.4814) |
| 8.Reduce labour costs per unit output | 0.2715 | 0.3040 | 0.1848 |
| | (0.4447) | (0.4600) | (0.3882) |
| 9.Reduce material costs per unit output | 0.1695 | 0.2032 | 0.0798 |
| | (0.3752) | (0.4024) | (0.2711) |
| 10.Reduce energy costs per unit output | 0.1692 | 0.1994 | 0.0888 |
| | (0.3750) | (0.3995) | (0.2845) |
| 11.Reduce environmental impacts | 0.2546 | 0.2870 | 0.1683 |
| | (0.4356) | (0.4523) | (0.3742) |
| 12.Improve health or safety of employees | 0.2662 | 0.3018 | 0.1711 |
| | (0.4420) | (0.4590) | (0.3767) |
| 13.Fulfill government regulation or standards requirements | 0.3041 | 0.3430 | 0.2005 |
| | (0.4600) | (0.4747) | (0.4004) |
| Absence strategy | 0.2370 | 0.2317 | 0.2510 |
| | (0.4252) | (0.4219) | (0.4336) |
| Unfocused strategy | 0.2263 | 0.2115 | 0.2660 |
| | (0.4185) | (0.4083) | (0.4419) |
| Focused strategy | | | |
| Market | 0.2733 | 0.2865 | 0.2381 |
| | (0.4457) | (0.4521) | (0.4260) |
| Production | 0.2432 | 0.2352 | 0.2645 |
| | (0.4290) | (0.4242) | (0.4411) |
| Cost | 0.1743 | 0.2091 | 0.081 |
| | (0.3794) | (0.4067) | (0.2734) |
| Environmental and regulatory | 0.2643 | 0.3016 | 0.1650 |
| | (0.4409) | (0.4589) | (0.3712) |

F: number of firms. Standard deviation in brackets.

Consequently, Spanish firms try to keep their market position and survive during the period analysed (2008–2012) by creating differentiated products and services and distinguish themselves from competitors. This is the opposite to Chinese firms, where the main innovation objectives that firm pursue are these related to lowering productions costs (Guan et al., 2009; Zheng, 2014).

Next to objectives related to competition, demand and market, firms also take into account increasing the capacity and flexibility of production (34%) and fulfillment 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.

Differentiating between sectors, 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%, however, in the services sector this percentage is much lower (17%). As Cainelli et al. (2015) point out, manufacturing firms are increasingly challenged to include environmental innovations in their business activities.

## 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 for the whole sample, and for the manufacturing and services firms, respectively[12]. Pearson's statistics with respect to all of the models were close to 1, indicating that the models were not overdispersed.

As expected, not having an innovation strategy has a negative and significant impact on the likelihood of achieving successful innovation measured in terms of product or process innovations. Firms that design an innovation strategy show mixed results, depending on the innovation strategy and the innovation success pursued. The results also indicate that an unfocused strategy increases the probability of innovation in products, while it decreases the probability of innovation in processes; however, the latter coefficient is not significant. Given the different nature of manufacturing and service sectors, we also focus on the differences that innovation strategy may exert on the probability of innovating (Table 4). In general, the absence of an innovation strategy to pursue has a negative significant influence on the innovation success in manufacturing and services firms., However, the size of the effect of this variable is quite heterogeneous across both sectors.

[12] 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, R&D activities and exports are highly persistent and there is very little variation over time.

Services firms that do not have an innovation strategy is associated with a 13% decrease in the probability of being a successful innovative firm measured in terms of process innovation, while manufacturing firms are associated with a 2.5% decrease, these revealing sectorial differences.

Regarding focused 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 market strategy show a positive and significant impact on product innovation and negative but no significant impact on process innovation. Concretely, firms that pursue a market strategy would increase with a 7% the likelihood of being successful innovative firms in product innovations. Comparing the marginal effects between unfocused strategy and focus on market strategy, the results show that the impact of focused strategy on product innovation is about 5% higher, as we expected. By sectors, manufacturing firms show higher probability of having successful innovation product (4.5%) than their counterparts (2.3%).

The results also show that product, cost and environmental and regulatory strategy have a negative impact on product innovation and a positive and significant impact on process innovation when we look at the results for the whole sample, or for the manufacturing firms. 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.

Services firms that design and environmental and regulatory strategy would decrease with a 4% the probability of being a successful innovative firm measured in terms of process innovation, whereas manufacturing firms would increase the probability with a 3%. The size of the effect of these three strategies on process innovation success are quite different. Production strategy shows the strongest effect, followed by cost strategy and environmental and regulatory strategy. In addition, the results also show sectorial differences. The likelihood of being a successful innovative firm measured as process innovation would increase with a 15% when manufacturing firms follow a production strategy or just with a 10% when services firms follow the same strategy.

**Table 3**
**Generalized linear models (whole sample)**

| Variables | Product innovation | | Process innovation | |
|---|---|---|---|---|
| | Coeff. | MEMs | Coeff. | MEMs |
| Absence strategy t-1 | -0.2321*** | -0.0359*** | -0.2822*** | -0.0582*** |
| | (0.060) | (0.009) | (0.061) | (0.013) |
| Unfocused strategy t-1 | 0.1942*** | 0.0300*** | -0.0351 | -0.0072 |
| | (0.064) | (0.010) | (0.062) | (0.013) |
| Market strategy t-1 | 0.5055*** | 0.0781*** | -0.0148 | -0.0031 |
| | (0.050) | (0.008) | (0.051) | (0.010) |
| Production strategy t-1 | -0.0933* | -0.0144* | 0.6673*** | 0.1375*** |
| | (0.049) | (0.008) | (0.052) | (0.011) |
| Cost strategy t-1 | -0.0500 | -0.0077 | 0.2544*** | 0.0524*** |
| | (0.051) | (0.008) | (0.055) | (0.011) |
| Environ. and regulatory | -0.0537 | -0.0083 | 0.1392*** | 0.0287*** |
| | (0.049) | (0.008) | (0.050) | (0.010) |
| lSize $_{t-1}$ | 0.0378** | 0.0058** | 0.1827*** | 0.0376*** |
| | (0.016) | (0.002) | (0.016) | (0.003) |
| lAge $_{t-1}$ | 0.0173 | 0.0027 | 0.0279 | 0.0057 |
| | (0.028) | (0.004) | (0.026) | (0.005) |
| Group $_{t-1}$ | -0.0481 | -0.0074 | -0.0455 | -0.0094 |
| | (0.039) | (0.006) | (0.037) | (0.008) |
| Export $_{t-1}$ | 0.1203*** | 0.0186*** | 0.0246 | 0.0051 |
| | (0.036) | (0.006) | (0.035) | (0.007) |
| Human resources $_{t-1}$ | 0.1555*** | 0.0240*** | 0.7714*** | 0.1589*** |
| | (0.050) | (0.008) | (0.052) | (0.010) |
| Market resources $_{t-1}$ | 1.9265*** | 0.2976*** | 0.1401*** | 0.0289*** |
| | (0.068) | (0.008) | (0.036) | (0.008) |
| lInternal R&D $_{t-1}$ | 0.0448*** | 0.0069*** | -0.0418*** | -0.0086*** |
| | (0.005) | (0.001) | (0.005) | (0.001) |
| lExternal R&D $_{t-1}$ | -0.0110** | -0.0017** | -0.0003 | -0.0001 |
| | (0.005) | (0.001) | (0.005) | (0.001) |
| Cooperation $_{t-1}$ | 0.3024*** | 0.0467*** | 0.2691*** | 0.0554*** |
| | (0.040) | (0.006) | (0.036) | (0.007) |
| Protection $_{t-1}$ | 0.3882*** | 0.0600*** | 0.1350*** | 0.0278*** |
| | (0.041) | (0.006) | (0.035) | (0.007) |
| Subsidy $_{t-1}$ | 0.0323 | 0.0050 | 0.1028*** | 0.0212*** |
| | (0.039) | (0.006) | (0.036) | (0.007) |
| HT manuf. and HKIS $_{t-1}$ | 0.2560*** | 0.0395*** | -0.3356*** | -0.0691*** |
| | (0.034) | (0.005) | (0.032) | (0.007) |
| Constant | 0.3486*** | | 0.6942*** | |
| | (0.111) | | (0.112) | |
| (1/df) Pearson | 0.9542 | | 0.9949 | |
| AIC | 0.9139 | | 1.0497 | |
| BIC | -136,932.3 | | 134,804.6 | |
| 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.

So, when considering the analysis of each innovation objective, our results are similar to previous ones (strategies analyses).[13] Market 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 the objective 1, increase range of goods or services, show the highest likelihood of being a successful innovative firm in product innovations. 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%. 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 fulfill 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 19%.

Finally, with respect to the other variables extensively analysed, our results are in accordance with the literature (Ahuja et al., 2008; Becheikh et al., 2006; Hashi and Stojčić, 2013; Mohnen et al., 2006). 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 (Becheikh et al., 2006; Bhattacharya and Bloch, 2004). In general, other characteristics of the firm such as age, 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 is associated with a 16% increase in the probability of being a successful innovative firm in process innovations and if firms invest in supporting the introduction of innovations into the market activities is associated with a 30% increase in the probability of being a successful innovative firm in product innovations.

As regards external factors, we observe that manufacturing and services 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

[13] See Appendix V for a more detail.

respect to public subsidies, we observe that having access to public R&D subsidies has a positive and significant impact on process innovation, however, we find no relation with product innovation. It is also observed that high tech manufactures and high KIS have positive and significant impact on product innovation, but a negative impact on process innovation.

**Table 4**
**Generalized linear models (by sectors)**

| | Manufactures | | | | Services | | | |
|---|---|---|---|---|---|---|---|---|
| | Product innovation | | Process innovation | | Product innovation | | Process innovation | |
| Variables | Coeff. | MEMs | Coeff. | MEMs | Coeff. | MEMs | Coeff. | MEMs |
| Absence strategy $_{t-1}$ | -0.2346*** | -0.0334*** | -0.1975*** | -0.0386*** | -0.1408 | -0.0251 | -0.5675*** | -0.1275*** |
| | (0.072) | (0.010) | (0.072) | (0.014) | (0.120) | (0.022) | (0.122) | (0.027) |
| Unfocused strategy $_{t-1}$ | 0.1534** | 0.0218** | -0.0478 | -0.0093 | 0.3093** | 0.0552** | -0.1381 | -0.0310 |
| | (0.077) | (0.011) | (0.073) | (0.014) | (0.126) | (0.022) | (0.124) | (0.028) |
| Market strategy $_{t-1}$ | 0.4776*** | 0.0680*** | 0.0031 | 0.0006 | 0.4376*** | 0.0781*** | -0.1175 | -0.0264 |
| | (0.059) | (0.008) | (0.059) | (0.012) | (0.104) | (0.019) | (0.104) | (0.023) |
| Production strategy $_{t-1}$ | -0.1143** | -0.0163** | 0.7659*** | 0.1496*** | 0.0182 | 0.0032 | 0.4759*** | 0.1069*** |
| | (0.057) | (0.008) | (0.064) | (0.012) | (0.102) | (0.018) | (0.098) | (0.022) |
| Cost strategy $_{t-1}$ | -0.0995* | -0.0142* | 0.2155*** | 0.0421*** | 0.0548 | 0.0098 | 0.2587** | 0.0581* |
| | (0.059) | (0.008) | (0.062) | (0.012) | (0.119) | (0.021) | (0.132) | (0.030) |
| Environ. Regul. Strategy $_{t-1}$ | -0.0435 | -0.0062 | 0.1439** | 0.0281** | 0.0852 | 0.0152 | -0.1845* | -0.0415* |
| | (0.058) | (0.008) | (0.059) | (0.011) | (0.106) | (0.019) | (0.110) | (0.025) |
| lSize $_{t-1}$ | 0.0560** | 0.0080** | 0.1891*** | 0.0369*** | 0.0431* | 0.0077* | 0.1750*** | 0.0393*** |
| | (0.022) | (0.003) | (0.021) | (0.004) | (0.025) | (0.005) | (0.026) | (0.006) |
| lAge $_{t-1}$ | -0.0177 | -0.0025 | 0.0030 | 0.0006 | -0.1129** | -0.0202** | -0.1072* | -0.0241* |
| | (0.035) | (0.005) | (0.033) | (0.006) | (0.053) | (0.009) | (0.056) | (0.013) |
| Group $_{t-1}$ | -0.0124 | -0.0018 | -0.0997** | -0.0195** | -0.1376** | -0.0246** | -0.0196 | -0.0044 |
| | (0.049) | (0.007) | (0.045) | (0.009) | (0.068) | (0.012) | (0.066) | (0.015) |
| Export $_{t-1}$ | 0.0299 | 0.0043 | 0.0498 | 0.0097 | 0.0674 | 0.0120 | -0.1390** | -0.0312** |
| | (0.051) | (0.007) | (0.050) | (0.010) | (0.066) | (0.012) | (0.060) | (0.013) |
| Human resources $_{t-1}$ | 0.1636** | 0.0233** | 0.7078*** | 0.1383*** | 0.2174*** | 0.0388*** | 0.8733*** | 0.1962*** |
| | (0.067) | (0.010) | (0.067) | (0.013) | (0.077) | (0.014) | (0.085) | (0.018) |
| Market resources $_{t-1}$ | 1.9274*** | 0.2743*** | 0.1034** | 0.0202** | 1.7933*** | 0.3201*** | 0.2467*** | 0.0554*** |
| | (0.080) | (0.009) | (0.043) | (0.008) | (0.126) | (0.018) | (0.072) | (0.016) |
| lInternal R&D $_{t-1}$ | 0.0581*** | 0.0083*** | -0.0335*** | -0.0065*** | 0.0304*** | 0.0054*** | -0.0490*** | -0.0110*** |
| | (0.006) | (0.001) | (0.006) | (0.001) | (0.009) | (0.002) | (0.010) | (0.002) |
| lExternal R&D $_{t-1}$ | -0.0061 | -0.0009 | -0.0092 | -0.0018 | -0.0013 | -0.0002 | 0.0016 | 0.0004 |
| | (0.007) | (0.001) | (0.006) | (0.001) | (0.009) | (0.002) | (0.008) | (0.002) |
| Cooperation $_{t-1}$ | 0.2413*** | 0.0343*** | 0.3289*** | 0.0643*** | 0.5124*** | 0.0914*** | 0.1920*** | 0.0431*** |
| | (0.049) | (0.007) | (0.045) | (0.009) | (0.070) | (0.012) | (0.066) | (0.015) |
| Protection $_{t-1}$ | 0.4635*** | 0.0660*** | 0.1317*** | 0.0257*** | 0.2120*** | 0.0378*** | 0.1766*** | 0.0397*** |
| | (0.050) | (0.007) | (0.042) | (0.008) | (0.074) | (0.013) | (0.067) | (0.015) |
| Subsidy $_{t-1}$ | 0.0179 | 0.0026 | -0.0061 | -0.0012 | -0.0416 | -0.0074 | -0.2485*** | -0.0558*** |
| | (0.047) | (0.007) | (0.043) | (0.008) | (0.077) | (0.014) | (0.072) | (0.016) |
| HT manuf. and HKIS $_{t-1}$ | 0.5878* | 0.0837* | 0.2058 | 0.0402 | 0.4970* | 0.0887* | -0.4493 | -0.1009 |
| | (0.344) | (0.049) | (0.310) | (0.061) | (0.292) | (0.052) | (0.532) | (0.119) |
| Constant | 0.1929 | | 0.1195 | | -0.2058 | | 1.6064*** | |

| | | | | |
|---|---|---|---|---|
| | (0.320) | (0.302) | (0.334) | (0.568) |
| (1/df) Pearson | 0.9686 | 0.9869 | 0.9631 | 1.0145 |
| AIC | 0.8802 | 1,0241 | 0.9713 | 1.0888 |
| BIC | -96,148.17 | -94,507.44 | -31,419.17 | -30,918.17 |
| Observations | | 11,400 | | 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.

## 6. Concluding remarks

This study examines the role played by innovation objectives, 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 manufacturing and services Spanish innovative firms. Firstly, applying a principal component analysis we identified the innovation strategies that innovative firms can design (no strategy, unfocused, market, production, cost and environmental and regulatory strategy). Secondly, after controlling positive skewness of the dependent variables a generalized linear model is used to exanimate the impact of these innovation strategies.

Our econometrics results show that having an innovation strategy is an important factor in increasing the probability of being 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. Market 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 groups of Spanish innovative firms: 1) firms that have the intention to be innovative, but do not have an explicit strategy and consequently perform worst; 2) firms that have an innovation strategy and want to innovate, but do not know exactly what to focus on and, finally, 3) those firms that have an oriented innovation strategy and experience greater innovation success.

Considering these results, we must point out that policy-makers and managers need to take into account a broader range of characteristics that may influence innovation success such as innovation strategy. In terms of managerial implications, these results suggest that encouraging innovation begins 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. Thus, innovation policies should provide a series of tools to firms wishing to initiate internal reflection on their ability to innovate. Besides, evaluating and understanding the strategic orientation of innovative firms allow governments to develop appropriate innovation policies.

Despite these conclusions, we are aware of the main limitations of this work which also constitute opportunities for future research. First, the definition of innovation success is limited to technological innovation. Second, due to the data available, this study focuses on the firm level and it is not possible to link innovation strategy to a particular innovation project of the firm, and we take all the innovation projects as a whole when sometimes not all projects have the same impact or successful. Third, our research has focused on the Spanish case; evidence from other countries might help to develop more general empirical evidence.

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

According to Eurostat NACE Classification firms are grouped depending on their technological intensity.

**Table A.1**

**Aggregations of manufacturing and services based on NACE Rev. 2**

| | |
|---|---|
| **Manufacturing industries** | |
| *1. Industry: High Technology* | |
| 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 |
| *2. Industry: Medium High Technology* | |
| 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) |
| *3. Industry: Medium Low Technology* | |
| 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 |
| *4. Industry: Low Technology* | |
| 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** | |
| *5. High-Tech Knowledge intensive services* | |
| 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 |
| *6. Other knowledge intensive services* | |
| 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 II. Variable definitions

**Table A.2**

| | |
|---|---|
| ***Dependent variables*** | |
| 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 |
| ***Independent variables*** | |
| *Firms' resources and capabilities* | |
| Absence of innovation strategy | Dummy variable which takes the value 1 if the firm pursues less than two objectives with high importance during t–2 to t; 0 if not |
| Innovation strategy: | |
| Unfocused 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 |
| Market strategy | Dummy variable which takes the value 1 if the firm has a strategy oriented towards the market. 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 market. 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) |
| Age | Log of firm's age (as the difference between the period of observation and the year of creation) (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) |
| Human resources | Dummy variable that takes a value equal to 1 if firm invests in training expenditure for innovation activities; 0 if not |
| Market competences | Dummy variable which takes the value equal 1 if the firm has made investments to support the introduction of innovations…. into the market; 0 if not |
| *Firm industry* | |
| 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 |
| *Technological opportunities* | |
| 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 |
| External R&D | Investment in external R&D per worker (in logs) |
| *Appropriability conditions* | |
| Protection | Dummy variable that takes a value equal to 1 if the firm had protected their innovations using patents, registration of utility models, trademarks or copyrights during t–2 to t; 0 if not |
| *Government and public policies* | |
| 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 III. 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 | Unfocused strategy Obs=4,436 F=887 | Market 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 | 290.93 | 211.88 | 353.18 | 387.46 | 374.42 | 363.7089 |
| | (891.64) | (1156.10) | (898.97) | (1568.31) | (1388.32) | (1344.25) | (1281.58) |
| Age (years) | 28.98 | 29.21 | 27.44 | 29.15 | 30.09 | 31.156 | 31.27 |
| | (20.10) | (22.3512) | (19.155) | (22.10) | (24.79) | (21.61) | (24.09) |
| Group[1] | 0.4357 | 0.4936 | 0.4675 | 0.4784 | 0.5235 | 0.5901 | 0.5376 |
| | (0.4959) | (0.4999) | (0.4990) | (0.4995) | (0.4994) | (0.4918) | (0.4986) |
| Export by sales[1] | 0.6822 | 0.7305 | 0.7044 | 0.7731 | 0.7082 | 0.7854 | 0.7698 |
| | (0.4656) | (0.4437) | (0.4563) | (0.4188) | (0.4546) | (0.4105) | (0.4209) |
| R&D training[1] | 0.1138 | 0.2134 | 0.1832 | 0.2251 | 0.2494 | 0.2330 | 0.2438 |
| | (0.3177) | (0.4097) | (0.3869) | (0.4177) | (0.4327) | (0.4228) | (0.4294) |
| Market competences[1] | 0.1944 | 0.3431 | 0.3189 | 0.3957 | 0.3293 | 0.3512 | 0.3604 |
| | (0.3957) | (0.4747) | (0.4661) | (0.4890) | (0.4700) | (0.4774) | (0.4801) |
| Internal R&D per worker (€) | 6570.30 | 8539.51 | 9046.01 | 8489.58 | 7919.39 | 7004.77 | 8506.80 |
| | (28610.60) | (32156.19 | (48690.5) | (17231.34) | (25734.91) | (16712.46) | (18949.93) |
| External R&D per worker (€) | 1443.42 | 1706.74 | 1445.14 | 1655.79 | 1627.46 | 1491.96 | 2034.50 |
| | (13977.46) | (11187.17) | (7024.45) | (7358.225) | (13468.46) | (10136.31) | (14958.37) |
| Cooperation[1] | 0.3001 | 0.4723 | 0.4537 | 0.4804 | 0.4856 | 0.4947 | 0.4872 |
| | (0.4583) | (0.4992) | (0.4979) | (0.4996) | (0.4998) | (0.5000) | (0.4998) |
| Protection[1] | 0.2510 | 0.3596 | 0.3320 | 0.4048 | 0.3570 | 0.3776 | 0.3859 |
| | (0.4336) | (0.4799) | (0.4710) | (0.4909) | (0.4791) | (0.4848) | (0.4868) |
| Subsidy [1] | .03608 | 0.4922 | 0.4862 | 0.5070 | 0.4740 | 0.5014 | 0.4996 |
| | (0.4802) | (0.4999) | (0.4998) | (0.4999) | (0.4993) | (0.5000) | (0.5000) |
| HT manuf. and HKIS[1] | 0.4607 | 0.5117 | 0.5076 | 0.5417 | 0.4786 | 0.4812 | 0.5075 |
| | (0.4985) | (0.4998) | (0.4999) | (0.4983) | (0.4995) | (0.4997) | (0.4999) |
| Product innovation[1] | 0.6206 | 0.7983 | 0.8016 | 0.8579 | 0.7734 | 0.7827 | 0.7949 |
| | (0.4852) | (0.4012) | (0.3988) | (0.3491) | (0.4186) | (0.4124) | (0.4037) |
| Process innovation [1] | 0.6066 | 0.7662 | 0.6837 | 0.7720 | 0.8770 | 0.85681 | 0.8148 |
| | (0.4885) | (0.4232) | (0.4650) | (0.4195) | (0.3283) | (0.3502) | (0.3884) |

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.
[1]Percentage of firms.
F: number of firms.

## Appendix IV. Correlation matrix

**Table A.4**
**Correlation matrix**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.Size | 1 | | | | | | | | | | | | | | | | | | | |
| 2.Age | 0.259* | 1 | | | | | | | | | | | | | | | | | | |
| 3.Group | 0.181* | 0.088* | 1 | | | | | | | | | | | | | | | | | |
| 4.Export | -0.027* | 0.092* | 0.077* | 1 | | | | | | | | | | | | | | | | |
| 5.Human resources | 0.072* | -0.019* | 0.031* | -0.005 | 1 | | | | | | | | | | | | | | | |
| 6.Market comp. | 0.075* | 0.032* | 0.024* | 0.072* | 0.217* | 1 | | | | | | | | | | | | | | |
| 7.Internal R&D | -0.029* | -0.088* | -0.002 | -0.025* | 0.040* | 0.039* | 1 | | | | | | | | | | | | | |
| 8.External R&D | -0.002 | -0.044* | 0.034* | -0.016* | 0.032* | -0.001 | 0.189* | 1 | | | | | | | | | | | | |
| 9.Cooperation | 0.095* | 0.013 | 0.132* | 0.020* | 0.149* | 0.128* | 0.115* | 0.086* | 1 | | | | | | | | | | | |
| 10.Protection | 0.046* | 0.026* | 0.033* | 0.097* | 0.096* | 0.151* | 0.082* | 0.062* | 0.143* | 1 | | | | | | | | | | |
| 11.Subsidy | 0.029* | -0.069* | 0.044* | 0.050* | 0.123* | 0.105* | 0.151* | 0.092* | 0.367* | 0.175* | 1 | | | | | | | | | |
| 12. HT manuf. HKIS | -0.040* | -0.126* | -0.009 | 0.062* | 0.056* | 0.060* | 0.124* | 0.052* | 0.044* | 0.091* | 0.086* | 1 | | | | | | | | |
| 14. No strategy | -0.023* | -0.004 | -0.049* | -0.045* | -0.108* | -0.137* | -0.026* | -0.009 | -0.147* | -0.098* | -0.112* | -0.045* | 1 | | | | | | | |
| 15. Market strategy | 0.042* | -0.000 | -0.001 | 0.073* | 0.052* | 0.116* | 0.008 | 0.001 | 0.060* | 0.092* | 0.056* | 0.054* | -0.341* | 1 | | | | | | |
| 16. Production strategy | 0.057* | 0.024* | 0.049* | -0.013 | 0.086* | 0.026* | -0.002 | -0.001 | 0.061* | 0.027* | 0.014* | -0.036* | -0.316* | 0.223* | 1 | | | | | |
| 17. Cost strategy | 0.040* | 0.042* | 0.101* | 0.067* | 0.050* | 0.043* | -0.015* | -0.005 | 0.058* | 0.042* | 0.037* | 0.059* | -0.256* | 0.199* | 0.313* | 1 | | | | |
| 18. Environ. strategy | 0.047* | 0.058* | 0.069* | 0.068* | 0.082* | 0.068* | 0.008 | 0.019* | 0.067* | 0.066* | 0.046* | 0.095* | -0.334* | 0.220* | 0.239* | 0.330* | 1 | | | |
| 19.Unoriented strategy | -0.031* | -0.042* | -0.012 | -0.017* | -0.009 | 0.013 | 0.016* | -0.009 | 0.024* | -0.002 | 0.027* | -0.027* | -0.301* | -0.331* | -0.307* | -0.248* | -0.324* | 1 | | |
| 20.Product innovation | 0.043* | -0.006 | 0.014* | 0.073* | 0.105* | 0.346* | 0.036* | 0.002 | 0.153* | 0.169* | 0.107* | 0.090* | -0.176* | 0.145* | 0.022* | 0.028* | 0.054* | 0.057* | 1 | |
| 21.Process innovation | 0.067* | 0.053* | 0.074* | 0.018* | 0.163* | 0.083* | -0.021* | -0.021* | 0.118* | 0.064* | 0.023* | -0.057* | -0.152* | 0.060* | 0.189* | 0.132* | 0.116* | -0.054* | 0.087* | 1 |

# Appendix V. Results of innovation objectives

**Table A.5**
**Generalized linear models. Innovation objectives (whole sample)**

| | Product innovation | | Process innovation | |
|---|---|---|---|---|
| Variables | Coeff. | MEMs | Coeff. | MEMs |
| Objective 1 $_{t-1}$ | 0.5477*** | 0.0829*** | -0.0066 | -0.0013 |
| | (0.040) | (0.006) | (0.036) | (0.007) |
| Objective 2 $_{t-1}$ | 0.0449 | 0.0068 | 0.0328 | 0.0067 |
| | (0.040) | (0.006) | (0.037) | (0.008) |
| Objective 3 $_{t-1}$ | 0.1277*** | 0.0193*** | -0.0005 | -0.0001 |
| | (0.045) | (0.007) | (0.041) | (0.008) |
| Objective 4 $_{t-1}$ | 0.2042*** | 0.0309*** | -0.0303 | -0.0061 |
| | (0.045) | (0.007) | (0.042) | (0.008) |
| Objective 5 $_{t-1}$ | 0.1166*** | 0.0176*** | 0.0110 | 0.0022 |
| | (0.039) | (0.006) | (0.036) | (0.007) |
| Objective 6 $_{t-1}$ | 0.0248 | 0.0038 | 0.4407*** | 0.0893*** |
| | (0.044) | (0.007) | (0.044) | (0.009) |
| Objective 7 $_{t-1}$ | -0.1000** | -0.0151** | 0.5030*** | 0.1019*** |
| | (0.045) | (0.007) | (0.045) | (0.009) |
| Objective 8 $_{t-1}$ | -0.0748 | -0.0113 | 0.2256*** | 0.0457*** |
| | (0.049) | (0.007) | (0.049) | (0.010) |
| Objective 9 $_{t-1}$ | 0.0793 | 0.0120 | 0.0285 | 0.0058 |
| | (0.064) | (0.010) | (0.063) | (0.013) |
| Objective 10 $_{t-1}$ | -0.1178* | -0.0178* | 0.0845 | 0.0171 |
| | (0.062) | (0.009) | (0.064) | (0.013) |
| Objective 11 $_{t-1}$ | -0.1522*** | -0.0230*** | 0.1052** | 0.0213** |
| | (0.054) | (0.008) | (0.053) | (0.011) |
| Objective 12 $_{t-1}$ | -0.1465** | -0.0222** | 0.0194 | 0.0039 |
| | (0.058) | (0.009) | (0.055) | (0.011) |
| Objective 13 $_{t-1}$ | 0.1908*** | 0.0289*** | 0.0695 | 0.0141 |
| | (0.055) | (0.008) | (0.048) | (0.010) |
| lSize $_{t-1}$ | 0.0411*** | 0.0062*** | 0.1712*** | 0.0347*** |
| | (0.016) | (0.002) | (0.016) | (0.003) |
| lAge $_{t-1}$ | 0.0227 | 0.0034 | 0.0246 | 0.0050 |
| | (0.028) | (0.004) | (0.027) | (0.005) |
| Group $_{t-1}$ | -0.0553 | -0.0084 | -0.0471 | -0.0095 |
| | (0.039) | (0.006) | (0.037) | (0.007) |
| Export $_{t-1}$ | 0.1002*** | 0.0152*** | 0.0366 | 0.0074 |
| | (0.036) | (0.006) | (0.036) | (0.007) |
| Human resources $_{t-1}$ | 0.1729*** | 0.0262*** | 0.7461*** | 0.1511*** |
| | (0.050) | (0.008) | (0.052) | (0.010) |
| Market resources $_{t-1}$ | 1.8834*** | 0.2852*** | 0.1475*** | 0.0299*** |
| | (0.068) | (0.008) | (0.037) | (0.007) |
| lInternal R&D $_{t-1}$ | 0.0396*** | 0.0060*** | -0.0391*** | -0.0079*** |
| | (0.005) | (0.001) | (0.005) | (0.001) |
| lExternal R&D $_{t-1}$ | -0.0101* | -0.0015* | 0.0004 | 0.0001 |
| | (0.005) | (0.001) | (0.005) | (0.001) |
| Cooperation $_{t-1}$ | 0.2791*** | 0.0423*** | 0.2624*** | 0.0532*** |
| | (0.040) | (0.006) | (0.036) | (0.007) |
| Protection $_{t-1}$ | 0.3479*** | 0.0527*** | 0.1443*** | 0.0292*** |
| | (0.041) | (0.006) | (0.035) | (0.007) |
| Subsidy $_{t-1}$ | -0.0366 | -0.0055 | -0.1004*** | -0.0203*** |
| | (0.039) | (0.006) | (0.036) | (0.007) |
| HT manuf. and HKIS $_{t-1}$ | 0.2333*** | 0.0353*** | -0.3179*** | -0.0644*** |
| | (0.035) | (0.005) | (0.033) | (0.007) |
| Constant | 0.1022 | | 0.4483 | |
| | (0.100) | | (0.1004)*** | |
| (1/df) Pearson | 0.9677 | | 0.9926 | |
| AIC | 0.8983 | | 1.0353 | |
| BIC | -137,124 | | -134,976 | |
| 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.