

Does entrepreneur gender matter in SMEs performance? The role of innovations

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Does entrepreneur gender matter in SMEs performance? The role of innovations.

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Abstract

This study explores whether there are significant differences between female- and male-led businesses in terms of the performance results they obtain from innovating. We use a sample of 1,376 Spanish small and medium enterprises (SMEs) to analyze the impact of entrepreneur gender on business performance considering the mediating effect of innovations, that is, the possibility that gender indirectly influences business performance by affecting the introduction of innovations. Using econometric techniques, we estimate discrete choice models to explore the relationship among gender, innovations and business' performance. Our analysis is multi-dimensional in that we consider two types of performance indicators, financial and operational, and three types of innovations: product, process and organisational innovations. Our empirical findings show that, after controlling for other entrepreneurial and business characteristics, men-led SMEs are more likely to obtain better performance from their innovations, and in particular, from their higher propensity to introduce process innovations, as compared to women-led SMEs. We extend existing empirical literature in the gender and entrepreneur research fields regarding the role of entrepreneur gender in the innovation-performance relationship, and contribute to the understanding of the role of gender in SMEs performance. Our study suggests the need to incorporate a gender perspective in those policies dealing with enhancing SMEs innovativeness and performance.

Keywords: Gender of entrepreneur; small and medium-enterprises; innovations; financial performance; operational performance; *bivariate probit* model.

JEL Classification: C35, J16, F14, M21.

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1. Introduction

Though innovativeness is a crucial resource for improving business performance (Van Auken et al., 2008; Buratti et al. 2017), women entrepreneurs usually have greater limitations to implement innovations in their firms compared to men. This responds to multiple factors, such as a lower access to financial resources, lack of adequate human capital and business and innovation networks, among others (Fairlie and Robb, 2009, Expósito et al., 2021). As a consequence, the performance of businesses run by women entrepreneurs may be poorer when compared to the that of men counterparts.

Innovation requires the combination of specific financial, technological and human capital resources together with organizational capabilities, which may be a challenge, specifically for small and medium enterprises (SMEs) (Hashi and Stojčić, 2012; Sok et al. 2016). Recent studies have revealed that entrepreneur gender influences firm's innovation behaviour in terms of the types of innovation implemented by the firm (see Marvel et al. 2015; and Expósito et al. 2021; among others). However, the direct and/or indirect effects of entrepreneur's gender on how innovation may impact business performance remain insufficiently explored (Link 2017; Elam et al. 2019). Although literature focusing on the analysis of the impact of the entrepreneur/manager's gender on business performance has experienced a significant development in the last decade (Alsos et al. 2013; Marvel et al. 2015; Coleman, 2016; among others), this has basically focused on the start-up stage of the venture, not paying sufficient attention to the role of the entrepreneur gender on the innovation profile of the firm and on the impact of the innovation strategy on business performance (Alsos et al. 2013).

Among the few studies that have analysed the role played by gender on the innovation capacity of the firm are those of Weber and Geneste (2014), Buratti et al. (2017), Marvel et al. (2015), Dohse et al. (2019), and Na and Shin (2019). Regarding the role played by entrepreneur's gender on business performance, the literature is more extensive. Particularly, the role of gender has been analysed regarding potential differences in business costs (Watson, 2002), employment and labor productivity (Rosa *et al.*, 1996; Menzies *et al.*, 2004; Chirwa, 2008; Ali and Shabir, 2017); revenue and profitability (Kalleberg and Leicht, 1991; Du Rietz and Henrekson, 2000; Menzies *et al.*, 2004), risk management (Jianakoplos and Bernasek, 1998; Robb and Watson, 2012); capacity utilization (Ali and Shabir, 2017); and business survival (Kalleberg and Leicht,

1991; Boden and Nucci, 2000; Basyith *et al.*, 2014). Despite this wide range of studies, empirical evidence on the role played by entrepreneur's gender on business performance remains inconclusive. Additionally, the potential mediation effects of other factors, such as firm's innovation capabilities in the relationship between gender and business performance have not been sufficiently analysed in the existing literature (Lee *et al.*, 2016). To the best of our knowledge, no empirical study has paid attention to the possibility of entrepreneur gender indirectly influencing business performance by affecting the introduction of innovations.

In this study we attempt to fill this gap by empirically exploring the mediation effect of firms' innovations in the relationship between the entrepreneur's gender and different dimensions of business performance. In particular, our research questions are the following. Does the gender of the entrepreneur matter in SMEs performance? Do innovations mediate between entrepreneur's gender and business performance? Do female- and male-led businesses significantly differ in terms of (financial and operational) business performance resulting from their innovations?

To answer these research questions, we use a quantitative and multidimensional empirical approach applied to a sample of 1,376 Spanish SMEs. Despite its advance towards gender balance in many aspects of society, Spain still lags behind many European countries in terms of gender equality regarding labour and economic participation (World Economic Forum, 2021).¹ In addition, SMEs play a significant role in creating value added and employment in Spain (European Commission, 2018). For our empirical analysis we use an innovation survey carried out in 2012 to businesses corresponding to manufacturing, construction, commercial and services sectors, and containing information at the business level, including innovation activities and performance indicators. In addition to having a large number of businesses, which allow us to compare male versus female-led businesses, the survey has the advantage of including information on a number of personal attributes of the entrepreneur, such as risk-tolerance, self-

¹ In fact, the sub-index of Economic Participation and Opportunity of the Global Gender Gap Report (World Economic Forum, 2021) indicates that Spain has slightly improved during the last decade, increasing from a score of 0.65 (75th position) in 2012 up to 0.69 in 2020 (71st position), far behind other advanced European economies such as Germany, UK and the Scandinavian countries

confidence and educational level, which are factors likely to influence firms' performance (Marlow and McAdam, 2013).

We follow the empirical approach of Baron and Kenny (1986) to mediation in order to explore whether the introduction of innovations mediate in the relationship between entrepreneurial gender and firms' performance. We follow the work of Expósito and Sanchis-Llopis (2018) and consider that the innovation-performance relationship is multi-dimensional and depends upon the type of innovation and the performance indicator considered. Following the definition of the OECD, three types of innovations (product, process and organizational innovations), will be considered to characterize the innovation profile of the firm (OECD, 2010). Technological innovations, such as product and process innovations, are usually the result of technological change to develop or improve products, services and processes (Freeman, 1974). Alternatively, organizational innovations are usually related to non-technological changes affecting the business organizational and administrative dimensions (Camisón and Villar-López, 2014; Walker et al., 2015), and have been less explored in the literature. Regarding business performance, we analyse two dimensions, namely, financial and operational performance, and we use two indicators to capture each dimension. Financial performance is measured using sales increase and costs reduction, while operational performance is measured using the improvement in the quality of products/services offered by the firm, and the increase in production capacity. Our multi-dimensional approach then allows us to undertake a fine-grained analysis on the role of entrepreneur gender on the introduction of different types of innovations, and on the impact of each type of innovation on the different performance dimensions.

Our empirical findings show that SMEs led by male entrepreneurs are more likely to introduce process innovations, as compared to those run by females, and that process innovations are positively related to financial and operational performance. In addition, our findings show that there are no differences between male and female-run SMEs in the probability to introduce product and organizational innovations, and that these two types of innovations are also positively associated with SME performance. Thus, our study provides empirical evidence that gender matters primarily in the fact that female entrepreneurs differ with respect to the type of innovation they tend to introduce, which in turns has an impact on the different business performance dimensions.

The main contributions of this study are as follows. First, despite the increasing academic and practical interest in gender and entrepreneurial issues, the question of how the gender of the entrepreneur may affect SMEs performance has not been sufficiently addressed. We extend existing empirical literature in the gender research field by using a quantitative and multi-dimensional approach that allows us to analyse the role of entrepreneur gender in the innovation-performance relationship, using a large sample of Spanish SMEs. Second, following the mediation approach of Baron and Kenny (1986), we propose and test a parsimonious mediation model to explore whether business innovations mediate in the relationship between entrepreneur' gender and firms' performance. The work of Lee et al. (2016) analyse the mediating role of innovation capabilities (R&D expenditures) on the relationship between gender of owners and export performance for a large sample of Korean new ventures. Recent studies have focused on the impact of gender diversity of board composition on business performance using samples of new ventures (Lee and Marvel, 2014), and large firms (see Cabeza-García et al. 2021, and references therein).² However, no study has undertaken a multi-dimensional research on entrepreneur gender-innovation-performance relationship for SMEs, so that this is the first empirical analysis on the mediating role of innovations on the relationship between entrepreneurial gender and business performance.

The article is organized as follows. The next section reviews the main literature on entrepreneur gender and innovation-performance relationship, and establishes our main research hypotheses. Data and descriptive statistics are presented in Section 3. Section 4 describes the empirical methodology and reports the estimation results. Finally, Section 5 presents the discussion of results and concluding remarks.

2. Related literature and hypotheses

We use insights from different strands of literature related to the resource-based view (RBV) of the firm, together with feminist theories and gendered institutions theory, with

² The work of Lee and Marvel (2014) for a large sample of Korean firms document that firms' assets, industry and location mediate the entrepreneur gender-business performance relationship (measured in terms of sales and exports per employee). The work of Cabeza-García et al (2021) analyse the moderating role of R&D investment on the relationship between gender board diversity and financial performance for a sample of large European firms.

the aim to investigate how the relationship between entrepreneurs' gender and business performance may be mediated by the introduction of innovations within the firm. A recent review on the relationship between entrepreneur gender and business performance can be found in Coleman (2016), who documents that empirical evidence is not conclusive as to whether manager's gender plays a role on business performance, and on which indicators are appropriate for measuring performance. While a number of studies have reported underperformance of women entrepreneurs, as compared to men (Fairlie and Robb, 2009; Ali and Shabir, 2017), other studies have shown that the differences in performance by gender disappear once a number of business characteristics are considered (Du Rietz and Henrekson 2000; Kalleberg and Leicht 1991; Watson, 2002; Johnsen and McMahon 2005; Khalife and Chalouhi, 2013). Nevertheless, the mediating effects of other factors, such as innovative activities of the firm, on the relationship between entrepreneur's gender a firm's performance needs further research (Lee et al., 2016).

According to the RBV (Barney, 1991), firms' performance depends not only on the resources that are available to the firm (e.g., in terms of human capital or financial capital), but also on the individual-specific resources or abilities of their decision-makers to use those resources (Barney, 1991; Wernerfelt, 1984; Alvarez and Busenitz, 2001; Wang et al., 2016). Within this strand of the literature, the role of the entrepreneur's gender has attracted insufficient attention as a factor that may influence the use of resources (including innovation activities) to improve business performance.

In addition, social constructionist and poststructuralist feminist theories postulate that cultural factors and norms, upbringing and social interactions explain disparities among men and women in society (Fischer et al., 1993; Ahl, 2006). Gender is considered to be determined by the societal structure, leading to stereotypes regarding attitudes, abilities and behavioural patterns between men and women, including those related to the development of the businesses' innovations and performance achievements, to women disadvantage (Fischer et al., 1993; Wieland et al., 2019). Further, the theory of gendered institutions (Acker, 1992) states that female entrepreneurs are at disadvantage regarding the access to crucial resources for innovation and business performance, such as financial, human and social capital resources (van Staveren, 2013). According to this theory, female entrepreneurs have access to less diverse informal networks (Estrin and Mickiwicz, 2011; Kelley et al., 2011) and they lack required financial, human, and social capital to

ensure the development of innovation capabilities as compared to their male counterparts (Carter et al., 2007; Orser et al., 2006), what may imply higher constraints for female entrepreneurs to successfully run their businesses and obtain high performance (Bardasi et al. 2011).

Entrepreneur gender and the firm's innovativeness

A growing number of studies, such as Alsos et al. (2013), Marvel et al. (2015), Reutzel et al. (2018) and Arun and Rojers (2021), among others, point out that the innovation profile of a company is affected by the entrepreneur's gender, among other factors. Specifically, some of these studies have documented significant differences between male and female entrepreneurs that could explain different propensities to undertake innovation decisions (Alsos et al., 2013, Arun and Rojers, 2021). In this same line, Weber and Geneste (2014) documented that female entrepreneurs were less concerned with the development and implementation of innovations in their firms and with the achievement of high financial performance due to the associated risks and the resources needed for innovation. As reported by Pelger (2012), female entrepreneurs have different preferences and therefore different goals as compared to male entrepreneurs, and these differences are significant in explaining the lower interest in innovation. Also, according to Cliff (1998), female entrepreneurs also show a preference for businesses of a smaller size in order to be able to maintain the company's control, to devote a proper amount of time and effort to balance work and family. This helps to explain why female entrepreneurs will be less likely to pursue riskier high-growth business strategies. In a recent study on the strategies adopted by Italian entrepreneurs to face the economic crisis, Buratti et al (2017) have acknowledged that, compared to male entrepreneurs, females had a lower propensity towards offensive strategies (such as innovation, development or growth), and a higher propensity to adopt a defensive approach (restructuring and resizing strategies). The work of Foss et al. (2013) argues that though female and male entrepreneurs are equal in generating new ideas and innovation, those coming from women would be less implemented in the firm.

Some explanations have been discussed in the literature to shed some light on the entrepreneur's gender gap regarding the innovation profile of the firm. One of these plausible explanations would be ascribed to the stereotyping masculine versus feminine

categories from the functioning of informal gendered institutions, as firstly argued by Agarwal (1997). In addition, the gender difference in the entrepreneur's education background may also explain these uneven innovative propensities between male- and female entrepreneurs (Brush, 1992; Walters and McNeely, 2010). Further, female entrepreneurs would also face limitations to the access to crucial financial resource and to the advantages provided by extensive business networks (Estrin and Mickwicz, 2011; Kelley et al. 2011). Audretsch et al. (2020) highlight that access to financial resources and the institutional environment are crucial factors to spur innovation activities in women-led businesses.

Despite the increasing literature on this subject, existing knowledge on whether there is a gender gap in SMEs' innovativeness is still inconclusive (Alsos et al. 2013; Buratti et al. 2017; Link 2017; Elam et al. 2019). Regarding the types of innovation, the potential impact of entrepreneur's gender has recently been analysed for both technological innovations, like product innovation (Pablo-Martí et al., 2014; Protogerou et al., 2017) and process innovations (Faems and Subramanian, 2013; Fernández, 2015), and non-technological innovations like organizational innovations (Heyden et al., 2018; Lyngsie and Foss, 2017). Nevertheless, few studies have analysed both types of innovation simultaneously in a multi-sector sample of firms. A majority of studies have focused on technological innovations, such as product and process innovations, in high-technology and manufacturing sectors, since they are considered to represent fields where innovation occurs, thus ignoring innovation in services and other female-oriented sectors (Nählinger et al. 2012; Pettersson and Lindberg 2013; Alsos et al. 2013). The work of Expósito et al. (2021), which simultaneously includes both technological and non-technological innovation types, as well as all business sectors, does not find significant differences in the propensity of male- and female- led businesses to introduce innovations of new products and new forms of organization in the firm, after controlling for a wide number of personal attributes and business characteristics. However, it is observed a significantly higher propensity of male managers to introduce process innovations, as compared to their female counterparts. In summary, a number of studies have documented the existence of significant differences between women and men entrepreneurs in terms of the firm's innovativeness. Based on this argument, the following hypothesis is presented:

Hypothesis 1. SMEs managed by female entrepreneurs show a lower innovativeness than those managed by males.

This hypothesis will be tested for the three types of innovation considered (product, process and organizational innovations).

Innovativeness and business performance

Innovativeness of the firm constitutes an extremely important factor to explain business competitive advantages and performance. Literature in this field is extensive, both in developed and developing economies (Hashi and Stojčić 2013; Love and Roper 2015; Lichtenthaler 2016; Buratti et al. 2017; Ramadani et al. 2017; Reçica et al. 2019; and Mahmutaj and Krasniqi 2020; among others). Firms' innovativeness may help to enjoy first-mover advantages in the markets, enhancing business performance on different indicators, such as sales, costs and profitability. By implementing innovations, firms may achieve enhanced production efficiency through reducing operational costs, technological upgrading and greater economies of scale by augmenting production capacity (Lee et al, 2016). Additionally, greater innovativeness may help SMEs to diversify the portfolio of products and services (product innovation), as well as to increase their quality, leading to the development of differentiation strategies in the markets and better business performance.

Focusing on the financial dimension of business performance, several studies found evidence on the positive impact of innovation in SMEs on financial indicators, such as sales and production costs, thanks to an increase in labour productivity and business efficiency (Añón-Higón et al., 2015; Foreman-Peck, 2013; Máñez et al. 2013). Regarding the type of innovation implemented by the firm, some studies show that product and process innovations exert a positive impact on reducing production costs (Hall et al., 2009) and on increasing financial turnover in SMEs (Foreman-Peck, 2013). Studies such as Añón-Higón et al. (2015) and Hervás-Oliver et al. (2014) confirm these findings in the case of Spanish SMEs. The study of Hervás-Oliver et al. (2014) also finds a positive impact of organizational innovation on the SMEs' financial performance. Conversely, other studies do not confirm these positive impacts. In fact, Freel and Robson (2004) and

Hall (2011) argue that product and process innovations might negatively impact sales growth and productivity in SMEs, as shown by empirical evidence in the case of Scotland (UK). These results are also confirmed by the study of Jaumendreu and Mairesse (2016) that shows evidence on the cost increase provoked by product innovation. Finally, in the case of organization innovation, and though the literature on this type of innovation is scander, its impact on sales increase would be positive, as argued by Lin and Chen (2007) and Expósito and Sanchis-Llopis (2020).

The literature investigating the impacts of innovation on the operational dimension of SMEs' business performance is scarcer since most of studies have usually focused on performance financial indicators, such as sales growth, productivity, turnover, costs, etc. In this study, we consider two indicators regarding the operational dimension of business performance, that is quality enhancement of products/services provided by the firm and increase in the firm's productive capacity. Among the few studies regarding the impact of innovation on quality enhancement, the following should be highlighted. The study of Prajogo et al. (2013) asserts that improvement of quality features in products and services provided by the firm is significantly determined by the innovation profile of the firm. In a similar line, López-Mielgo et al. (2009) and Saunila (2016) argue that continuous improvement of product quality requires strong innovation capabilities of the firm. Along these lines, studies such as Scarbrough et al. (2015) and Prajogo et al. (2013) discuss that process and organisational innovations foster the introduction of new forms of management that generally lead to quality improvements in goods and services provided by the firm.

The analysis of the impact of innovation on production growth has traditionally focused on financial indicators, such as sales growth. Nevertheless, sales do not necessarily reflect an operational transformation of the firm in terms of, for example, higher number of employees and/or greater productive capacity. Though growth in terms of employment generation has attracted some attention in the existing literature on innovation (see, for example, Harrison et al., 2014; Triguero et al., 2014), the plausible impact of innovation on augmenting the productive capacity of the firm (and thus, increasing its employment and investment levels) has only recently received some attention (Expósito and Sanchis-Llopis, 2018). Our study follows the work of Expósito and Sanchis-Llopis (2018) by considering a multidimensional analytical framework with

multiple types of innovations and business performance measurements (financial and operational). Thus, the following hypothesis is presented:

Hypothesis 2. Business innovativeness asserts a positive effect on financial and operational business performance.

This hypothesis will be tested for the three types of innovation considered (product, process and organizational innovations) and the four performance indicators, that is sales increase and cost reduction (financial dimension), and increase of productive capacity and quality enhancement of product and/or services (operational dimension).

Indirect impact of entrepreneur gender on business performance.

As previously remarked, empirical studies about the impact of entrepreneur gender on business performance are extensive, though showing inconclusive results (Coleman, 2016). Further, most of these studies have generally focused on the financial dimension of business performance, basically using indicators related to sales growth, profitability and survival rates (Johnsen and McMahon, 2005; Khalife and Chalouhi, 2013; Coleman, 2016). Following the mediation framework by Baron and Kenny (1986), the previous hypotheses posit that entrepreneur gender directly affects the innovativeness of the firm, as measured by the capability of implementing product, process and/or organizational innovations, which, in turn, also directly affect business performance in its two dimensions, financial and operational. As a result, entrepreneur's gender may indirectly affect business performance through the innovativeness of the firm. According to the RBV of firms (Barney, 1991), the possession of certain resources and capabilities by the firm, such as capability to implement innovations, are crucial to improve business performance. Additionally, this theory also argues that personal features of the entrepreneur, such as gender, should be considered since they might determine the firm's capabilities (Alvarez and Busenitz, 2001; Wang et al., 2016). In this regard, the theory of gendered institutions (Acker 1992) states that female entrepreneurs are at disadvantage compared to males regarding the access to those unique resources (e.g., financial, human and social capital resources) that are needed to successfully develop innovations, so that they may be less able to succeed in terms of achieving certain performance goals (Lee et

al., 2016). In this regard, and as suggested by the theory of gendered institutions, there might be an underlying mediating relationship between entrepreneur gender and business performance of the firm. With this theoretical framework in mind, we aim to test following hypothesis:

Hypothesis 3. The relationship between entrepreneur gender and business performance is mediated by firm' innovativeness.

Similarly to previous hypotheses, firms' innovativeness will be measured by the capability of the firm to implement product, process and/or organization innovations, whereas business performance takes into account the two dimensions, financial (that is, sales increase and costs reduction) and operational (that is, increase of productive capacity and improvement in the quality of goods and services).

Figure 1 represents our theoretical framework and hypotheses to be tested.

[Insert Figure 1 around here]

3. Data, variables and descriptive statistics.

The data we analysed come from a survey on a sample of Spanish SMEs, undertaken in 2012 and designed to include only firms with less than 250 employees and annual sales below €50 million, with the exception of self-employed entrepreneurs without employees. Although the data is from 2012, we must note that the composition of Spanish SMEs, both in terms of sectors and innovativeness orientation, has not changed significantly in the last years. This survey was financed by the Spanish Ministry of Economy, Industry and Competitiveness, together with several Spanish regional governmental agencies, and was conducted across six Spanish regions, representing the southern, central and northern regions of the country: Andalusia, Extremadura, Madrid, Murcia, Navarre and the Basque Country.³

³ The sampling procedure was designed to represent the regional structure of Spain following the stratified sampling principles corresponding to finite populations. The population of SMEs was segmented by size, sector and location to ensure wide coverage, and the number of businesses in each stratus was calculated in relation to the information provided by the Central Directory of Firms, which is collected by the Spanish National Statistics Institute. The stratified sample was representative of the population of SMEs in all the regions included in the survey, and no bias was revealed between respondents and non-respondents.

The dataset is composed of a total of 1,424 SMEs. Out of these, we consider only those businesses that have overcome the difficulties associated with the start-up stage, that is, SMEs that have been operating in the market for at least three years. Hence, our final sample includes 1,376 SMEs, out of which 969 businesses (70,42%) are run by a male entrepreneur, and 407 businesses (29,58%) are run by a female entrepreneur.

The survey was designed to include questions on the innovative activities of businesses and on the impact of innovations on several dimensions of business performance. The questionnaire also included information on a number of personal traits of the entrepreneur, and on characteristics and strategies of the business. The survey was addressed to the person holding the role of entrepreneur, defined as the person performing the main managerial functions within the business. It is interesting to note here that there is empirical evidence documenting that entrepreneurs undertake the most important decisions within their businesses, including innovation strategies (Van Gills, 2005; Alegrem et al., 2011; Donate and Sánchez de Pablo, 2015). In addition, several studies indicate that self-reported information by entrepreneurs may be considered as an appropriate approach to analyse business strategies and performance (Foreman-Peck, 2013; Goya et al. 2016; Madrid-Guijarro et al., 2013; Ribau et al. 2017).

To measure business performance, we use information provided by the entrepreneurs on whether they consider that innovations introduced in the previous three years have had a considerable impact on business performance, distinguishing between financial performance (cost reduction and increase in sales) and operational performance (improvement in the quality of products/services and increase in production capacity). Regarding innovation, the survey provides information on three types: product, process and organizational innovations. These innovations are defined in the survey as new or significantly improved innovations that have been introduced during the last three years. From this information, we construct three binary variables indicating whether or not each innovation type has been introduced in the business.

In our analysis, the key independent variable of interest is entrepreneurial gender. The survey provides information on the gender of the major decision-maker of the SME, or entrepreneur, who is the person in charge of answering the questionnaire. From this information we construct a dummy variable taking value of one when the entrepreneur is male, and value zero when the entrepreneur is female.

In our empirical analysis we also consider a number of control variables that may have explanatory relevance for our analysis and that we introduce as follows. These control variables are grouped into three categories: entrepreneurial traits, business characteristics and strategies, and determinants of the business environment. As regards entrepreneurial traits, apart from gender, we consider risk tolerance, self-confidence, age and level of education. These variables have been proven to play a role in explaining SME performance (Entrialgo 2002; Saunila 2016; Koryak et al. 2015; Kraus et al. 2012; Martínez-Roman and Romero 2017). The second group of control variables are businesses characteristics and strategies. We consider first business size and age, which have been extensively analysed in the literature as determinants of SMEs performance (Goya et al. 2016; Hall et al. 2009; Rosenbusch et al. 2011). We also control for business strategies, such as involvement in collaborative R&D activities, which includes networks and alliances with other businesses and with public institutions. These collaborative strategies are aimed at sharing the risk associated with innovation and may have a positive impact on performance (Vásquez-Urriago et al. 2016; Greco et al. 2015; Vahter et al. 2013). We also include a variable capturing whether the firm participates in business sectoral trade fairs, which may be considered as an initiative to promote both collaboration and firms' products/services. Last, we also include whether the SME participates in exporting and importing activities, which may be positively associated with better business performance (Love and Roper 2015; Oura et al. 2016). Finally, we control for the business environment where the SME operates. In particular, we rely on regional and industry dummies to capture differences in the levels of technology between sectors, and in the level business regulations and policies among regions.

Table 1 presents the descriptive statistics for our sample of SMEs, including the mean and standard deviation of all variables used in our empirical analysis, and distinguishing between those businesses run by a male entrepreneur (70,42%) and those run by a female entrepreneur (29,58%). As regards to business performance measures, we observe that SMEs run by male entrepreneurs are more likely to report cost reductions (46.13%), as compared to SMEs run by female counterparts (40.29%), being this difference statistically significant. In addition, the other three measures of performance are also higher for businesses run by male entrepreneurs than for businesses run by women, although the differences are not statistically significant. Regarding innovations, we observe that male entrepreneurs are more likely to introduce process innovations

(30,44%), as compared to female counterparts (22,35%), and this difference is statistically significant. We also observe that product innovations are the type of innovation more common to be introduced by both male and female entrepreneur (54.59% and 56.02%, respectively), followed by organizational innovations, which are introduced by 32.50% and 32.43 % of male and female entrepreneurs, respectively. Turning to entrepreneurial traits, we also observe that there are statistically significant differences between male and female entrepreneurs regarding age and education: male entrepreneurs are 48 years old, on average, whereas this figure is 44 for female entrepreneurs; a higher proportion of male entrepreneurs have only primary education, and a higher proportion of female entrepreneurs hold tertiary education. Finally, regarding significant differences in business characteristics, SMEs run by female entrepreneurs are on average smaller, younger, and belong to the services sector in a higher proportion, whereas SMEs run by male entrepreneurs show a higher participation in business trade fairs and in importing activities.

[Insert Table 1 around here]

Table 2 reports the Pearson correlation matrix to test for multicollinearity. As it can be inspected, all correlations between the pairs of variables are low and not significant. None of the correlation coefficients is higher than 0.8, so that we are confident that our empirical approach is free of multicollinearity concerns. In addition, Table 2 also provides information regarding the Variance Inflation Factor (VIF) test, indicating that the results are not biased due to multicollinearity since all the values are around or lower than 2.

[Insert Table 2 around here]

4. Model specification and results

4.1. Model specification.

In order to test Hypothesis 1, we jointly analyse the three types of innovation decisions (introducing new products into the market, new processes of production and organizational innovations), as we explore the possibility that the CEO of the firm may

consider simultaneously the different types of innovations. In order to do so, we use econometric techniques based on a multivariate *probit* specification that allows simultaneous innovation decisions by the CEO. In particular, a *trivariate probit* model is implemented, thus allowing for an estimation of the joint probability to introduce these three types of innovations studied in our analysis. More formally, we estimate the following *trivariate* discrete choice model for the three types of innovations:

$$\begin{aligned} Product_i &= \begin{cases} 1 & \text{if } \beta_0^{prod} + \beta_1^{prod} X_{1i}^{prod} + \beta_2^{prod} X_{2i}^{prod} + \varepsilon_i^{prod} \\ 0 & \text{otherwise} \end{cases} \\ Process_i &= \begin{cases} 1 & \text{if } \beta_0^{proc} + \beta_1^{proc} X_{1i}^{proc} + \beta_2^{proc} X_{2i}^{proc} + \varepsilon_i^{proc} \\ 0 & \text{otherwise} \end{cases} \\ Organizational_i &= \begin{cases} 1 & \text{if } \beta_0^{org} + \beta_1^{org} X_{1i}^{org} + \beta_2^{org} X_{2i}^{org} + \varepsilon_i^{org} \\ 0 & \text{otherwise} \end{cases} \end{aligned} \quad (1)$$

where i refers to the SME; the three dependent variables are binary variables taking value one when the business CEO reports to have introduced product, process and organizational innovations, respectively, during the last three years, and zero otherwise; X_{1i} is a vector of personal traits that includes the gender of the CEO and other managerial attributes (risk-tolerance, self-confidence, age and education); X_{2i} is a vector of business characteristics that may have an effect on the decision to innovate, including size, age, R&D cooperation with other business or institutions, participation in business exhibitions, R&D spending, industry and region; and, finally, ε_i is an error term.

The multivariate *probit* specification allows for systematic correlations between the choices of the different types of innovation.⁴ These correlations may emerge from complementarities or substitutabilities between the three forms of innovation. The existence of significant correlations would indicate that estimating separate *probit* specifications for each of the three innovation decisions would be inefficient and also the convenience to analyse the three innovation decisions jointly. This specification is estimated using the simulated maximum-likelihood three-equation *probit* model using the Geweke-Hajivassiliou-Keane (GHK) smooth recursive simulator to compute the maximum likelihood.

⁴ It is worth noting that the specified models do not impose that the three decisions are necessarily interrelated, but allows all possible combinations in the sense that some firms' implement different innovation decisions.

To test Hypotheses 2, we estimate bivariate *probit* models for the two financial performance measures, on the one hand, and for the two operational business performance measures, on the other hand. It is sensible to assume that implementing product, process, and organisational innovations might have an impact on the firm's sales and/or on its costs. Likewise, for the case of the operational performance measures, innovation might have an effect on the productive capacity of the firm and/or on the improvement in quality. We therefore acknowledge the existence of a potential correlation between each of the two financial performance measures (sales increase and costs reduction) and between the two operational performance measures (increase of productive capacity and improvement in quality). Thus, the model to be estimated for the two financial performance measures we have is as follows,

$$\begin{aligned} Sales\ increase_i &= \begin{cases} 1 & \text{if } \beta_0^s + \beta_1^s prod_i + \beta_2^s proc_i + \beta_3^s org_i + \beta_4^s X_{1i} + \beta_5^s X_{2i} + \varepsilon_i^s \\ 0 & \text{otherwise} \end{cases} \\ Costs\ reduction_i &= \begin{cases} 1 & \text{if } \beta_0^c + \beta_1^c prod_i + \beta_2^c proc_i + \beta_3^c org_i + \beta_4^c X_{1i} + \beta_5^c X_{2i} + \varepsilon_i^c \\ 0 & \text{otherwise} \end{cases} \end{aligned} \quad (2)$$

where subscripts *s* and *c* in the right-hand side stand for sales increase and cost reduction, respectively. The two dependent variables are *sales increase* and *costs reduction*, corresponding to two binary variables taking value one when the firm states sales increase and costs reduction, respectively, and value zero otherwise. The variables *prod*, *proc*, and *org* are binary variables indicating whether firm *i* has introduced product innovations, process innovations, and organisational innovations, in the previous three years, respectively. In each specification, we also introduce two set of control variables capturing entrepreneur traits, X_{1i} , and business characteristics and strategies, X_{2i} ; finally, ε_i is an error term.

Similarly, the bivariate *probit* specification model for the two operational performance measures is,

$$\begin{aligned} Capacity\ increase_i &= \begin{cases} 1 & \text{if } \beta_0^{ca} + \beta_1^{ca} prod_i + \beta_2^{ca} proc_i + \beta_3^{ca} org_i + \beta_4^{ca} X_{1i} + \beta_5^{ca} X_{2i} + \varepsilon_i^{ca} \\ 0 & \text{otherwise} \end{cases} \\ Quality\ improvemet_i &= \begin{cases} 1 & \text{if } \beta_0^q + \beta_1^q prod_i + \beta_2^q proc_i + \beta_3^q org_i + \beta_4^q X_{1i} + \beta_5^q X_{2i} + \varepsilon_i^q \\ 0 & \text{otherwise} \end{cases} \end{aligned} \quad (3)$$

where subscripts *ca* and *q* in the right-hand side stand for capacity increase and quality improvement, respectively. The two dependent variables are *capacity increase* and

quality improvement, corresponding to two binary variables taking value one when the firm states an increase in capacity and an improvement in the quality of its products, respectively, and value zero otherwise. The variables *prod*, *proc* and *org* are binary variables indicating whether firm *i* has introduced product innovations, process innovations, and organisational innovations, in the previous three years, respectively. In each specification, we also introduce two sets of control variables capturing entrepreneur traits, X_{1i} ; and business characteristics and strategies, X_{2i} ; finally, ε_i is an error term.

4.2. Estimation results.

In this section we present our estimation results. Following our conceptual approach, we test whether the gender of the decision-maker has an indirect effect on performance through the introduction of innovations. In particular, we test whether innovations (product, process and organizational innovations) mediate between entrepreneurial gender and business (financial and operational) performance. We follow the approach of Baron and Kenny (1986) for mediation, a method that has been widely used in previous studies. According to this approach, four conditions need to be satisfied for mediation effects to exist between the gender of the entrepreneur and business performance, as follows. First, the entrepreneur gender should have a significant influence on the mediators, i.e., product, process and organizational innovations. Second, the mediators should show significant effects on business performance. Third, the gender of entrepreneur will significantly affect performance. And fourth, when including both the gender of the entrepreneur and the mediators in the same regression, the effect of gender on performance should become insignificant (i.e., full mediation) or the size of its coefficient should be reduced (i.e., partial mediation), compared to those estimated without the mediators. When empirical results satisfy these four conditions, they support mediation effects, through the introduction of innovations, between the gender of the entrepreneur and SMEs performance.

The first condition for mediation to hold is that the gender of entrepreneur must have a direct impact on (product, process and organizational) innovations, and this condition corresponds to testing Hypothesis 1, stating that SMEs run by male entrepreneurs show a higher likelihood of introducing innovations, as compared to females. To test for Hypothesis 1 we use a *trivariate probit* model where we estimate the

joint probabilities of introducing product, process and organizational innovations, as given by equation (2).

[Insert Table 3 around here]

In Table 3 we present the results of the *trivariate probit* model for the joint decision to introduce the three types of innovations: introducing new products into the market, new processes of production, and organizational innovations.⁵ The coefficients for the covariates estimated differ sensibly across the three equations, indicating the existence of heterogeneity in the three innovations decisions. These results are in line with the works of Carboni and Russu (2018) and Doran (2012), who found complementarities among product, process and organisational innovations for a sample of European firms and Irish firms' data, respectively.

Results in Table 3 show that gender is positive and statistically significant for the decision to introduce process innovations, but non-significant for the decision to either introduce product or organizational innovations. Hence, we obtain that SMEs run by male decision-makers are more prone to introduce process innovations as compared to businesses run by females. In addition, we obtain that entrepreneurial gender does not influence the likelihood of introducing product and organizational innovations, so that male and female entrepreneurs are equally likely to introduce these two types of innovations. Hence these results support Hypothesis 1 only regarding process innovations, so that the first condition for mediation only holds for process innovations. These results reinforce previous findings reporting that male entrepreneurs are more prone to introduce process innovations (Expósito et al. 2021).

From a feminist theoretical perspective, this finding is in line with social and constructionist feminist theories, stating that gender is a socialization concept influencing managerial behaviour, so that gender differences in process innovations would remain after controlling for differences in managerial and business attributes. These findings are only partially in line with those of Na and Shin (2019) for a cross-country data of emerging countries, who show that female top managers are not significantly more likely

⁵ The correlation coefficients among the three innovation decisions, reported at the bottom of Table 3 are positive and statistically significant, indicating that it is appropriate to jointly analyse the three decisions.

to introduce either product, process nor organizational innovations. Further, our results are in contrast to the higher propensity of female managers to introduce product innovations found by Dohse et al. (2019) for a large sample of developing countries.

The rest of the managerial traits show different impacts on the propensity to introduce the three types of innovations by the firm. Having a high tolerance to undertake risky projects positively and significantly affects the probability to introduce product and organizational innovations, whereas having a high self confidence in managerial skills increases the probability to introduce technological product innovations. The age of the entrepreneur is negatively and significantly associated with the propensity to introduce the three types of innovations. Having secondary and tertiary education increases the probability to introduce organisational innovations, but it does not affect the probability to introduce product or organisational innovations. Regarding business characteristics, being a small SME (a firm with 10-50 employees), as compared to be a microbusiness (the benchmark) is positively associated with innovativeness. R&D cooperation and participation in businesses exhibitions positively affect the introduction of both product and process innovations. Finally, regarding business spending in R&D, results confirm the strong, positive and significant impact on introducing innovations of any type.

We now turn to the analysis of the second condition that needs to hold for mediation, according to Baron and Kenny (1986), that is, whether there is a direct impact of innovations on (financial and operational) performance. This second condition corresponds to testing for Hypothesis 2, stating that the introduction of innovations is positively related to financial and operational business performance. Table 4 reports the bivariate *probit* estimates for financial and operational performance given by the equation (3) above.

[Insert Table 4 around here]

Estimating results of Table 4 show the direct impact of the three types of innovations on both financial and operational performance. Columns (1) and (2) present the bivariate *probit* estimates of the two indicators of financial performance, namely, cost reduction and sales increase, which are jointly estimated to allow for potential correlation between them. In addition, Columns (3) and (4) report the bivariate *probit* estimates of the two indicators of operational performance, namely, quality improvement and capacity

increase, which are also jointly estimated to allow for potential correlation between them. The tests for these correlations are reported at the bottom of Table 4, and in both cases, we reject the null hypothesis of no correlation between the two indicators, which reveals that both indicators within each performance dimension are correlated, and hence, that their joint estimation is appropriate.

Regarding business financial performance (columns 1 and 2), results show that both introducing process and organizational innovations during the last three years is positively and significantly associated with cost reduction, and that product and organizational innovations introduced during the previous three years are positively related to sales increase. As for the impact of innovations on operational performance (columns 3 and 4), our results indicate that the three types of innovations introduced by the firm during the previous three years are positively and significantly associated with both quality improvement and capacity increase. Therefore, these findings provide empirical support to our Hypothesis 2, and indicate that the second condition for the mediation to hold is satisfied, that is, the mediators (product, process and organizational innovations) show a significant effect of business performance.

The rest of covariates in Table 4 indicate that managerial traits, such as risk-tolerance and self-confidence are positively associated with both financial and operational business performance, whereas the age of the entrepreneur shows a negative impact on both dimensions of performance. Regarding business characteristics, being a small business is positively associated with cost reduction, whereas medium businesses are positively linked to capacity increase. R&D cooperation with other businesses is positively related to cost reduction, quality improvement and capacity increase, and R&D cooperation with public institutions is related to sales increase. Finally, being an exporting firm is also positively associated with both financial and operational performance.

The third and fourth condition of Baron and Kenny (1986) for mediation to hold corresponds to testing Hypothesis 3, stating that the relationship between entrepreneurial gender and business performance is mediated by the introduction of innovations. Tables 5 and 6 present the *bivariate probit* estimating results for financial and operational business performance, respectively, considering the role of entrepreneurial gender.

[Insert Table 5 around here]

Previously to discussing the results, we would like to stress that in both Tables 5 and 6 we report the correlation tests between the two indicators: the correlation between the increase of sales and costs reduction, for financial performance in Table 5; and the correlation between the augmentation of productive capacity and the improvement in quality, for operational performance in Table 6. In all cases we reject the null hypothesis of no correlation, indicating that both indicators in each performance measure are correlated and therefore that joint estimations are appropriate (see the results for this test at the bottom of each table).

Table 5 reports the results regarding financial performance. Columns (1) and (2) show the impact of gender on the two indicators of financial performance, namely, cost reduction and sales increase. Results show that gender positively affects cost reduction but has no impact on sales increase. Hence, the third condition for mediation holds only for cost reduction: the gender of the entrepreneur positively and significantly affects cost reduction. Columns (3) and (4) of Table 5 include both the gender of the entrepreneur and the three types of innovations (the mediators). Regarding the impact of gender, we observe that the size of its coefficient for cost reduction is reduced, compared to the estimation without the mediators, indicating that the fourth condition for mediation holds, so that a partial mediation effect for process innovation is found. Hence, regarding financial performance, our empirical results satisfy the four conditions for mediation in the case of process innovations, that is, our results show that the introduction of process innovations partially mediate the relationship between entrepreneurial gender and business cost reduction (the coefficient of gender is reduced). The impact of the rest of covariates in Table 5 regarding entrepreneurial and business traits on the two indicators of financial performance is similar to those reported in columns (1) and (2) of Table 4.

[Insert Table 6 around here]

Table 6 presents the results of the bivariate *probit* estimates for operational performance. Columns (1) and (2) show the impact of gender on the two indicators of operational performance, namely, quality improvement and capacity increase. Results show that gender positively affects both indicators of operational performance. Hence,

the third condition for mediation holds. Columns (3) and (4) of Table 6 include both the gender of the entrepreneur and the three types of innovations (the mediators). Regarding the impact of gender, we observe that the size of its coefficient for quality improvement is reduced, and that the coefficient for capacity increase becomes insignificant, compared to the estimation without the mediators, indicating that the fourth condition for mediation holds. Hence, our results show that a partial mediation effect for the introduction of process innovation is found in the case of quality improvement, and a full mediation effect in the case of capacity increase. Therefore, regarding operational performance, our empirical results also satisfy the four conditions for mediation in the case of process innovations, that is, our results show that the introduction of process innovations partially mediate the relationship between entrepreneurial gender and business quality improvement (the size of the coefficient of gender is reduced, although it is still significant), and fully mediate the relationship between entrepreneurial gender and capacity increase (the coefficient of gender becomes insignificant). The influence of the rest of covariates in Table 6 regarding entrepreneurial traits and business characteristics on the two indicators of operational performance is similar to those reported in columns (3) and (4) of Table 4.

Results in Table 5 and 6 confirm that the impact of innovativeness on business performance should be analysed from a multi-dimensional approach, as also suggested by other authors, such as Expósito and Sanchis-Llopis (2018), Damanpour et al. (1989), Edwards et al. (2005), and Wolff and Pett (2006).

Finally, we perform several additional analyses to illustrate that the results presented are robust to alternative sample selection of SMEs, and to the inclusion of other control variables. First, our results are also robust to an alternative sample selection of SMEs. We undertake our empirical analysis including in the sample not only those firms active in the market for at least three years (i.e., established SMEs) but also nascent SMEs. These new-born businesses have to overcome the problems related to the setup stage, which may be harder for female entrepreneurs, as already acknowledged in the literature (Koellinger et al., 2013). When using this broader sample of SMEs, we obtain similar results, so that our empirical results are robust to also including nascent SMEs. Second, the robustness of our results has been also tested by introducing a number of other controls in the estimated models. The inclusion of other characteristics of the business, such as a dummy variable capturing the ownership structure of the SME as a

limited liability company and a dummy variable controlling for being part of a group rendered non-significant coefficients, thus not altering the estimated results.

5. Discussion and conclusions.

In this study we extend existing empirical literature in the entrepreneur and gender research fields by analysing the role of the gender of the entrepreneur on business performance, considering the mediating effect of innovations. In particular, we explore the possibility that gender indirectly influences business performance through the introduction of innovations, using quantitative analysis methods and a sample of 1,376 Spanish small and medium enterprises (SMEs). Our approach is multi-dimensional in that we consider two types of performance indicators, financial and operational, and three types of innovations: product, process and organisational innovations.

Our empirical findings show that, after controlling for other entrepreneurial and business characteristics, SMEs run by male entrepreneurs are more likely to obtain better performance from their innovations. We obtain that SMEs led by male entrepreneurs are more likely to introduce process innovations, as compared to SMEs run by females, and that process innovations are positively related to financial and operational performance. Hence, our findings show that SMEs run by male entrepreneurs achieve better performance through process innovations. In particular, we obtain that process innovation partially mediates the relationship between the gender of the entrepreneur and costs reduction, and also between gender and quality improvement. Furthermore, process innovation plays a total mediation role in the relationship between the entrepreneur' gender and SMEs production capacity increase.

The higher propensity of male entrepreneurs, as compared to females, to implement process innovations may be associated with at least two factors (Expósito et al. 2021). First, there is exist an education bias in that male students tend to choose fields of study more technically oriented, and thus more likely to provide them the technical know-how and skills to introduce process innovations (Busolt and Kugele 2009; Strohmeyer and Tonoyan 2005; Walters and McNeely 2010). Female students traditionally focus on non-technical fields, so that they are at disadvantage regarding technological innovations as compared to their male counterparts (Link 2017; Link and Link 1999). Secondly, there is a gender-specific sectoral or occupational segregation

whereby female entrepreneurs are oriented towards traditional sectors and services instead of technologically oriented sectors, and process innovations are less often implemented in those female-oriented sectors/occupations (Anna et al. 1999, Strohmeier and Tonoyan 2005; Carrasco 2014). Regrettably, our data do not allow us to explore the importance of these two factors, so that this issue opens a path for further research.

Although some of our results reinforce previous findings reporting that male entrepreneurs are more prone to introduce process innovations (Expósito et al. 2021), the relevant question, however, is whether this greater propensity to introduce process innovations pays off in terms of higher business performance. At the end, the important issue is not whether male-run SMEs are more innovative than female-run ones, but instead, whether they are able to obtain superior performance from their innovations. Our results indicate that male entrepreneurs obtain superior performance from their process innovations. Hence, our results indicate that the entrepreneur gender matters: male entrepreneurs are able to obtain superior performance from their innovations. Our findings therefore contribute to a better understanding on the role played by the entrepreneur gender on the innovation-performance relationship of SMEs, and suggest the need to incorporate a gender perspective in those policies dealing with enhancing SMEs innovativeness and performance. In particular, public policy should deal with the design of more effective policy instruments to promote innovativeness, particularly process innovations by female entrepreneurs as a way to increase their business performance, and also with establishing mechanisms to reduce gender segregation in education and in the job market. Finally, a major implication of our study is that future research is needed to investigate those factors explaining why female entrepreneurs are less prone to introduce process innovations as compared to their male counterparts.

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Table 1. Means and standard deviations for all variables.

	Male		Female		Difference
	Mean	s.d.	Mean	s.d.	
<i>Business performance</i>					
<i>Cost reduction</i>	0.461	0.498	0.403	0.491	0.058**
<i>Sales increase</i>	0.551	0.497	0.538	0.497	0.013
<i>Quality improvement</i>	0.801	0.399	0.764	0.425	0.037
<i>Capacity increase</i>	0.594	0.491	0.570	0.495	0.024
<i>Innovation type</i>					
<i>Product innovation</i>	0.546	0.498	0.560	0.496	0.014
<i>Process innovation</i>	0.304	0.460	0.224	0.417	0.081***
<i>Organizational innovation</i>	0.325	0.468	0.324	0.468	0.001
<i>Entrepreneurial traits</i>					
<i>High risk-tolerance</i>	0.119	0.323	0.101	0.301	0.018
<i>High self-confidence</i>	0.405	0.491	0.410	0.492	0.006
<i>Age of the entrepreneur</i>	48.270	9.885	44.567	8.691	3.702***
<i>Primary education</i>	0.140	0.347	0.086	0.280	0.054***
<i>Secondary education</i>	0.195	0.396	0.182	0.386	0.013
<i>Vocational training</i>	0.173	0.378	0.199	0.399	-0.026
<i>Tertiary education</i>	0.480	0.499	0.528	0.499	-0.048*
<i>Business characteristics & strategies</i>					
<i>Micro business (1-9 employees)</i>	0.867	0.339	0.904	0.294	-0.037**
<i>Small business (10-49 employees)</i>	0.115	0.318	0.086	0.280	0.029
<i>Medium business (50-250 employees)</i>	0.019	0.135	0.010	0.098	0.009
<i>Age of Business</i>	19.99	14.470	15.982	11.122	3.007***
<i>Market R&D cooperation</i>	0.244	0.429	0.221	0.415	0.022
<i>Public R&D cooperation</i>	0.156	0.362	0.143	0.349	0.013
<i>Trade fair</i>	0.756	0.429	0.681	0.466	0.076**
<i>R&D spending</i>	0.034	0.098	0.027	0.098	0.007
<i>Export</i>	0.198	0.398	0.179	0.384	-0.019
<i>Import</i>	0.272	0.445	0.221	0.415	0.051**
<i>Business sector</i>					
<i>Manufacturing</i>	0.118	0.322	0.091	0.287	0.027
<i>Real estate and construction</i>	0.158	0.364	0.125	0.331	0.033
<i>Commercial</i>	0.258	0.437	0.265	0.442	-0.007
<i>Services</i>	0.466	0.499	0.518	0.500	-0.052*
<i>Number of obs.</i>	969		407		

Note: ***, ** and * indicate that the difference between male and female mean is significant at the 1%, 5% and 10% levels, respectively.

Table 2. Correlations of main independent variables.

<i>Panel A: Analysis of pairwise Correlation Coefficients</i>																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Gender	1																		
2. Product innov.	-0.01	1																	
3. Process innov.	0.08***	0.24***	1																
4. Org. innov	0.01	0.10***	0.26***	1															
5. High risk-tolerance	0.03	0.07***	0.04	0.07**	1														
6. High self-confidence	-0.01	0.08***	0.04	0.03	0.09***	1													
7. Age of entrepreneur	0.17***	-0.10***	-0.06**	-0.10***	0.01	0.01	1												
8. Secondary education	0.02	-0.02	0.000	0.01	0.01	0.03	0.06**	1											
9. Vocational training	-0.03	0.00	-0.02	-0.06**	-0.03	-0.05	-0.08***	-0.23***	1										
10. Tertiary education	-0.05	0.05**	0.04	0.08***	-0.05	-0.05	-0.09***	-0.48***	-0.47***	1									
11. Small business	0.04	0.07***	0.10***	0.10***	0.00	-0.04	0.04	-0.04	-0.05	0.09***	1								
12. Medium business	0.03	0.05	0.06**	0.05	0.03	0.04	0.03	-0.05	-0.02	0.05	-0.05	1							
13. Age of business	0.10***	-0.01	0.05**	0.05	0.00	-0.04	0.28***	0.03	-0.07**	-0.03	0.16***	0.08***	1						
14. Market R&D coop.	0.03	0.16***	0.24***	0.08***	0.02	-0.04	0.03	-0.03	-0.04	0.09***	0.12***	0.08***	0.03	1					
15. Public R&D coop.	0.02	0.13***	0.18***	0.08***	0.01	-0.02	0.03	-0.05	-0.06**	0.17***	0.10***	0.11***	0.02	0.42***	1				
16. Trade fair	0.08***	0.15***	0.13***	0.03	0.02	0.05	0.05**	0.03	-0.04	0.04	0.04	0.01	0.05	0.08***	0.09***	1			
17. Export	0.02	0.08***	0.12***	0.07**	0.05	0.02	0.02	-0.01	-0.04	0.07**	0.15***	0.06**	0.06**	0.13***	0.12***	0.03	1		
18. Import	0.05**	0.13***	0.07***	0.05	0.03	0.02	0.07	0.03	-0.01	0.02	0.11***	0.02	0.15***	0.10***	0.05	0.16***	0.29***	1	
19. R&D spending	0.03	0.11***	0.16***	0.83***	0.10***	0.06**	-0.02	-0.04	-0.01	0.05*	0.04	0.00	-0.02	0.18***	0.17***	0.06**	0.11***	0.11***	1
<i>Panel B: Multicollinearity Diagnostics using Variance Inflation Factor (VIF)</i>																			
	1.05	1.13	1.21	1.11	1.03	1.03	1.17	2.01	2.01	2.57	1.09	1.03	1.15	1.28	1.27	1.07	1.13	1.15	1.09

Notes:

1. Pearson's correlation matrix.
2. Variance Inflation Factor (VIF).
3. *** Significant at 1%, ** at 5% and * at 10%.

Table 3. Trivariate probit estimates of process, product and organizational innovations.

Dependent Variable	Product innovation	Process innovation	Organizational innovation
<i>Entrepreneurial traits</i>			
Gender	-0.017 (0.078)	0.208** (0.083)	0.012 (0.080)
High risk-tolerance	0.248** (0.113)	0.029 (0.115)	0.218* (0.111)
High self-confidence	0.211*** (0.072)	0.109 (0.076)	0.101 (0.073)
Age of entrepreneur	-0.708*** (0.180)	-0.658*** (0.188)	-0.714*** (0.181)
Secondary education	0.071 (0.126)	0.108 (0.138)	0.260** (0.132)
Vocational training	0.120 (0.129)	0.070 (0.136)	0.001 (0.136)
Tertiary education	0.132 (0.113)	0.039 (0.123)	0.275** (0.118)
<i>Business characteristics & strategies</i>			
Small business	0.218* (0.119)	0.170 (0.121)	0.342*** (0.115)
Medium business	0.317 (0.298)	0.282 (0.300)	0.412 (0.285)
Age of business	-0.016 (0.058)	0.071 (0.061)	0.109* (0.059)
Market R&D cooperation	0.335*** (0.093)	0.523*** (0.092)	0.108 (0.092)
Public R&D cooperation	0.218* (0.112)	0.234** (0.110)	0.113 (0.108)
Trade fair	0.350*** (0.080)	0.335*** (0.089)	0.026 (0.082)
RD spending	1.048** (0.433)	1.290*** (0.389)	0.746** (0.381)
Constant	2.483*** (0.688)	1.551** (0.702)	1.740** (0.692)
N. of observations		1,376	
$\rho_{process_product}$		0.242*** (0.045)	
$\rho_{process_organizational}$		0.334*** (0.049)	
$\rho_{product_organizational}$		0.082* (0.045)	
<i>LR test of $\rho_{12}=\rho_{13}=\rho_{23}=0$:</i>			
<i>Chi²(3)</i>		88.177	
<i>Prob > Chi²</i>		5.396e-19	

Notes:

1. Gender is a dummy variable taking value of 1 when the entrepreneur is male, and value of 0 when the entrepreneur is female.
2. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.
3. Standard errors given in parentheses. Sectoral and regional dummies included in all specifications.

Table 4. Bivariate probit estimates for financial and operational performance.

Dependent Variable	Financial performance:		Operational performance:	
	Costs reduction	Sales increase	Quality improvement	Capacity increase
Product innovations	0.083 (0.0739)	0.357*** (0.074)	0.365*** (0.084)	0.263*** (0.075)
Process innovations	0.166** (0.084)	0.107 (0.087)	0.258** (0.104)	0.302*** (0.088)
Organizational innov.	0.220*** (0.077)	0.146* (0.079)	0.205** (0.092)	0.229*** (0.080)
<i>Entrepreneurial traits</i>				
High risk-tolerance	0.223** (0.109)	0.292*** (0.114)	0.158 (0.137)	0.295** (0.117)
High self-confidence	-0.0338 (0.071)	0.311*** (0.072)	0.248*** (0.083)	0.270*** (0.073)
Age of entrepreneur	-0.062 (0.177)	-0.450** (0.181)	-0.212 (0.205)	-0.554*** (0.185)
Secondary education	0.059 (0.126)	0.015 (0.127)	-0.024 (0.145)	-0.159 (0.129)
Vocational training	0.0583 (0.128)	0.081 (0.129)	-0.096 (0.147)	-0.0445 (0.132)
Tertiary education	0.125 (0.113)	0.097 (0.113)	-0.210 (0.129)	-0.154 (0.116)
<i>Business characteristics and strategies</i>				
Small business	0.240** (0.117)	0.181 (0.122)	-0.0555 (0.137)	0.0557 (0.121)
Medium business	0.451 (0.288)	0.112 (0.295)	0.735 (0.563)	0.959** (0.405)
Age of business	0.035 (0.057)	0.030 (0.058)	0.083 (0.066)	-0.092 (0.058)
Market R&D cooperation	0.244** (0.092)	-0.015 (0.094)	0.192* (0.114)	0.184* (0.097)
Public R&D cooperation	-0.060 (0.109)	0.199* (0.112)	0.193 (0.139)	-0.052 (0.114)
Trade fair	-0.076 (0.081)	0.116 (0.082)	0.155* (0.090)	0.060 (0.083)
Export	0.167* (0.094)	0.165* (0.096)	0.121 (0.112)	0.170* (0.097)
Import	-0.155* (0.088)	0.034 (0.090)	-0.058 (0.104)	-0.061 (0.091)
Constant	-0.118 (0.695)	1.042 (0.706)	-0.0341 (0.696)	1.078 (0.707)
N. of observations	1,376		1,376	
Rho	0.397*** (0.0467)		0.396*** (0.047)	
<i>LR test of $\rho=0$:</i>				
<i>Chi²(2)</i>	72.205		162.197	
<i>Prob > Chi²</i>	0.000		0.000	

Notes:

1. Gender is a dummy variable taking value of 1 when the entrepreneur is male, and value of 0 when the entrepreneur is female.

2. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

3. Standard errors in parentheses. Sectoral and regional dummies included in all specifications.

Table 5. Bivariate probit estimates for financial performance.

	Costs reduction	Sales increase	Costs reduction	Sales increase
Gender	0.154** (0.078)	0.068 (0.078)	0.145* (0.078)	0.0627 (0.079)
Product innovations	-	-	0.085 (0.074)	0.358*** (0.074)
Process innovations	-	-	0.155* (0.085)	0.102 (0.087)
Organisational innov.	-	-	0.222*** (0.077)	0.147* (0.079)
<i>Entrepreneurial traits</i>				
High risk-tolerance	0.251** (0.109)	0.340*** (0.113)	0.223** (0.110)	0.292** (0.114)
High self-confidence	-0.012 (0.071)	0.338*** (0.072)	-0.0314 (0.0714)	0.312*** (0.0723)
Age of entrepreneur	-0.220 (0.176)	-0.612*** (0.179)	-0.109 (0.179)	-0.471*** (0.182)
Secondary education	0.094 (0.125)	0.041 (0.126)	0.0669 (0.126)	0.0183 (0.127)
Vocational training	0.069 (0.128)	0.097 (0.129)	0.0680 (0.128)	0.0852 (0.130)
Tertiary education	0.159 (0.112)	0.130 (0.113)	0.136 (0.113)	0.102 (0.114)
<i>Business characteristics and strategies</i>				
Small business	0.272** (0.117)	0.226* (0.120)	0.236** (0.118)	0.179 (0.122)
Medium business	0.475* (0.286)	0.159 (0.290)	0.436 (0.288)	0.106 (0.295)
Age of business	0.039 (0.057)	0.031 (0.058)	0.031 (0.057)	0.028 (0.058)
Market R&D cooperation	0.292*** (0.090)	0.055 (0.092)	0.246*** (0.092)	-0.015 (0.094)
Public R&D cooperation	-0.027 (0.108)	0.242** (0.111)	-0.061 (0.109)	0.199* (0.112)
Trade fair	-0.054 (0.080)	0.170** (0.080)	-0.085 (0.082)	0.112 (0.082)
Export	0.186** (0.093)	0.180* (0.095)	0.167* (0.094)	0.165* (0.096)
Import	-0.147* (0.088)	0.061 (0.089)	-0.163* (0.088)	0.031 (0.090)
Constant	0.510 (0.678)	1.826*** (0.688)	-0.034 (0.696)	1.078 (0.707)
N. of observations	1,376		1,376	
Rho	0.406*** (0.046)		0.396*** (0.047)	
<i>LR test of $\rho=0$:</i>				
<i>Chi²(2)</i>	76.488		71.658	
<i>Prob > Chi²</i>	0.000		0.000	

Notes:

1. Gender is a dummy variable taking value of 1 when the entrepreneur is male, and value of 0 when the entrepreneur is female.

2. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

3. Standard errors in parentheses. Sectoral and regional dummies included in all specifications.

Table 6. Bivariate probit estimates for operational performance.

	Quality improvement	Capacity increase	Quality improvement	Capacity increase
Gender	0.153* (0.086)	0.134* (0.079)	0.145* (0.088)	0.116 (0.080)
Product innovations	-	-	0.370*** (0.084)	0.265*** (0.075)
Process innovations	-	-	0.245** (0.105)	0.293*** (0.088)
Organizational innov.	-	-	0.207** (0.092)	0.230*** (0.080)
<i>Entrepreneurial traits</i>				
High risk-tolerance	0.219 (0.135)	0.338*** (0.116)	0.161 (0.137)	0.296** (0.117)
High self-confidence	0.287*** (0.082)	0.305*** (0.073)	0.252*** (0.083)	0.272*** (0.073)
Age of entrepreneur	-0.434** (0.202)	-0.763*** (0.183)	-0.263 (0.207)	-0.595*** (0.187)
Secondary education	0.005 (0.142)	-0.114 (0.127)	-0.018 (0.145)	-0.153 (0.129)
Vocational training	-0.056 (0.145)	-0.024 (0.131)	-0.083 (0.147)	-0.036 (0.132)
Tertiary education	-0.154 (0.126)	-0.103 (0.114)	-0.200 (0.129)	-0.145 (0.116)
<i>Business characteristics and strategies</i>				
Small business	0.008 (0.135)	0.110 (0.120)	-0.061 (0.137)	0.053 (0.121)
Medium business	0.770 (0.539)	1.018** (0.402)	0.721 (0.564)	0.949** (0.405)
Age of business	0.0873 (0.065)	-0.083 (0.058)	0.081 (0.066)	-0.095 (0.059)
Market R&D cooperation	0.289*** (0.111)	0.276*** (0.094)	0.198* (0.114)	0.186* (0.097)
Public R&D cooperation	0.264* (0.137)	0.003 (0.113)	0.197 (0.140)	-0.053 (0.115)
Trade fair	0.208** (0.088)	0.113 (0.081)	0.146 (0.090)	0.053 (0.083)
Export	0.151 (0.11)	0.194** (0.096)	0.118 (0.112)	0.169* (0.097)
Import	-0.023 (0.102)	-0.0351 (0.090)	-0.0660 (0.104)	-0.067 (0.091)
Constant	1.793** (0.782)	3.058*** (0.705)	0.911 (0.806)	2.207*** (0.726)
N. of observations	1,376		1,376	
rho	0.812*** (0.0607)		0.778*** (0.061)	
<i>LR test of $\rho=0$:</i>				
<i>Chi²(2)</i>	179.065		161.414	
<i>Prob > Chi²</i>	0.000		0.000	

Notes:

1. Gender is a dummy variable taking value of 1 when the entrepreneur is male, and value of 0 when the entrepreneur is female.

2. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

3. Standard errors given in parentheses. Sectoral and regional dummies included in all specifications.

Appendix

Table A1. Definition of variables.

Variable name	Definition
<i>Business performance</i>	
<i>Cost reduction</i>	Dummy variable taking the value of 1 if the business has reduced costs due to innovations introduced during the last three years, and zero otherwise.
<i>Sales increase</i>	Dummy variable taking the value of 1 if the business has increased sales due to innovations introduced during the last three years, and zero otherwise.
<i>Quality improvement</i>	Dummy variable taking the value of 1 if the business has increased the quality of products or services due to innovations introduced during the last three years, and zero otherwise.
<i>Capacity increase</i>	Dummy variable taking the value of 1 if the business has increased capacity due to innovations introduced during the last three years, and zero otherwise.
<i>Innovation types</i>	
<i>Product innovation</i>	Dummy variable taking the value of 1 if the business has introduced any new product or service during the last three years, and 0 otherwise.
<i>Process innovation</i>	Dummy variable taking the value of 1 if the business has introduced any new process of production during the last three years, and 0 otherwise.
<i>Organizational innovation</i>	Dummy variable taking the value of 1 if the business has introduced any organizational innovation during the last three years, and 0 otherwise.
<i>Entrepreneurial traits</i>	
<i>Gender</i>	Dummy variable taking the value of 1 if the manager of the business is male, and the value of 0 if female.
<i>High risk-tolerance</i>	Dummy taking the value of 1 if the CEO reports a high level of risk tolerance, and 0 otherwise. Risk tolerance is measured as a self-reported statement of having a high predisposition to undertake projects of high risk and high expected returns.
<i>High self-confidence</i>	Dummy taking the value of 1 if the CEO reports a high level of self-confidence, and 0 otherwise. We consider that the CEO shows a high level of self-confidence when she/he states a high probability of success in the case that she/he decided to expand the business.
<i>Age of entrepreneur</i>	Log of the age of the manager.

<i>Primary education</i>	Dummy variable taking the value of 1 if the manager level of studies is primary education, and 0 otherwise.
<i>Secondary education</i>	Dummy variable taking the value of 1 if the manager level of studies is secondary education, and 0 otherwise.
<i>Vocational training</i>	Dummy variable taking the value of 1 if the manager level of studies is vocational training, and 0 otherwise.
<i>Tertiary education</i>	Dummy variable taking the value of 1 if the manager holds a university degree, and 0 otherwise.
<i>Business characteristics & strategies</i>	
<i>Micro business (1-9 employees)</i>	Dummy variable taking value one if the number of employees of the business is between 1 and 9, and zero otherwise
<i>Small business (10-49 employees)</i>	Dummy variable taking value one if the number of employees of the business is between 10 and 49, and zero otherwise.
<i>Medium business (50-250 employees)</i>	Dummy variable taking value one if the number of employees of the business is between 10 and 49, and zero otherwise
<i>Age of business</i>	Log of the age of the business, measured as the number of years since its founding.
<i>Market R&D cooperation</i>	Dummy variable taking the value of 1 if the business reports cooperation in R&D with other businesses (customer, suppliers or competitors), and 0 otherwise.
<i>Public R&D cooperation</i>	Dummy taking the value of 1 if the business reports cooperation in R&D with institutions and public technology centres (universities, laboratories, etc.), and 0 otherwise.
<i>Trade fair</i>	Dummy variable taking the value of 1 if the business participates in trade fairs, and 0 otherwise-
<i>R&D spending</i>	Percentage of business spending in R&D over the business budget, during the last three years.
<i>Export</i>	Dummy variable taking value one if the business exports abroad, and zero otherwise.
<i>Import</i>	Dummy variable taking value one if the business imports from abroad, and zero otherwise.
<i>Business environment</i>	
<i>Region</i>	Six dummy variables corresponding to six Spanish regions (Autonomous Communities): 1. Andalusia; 2. Extremadura; 3. Madrid; 4. Murcia; 5. Navarra; 6. Basque Country.
<i>Sector</i>	Four dummy variables taking the following values: 1. Manufacturing; 2. Real estate and construction; 3. Commercial; 4. Services.

Figure 1. Conceptual framework

