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Abstract

This study examines the role played by firm innovation on downsizing, an unexplored matter in the management literature. Drawing on economic and management views, we identify potential differences in firm downsizing behaviour depending on the specific innovation activities performed —process *versus* product-oriented innovations. The empirical setting is a sample of Spanish manufacturing firms over the period 1994-2006. Results suggest that those process innovations associated with acquiring and deploying new production equipment are positively related to a diminishing probability of carrying out drastic cuts in workforce. However, a negative effect is found when process innovations are linked to the adoption of new methods of organizing the workforce. Regarding product-oriented innovations our findings also show a negative effect of such innovations on the probability of carrying out important reductions in workforce. Our study stresses the need to consider innovation as a key determinant when analyzing the causes of downsizing in future research.

Key words: process and product innovations, downsizing, Spanish manufacturing firms.

JEL classification: J21, J63, L60, M51, O33.

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1. INTRODUCTION

Downsizing is an economic phenomenon that has become very popular in firms around the world over the last two decades (Budros, 1999, 2000, 2004; Datta *et al.*, 2010; Gandolfi, 2005, 2008). Massive layoffs and labour attrition have become ubiquitous in the business world and media[1]. In academic outlets as well, attention to this topic has been extraordinarily important from the end of 1980s until now. However, while in the 1980s and early 1990s firms basically implemented downsizing in response to hard times, since the middle 1990s downsizing is regarded as one of the preferred management strategies to turning around declining firms by cutting costs and increasing organizational outcomes —for instance, in terms of profitability, efficiency and competitiveness— (Gandolfi, 2008: 46; Wilkinson, 2004: 1079). Despite a growing body of research that the short- and long-term consequences of downsizing may be also negative, it has gained legitimacy in Western economies and it is more and more present in Eastern Europe and Asian economies (Datta *et al.*, 2010; Gandolfi, 2008; Magán and Céspedes, 2007; Wilkinson, 2004). Moreover, it can be seen how over the last two years most companies around the world are experiencing significant employee reductions as a result of the economic crisis. As clear evidence of this latter is the great increase in unemployment figures in most economies. Undoubtedly, all this facts help to understand why employee downsizing is viewed "as one of the most far-reaching and significant management issues of the current era" (Datta *et al.*, 2010: 282).

In a comprehensive review on employee downsizing, Datta *et al.* (2010) identify 91 empirical studies performed between 1988 and 2008 by researchers from different countries. From this review, it can be seen how most researchers have traditionally been interested in examining the consequences of employee downsizing. Yet, it also reveals a growing interest among management scholars in the potential determinants of employee downsizing.

This study adds to the latter research stream by providing new empirical evidence on causes of employee downsizing —defined as a significant reduction of workforce (Bruton *et al.*, 1996; Budros, 1999; Mellahi and Wilkinson, 2009). In particular, our main concern is examining the role of different types of firm innovation on employee downsizing using a sample of manufacturing Spanish firms from 1994 to 2006. Surprisingly, in light of extant evidence on the antecedents of downsizing (see Datta *et al.*, 2010: 285-307), the study of the effect of firm innovation on employee downsizing has received limited attention by management scholars. Thus, our study contributes to fill this gap in management literature.

In any case, it is interesting to note that innovation has been frequently viewed by economic literature as a critical source of employment dynamics (e.g. Alonso-Borrego and

[1] The number of increasing references to the term 'downsizing' provided by Google TM offers an approximate indication of this on growing concern: from 1.4 million references available for the 2000-2004 period to about 1.9 million references from 2005 to 2009.

Collado, 2002; Coad and Rao, 2007; Mastrostefano and Pianta, 2005; Peters, 2004). Initially, economists evaluated the impact of several aspects of innovation on total employment at macroeconomic and industry levels. Nonetheless, in recent years there have been a growing number of firm-level studies (see reviews by Edquist *et al.*, 2001; Pianta 2005 or Spiezia and Vivarelli, 2002). Most of these studies look into the effect of process-related and product-oriented innovation on employment growth rates.

Theoretically, it can be argued that process-oriented innovations are likely to result in job losses as they are usually aimed at producing the same amount of output —product— with less input —jobs. Drastic cuts in the workforce can also take place as consequence of the need to carry out important organizational changes (*displacement effect*). However, improved or new processes can also lead to hiring more employees as firms can pass on the cost reductions to product prices and, then, a higher demand should be expected (*compensation effect*). On the other hand, product innovations are mostly oriented to increasing the quality and variety of the firm's product portfolio which will presumably enhance the products' added value and/or attract new customers. As a result, product innovations should be linked to increasing rates of employment (*compensation effect*). Yet such innovations are sometimes highly uncertain and expensive activities and are exposed to a considerable risk of failure (*displacement effect*) (e.g. Greenan, 2003; Mastrostefano and Pianta, 2005; Peters, 2004).

From past research, it can be inferred that employee downsizing will be closely linked to the specific type of innovation adopted by firms, but such an effect needs to be empirically determined. Drawing on economic and management views, we assess the potential positive or negative effect of different types of processes (i.e. new technology via the introduction of new equipment as well as new methods of organizing the workforce) and product innovations (i.e. number of innovations) on employee downsizing. Therefore, our research is aimed at empirically detecting potential differences in firm downsizing behaviour depending on their innovation activities i.e., process-oriented *versus* product-related innovations.

Our study can contribute to the literature on employee downsizing in a number of significant ways. Firstly, we make an effort to provide alternative explanations about why firms downsize as it analyzes different types of process and product innovations whose effects on employment (and, thus, downsizing) do not seem to be clear. Most importantly, we shed insights on the potential effect of two distinct process innovations in nature: new equipment and new methods of organizing the workforce. To our knowledge, this is a neglected matter by past research. Secondly, we examine this phenomenon in Spain during a recent time period, 1994-2006. There are many empirical studies on causes and effects of employee downsizing carried out by researchers in different countries —including Spain (e.g.

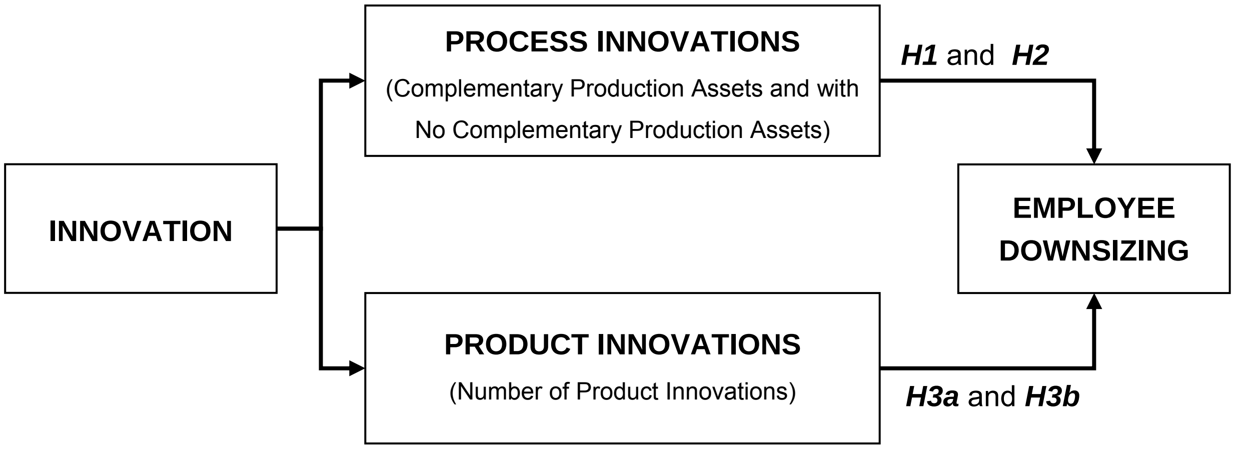
Magán and Céspedes, 2007; Suárez-González, 2001; Vicente-Lorente and Suárez-González, 2007) in the last ten years. Yet, there are few empirical studies analyzing downsizing with recent firm data (see Datta *et al.*, 2010). Finally, unlike prior research which primarily examined large firms, our sample includes firms of very different sizes (small, medium and large-sized firms), although there is a great proportion of small and medium-sized ones. Furthermore, our empirical setting can provide representative findings about the downsizing behaviour of firms belonging to an economy where unemployment rates are especially high. The sample size used is an unbalanced panel of 2,366 manufacturing firms, selected from the Survey on Firm Strategies ("Encuesta de Estrategias Empresariales"). Lastly, we think the consideration of all these issues can help researchers to have a more complete view of the downsizing phenomenon.

The study is organized as follows. The next section presents the theoretical framework regarding the effects of different process and product-oriented innovations on employee downsizing. The third section describes the methodology used to test this framework. The empirical findings are presented in the following section. The last section discusses the main results and concludes with some suggestions for future research.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Figure 1 illustrates the theoretical framework and hypotheses which will be empirically tested in this study. As depicted in this framework, we assume that there is a relationship between innovation and employee downsizing.

Figure 1: Relationships between different types of innovation and employee downsizing



In line with past research from the economics and management fields, we argue that such a relationship will basically depend on two types of innovation —process and products. In particular, we will test two alternative hypotheses in the case of process-oriented innovations (*H1* and *H2*). These hypotheses respectively refer to the potential effect of the adoption of process innovations related and not related to the acquisition of complementary production assets on employee downsizing. In this regard, we posit that the first type of innovation is more likely to be associated to the introduction of new equipment while the latter one to the adoption of new methods of organizing the workforce. It will allow us to see which specific effect (compensation *versus* displacement) is more relevant when explaining the impact of each process innovation on downsizing. On the other hand, we will test two opposing hypotheses for product innovations (*H3a* and *H3b*). Both hypotheses will permit us to test which specific effect (compensation or displacement) is more important when explaining the effect of the number of product innovations on downsizing. We begin by analyzing the effect of process-oriented innovations on employee downsizing. Next, we discuss the potential effect of product-oriented innovations.

2.1. The Effect of Process-Oriented Innovations on Downsizing: New Equipment and New Methods of Organizing the Workforce

The development of a global economy over the last few decades has led firms in most industries around the world to raise their productivity levels (efficiency) to continue to be competitive and to ensure organizational survival. The adoption (or development) of innovations in productive processes via the introduction of new technology —for instance, new machines and equipment— is a traditional way of achieving greater efficiency when manufacturing a product. As a direct result of this fact, firms can reduce production unit costs (Harrison *et al.*, 2005; Peters, 2004; Pianta, 2005; Porter, 1980; Üçdogruk, 2006). In many cases, an immediate outcome of an increase in a firm productivity is the elimination of headcount and the reduction of the overall number of workers. This negative effect of new technology on workforce is called by economists a *displacement effect* (see Peters, 2004; Harrison *et al.*, 2005; Pianta, 2005). Since new efficient technology can allow firms to operate with fewer workers, it is logical to think that firms that make a large investment in efficient technologies will have higher employee downsizing rates than ones that make a smaller investment in such technologies (Budros, 1999: 74; Gandolfi, 2005: 59).

But while this new technology-employee downsizing relationship seems logical, there is an alternative way of viewing the relationship. Anecdotal evidence and most researchers also suggest that more innovative firms can pass on the cost reduction to product prices which can result in a higher demand for a product in the market. This higher demand can lead firms to increase their production and employment levels as well as their market sales. Obviously, this effect will depend on the amount of price reduction and the degree of competitive rivalry among different firms (Harrison *et al.*, 2005; Peters, 2004; Porter, 1980; Üçdogruk, 2006). In this sense, it can be argued that the more intense the competition in the product market, the higher the extent to which cost reductions will be passed to product prices and, hence, the higher the probability of producing and selling a greater amount of product (Peters, 2004: 3). Lastly, the subsequent increase in firm production and market sales usually entails the need for hiring new personnel. This positive effect of new technology on workforce is called by economists a *compensation effect* (see Harrison *et al.*, 2005; Peters, 2004 or Pianta, 2005). Therefore, from this view, it can also be inferred that firms that make large investments in efficient technologies can undergo lower employee downsizing rates than ones that make smaller investments in such technologies.

On the other hand, from a management perspective, it is interesting to underline how in most firms the introduction of new technology is accompanied by the need to introduce some relevant organizational changes (Brynjolfsson and Hitt, 2000; Brynjolfsson *et al.*, 2002; Caroli, 2001; Greenan, 2003). Anecdotal evidence shows how it frequently implies adopting new methods of organizing the workforce. Given that such methods may have a direct impact on the way of doing things or producing a firm product, they can also be conceived as process innovations. The elimination of some jobs but also the creation of new jobs in a firm is a likely outcome of introducing these management practices and methods. This is why it usually encompasses activities such as abolishing some functions and creating other new ones, creation of new skilled work teams, consolidating new organizational units or redesigning different tasks. Thus, the introduction of new methods of organizing can be associated, in some situations, to layoffs while in other cases it can imply the need to hire more personnel. Lastly, as occurred with new technology, the study of the effect of introducing new management practices and methods on downsizing is an empirical issue as it may be positive or negative.

Overall, it can be asserted that existing empirical evidence on the relationship between process-oriented innovations (mainly, via new technology) and employment (or workforce) is far from having provided a conclusive answer. Certainly, from many studies a negative impact of process innovations on employee downsizing can be deduced. This is what can be gleaned from the study by Doms *et al.* (1995). These authors, analysing data on US manufacturing establishments, observe that the use of advanced manufacturing technology has a positive effect on workforce growth. Relatedly, Blanchflower and Burgess (1998) find a positive relation between process innovations and employment growth in UK firms in 1990 and in Australian firms in 1989/1990. Greenan and Guellec (2000), using data from French manufacturing firms during the period 1986-90, find a positive relationship between process innovation and total workforce. Likewise, Smolny (1998), analyzing data of German firms from 1980 to 1992, shows a positive effect of process innovations on workforce. Alonso-

Borrego and Collado (2002), examining a sample of Spanish manufacturing firms during the period 1990-1997, obtain that the indicator of process innovations also has a positive and significant effect on job creation. In a similar vein, Greenan (2003), in a study on a large representative sample of French firms that introduced advanced manufacturing systems in 1988-93, finds that firms innovating in technologies created more jobs than non-innovators. Results by Mastrostefano and Pianta (2005), using data on 11 industrial sectors and ten European countries also show that employment change is explained by positive effects of process innovations. Fung (2006), using a sample of the top 100 bank holding companies during the period 1992-2003, finds that new technology has a positive impact on firm-level employment. The study by Üçdogruk (2006) on a sample of Turkish manufacturing industries over the periods 1995-1997 and 1998-2000 reveals that the employment growth rates of process innovators are positive. Recently, Zimmermann (2008), in a research study on small and medium-sized German firms in the years 2003, 2005 and 2006, finds that the introduction of new or improved processes has a positive impact on total employment growth.

However, from other studies it is also possible to infer the existence of a potential positive effect of such process innovations on employee downsizing. This is what can be drawn from the study by Taimaz (1996). He finds that technological change has a negative but weak impact on workforce growth in a sample of Turkish manufacturing industries over the period 1985-1992. Likewise, Rottmann and Ruschinski (1997) carry out analyses with German firms and find significantly negative effects of process innovations on employment growth. Findings of the study by Blechinger *et al.* (1998) suggest that the introduction of new production technologies led to a reduction in workforce in manufacturing firms in Western Germany in the mid nineties —the effect being more pronounced in larger firms. Jaumandreu (2003) also finds some indication that the net outcome of process innovation is employment displacement in the Spanish service sector during the years 1998-2000. In a similar vein, results by Peters (2004) reveal that displacement effects outweigh compensation effects in process innovations, resulting in negative employment effects in the German manufacturing firms between 1998 and 2000. Using data of manufacturing and service firms from 4 European countries (France, Germany, Spain and the UK) in 1998 and 2000, Harrison *et al.* (2005) show that process innovations have a negative effect on workforce, although the authors recognize that this effect may be attenuated (or even reversed) through compensation effects.

After reviewing the empirical literature, we can conclude that the role of process-oriented innovations on job creation is far from being conclusive since it appears to be contingent on contextual and organizational factors. Clearly, the potential sources of heterogeneous empirical outcomes are numerous. The institutional environment as concerns labour market regulation in terms of the available ways of hiring and firing employees, access to a supply of skilled employees and the spread of technological knowledge and public support to both innovation and employment can pose significant differences in the link between process innovation and downsizing across different countries.

From our view, another unexplored source of the inconclusive findings described above arises from the *type* of process innovation since improvements in the productive process might differ in nature. The incorporation of new equipment in a process usually requires additional investments in tangible (e.g. machines) and intangible assets (e.g. employee training, use of licensed/patented proprietary knowledge, among others). From an economic perspective, this growth in physical and knowledge capital would increase the firm's labour productivity as a result of the augmented capital-to-labour ratio, and therefore an increase on labour demand might be expected. Alternatively, process innovations consisting of the mere adoption of new work methods and/or the internal reorganization of production need not be accompanied by a significant amount of investment and hence their effect on the capital-to-labour ratio is undetermined. There are also significant differences in terms of the goals and expected gains related to the type of process innovations. Efficiency losses derived from excess capacity, redundant jobs, and ineffective hierarchical structures can be easily overcome by redesigning methods and procedures of work with no need of capital investment. Consequently, these changes in processes are presumably aimed at rationalizing jobs and work flows and, therefore, they would exhibit a straightforward and positive effect on employment cuts. Conversely, the existence of complementary investments can reveal an actual commitment of managers to realize growth market opportunities by, for example, increasing the capacity and quality of productive processes. In other words, we suggest that the role played by a process innovation in a firm's downsizing choice depends heavily upon the existence/lack of complementary investment in production assets: process innovation accompanied by actual (by no) investment in new equipment will be related to a lower (higher) downsizing proclivity. These conclusions lead us to posit the following hypotheses:

H1: *Firms that adopt process innovations related to the acquisition of complementary production assets have a lower probability of downsizing than those that do not innovate.*

H2: *Firms that adopt process innovations not related to the acquisition of complementary production assets have a higher probability of downsizing than those that do not innovate.*

2.2. The Effect of Product-Oriented Innovations on Downsizing

The new challenging and rapidly changing business environment is also forcing most firms around the world to continuously introduce innovations in their product(s) to continue being competitive and surviving. In this context, firm managers feel obliged to make decisions on product innovations to increase the quality and variety of their products (Pianta, 2005). According to some recent estimations, on average, more than 35% of firm revenues are generated from products that did not exist five years ago (Berkowitz *et al.*, 2007).

Generally, it is argued that employee downsizing effects of product-oriented innovations are highly likely to depend on the degree of product novelty (Peters, 2004). The product life cycle theory (Vernon, 1966, 1979), which states that each product or sector follows a specific life cycle, provides one interesting explanation regarding the potential effect of product innovation on employee downsizing. By definition, market novelties can initiate the cycle of one specific product (or even industry). According to this approach, firms introducing new products may experience higher demand increases as consumers are not yet well equipped (Greenan and Guellec, 2000; Peters, 2004). As a consequence, successful market novelties might, ceteris paribus, result in higher production and sales levels of the product in question and, thus, prompt workforce growth by means of hiring of new personnel. Evidently, the amount and sustainability of this positive effect on workforce will depend on the nature of competition and the delay with which rival firms react to the introduction of new products and/or can imitate them (Garcia *et al.*, 2002; Harrison *et al.*, 2005; Peters, 2004). Thus, the positive effect of product innovation on firm's employment demand should be more likely in the initial phases of the product life cycle as a result of the low degree of rivalry among firms.

An alternative explanation for this compensation effect can be provided from the competitive advantage approach (Porter, 1980), which posits that firms can follow different competitive strategies linked to products. Two of the most popular ones are cost leadership and product differentiation. While the former is associated with the possibility of producing with low unit cost (efficiency view), the second one is precisely based on the possibility of providing highly innovative products. Firms following a differentiation strategy provide products which are perceived as distinct by consumers so they are prepared to pay higher prices for them. From this standpoint, these firms can find it easier both to maintain and/or increase their sales. This may occur because, as Coucke *et al.* (2007: 171) point out, competitive pressure may be less severe in firms following a product differentiation strategy and, thus, the probability of restructuring and downsizing may, on average, be lower. Specifically, these authors find from a sample of Belgium firms between 1990 and 1999 that firms following a product differentiation strategy have less chances of undergoing drastic cuts in their workforce.

Reviewing past empirical research which especially focuses on the potential impact of product innovations on employment growth, it can be noted that the majority of studies find a stimulating effect of such innovations. Therefore, these studies provide some preliminary support for a negative impact of product-oriented innovations on employee downsizing. This is resulted from the study by Entorf and Pohlmeier (1990). These authors, investigating German manufacturing firms in 1984, find a positive effect of product innovation on total employment growth. Brouwer *et al.* (1993) find the same effect for Dutch firms in the 1980s. Results obtained by Van Reenen (1997), analyzing UK manufacturing firms over the period 1979-1982, also show that product innovations are associated with higher firm level employment. In a similar vein, Pianta (2001), using data for five European countries (Denmark, Italy, Germany, The Netherlands and Norway) between 1989 and 1993, finds that product innovations have a positive impact on employment changes. The study by Meriküll (2008), analyzing data on Estonian firms in two periods (1998-2000 and 2002-2004), suggests that product innovations have a strong positive effect on employment growth. The same results are confirmed by Greenan and Guellec (2000), Rottmann and Ruschinski (1997), Smolny (1998), Jaumandreu (2003), Harrison *et al.* (2005) and Mastrostefano and Pianta (2005).

Additionally, there is an opposing way of viewing the relationship between product-oriented innovations and employee downsizing. Such a view is based on the potential influence of the degree of substitutability between the old and new products as well as the uncertainty and failure associated with market novelties (Edquist *et al.*, 1998; Harrison *et al.*, 2005; Peters, 2004). On the one hand, new products can (totally or partially) replace old ones. In this setting, market sales of new or improved products may cannibalise some proportion of the firm's current sales (Harrison *et al.*, 2005: 5). Consequently, the need for workers for old products may decrease so that the overall effect on firm workforce is not clear (i.e. it could be negative, positive or neutral). On the other hand, new products can also be associated with a higher uncertainty and a higher risk of failure. New products are unknown to consumers and thus, they are exposed to a high rate of failure. Anecdotal empirical evidence is quite categorical on this matter by showing a failure rate of new products between 40 and 75% (Stevens and Burley, 2003; Joshi and Sharma, 2004). Therefore, it is logical to think that firms with failing products may be forced to restructure and thus resort to layoffs (displacement effect) since they can experience significant reductions in production and market sales.

In light of all the prior theoretical arguments and empirical research, we posit two opposing hypotheses relating to product-oriented innovations and downsizing:

H3a: *Firms that introduce more product innovations will have a lower probability of downsizing than ones that introduce fewer innovations.*

H3b: *Firms that introduce more product innovations will have a higher probability of downsizing than ones that introduce fewer innovations.*

3. METHODS

3.1. Data

We performed the empirical analysis using data from the Survey on Firm Strategies. This data base is the outcome of a panel survey conducted by a research foundation (*Fundación SEPI*) and financially supported by the Spanish Ministry of Industry, Tourism and Commerce. The survey provides micro data of a sample of Spanish manufacturing firms from the early 1990s to 2006. The reference population of the sample comprises Spanish manufacturing firms with ten or more employees. The available data are the result of a random stratified sampling and are updated yearly in order to minimize their decay over time. All these procedures are mainly oriented to preserving the sample representativeness. Information available from this survey includes a broad set of variables related to markets, employment, and innovation activities, among others. Along with these advantageous characteristics, this database also has some restrictions. Anonymity of surveyed firms is assured and they are free to provide or omit at will the information requested by the questionnaire. This fact precludes, in some cases, the completion of missing data and implies a substantial reduction of the sample size when using some items with a low response rate.

The whole available raw data base includes information from 4,357 firms over the period 1990 to 2006 on a yearly basis. This implies a maximum potential sample size of 56,641 cases (firm *x* year observations). However, there is a number of missing data owing to (1) eventual entry/exit of companies in the survey, and (2) the absence of firms' responses to some variables or questionnaire items. For instance, the number of cases (year *x* firm observations) with a valid response to the variable *number of total employees* is 22,737. Cases/observations are also lost when computing some variables (described in the next section) such as the rates of sales and employment growth. An additional loss in sample size stems from the fact that all explanatory variables (except for 'year' and 'industry' dummy controls) are one year lagged with respect to the dependent binary variable in order to control for the endogeneity/simultaneity problem. We also detect some anomalous (abnormally large) values in the ratio of R&D expenditures over net sales for two firms: 3,266% and 98.9%, respectively. All cases of these firms were removed. As a result, the final sample size used for estimation is an unbalanced panel of 2,366 firms and 15,004 cases (firm *x* year).

The aforementioned database meets certain valuable requirements as the empirical setting for the research targets of this study. On the one hand, a number of items are able to capture detailed information on the sources (R&D investments) and outcomes (type and/or number of innovations) of the firm's innovative activity within a highly representative sample of Spanish firms. On the other hand, the Spanish economy exhibits one of the largest and sustained rates of unemployment within the OECD countries and thus, our empirical results could be useful to identify common and/or peculiar patterns of downsizing phenomena when comparing to extant or future evidence from other countries[2].

3.2. Definition and Measure of Variables

3.2.1. Dependent variable: Downsizer

We consider that a firm has downsized during a given year if the growth rate of total employees is less than -0.05 (-5%). This threshold attempts to distinguish short-term cycle adjustments in workforce markets and firms' policies from those size reductions due to long-lasting restructuring decisions and it has been proposed in many previous empirical studies (e.g. Cascio *et al.*, 1997, Cascio and Young, 2003; Guthrie and Datta, 2008; Osterman, 2000; Said *et al.*, 2007). The resulting dichotomous variable, *Downsizer*, takes a value of 1 if a firm has downsized during a given year and 0 otherwise, and its statistical distribution approximates the probability/frequency of downsizing.

3.2.2. Independent variables

Our data base offers potential useful information about the output indicators of innovation activities. In particular, the survey includes data about the specific type of innovation in productive processes as well as the number of product innovations. We used this data to build three variables addressed to estimating and comparing the different effects of the type of innovation upon the probability of downsizing. Process innovation is approximated by two binary variables that take a value of 1 if the innovation is related to the acquisition/improvement of new equipment (*Process Innovation by New Equipment*) or if it is related to the implementation of new methods and/or the reorganization of the workforce (*Process Innovation by New Methods*). Both variables are respectively used to see to what extent process innovations are related or not to the acquisition of complementary production assets. The variable *Number of Product Innovations* which ranges from 0 to 950 for the firms within the sample and approximates the aggregate absolute intensity in product innovation.

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[2] In 1994 (the former year of analysis in our study) the unemployment rate in Spain was of 24.8%, 6.1% in the US, 2.9% in Japan and 14% in the European Union. In 2006 (the latter year of analysis) the unemployment rates were of 8.1% in Spain, 4.6% in the US, 4.4% in Japan and a bit more than 8% in the EU countries.

3.2.3. Control variables

All estimated models incorporate a set of control variables in order to minimize the risk of the omitted variable bias. *R&D Intensity* is defined by the percentage of total R&D investments over net sales. This variable is available for a large number of the companies within the sample but with little or no informative content about the outcome of the innovation activity (i.e. product or process innovation). In essence, the ratio of R&D intensity can be viewed as a composite input-based indicator of the innovation activities of the firm (see Burton *et al.*, 1996; Peters, 2004 or Pianta, 2005). There are several reasons to include R&D intensity as an explanatory variable: (1) R&D activities can generate outcomes different from product and/or process innovations (e.g. access to new knowledge with no straightforward application); and (2) R&D intensity has been used as a proxy for a firm's intangible assets and/or growth opportunities (see Deeds, 2001; Heunks, 1998; Stam and Wennberg, 2009).

Prior evidence on the downsizing antecedents reveals a number of potential determinants that should be taken into account in the empirical research. Substantial changes in the organization, property and firm structure are commonly associated with workforce reallocations that make jobs reductions more likely (see Budros 2002; Conyon *et al.*, 2002 or Letho and Bockerman, 2008). We approximate these kinds of events by a binary variable (*M&A*) that takes a value of 1 if the firm has been engaged in a merger and/or acquisition process. The role of demand changes in employment variation is a well proved empirical regularity (see Baumol *et al.*, 2003; Filatochev *et al.*, 2000 or Wagar, 1997); thus, we consider the rate of sales variation (*Sales Growth*) as an additional control. *Firm Size* is also included as a control variable since it is usually argued that downsizing is more prevalent among larger firms (see Budros, 1997, 1999; Coucke *et al.*, 2007 or Wagar 1997). It is measured as the natural logarithm of total sales. A better financial performance enhances the firm's options for growth and signals the advantageous competitive position of the firm (see Ahmadjian and Robinson, 2001; Baumol *et al.*, 2003; Budros, 2002, 2004 or Coucke *et al.*, 2007). Thus we approximate profitability using the *Gross Margin*, which is defined as the percentage of operative profit over net sales. We include the share of foreign ownership in the firm equity (*Foreign Ownership*) since previous evidence suggests that domestic investors are less prone to adopt drastic employment reductions (see Vicente-Lorente and Suárez-González, 2007). Solvency problems and/or the limited ability to raise funds can also be a serious restriction that may lead firms to downsize when their financial autonomy is compromised (see Gittell *et al.*, 2006 or Hillier *et al.*, 2006). The percentage of total equity over total funds is used to define the variable *Capital Structure*. Downsizing is often motivated by market share declines (see Ahmadjian and Robinson, 2001 or Budros

1997, 2000). *Market Share* is measured as the perceived market share (in percentage) of the firm's main market.

We also included two additional control variables whose role remains unexplored in previous studies on the downsizing determinants: *Internationalization* computed as the ratio of total value of exports over total sales, and the breadth of product portfolio (*Number of Products*) measured as the number of products manufactured by the company (ranging from one to six products). We propose these indicators in order to test the significance of factors related to the firm's corporate strategy. Given the lack of previous evidence, estimates of the effect these variables will be useful as an exploratory insight as well as for control purposes. Finally, commonly used industry and time dummy variables are used in all estimations.

All the aforementioned independent and control variables are lagged one year with respect to the dependent variable (*Downsizer*) in order to control for potential endogeneity/simultaneity problems.

3.3. Preliminary Findings from the Descriptive Analysis

Before proceeding further with the description of the empirical method employed in this study, we summarize some remarkable stylized facts regarding our research target by examining some of the main descriptive statistics of the above variables (see table 1).

First, the workforce reduction is not a rare but a quite common event in the Spanish context over the period considered: nearly a quarter (23.4%) of the cases (firm *x* year) are representative of workforce reductions equal or larger than a 5%. This fact is remarkable since these data comprise a period of sustained growth of the Spanish Gross Domestic Product (i.e. 1994-2006). Second, the sign of the co-variation (i.e. correlation) between the occurrence of downsizing and the type of innovation reveals meaningful differences. Whilst *Process Innovations by New Methods* is positively correlated to workforce reductions, *Process Innovations by New Equipment* and *Number of Product Innovations* show an inverse linear correlation to downsizing events. We also find that *Process Innovations by New Equipment* is nearly three times more frequent (14.1%) than *Process Innovations by New Methods* (4.2%), and that both types of process innovation exhibit a strong and negative correlation (-0.084). Finally, both types of process innovation and the *Number of Product Innovations* are positively correlated although the linear relationship between *Process Innovations by New Methods* and *Number of Product Innovations* is substantially weaker (0.005).

Table 1: Descriptive Statistics: Mean, Standard Deviation, and Correlations

	Variables	*Mean*	*Std. D.*	1	2	3	4	5	6	7	8	9	10
1	*Downsizer*	0.234	0.003										
2	*Process Innovations by New Equipment*	0.141	0.003	-0.050									
3	*Process Innovations by New Methods*	0.042	0.002	0.012	-0.084								
4	*Number of Product Innovations*	2.768	0.175	-0.020	0.038	0.005							
5	*R&D Intensity*	0.693	0.018	-0.035	0.046	0.062	0.075						
6	*M&A*	0.022	0.001	0.002	0.006	0.037	0.000	0.042					
7	*Sales Growth*	0.127	0.026	-0.010	0.000	-0.003	-0.001	-0.002	0.024				
8	*Firm Size*	15.782	0.017	-0.074	0.087	0.049	0.056	0.186	0.157	0.015			
9	*Gross Margin*	9.478	0.109	-0.069	0.086	-0.002	0.000	-0.020	0.016	0.006	0.118		
10	*Capital Structure*	57.219	0.188	0.008	-0.009	0.011	-0.013	-0.021	0.011	0.013	-0.110	-0.178	
11	*Internationalization*	0.188	0.002	-0.018	0.036	0.025	0.056	0.157	0.037	0.024	0.427	0.014	-0.046
12	*Foreign Ownership*	18.824	0.307	-0.029	0.016	0.028	0.015	0.086	0.114	0.001	0.512	0.050	-0.068
13	*Market Share*	12.119	0.164	-0.018	0.054	0.020	0.017	0.036	0.050	-0.002	0.345	0.114	-0.135
14	*Number of Products*	1.148	0.004	-0.012	0.023	0.014	-0.009	0.002	0.023	-0.002	0.088	-0.009	0.003

		11	12	13	14
12	*Foreign Ownership*	0.308			
13	*Market Share*	0.095	0.217		
14	*Number of Products*	0.027	0.016	0.044	

The above preliminary facts are compatible with several interpretations. The negative correlation between both types of process innovation (new equipment and new methods) may reflect that there are, to some extent, alternative or substitutive for a given company. Alternatively, innovations by new equipment could require additional investments only feasible for large and/or profitable companies whilst the introduction of new methods could be implemented by those small and less profitable companies that accounts for a more limited resource budget. The correlations of process innovation related-variables and other ones like *Firm Size* and *Gross Margin* provide a rough support to this conjecture. Anyway, the examination of descriptive statistics only provide a preliminary and approximate explanations based upon uni- or bivariate analysis that should be interpreted cautiously given the potential overlapping effects of other relevant variables. In this sense, a more rigorous and accurate identification of the isolated effects of explanatory variables should include a complementary multivariate analysis. Consequently, we opt for formulating a multivariate econometric specification that is described in the next section.

3.4. Empirical Model

We employ probit models for panel data as an empirical tool. This statistical method offers estimates of the effects of the proposed explanatory variables upon a binary dependent variable. Given the characteristics of the sample, we opt for estimating the empirical models with panel data specifications since this technique allows us to control for unobserved or unmeasured heterogeneity of individuals within the sample. The model can be represented as follows:

$$Pr\ (Y=1 \mid X) = \Phi\ (X'\beta),$$

where Pr denotes probability and Φ is the cumulative distribution function of the standard normal distribution. The vector of estimates is β and X is the vector of explanatory variables. In our case, Y=1 represents the event of downsizing at year *t*, and X is the set of independent and control variables valued at year *t-1*. Individual unmeasured effects are considered random and the β parameters are estimated by maximum likelihood.

4. DISCUSSION OF RESULTS

We have estimated four models to examine the effect of different types of innovation considered on employee downsizing. Results are illustrated in table 2. Model 1 incorporates only the control variables. Models 2 and 3 consider process-related and product-related innovation variables, respectively (i.e. the independent variables of interest in this study), and Model 4 includes all explanatory variables (i.e. independent and control variables).

Table 2. Probit Estimates for Panel Data (Dependent Variable: Downsizer)

	Model 1	**Model 2**	**Model 3**	**Model 4**
R&D Intensity	-0.0157**	-0.0155**	-0.0146**	-0.0144**
M&A	0.1761**	0.1693**	0.1747**	0.1680**
Sales Growth	-0.0570**	-0.0551**	-0.0569**	-0.0551**
Firm Size	-0.0514***	-0.0502***	-0.0503**	-0.0491***
Gross Margin	-0.0049***	-0.0048***	-0.0050***	-0.0048***
Capital Structure	-0.0001	-0.0002	-0.0002	-0.0002
Internationalization	0.0861	0.0902	0.0892	0.0932
Foreign Ownership	0.0005	0.0005	0.0005	0.0005
Market Share	0.0012*	0.0013**	0.0012*	0.0013*
Number of Products	-0.0086	-0.0077	-0.0095	-0.0085
Process Innovation by New Equipment		-0.1306***		-0.1287***
Process Innovation by New Methods		0.1080*		0.1088**
Number of Product Innovations			-0.0017**	-0.0016**
Number of firms	2,366	2,366	2,366	2,366
[a]Wald $\chi 2$ test (d.f)	277.4*** (39)	296.2*** (41)	281.6 *** (40)	300.0*** (42)
[b]Likelihood test $\rho=0$	43.5***	38.5***	43.3***	38.4***

Estimates of *Industry* and *Year* (not shown in the table) are jointly significant at the 99% level of confidence.
* *p*-value<0.10; ** *p*-value<0.05; *** *p*-value<0.01;
[a] Goodness of fit test.
[b] Likelihood ratio $\chi 2$ test of lack of individual random effects.

We find significant and robust effects on downsizing probability depending upon the type of process innovation (see Models 2 and 4 of table 2). Improvements in the productive process associated with acquiring and deploying new equipment is strongly related to a diminishing probability of carrying out drastic cuts in employment. On the contrary, we find the opposite (positive) effect when the innovation in processes is linked to the adoption and implementation of new methods of organizing the workforce. These findings strongly support hypotheses H1 and H2. Thus, it can be inferred that firms adopting process innovations related to the acquisition of complementary production assets exhibit lower downsizing rates than those do not innovate (H1). On the other hand, it could be deduced that firms adopting process innovations not related to the acquisition of such assets have higher downsizing rates than those that do not innovate (H2).

Although we do not appraise remarkable collinearity problems in our multivariate model, it is also certain that the bivariate correlation between innovation-related variables detected and described in prior section can raise some doubts on the overlapping and/or interacting effects between those explanatory variables that could lead to a misleading interpretation of the estimates. In order to assure the robustness of our findings, we estimated additional empirical models (not shown in the paper) including the whole set of control variables and all potential combinations of the three variables of interest (i.e. *Process Innovations by New Equipment*, *Process Innovations by New Methods* and *Number of Product Innovations*). The estimates of these models did not differ substantially in terms of coefficients signs and significance from those shown in table 2. Additionally we also test the relevance of all potential interactions between the three innovation-related variables. Such interactions terms turned to be far from being statistically significant at the usual levels of confidence.

Prior results have several implications. First, the impact of process innovation on a firm's employment is complex and deserves a more detailed examination in light of our results. The nature and goals of process innovation can explain the significant differences in its role as an enhancing or inhibiting factor of a firm's employment decision. Second, these differences could partially clarify the prior contradictory evidence on the link between process innovation and job creation at firm level. At this point, additional efforts are needed to propose new and more fine-grained definitions and typologies of process innovations. From our view, the usual measures of process innovation could offer mixed evidence derived from a measurement problem. Third, the estimated effect of process innovation provides indirect evidence for assessing the relevance of the displacement and compensation effects of this type of innovation upon employment change at firm level. Our evidence on this matter would suggest that the displacement effect of process innovation dominates over the compensation effect when such innovations are related to or accompanied by complementary production investments. On the contrary, the absence of these investments favours the dominance of the displacement effect.

In other words, process innovative companies can meet favourable conditions to translate efficiency gains into a higher labour demand. This finding is in line with some previous evidence (e.g. Blanchflower and Burgess, 1998; Doms *et al.*, 1995; Fung, 2006; Greenan, 2003; Greenan and Guellec, 2000 or Zimmermann, 2008), but this is only true when complementary productive assets are acquired and deployed. Otherwise the improved process can help firms to cut costs but their growth opportunities might remain unaffected or even worsened. This latter context would justify that the process improvement in terms of managerial practices and new methods of organizing work can spark off relevant organizational changes (Brynjolfsson and Hitt, 2000; Brynjolfsson *et al.*, 2002; Caroli, 2001), and that these changes can ultimately lead firm managers to dismiss a significant number of employees.

The negative and significant effect of the number of product-oriented innovations (see Models 3 and 4 of table 2) strongly supports hypothesis H3a and, consequently, leads us to reject the competing hypothesis H3b. Therefore, it can be stated that firms that introduce more product innovations have lower downsizing rates than ones that introduce fewer innovations. This evidence seems consistent with the view that continuous and/or intense efforts aimed at improving existing products and/or developing new ones are likely to boost the firm's competitiveness and to enhance growth opportunities. In this sense, it can be expected that the successful exploitation of these growth opportunities will be associated with the need to hire new personnel. In some way, this finding is in line with past empirical research from the economic field which mostly finds a positive link between product innovations and employment growth (e.g. Greenan and Guellec, 2000; Rottmann and Ruschinski, 1997; Smolny, 1998; Jaumandreu, 2003; Harrison *et al.*, 2005 or Mastrostefano and Pianta, 2005).

The effect of most of the control variables appears to be consistent with previous research on the relevance of environmental and organizational factors in the downsize choice. So, the positive and significant effect of the variable *M&A* confirms that companies engaged in mergers and spin-off processes tend to be more plausible downsizers. In addition, *Firm Size*, the pressure of an increasing demand (*Sales Growth*) and the advantage of a profitable position (*Gross Margin*) seem to prompt firms to increase their workforce and thus, inhibit layoffs. Finally, we find that the share of the firm's main market (*Market Share*) makes downsizing decisions more likely. We venture two feasible explanations for this fact. First, as the level of competitiveness in output markets lowers, firms tend to adopt a more defensive behaviour in the inputs market (i.e. hire fewer and/or fire more employees). Another potential explanation is that data on market share depend heavily on how the respondents define their reference markets (i.e. the set of "closest" competitors) and it is plausible that firms with poor growth opportunities and/or worse competitive positions tend to redefine the boundaries of their market in narrower terms.

With respect to the negative effect of *R&D intensity* on employee downsizing, our findings show that firms more intensive in R&D are more likely to generate new knowledge. And, since new knowledge usually translates into a higher firm creativity, it is highly likely that such creativity ultimately fosters a firm success and growth and, thus, the need to hire new personnel. It is interesting to note that the estimated impact of *R&D intensity* is negative and robust for every model estimated. The statistical significance of this variable decreases when additional explanatory variables are added but even in those models including the ‘output-based’ indicators of the innovation activities (i.e. type of process innovation and number of product innovations) this estimate still remains highly significant (at the 95% level).

Neither the share of foreign ownership (*Foreign Ownership*) nor the financial structure of the firm (*Capital Structure*) achieves statistical significance. The relative importance of foreign markets (*Internationalization*) appears to increase the probability of downsizing even though the estimated effect is not statistically significant at the usual levels of confidence. Finally, there is no distinctive downsizing behaviour either depending upon the breadth of the firm’s product portfolio (*Number of Products*).

5. CONCLUSIONS

This study has provided empirical evidence on the relationship between firm innovation and downsizing in a sample of Spanish manufacturing firms from 1994 to 2006. Our findings add new evidence to this relatively unexplored matter in the management field whose concerns have usually been focused on examining the reverse relationship (e.g. Bruton *et al.*, 1996; Dougherty and Bowman, 1995 or Espahbodi *et al.*, 2000). Specifically, we have analysed how different types of process and product-oriented firm innovations affect the probability of performing drastic cuts in the workforce. To this end, we have formulated a set of hypotheses on the impact of process and product related innovations on downsizing probability for a sample of Spanish manufacturing firms.

Our empirical study reveals that the effect of process-oriented innovations on downsizing is strongly dependent on the specific type of innovation being introduced by firm managers. Specifically, our results suggest that those firms that make investments in complementary production assets when the process innovations occur have significantly lower downsizing rates than ones that do not make such investments. As far as product-oriented innovations are concerned, our results reflect the existence of a negative and significant effect of the role played by the number of product innovations on the probability of carrying out drastic reductions in workforce.

Nevertheless, our findings also highlight that the probability of carrying out drastic reductions of workforce in the sample of Spanish manufacturing firms depends on some other relevant factors. This is, for example, what occurs with *R&D intensity*, *M&A*, *Sales Growth*, *Firm Size*, *Gross Margin* and *Market Share*. We find a negative and robust effect in the case of *R&D Intensity*, *Sales Growth*, *Firm Size* and *Gross Margin* on the probability of downsizing, while a positive and significant effect is found for *M&A* and *Market Share*.

Some relevant implications for managers and policy makers can be derived from our results. Nowadays, it is widely acknowledged by managers, politicians, economists and management scholars that innovation is one of the main pillars of a country and firm's growth and competitiveness and, ultimately, employment creation. Our findings suggest that managers could play a significant role in employment creation, especially when they carry out process innovations related to the acquisition of complementary production assets and market highly innovative products. Even though significant employee reductions can be justified in the case of some innovative activities, managers should be cautious when they carry out them since downsizing might also have negative effects on the future innovative capability of firms they manage (see Mellahi and Wilkinson, 2009).

Policy makers might also contribute to diminish the potential number of employees affected by firms' downsizing strategies by designing, for instance, public subsidies systems that deliberately prompt both types of innovations. In this regard it is interesting to note that many governments around the world are currently devoting large amounts of public funds to encourage innovative activities carried out by private firms. Our findings suggest that policy makers should be selective when they fund to private firms since there may be some innovative activities that not prevent significant employee reductions.

The current limitations of our study also bring forth some fruitful and possible avenues for future research that might be considered in relation to the phenomenon of study. In line with much of the past research our study does not distinguish the effect of innovation on downsizing decisions taking into account its effect on different types of employees —for instance, in terms of more skilled workers *versus* less skilled ones, or 'strategic' *versus* 'nonstrategic' employee groups (e.g. Datta *et al.*, 2010; Lepak and Snell, 1999). Consequently, it could be very interesting to explore this important matter in future research. In this sense, there is empirical evidence highlighting that, in general, downsizing can negatively affect the innovation ability of a firm (e.g. Hoffman *et al.*, 1998; Mellahi and Wilkinson, 2009; Shah, 2000). In our view, the consideration of such a distinction could shed new light on this latter relationship.

On the other hand, our study analyzes the effect of innovation on employee downsizing in a sample of manufacturing firms. Therefore, our findings should be interpreted in light of this fact. In this context, it could be very interesting to examine the same matter in future research, but also using samples of service firms. It is widely known that new information technologies are playing a pivotal role in revolutionising the way in which most of the 'traditional' services are generated, traded and delivered, as well as offering opportunities for the generation of new activities in many service industries (e.g. Evangelista and Savona, 2003). Such an empirical analysis could also allow researchers to test to what extent the findings found on the impact of firm innovation on downsizing may be dependent on their pertaining to the manufacturing or services industries.

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