# Gender diversity and innovation performance in family firms: Evidence from the Spanish manufacturing industry

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# Gender diversity and collaboration with universities: Drivers of innovation in family firms

## Abstract

**Purpose:** This paper provides empirical evidence for how gender diversity in top management teams and collaboration with university and technological centres lead to innovation outcomes. We review past research on these concepts and illustrate their individual and joint effects on process innovation specifically in the unique context of family firms.

**Study design/methodology/approach:** We used a sample of 788 Spanish manufacturing family firms in 2016 and applied logistic regression models since the dependent variables are dummies.

**Findings:** We found a positive relationship between gender-diverse top management teams, process innovation and R&D-based process innovation. Similarly, the collaboration with university technological centres is positively associated with higher innovation outcome of family firms. In addition, we also found that the presence of women in top management teams shapes the relationship between the collaboration with university technological centres and process innovation.

**Originality/value:** This paper contributes to the research on collaborative innovation in family firms by emphasizing the collaboration with university technological centres, an external partner often ignored by this stream of literature. This research also responds to the calls for further study of the effect of the heterogeneity of the top management teams on the innovation outcome of family firms, from the perspective of the resource-based view of the firms.

**Keywords:** gender diversity, family firms, innovative performance, university and technology centres, firm-university collaboration

## 1. INTRODUCTION

The competitiveness of a firm in the market of products begins in the market of resources (Wernerfelt, 1984). According to the resource-based view of the firm (RBV) (Barney, 1991; Peteraf, 1993), firms get competitive advantage in markets where their resources are superior to those of their competitors (Wernerfelt, 1989). However, having unique resources is not enough to maintain a competitive advantage in the market of products, but it is necessary to link them with organizational capacities (Grant, 1991). According to this approach, the innovation capacity of a firm is supported by a differential know-how (Hall, 1993). Thus, it looks relevant to connect a firm's innovation capacity to its ability to get beneficial cooperative agreements and diverse know-how.

Firms have two main alternatives to increase their innovation capacity: (1) To invest in R&D (Faems et al., 2010; Paula and Silva, 2018) and/or (2) to build strategic partnerships with external innovation providers (Ankrah and Tabbaa, 2015; Cordeiro-Bastos, 2021). Due to their resource constraints, small firms are unable to compete with large firms in developing internal R&D capacities, so the collaboration with external players becomes the main source for developing their innovation capacity (Chun and Mun, 2012; Fitjar and Rodríguez-Pose, 2013). Indeed, the role of collaborative innovation in enhancing a firm's innovation potential is widely recognized (Aiello et al., 2020; Cassiman and Veugelers 2002). Nevertheless, the profile of the partner that firms choose to team up with conditions several aspects of the collaboration such as the coordination, monitoring and transaction costs (Gkypali et al., 2017). This makes strategically relevant the election of the external collaborator. In this respect, compared with other R&D partners (i.e., suppliers, customers, or competitors), University and Technology Centres (UTCs) have particular characteristics, which are favourable to small firms. Through collaboration with UTCs, these firms can get access to cutting-edge technologies and research facilities

(Bonarccorsi and Piccaluga, 1994), while retaining more control over the R&D agreement (Ankrah and Tabbaa, 2015) and, therefore, the outcome[1] of the collaborative innovation.

From the RBV approach, the collaboration of small firms with UTCs is related to the attitudes, behaviours and outcomes of different partners to achieve a common interorganizational relationship based on common or different goals (Castañer and Oliveira, 2019), and it is aligned with the definition of cooperation of Edström (1984: 147-148): “the relationship of ownership or common hierarchy which develop between two or more independent organizations as a result of an explicit agreement concerning exchange of resources, concerted action, and/or joint decision making in the future.” Following the RBV approach, and from the perspective of this analysis, small firms can take a competitive advantage in the market of resources when build a consistent relationship with UTCs for innovation, as this collaboration increases the innovation capacity of these firms (Forsman, 2011).

The RVB considers people as skilled assembly labour (Wernerfelt, 1984), and top management as a key resource (Castanias and Helfat, 1991). However, the gender diversity of top management teams (TMTs) and its potential relationship with the innovation capacity of firms has not been widely explored in the literature on firm innovation (Ruiz-Jiménez et al., 2016). Nevertheless, gender diversity enriches the know-how of TMTs with complementary perspectives and decision-making styles (Koryak et al., 2018), which are valuable resources for firm performance (Carpenter et al., 2004).

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[1] In this study, the terms "innovation/innovative capacity" and "innovation/innovative outcome" may be used interchangeably since the latter also encompasses the former according to the literature. Thus, Forsman (2011) indicates that the concept of “innovation capacity” is often equated with firms' formal R&D activities and innovation outputs with new products. Similarly, Koc and Ceylan (2007) relate “innovation capacity” to firm's capacity to engage in innovation, that is, the introduction of new processes, products, or ideas in the organization.

The aforementioned arguments merit to be explored in family firms (FFs), as they are different from non-family businesses, and traditionally have maintained a limited innovation capacity. Thus, previous research has signaled that FFs are different from non-family businesses in their goals (e.g., Gómez-Mejía et al., 2011), succession policies (e.g., Fiegener et al., 1994), and governance patterns (e.g., Chrisman et al., 2004; Schulze et al., 2001). The strategic choices in FFs often obey the yearn for control of family managers (Gómez-Mejía et al., 2007) and a long-term mindset due to the goal of transferring the business to the next generations (Miller et al., 2008; Hoffmann et al., 2016). These idiosyncrasies may lead FFs to prioritise collaborative innovation with UTCs over other external partners such as suppliers or competitors. Similarly, there is limited understanding of the relationships between gender diversity in TMTs and firm performance in the context of FFs, despite evidence indicating that these firms often provide better opportunities for women to attain management positions (Martínez-Jiménez, 2009; Chadwick and Dawson, 2018) and that diverse managerial teams could change the traditionally conservative approach to innovation strategies in FFs (Scholes et al., 2021).

Drawing on the RBV of the firm (Barney, 1991; Peteraf, 1993), we analyse whether gender-diverse TMTs and the collaboration with UTCs are associated with five innovation outcomes linked to the innovation capacity of FFs (patents, product innovation, process innovation, and R&D-based product and process innovation) in a sample of 788 Spanish manufacturing FFs. Additionally, we explore if the presence of women in TMTs shapes the relationship between engagement in R&D with UTCs and the innovative capacity of FFs.

Two major contributions are expected. First, the paper adds new evidence to the research on collaborative innovation in FFs (Aiello et al., 2020; Classen et al. 2012; De Massis et al. 2013) by emphasizing the collaboration with UTCs, an external partner often ignored by this stream of the literature (reviews of Bigliardi and Galati (2018) and Feranita et al. (2017). Second, this paper also responds to calls for further study of the relationship between the heterogeneity of FFs and innovative outcome (Röd, 2016; Calabrò et al., 2019) by focusing on the role of gender diversity (Ruiz-Jiménez et al., 2016) and acknowledging the heterogeneity of FFs (Daspit et al., 2021). In so doing, we also extend the current research on the role of female leadership in FFs (Campopiano et al., 2017; Nelson and Constantinidis, 2017; Chadwick and Dawson, 2018) from a RBV approach.

This paper is organized as follows: In Section 2 we summarize the literature review and introduce the conceptual framework of the analysis. In Section 3 we detail the data sample, variables used, strategy of estimation and model specification. In Section 4 we describe the results of the univariate and multivariate analyses. Finally, in Section 5 we conclude the analysis and provide suggestions for academics and practitioners.

## 2. THEORETICAL AND EMPIRICAL BACKGROUND

The innovation capacity of FFs has attracted increasing attention in recent years (Aiello et al., 2020; Calabrò et al., 2019). In fact, we found 11 reviews of the literature on FF innovation in the past decade (see Bigliardi and Galati, 2018; Feranita et al., 2017; Röd, 2016; Calabrò et al., 2019; Durán et al. 2016; De Massis et al. 2013; Filser et al., 2016; Gjergji et al., 2019; Hu and Hugues, 2020; Cassia et al., 2012). Despite this proliferation of studies, the role of gender-diverse TMTs and the collaboration with UTCs in the innovation outcome of FFs have been mostly overlooked. Building on the RBV of the firm and considering the unique characteristics of FFs, we discuss how gender-diverse TMTs and the collaboration with UTCs can be considered a resource, which is rare, heterogeneous, difficult to transfer and to imitate, and also valuable to increase the innovation outcomes of FFs, a group of companies traditionally limited by their innovation capacity. Further, we examine if gender diversity plays a moderating role in the relationship between the collaboration with UTCs and the innovation outcome of FFs.

### 2.1. Gender diversity and innovation capacity in FF context

The study of gender diversity in TMTs and the innovation capacity of firms has been somehow ignored by the literature on FF innovation (for recent reviews on the role of women leadership in FFs see Campopiano et al., 2017; Nelson and Constantinidis, 2017). This is surprising for two reasons. First, literature on firm innovation has positively related gender-diverse TMTs to innovation capacity (Miller and Triana, 2009; Ruiz-Jiménez et al., 2016; Valenti and Horner, 2020). This positive relationship has been found in several types of innovation, including radical innovation (Díaz-García et al., 2013), marketing innovation (Galia et al., 2015), service innovation (Fernández-Sastre, 2015), and process innovation (Xie et al., 2020). Also, some researchers have found that only a certain degree of gender diversity enhances firm innovation (Østergaard et al., 2011; Torchia et al., 2011).

Second, the contextual conditions of FFs provide a particular case for the analysis of the effect of gender-diverse TMTs on innovation capacity, due to the opportunities offered in these firms to let women assume management positions (Martínez-Jiménez, 2009; Chadwick and Dawson, 2018). In this sense, women belonging to the owning family are more often selected as members of boards (Ruigrok et al., 2007), and have faster promotions to top management positions (Barrett and Moores, 2009). Consequently, it is more common to find women on top management positions in FFs (Chadwick and Dawson, 2018).

Drawing on the Barney (1991) and Peteraf (1993) criteria, gender-diverse TMTs provide FFs with a heterogeneous resource, costly to imitate and transfer, and valuable in the market. Thus, the participation of women in the TMTs of FFs provides different and heterogeneous knowledge and perspectives than men (Huse, 2007), even although the former belong to the same family (Montemerlo et al., 2013; Ruiz-Jiménez et al., 2016). This framework has been previously applied to the own idiosyncrasy of FFs, considering as resource the involvement of family members of the firm as a sign of the long-lasting organizational structures (Colbert, 2004; Shinnar et al., 2013), and its effect on the innovation outcomes (Martínez-Alonso et al., 2022). However, the consideration of gender diversity as organizational driver for increasing innovation in FFs remain unexplored. Previous studies also provide evidence that women managers are likely to encourage knowledge exchange within organizations than men (Greene et al., 2003; Chadwick and Dawson, 2018). In this respect, researchers found that the management style of women is more collaborative (Eagly et al., 2003), and women leaders perceive power like a tool to spread knowledge and information within the organization (Krishnan and Park, 2005). This management style creates a proactive climate and knowledge exchange for innovation (Sandberg, 2003).

Moreover, gender diversity in FFs is also costly to imitate and transfer because the family loyalty and the need of preserving the socio-economical endowments of previous generations (Gomez-Mejía, 2011) shape the permanence of women in FFs. This creates an exit barrier not just between family and non-family firms, but also among FFs, as women are closely tied to their family businesses (Miller et al., 2008; Hoffmann et al., 2016; Gómez-Mejía et al., 2007; 2011). Additionally, as women are traditionally more risk-averse than men, it is more likely that they find FFs more attractive to work for than large firms (Block et al., 2016). Thus, gender diversity in FFs is considered a valuable resource because it lets TMTs build alternative management perspectives and discover new business opportunities (Miller and Triana, 2009; Díaz-García et al., 2013).

According to these arguments, we propose that:

*H1: FFs with gender-diverse TMTs achieve higher innovation outcome than those with TMTs composed solely of men or women.*

### 2.2. Collaboration with UTCs and innovation capacity in FF context

In the last fifty years an extensive literature has studied the university-industry collaboration (see Ankrah and Tabbaa, 2015; Cordeiro Bastos et al., 2021 for recent reviews), and more specifically, whether this collaboration impacts on firm's innovation capacity. Broadly speaking, previous research evidence that small firms lack the internal capacity to compete in intra-domain knowledge (i.e., internal expertise in a domain-specific knowledge) without collaborating with external partners (Chun and Mun, 2012; Fitjar and Rodríguez-Pose, 2013). Hence, small firms tend to tap into the knowledge from other organisations to overcome innovations barriers (Chun and Mun, 2012). Due to their specificities, UTCs are key suppliers that let firms absorb external knowledge to increase their innovative capacity.

Literature has acknowledged the significant role of UTCs in national innovation systems (Khanin et al., 2019), especially in the stages of development and promotion of innovations (Unger and Polt 2017; Kochetkov et al., 2017; Kolomytseva and Pavlovska, 2020). In this regard, Kolomytseva and Pavlovska (2020) considered UTCs as integrators of ecosystem for innovations; providers of innovations; platforms for cooperation; concentrators of resources needed for innovations; mechanisms for knowledge transfer and pillars of the advanced science and providers of new knowledge.

In Spain, the university system is made up of 85 universities (50 public and 35 private), as well as 322 research institutes. The Spanish R&D is characterized by a multilevel government where innovation policies are overlapped between universities and state and regional governments. Spanish UTCs are important in financial terms, but with a historically low level of involvement with industry (Charles, 2006), which reflected a poor collaborative innovation system (European Comission, 2019).

In recent decades, regional governments have promoted new forms of science-industry collaboration to solve this problem (Giachi and Fernández-Esquinas, 2018) achieving better results in terms of collaboration. Proportion of business-funded R&D expenditure that is carried out by universities is considered an indicator of firms' level of confidence in universities to carry out the R&D, but it may also show firms' own weak capacity to carry out the R&D investment they consider necessary. Spain has its own characteristics within the OECD countries with respect to this indicator. On the one hand Spain is the country with the second lowest R&D expenditure and the second lowest R&D expenditure financed by its companies. However, on the other hand it is the second with the highest level of business-funded R&D expenditure by universities. These data reveal that, in the last years, there does not seem to be any difficulty between Spanish companies and universities to collaborate in R&D execution (Hernandez-Armenteros and Pérez-García, 2023).

Researchers in the field of FFs has also studied the patterns of collaborative innovation (for recent reviews, see Bigliardi and Galati, 2018; Feranita et al., 2017). However, this stream of the literature has often overlooked the collaboration with UTCs (Duong et al., 2022). Based on a comprehensive review of the existing studies, Bigliardi and Galati (2018) and Feranita et al. (2017) underline that the yearn for control of family members and their long-term mindset can lead FFs to tap into the knowledge from external partners as an effective means of addressing their resource limitations and enhancing their innovation capacity.

The unwillingness of family members to lose control makes FFs reluctant to collaborate with external partners when the former have a limited control over the collaboration process (Bigliardy and Galati, 2017; Gomez-Mejia et al., 2014; Röd, 2016). In comparison to other external partners, such as customers, suppliers or competitors, firms usually have more independence and control over the outcomes of the collaborative innovation when collaborating with UTCs (Ankrah and Tabbaa, 2015). Accordingly, we argue that when FFs need to collaborate to overcome innovation barriers, they prefer to engage with UTCs instead of other external partners, because the researchers of UTCs are more product-focused than market-focused, and often limit their involvement to the boundaries of the innovation agreement. This alignment between management and ownership in FFs helps with the governance in choosing and implementing the results of the UTC's collaboration in these firms (Bigliardi and Galati, 2017). Accordingly, De Massis et al. (2015) and Nieto et al. (2015) highlight that when FFs engage in collaborative innovation, the alliances use to be vertical partnerships with public research centres, universities, or suppliers, which are the best option to maintain control of the collaboration process.

Previous research indicates that FFs show a long-term mindset due to the main goal of the "continuity" of the family business (Miller et al., 2008; Hoffmann et al., 2016). This long-term focus often leads to increased investment in employee training (Miller et al., 2008) and extended tenures, compared to non-family firms (Zahra, 2005; Brinkerink et al., 2017). Both conditions contribute to the accumulation of experience for successful collaboration with bureaucratic organizations such as UTCs (Bigliardi and Galati, 2018), which require expertise in the administrative procedure. Moreover, the extended collaborations allow workers to establish long-term formal and informal contacts with the academics and researchers at UTCs, resulting in better access to the cutting-edge knowledge created in these organizations. From the RBV approach, the accumulation of experience through the UTC collaboration in the FFs can be also considered a valuable resource that is difficult to imitate, transfer, and uncommon compared to other firms. In this sense, previous literature using RBV approach find evidences of the effect of the resource of collaboration on the innovation capacity of FFs (Das and Teng, 2000; Feranita et al., 2017). Following the same approach, and using the partner of collaboration as variable, recently Martínez-Alonso et al., 2022 found that FFs collaboration with UTCs moderates the effect of the involvement of the family members in TMTs on product innovation efficiency.

According to these arguments, we state that:

*H2: The FFs collaborating with UTCs achieve higher innovation outcome than the non-collaborative ones.*

### 2.3. Gender diversity, collaboration with UTCs and innovation capacity in FF context

Recent research evidence that firm-specific characteristics play a moderating role in the relationship between collaborative partners and innovation outcome. Particularly, in a pioneering study on FFs, Duong et al. (2022) analyse whether the FF status impacts the association between the knowledge usage from UTCs and innovation performance. In this respect, low levels of formalization enhance the relationship between collaboration with science-based partners and product innovation (Apa et al., 2021; Du et al., 2014). Accordingly, Duong et al. (2022) found that FFs outperform non-family businesses in using knowledge gained from the collaboration with UTCs due to lower levels of formalization in the former. The overlap of ownership and management in FFs, unlike in non-family firms, gives the TMT members the managerial discretion to avoid formalized methods in innovation coordination, relying on trust and informal knowledge transfer (De Massis et al., 2015).

In a similar vein that Duong et al. (2022), we suggest that gender-diverse TMTs in FFs can shape the relationship between collaboration with UTCs and the innovation outcome of these firms. Thus, research indicates that women are more likely to rely on structured methods and formally managed collaborations (Singh et al., 2008), achieving better performance in companies with more formal processes (Gompers et al., 2022). In contrast, a high degree of formal management can limit the potential for serendipitous discoveries and the technical feasibility expected from the collaboration with UTCs (Duong et al., 2022). Based on previous evidence, we argue that the presence of women in TMTs could attenuate the relationship between collaboration with UTCs and FFs' innovation outcome.

According to these arguments, we propose that:

*H3: The relationship between collaboration with UTCs and innovation outcome is weaker for FFs with gender-diverse TMTs.*

## 3. METHODS

In this section, we present the sample of firms used and describe the variables and the methodological procedure employed in the multivariate analysis.

### 3.1 The data and sample

The data were drawn from ESEE (Encuesta sobre Estrategias Empresariales, or Business Strategy Survey), which is an annual survey of a representative sample of Spanish manufacturing companies with more than 10 employees. More in detail, the ESEE dataset is an unbalanced panel of a random sample of small companies between 10 and 200 employees and a detailed sample of large companies with more than 200 employees. The ESEE gathers data regarding the innovation capacity and outcome of companies, as well as other financial and organizational details. This survey is commonly used in research on FF innovation (Monreal-Pérez et al., 2012; Kotlar et al., 2014; Diéguez-Soto et al., 2018).

Initially, the sample comprised 3,004 Spanish manufacturing firms observed during the period 2009–2016. Out of these firms, 1,642 are FFs according to ESEE data. The methodology of the ESEE survey defines family firms as those in which a family group actively participates in management and/or control. Additionally, in the last edition of data (2016), the survey also included information about the sex of each firm's manager. In order to include this relevant factor, we had to limit the study to 2016. As a result, the final sample consisted of 788 Spanish manufacturing FFs observed in 2016.

### 3.2 Definition and measurements of the variables

We use five dependent variables for identifying the innovation outcome of FFs: patents, product innovation, process innovation, R&D-based product innovation, and R&D-based process innovation.

According to Dahlstrand (1997) and Lee & Lee (2013), patents are a commonly used indicator of firms' innovation outcome and efforts in innovation process. Therefore, we constructed a dummy variable that takes the value 1 if the firm had registered any patent in the study year (PAT), and 0 otherwise. We considered patents registered in Spain and abroad.

The Oslo Manual (OECD, 2018) defines product [process] innovation as a new or improved product or service [process], which differs from the product or service [business process] that a firm has previously introduced in the market [into use in the company]. According to this definition, we used two dummy variables to show whether a firm had introduced product innovation (INNOPROD) and process innovation (INNOPROC), respectively.

Drawing on Spescha and Woerter (2019), we constructed two dummy variables (INNOPROD_RD and INNOPROC_RD) that take the value 1 if the company had product [process] innovation in 2016 and conducted R&D activities in the previous year, and 0 otherwise. The purpose of these variables is to measure the innovation resulting from R&D activities, because R&D activities need time to be transformed into innovation outcomes (Hall et al., 2010).

We created two main explanatory variables to measure gender diversity in the TMTs and the firm collaboration with UTCs in order to test the proposed hypotheses. The first variable (DIVERSITY) takes the value 1 if the TMT consists of both women and men, and 0 if it only consists of either men or women. The second variable (UTC) is defined similarly, indicating whether the company has collaborated with UTCs or not.

Additionally, we included four control variables in the estimated models[2]. The first variable was the natural logarithm of the number of employees (LNEMP) as a proxy of the firm size. The second variable was a dummy that takes the value 1 for companies in high-medium technology sectors based on the Eurostat classification[3] (HIGHTECH), and

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[2] In the estimations, we also used firm age as an additional control variable. Overall, the estimated coefficients of the variables of interest did not change in significance and sign. We decided to omit the firm age variable because it had many missing values.

[3] Eurostat uses the aggregation of the manufacturing industry according to technological intensity and based on the NACE Rev.2 at the two-digit level.

0 otherwise. Finally, the percentage of sales allocated to R&D (RD_SALES) and the percentage of employees dedicated to R&D (RD_EMP) were included as proxies for the firm's R&D intensity.

### 3.3 Strategy of estimation and model specification

Given the binary nature of the dependent variables, we used logistic regression models to analyse the relationship between the key independent variables and the probability of innovation outcome in Spanish manufacturing FFs. Specifically, we defined the following models:

**Model 1 (with DIVERSITY):**

$$\Pr(\mathrm{INNO}=1) = F(\beta_0 + \beta_1\mathrm{LNEMP} + \beta_2\mathrm{HIGHTECH} + \beta_3\mathrm{RD\_INTENSITY} + \beta_4\mathrm{DIVERSITY})$$

**Model 2 (with DIVERSITY and UTC):**

$$\Pr(\mathrm{INNO}=1) = F(\beta_0 + \beta_1\mathrm{LNEMP} + \beta_2\mathrm{HIGHTECH} + \beta_3\mathrm{RD\_INTENSITY} + \beta_4\mathrm{DIVERSITY} + \beta_5\mathrm{UTC})$$

**Model 3 (with DIVERSITY, UTC and interactions):**

$$\Pr(\mathrm{INNO}=1) = F(\beta_0 + \beta_1\mathrm{LNEMP} + \beta_2\mathrm{HIGHTECH} + \beta_3\mathrm{RD\_INTENSITY} + \beta_4\mathrm{DIVERSITY} + \beta_5\mathrm{UTC} + \beta_6\mathrm{DIVERxUTC})$$

where $F(z) = e^{z} = (1 + e^{z})$ is the cumulative logistic distribution, INNO denotes the dependent variable, $\beta_0$ is the constant and, in turn, RD_INTENSITY refers to the two R&D intensity variables (RD_SALES and RD_EMP) that are alternatively introduced in the specifications as they are slightly correlated.

Model 1 is the baseline model, which includes the control variables and the gender-diverse TMT variable. Model 2 adds the collaboration with UTCs variable. In the Model 3, gender-diverse TMTs and collaboration with UTCs variables were interacted (DIVERxUTC) to explore how the presence of women in TMTs shapes the potential relationship between collaboration with UTCs and the innovative outcomes of FFs. Each model presents three alternative specifications by introducing RD_SALES and RD_EMP alternatively one by one and together to address potential multicollinearity problems as the R&D intensity variables are slightly correlated.

## 4. EMPIRICAL RESULTS

### 4.1 Univariate analysis

Table 1 shows the descriptive statistics of the dependent, independent and control variables.

INSERT TABLE 1 HERE

In 2016, only 5.46% of the sample FFs registered a patent either in Spain or abroad. However, 16.62% and 38.58% of FFs respectively introduced some product or process innovation in that year. Focusing on innovation based on R&D, 10.96% and 19.82% of FFs carried out R&D-based product and process innovation, respectively.

Concerning the main explanatory variables, 23.98% of FFs collaborated with UTCs and 45.70% had gender-diverse TMTs. More in detail, 37 TMTs of the 398 firms with non-gender-diverse TMTs were exclusively integrated by women (9.30% of the FFs with non-gender diverse TMTs), while the remaining 361 TMTs were exclusively integrated by men (90.70%).

Regarding control variables, the mean number of employees was close to 134 and only 30% of FFs operated in high-medium technology industries. The average percentage of sales dedicated to R&D expenditures was 0.62%, while the average percentage of workers dedicated to R&D activities was about 2% (Table 2).

Table 2 shows the results of the t-test for the mean differences of the dependent variables between FFs with gender-diverse TMTs and those with only men or only women in TMTs. The results indicate that FFs with gender-diverse TMTs have significantly higher innovation in product and process innovation, as well as in product and process innovation based on R&D, while the differences in patent innovation (PAT) are not significant.

INSERT TABLE 2 HERE

The correlation matrix of the dependent and independent variables is showed in Table 3. To test the existence of multicollinearity, the variance inflation factor (VIF) for each variable and the average VIF were calculated. No VIF values exceeded 4.5, and the average VIF was 2.05, which could be considered an acceptable level (Greene, 2012). Still, the slight positive correlation between the two measures of R&D intensity (RD_SALES and RD_EMP) was taking into account in the specification of the models[4].

INSERT TABLE 3 HERE

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[4] Additionally, due to the relatively high correlation between the dependent variables INNOPROD_RD and INNOPROC_RD and the proxies for R&D intensity, we also estimated the models on R&D-based product and process innovation by excluding the R&D intensity proxies. The results obtained for the key independent variables were unchanged. These estimates are not presented for reasons of space, but they are available on request.

### 4.2 Multivariate analysis

Table 4 summarises the results for logit models on the innovation outcome of FFs[5].

INSERT TABLE 4 HERE

Regarding hypothesis 1 (H1), the estimations show a positive association between gender-diverse TMTs and innovation outcome, but only when the innovation outcome is measured in terms of process innovation (INNOPROC or INNOPROC_RD). As mentioned in the gaps of the literature on FF innovation, this relationship has not been previously tested. Nevertheless, the results are to some extent similar to those that, without taking into account the FF status, positively relate the presence of women in TMTs to process innovation (Xie et al., 2020), service innovation (Fernández–Sastre, 2015) and marketing innovation (Galia et al., 2015).

A plausible explanation for this significant relationship with process innovation but not with patents or product innovation may lie in the fact that diverse types of innovation are associated with different knowledge characteristics (Chang et al., 2015). While patents and product innovation are generally related to external knowledge (Gopalakrishnan and Damanpour, 1997), process innovation usually relies on internal and tacit knowledge (Chang et al., 2015). The accumulation of tacit knowledge, which is often embedded in human capital, is crucial for explaining the competitive advantage of innovative firms, particularly in smaller firms (Gupta et al., 2006; Zahra et al., 2007). Gender-diverse TMTs may be better equipped to exploit the firm's stock of tacit knowledge than non-gender diverse TMTs, as the female management styles are known to favour knowledge exchange more than male leadership styles.

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[5] Complete results are showed in ANNEX A.

In contrast, hypothesis 2 (H2) is supported in all estimated models, except for R&D-based product innovation (Table 4). Thus, the collaboration with UTCs is positively related to innovation outcome in FFs. Although these findings are not comparable to other studies on FF innovation, they are aligned with the results obtained by Fitjar and Rodríguez-Pose (2013) for large firms, and reinforce previous evidence of the preference of FFs for partnerships with universities to enhance their innovation capacity (De Massis et al., 2015; Nieto et al., 2015).

Finally, regarding hypothesis 3 (H3), the findings displayed in Table 4 reveal that gender-diverse TMTs in FFs play a subtle role in shaping the relationship between collaboration with UTCs and innovation outcome when it is measured in terms of process innovation (INNOPROC or INNOPROC_RD). More specifically, the significant interaction terms indicate that in FFs with gender-diverse TMTs, the positive association between collaborators and process innovation (innovation based on R&D) is lesser than with non-collaborators (or, alternatively, in collaborative FFs with non-gender diverse TMTs). This result is to some extent consistent with those obtained by Duong et al. (2022), suggesting that the preference of women for structured processes of collaboration might hinder the feasibility and effectiveness of innovation partnerships with UTCs.

### 4.3 Robustness analyses

In order to check the robustness of the findings, we conducted additional analyses. Firstly, we re-estimated the models in Table 4 excluding FFs with only women in the TMT (37 firms). This is particularly relevant for hypothesis 3 (H3). As stated, the prevalence of formal management that is characteristic of the female management style may reduce the occurrence of serendipitous discoveries and the expected technical feasibility of collaboration with UTCs. By removing these female-only managed FFs from the sample, we compared FFs whose TMTs consist solely of men (361 firms) with those that have some women in the TMT (390 firms). In general, the results presented in Table 5 remain consistent with the significance and direction of the relationships found in the original estimations (Table 4). Zooming on the estimates related to hypothesis 3 (H3), the significant interaction terms indicate that in FFs with women in their TMTs, the positive relationship between collaborators and process innovation (innovation based on R&D) is lesser than in collaborative FFs without women in their TMTs.

INSERT TABLE 5 HERE

Secondly, some explanatory variables such as gender diversity of TMTs may be affected by a potential endogeneity problem mainly due to the existence of unobservable organizational or contextual characteristics (Muñoz-Bullón et al., 2020) that potentially affect the independent variables and the dependent variables. To limit the biases associated with endogeneity problems we used the Heckman (1979) two-stage procedure. In the first step, a probit model on the likelihood of having a gender-diverse TMT was estimated and the inverse Mills ratio was calculated. Following Muñoz-Bullón et al. (2020), we used as instrumental variables the percentage of sales of FFs with gender-diverse TMTs in the total sales of the industry (FFINDUSTRYSALES) and the region (FFREGIONALSALES). It can be expected that FFs are more prone to have gender-diverse TMTs when they are in regions or industries with a higher percentage such firms. This assumption, coupled with the lack of theoretical arguments relating these variables to innovative performance, make both instruments empirically appropriate for estimating the probability of having a gender-diverse TMT.

In the second step, the inverse Mills ratio was included as an explanatory variable in the probit regression models on FFs’ innovative outcomes. Only Model 3 was estimated for each of the five dependent variables (Table 6).

INSERT TABLE 6 HERE

These results prove to be robust to changes in model specification and estimation methods. There is evidence to support that collaboration with UTCs is positively related to FFs' innovation outcome, and gender-diverse TMTs are positively related to process innovation. Also, the estimates indicate the moderating role of gender-diverse TMTs in the relationship between collaboration with UTCs and process innovation.

## 5. CONCLUSIONS AND IMPLICATIONS

Research on firm innovation has positively related innovation outcome to both gender-diverse TMTs and R&D collaboration with UTCs, but these relationships remain unexplored in FFs. This study contributes to the literature of FFs by adding new evidence to the recent debate about how gender-diverse TMTs and the collaboration with UTCs are individually and jointly associated to the innovation outcome of FFs. We followed the RBV approach, assuming that gender-diverse TMTs are a valuable resource for increasing the innovation outcome of FFs.

Based on a sample of 788 Spanish manufacturing FFs, the findings reveal that the presence of both men and women in TMTs is positively related with process innovation and R&D-based process innovation. This result weakly supports hypothesis 1, which laid out that FFs with gender-diverse TMTs could achieve higher innovation outcome than those with TMTs comprised solely of either men or women. As previous research has evidenced, gender-diverse TMTs tend to foster organizational designs that are more conducive to innovation. However, our finding also raise concerns about the potential risk aversion of women when it comes to investing in product innovation or patents, which could be the base of radical innovations, but at the same time involves a growth risk dilemma for the firms.

In contrast, the collaboration between FFs and UTCs is positively associated with the five measures of innovation outcome considered (H2). This finding is aligned with previous studies and reinforces the utility of UTCs also in the FFs context to overcome the previous risk aversion to internally invest in product innovation and patents.

Finally, in FFs with gender-diverse TMTs, the positive relationship between collaborators and process innovation (also R&D-based process innovation) is to some extent lesser than in non-collaborators (H3). This result suggests that the presence of women in TMTs may play a subtle role in the absorptive capacity of their collaborators, a topic that needs further investigation.

These findings contribute to the literature of RBV by studying, on the one hand, the gender diversity of TMTs as a heterogeneous resource, costly to imitate and transfer, and valuable in the market, and on the other hand, by exploring the moderating role of gender-diverse TMTs in the relationship between collaboration with UTCs and the innovation outcome of FFs. Recent literature studies the effect of intangible assets as the involvement of family members in TMTs of family firms on product innovation and the moderating effect of collaboration in this relation (Martinez-Alonso et al., 2022), following a RBV approach. Our study complements this contribution and also provides empirical support to the definition of cooperation proposed by Edström (1984), which is the only one to link cooperation with specific performance outcomes as a result of arrangements (Castañer et al., 2019), by adding new findings in the context of FFs, a current research gap in the literature on FF innovation.

Some recommendations can be drawn from the above results. In the last two decades, Spanish companies have faced significant pressure from regulation to build organisational policies and procedures that enable women to rise to management positions. Meanwhile, many FFs have naturally mantained gender-diverse TMTs. The estimates show that gender-diverse TMTs are positively associated with process innovation and R&D-based process innovation. Based on these results, FFs should develop policies that extend the advantage of having gender-diverse TMTs to other elements of their innovation outcomes (i.e. product innovation and patents). This implies reinforcing those aspects of women's management styles that are conducive to innovation.

FFs can leverage their traditional long-term vision to establish strategic partnerships with UTCs, allowing them to absorb external knowledge while maintaining control over the collaboration process from a competitive basis. From the UTCs' perspective, these organizations should also assess the cost-benefit of collaborating with FFs. UTCs typically seek knowledge transfer agreements by partnering with large, often non-family companies that have high financial capacity but also a great power to control the terms of the knowledge transfer process. From a strategic standpoint, it may be beneficial for UTCs to redirect the innovative collaboration efforts through their R&D transfer offices to FFs, in order to establish a sustained collaboration channel with these firms and avoid excessive administrative burden.

Finally, although in the last decade Spanish state and regional governments have designed policies aimed to introduce gender perspective in the processes of innovation, knowledge transfer and creation of companies, more effort and analysis should be done to correct some "gender biases".

As limitations of this study, we must point that it has been necessary to restrict the study to 2016 due to the availability of gender data for managers only for that year. Future studies could expand the time frame of the analysis to explore the connection between previous collaborations with UTCs and FFs' motivation to continue the partnership in the future.. It would be also convenient to study the role of gender-diverse TMTs and the collaboration with UTCs in different groups of FFs, considering the heterogeneity of these firms, evidenced in recent years (Daspit et al., 2021).

Finally, this study is aimed to help academics and practitioners to understand the value of collaboration between men and women and with research institutions to enhance the innovation outcome of FFs.

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Table 1. Descriptive statistics of dependent, independent and control variables

| | **Variable** | **Obs.** | **Mean** | **Std. Dev.** | **Min.** | **Max.** |
|---|---|---|---|---|---|---|
| DEPEND. | PAT | 788 | 0.0546 | 0.2273 | 0 | 1 |
| | INNOPROD | 788 | 0.1662 | 0.3725 | 0 | 1 |
| | INNOPROC | 788 | 0.3858 | 0.4871 | 0 | 1 |
| | INNOPROD_RD | 666 | 0.1096 | 0.3126 | 0 | 1 |
| | INNOPROC_RD | 666 | 0.1982 | 0.3989 | 0 | 1 |
| EXP | DIVERSITY | 733 | 0.4570 | 0.4985 | 0 | 1 |
| | UTC | 788 | 0.2398 | 0.4273 | 0 | 1 |
| CONT. | EMP[a] | 788 | 133.59 | 392.38 | 3 | 8451 |
| | HIGHTECH | 788 | 0.2995 | 0.4583 | 0 | 1 |
| | RD_SALES (%) | 786 | 0.6198 | 1.5945 | 0 | 17.1472 |
| | RD_EMP (%) | 784 | 1.9475 | 4.9829 | 0 | 48.7805 |

**Notes**: [a] Variable is not in logs.

Source: Authors own creation

Table 2. Differences between gender-diverse and non-gender diverse TMTs: *t*-test

| | **NON-GENDER DIVERSE (DIVERSITY=0)** | | **GENDER DIVERSE (DIVERSITY=1)** | | ***t*-test** | |
|---|---|---|---|---|---|---|
| | **Obs** | **Mean** | **Obs** | **Mean** | **t** | **p>0** |
| PAT | 398 | 0.0503 | 335 | 0.0687 | -1.0557 | 0.2915 |
| INNOPROD | 398 | 0.1181 | 335 | 0.2299 | -4.0601*** | 0.0001 |
| INNOPROC | 398 | 0.3166 | 335 | 0.5075 | -5.3408*** | 0.0000 |
| INNOPROD_RD | 348 | 0.0689 | 267 | 0.1610 | -3.6664*** | 0.0003 |
| INNOPROC_RD | 348 | 0.1436 | 267 | 0.2921 | -4.5631*** | 0.0000 |

**Notes**: The *t* statistic is used to test the equality of means. *p < 0.1; **p < 0.05; ***p < 0.01.
Source: Authors own creation

Table 3. Correlation matrix and VIF test

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (5) | VIF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PAT | 1 | | | | | | | | | | | 1.18 |
| INNOPROD | 0.2679* | 1 | | | | | | | | | | 3.54 |
| INNOPROC | 0.1425* | 0.3534* | 1 | | | | | | | | | 1.91 |
| INNOPROD_RD | 0.2835* | 0.8447* | 0.3415* | 1 | | | | | | | | 4.22 |
| INNOPROC_RD | 0.1867* | 0.4314* | 0.6689* | 0.5490* | 1 | | | | | | | 2.67 |
| LNEMP | 0.2167* | 0.3193* | 0.3135* | 0.3549* | 0.4272* | 1 | | | | | | 1.51 |
| HIGHTECH | 0.0625 | 0.0280 | 0.0111 | 0.0600 | 0.1045* | 0.0198 | 1 | | | | | 1.05 |
| RD_SALES | 0.2814* | 0.2705* | 0.1681* | 0.3486* | 0.3410* | 0.2585* | 0.1941* | 1 | | | | 1.97 |
| RD_EMP | 0.2404* | 0.2837* | 0.2042* | 0.3503* | 0.3686* | 0.1686* | 0.1438* | 0.6711* | 1 | | | 1.9 |
| DIVERSITY | 0.0390 | 0.1485* | 0.1938* | 0.1465* | 0.1812* | 0.3049* | 0.0366 | 0.1399* | 0.1195* | 1 | | 1.13 |
| UTC | 0.2183* | 0.3639* | 0.2692* | 0.3746* | 0.3902* | 0.4695* | 0.0739* | 0.3116* | 0.2773* | 0.2149* | 1 | 1.41 |
| Mean VIF | | | | | | | | | | | | 2.05 |

**Notes:** The Pearson correlation coefficients for the continuous variables considered in the empirical analysis are showed. *, **, *** denote significance at the 5%, 1%, and 0.1% levels.

Source: Authors own creation

Table 4. Summary of the relationships between the key explanatory variables and innovative outcomes

| | | MODEL 1 | | | MODEL 2 | | | MODEL 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 |
| PAT | DIVERSITY | -0.290 | -0.286 | -0.298 | -0.368 | -0.376 | -0.375 | -0.062 | -0.097 | -0.125 |
| | | (0.352) | (0.344) | (0.350) | (0.360) | (0.353) | (0.358) | (0.528) | (0.541) | (0.542) |
| | UTC | | | | 0.944* | 0.944* | 0.904* | 1.232* | 1.196* | 1.134* |
| | | | | | (0.380) | (0.377) | (0.378) | (0.537) | (0.530) | (0.536) |
| | DIVERxUTC | | | | | | | -0.534 | -0.475 | -0.431 |
| | | | | | | | | (0.708) | (0.711) | (0.719) |
| INNOPROD | DIVERSITY | 0.339 | 0.338 | 0.332 | 0.262 | 0.254 | 0.253 | 0.218 | 0.188 | 0.180 |
| | | (0.227) | (0.228) | (0.228) | (0.232) | (0.235) | (0.235) | (0.312) | (0.310) | (0.311) |
| | UTC | | | | 1.103*** | 1.032*** | 1.021*** | 1.040** | 0.937* | 0.917* |
| | | | | | (0.244) | (0.256) | (0.258) | (0.392) | (0.388) | (0.395) |
| | DIVERxUTC | | | | | | | 0.101 | 0.153 | 0.168 |
| | | | | | | | | (0.470) | (0.465) | (0.469) |
| INNOPROC | DIVERSITY | 0.461** | 0.454** | 0.456** | 0.425* | 0.421* | 0.423* | 0.615** | 0.596** | 0.602** |
| | | (0.165) | (0.167) | (0.167) | (0.166) | (0.168) | (0.168) | (0.193) | (0.193) | (0.193) |
| | UTC | | | | 0.689** | 0.623** | 0.635** | 1.159*** | 1.059** | 1.079*** |
| | | | | | (0.212) | (0.218) | (0.220) | (0.325) | (0.323) | (0.327) |
| | DIVERxUTC | | | | | | | -0.774* | -0.721+ | -0.731+ |
| | | | | | | | | (0.392) | (0.391) | (0.392) |
| INNOPROD_RD | DIVERSITY | 0.369 | 0.342 | 0.342 | 0.313 | 0.262 | 0.268 | -0.054 | -0.127 | -0.137 |
| | | (0.304) | (0.309) | (0.310) | (0.307) | (0.315) | (0.316) | (0.469) | (0.477) | (0.477) |
| | UTC | | | | 1.144*** | 1.069** | 1.038** | 0.712 | 0.635 | 0.581 |
| | | | | | (0.323) | (0.354) | (0.357) | (0.516) | (0.488) | (0.512) |
| | DIVERxUTC | | | | | | | 0.712 | 0.734 | 0.767 |
| | | | | | | | | (0.658) | (0.637) | (0.649) |
| INNOPROC_RD | DIVERSITY | 0.290 | 0.280 | 0.272 | 0.252 | 0.239 | 0.236 | 0.640* | 0.661* | 0.652* |
| | | (0.243) | (0.251) | (0.250) | (0.245) | (0.255) | (0.254) | (0.315) | (0.319) | (0.319) |
| | UTC | | | | 0.955*** | 0.854** | 0.828** | 1.545*** | 1.490*** | 1.459*** |
| | | | | | (0.273) | (0.293) | (0.299) | (0.418) | (0.417) | (0.429) |
| | DIVERxUTC | | | | | | | -1.003* | -1.090* | -1.073* |
| | | | | | | | | (0.510) | (0.521) | (0.524) |
| **CONTROL VARIABLES INCLUDED:** | | | | | | | | | | |
| | LNEMP | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | HIGHTECH | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | RD_SALES | Yes | No | Yes | Yes | No | Yes | Yes | No | Yes |
| | RD_EMP | No | Yes | Yes | No | Yes | Yes | No | Yes | Yes |

**Notes:** Robust standard errors in brackets; +, *, **, *** denote significance at the 10%, 5%, 1%, and 0.1% levels.
Source: Authors own creation

Table 5. Summary of the relationships between the key explanatory variables and innovative outcomes: sample excluding FFs with only women in the TMT.

| | | MODEL 1 | | | MODEL 2 | | | MODEL 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 |
| PAT | DIVERSITY | -0.326 | -0.322 | -0.333 | -0.402 | -0.408 | -0.407 | -0.124 | -0.159 | -0.185 |
| | | (0.350) | (0.342) | (0.348) | (0.357) | (0.351) | (0.355) | (0.526) | (0.539) | (0.540) |
| | UTC | | | | 0.935* | 0.933* | 0.894* | 1.197* | 1.159* | 1.100* |
| | | | | | (0.377) | (0.374) | (0.375) | (0.536) | (0.529) | (0.535) |
| | DIVERxUTC | | | | | | | -0.487 | -0.425 | -0.384 |
| | | | | | | | | (0.707) | (0.711) | (0.718) |
| INNOPROD | DIVERSITY | 0.305 | 0.304 | 0.300 | 0.228 | 0.221 | 0.220 | 0.180 | 0.148 | 0.142 |
| | | (0.226) | (0.228) | (0.229) | (0.232) | (0.235) | (0.235) | (0.312) | (0.311) | (0.311) |
| | UTC | | | | 1.111*** | 1.037*** | 1.027*** | 1.042** | 0.932* | 0.914* |
| | | | | | (0.244) | (0.258) | (0.259) | (0.396) | (0.393) | (0.400) |
| | DIVERxUTC | | | | | | | 0.110 | 0.168 | 0.180 |
| | | | | | | | | (0.473) | (0.468) | (0.472) |
| INNOPROC | DIVERSITY | 0.430* | 0.424* | 0.425* | 0.392* | 0.390* | 0.391* | 0.597** | 0.580** | 0.584** |
| | | (0.167) | (0.168) | (0.168) | (0.168) | (0.169) | (0.169) | (0.195) | (0.195) | (0.196) |
| | UTC | | | | 0.722*** | 0.669** | 0.677** | 1.239*** | 1.151*** | 1.165*** |
| | | | | | (0.215) | (0.219) | (0.221) | (0.336) | (0.333) | (0.336) |
| | DIVERxUTC | | | | | | | -0.834* | -0.781+ | -0.789* |
| | | | | | | | | (0.400) | (0.399) | (0.400) |
| INNOPROD_RD | DIVERSITY | 0.336 | 0.309 | 0.311 | 0.279 | 0.230 | 0.236 | -0.102 | -0.179 | -0.185 |
| | | (0.303) | (0.308) | (0.309) | (0.306) | (0.314) | (0.315) | (0.465) | (0.474) | (0.474) |
| | UTC | | | | 1.144*** | 1.067** | 1.038** | 0.694 | 0.610 | 0.560 |
| | | | | | (0.322) | (0.353) | (0.356) | (0.516) | (0.489) | (0.510) |
| | DIVERxUTC | | | | | | | 0.740 | 0.772 | 0.800 |
| | | 0.336 | 0.309 | 0.311 | 0.279 | 0.230 | 0.236 | -0.102 | -0.179 | -0.185 |
| INNOPROC_RD | DIVERSITY | 0.296 | 0.289 | 0.282 | 0.255 | 0.245 | 0.243 | 0.693* | 0.714* | 0.703* |
| | | (0.248) | (0.253) | (0.253) | (0.249) | (0.257) | (0.257) | (0.324) | (0.326) | (0.327) |
| | UTC | | | | 0.978*** | 0.891** | 0.860** | 1.645*** | 1.598*** | 1.558*** |
| | | | | | (0.277) | (0.296) | (0.300) | (0.434) | (0.431) | (0.442) |
| | DIVERxUTC | | | | | | | -1.114* | -1.190* | -1.168* |
| | | | | | | | | (0.522) | (0.529) | (0.533) |
| CONTROL VARIABLES INCLUDED: | | | | | | | | | | |
| | LNEMP | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | HIGHTECH | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | RD_SALES | Yes | No | Yes | Yes | No | Yes | Yes | No | Yes |
| | RD_EMP | No | Yes | Yes | No | Yes | Yes | No | Yes | Yes |

Notes: Robust standard errors in brackets; +, *, **, *** denote significance at the 10%, 5%, 1%, and 0.1% levels.

Source: Authors own creation

Table 6. Heckman two-stage models of the innovative outcomes

| | **PAT** | **INNOPROD** | **INNOPROC** | **INNOPROD _RD** | **INNOPROC _RD** |
|---|---|---|---|---|---|
| **First-step probit estimates** | | | | | |
| DIVERREGIONALSALES | -0.013** | 0.000 | 0.003 | -0.001 | 0.001 |
| | (0.005) | (0.003) | (0.002) | (0.004) | (0.003) |
| DIVERINDUSTRYSALES | 0.011* | 0.002 | 0.002 | -0.002 | 0.004 |
| | (0.005) | (0.003) | (0.002) | (0.004) | (0.003) |
| CONS | 0.503 | 0.773** | 0.779*** | 0.962* | 0.317 |
| | (0.483) | (0.294) | (0.202) | (0.436) | (0.302) |
| **Second-step probit estimates** | | | | | |
| LNEMP | 0.295*** | 0.259*** | 0.239*** | 0.408*** | 0.490*** |
| | (0.082) | (0.059) | (0.049) | (0.081) | (0.070) |
| HIGHTECH | -0.066 | -0.099 | -0.104 | -0.023 | 0.127 |
| | (0.187) | (0.136) | (0.110) | (0.179) | (0.148) |
| RD_SALES | 0.087+ | 0.021 | -0.027 | 0.038 | 0.011 |
| | (0.050) | (0.041) | (0.040) | (0.046) | (0.045) |
| RD_EMP | 0.029+ | 0.046*** | 0.036** | 0.061*** | 0.068*** |
| | (0.016) | (0.013) | (0.013) | (0.014) | (0.014) |
| **DIVERSITY** | **-0.087** | **0.109** | **0.364**** | **-0.040** | **0.351*** |
| | **(0.238)** | **(0.157)** | **(0.117)** | **(0.228)** | **(0.174)** |
| **UTC** | **0.532*** | **0.529*** | **0.667***** | **0.324** | **0.874***** |
| | **(0.268)** | **(0.214)** | **(0.194)** | **(0.273)** | **(0.227)** |
| **DIVERSITYxUTC** | **-0.230** | **0.106** | **-0.450+** | **0.416** | **-0.603*** |
| | (0.344) | (0.261) | (0.236) | (0.341) | (0.290) |
| CONS | -3.183*** | -2.464*** | -1.525*** | -3.535*** | -3.551*** |
| | (0.374) | (0.260) | (0.198) | (0.387) | (0.328) |
| MILLS (λ) | 0.126 | -0.228* | -0.591*** | -0.123 | -0.029 |
| | (0.128) | (0.099) | (0.104) | (0.132) | (0.098) |
| Nº observations | 731 | 731 | 731 | 613 | 613 |
| σ | 0.443 | 0.510 | 0.652 | 0.487 | 0.483 |
| ρ | 0.284 | -0.447 | -0.907 | -0.253 | -0.060 |
| Wald $X^2$ | 14.9*** | 0.67 | 3.53 | 0.25 | 2.3 |

**Notes**: Robust standard errors in brackets; +, *, **, *** denote significance at the 10, 5, 1, and 0.1% levels.

Source: Authors own creation

ANNEX A

Table A.1 Patent innovation (PAT): logit estimation

| | **Model 1.1** | **Model 1.2** | **Model 1.3** | **Model 2.1** | **Model 2.2** | **Model 2.3** | **Model 3.1** | **Model 3.2** | **Model 3.3** |
|---|---|---|---|---|---|---|---|---|---|
| CONS | -6.156*** | -6.640*** | -6.431*** | -5.796*** | -6.237*** | -6.066*** | -5.905*** | -6.325*** | -6.148*** |
| | (0.691) | (0.768) | (0.749) | (0.689) | (0.757) | (0.738) | (0.723) | (0.780) | (0.762) |
| LNEMP | 0.698*** | 0.791*** | 0.743*** | 0.551*** | 0.637*** | 0.600*** | 0.546*** | 0.631*** | 0.595*** |
| | (0.135) | (0.145) | (0.143) | (0.141) | (0.149) | (0.146) | (0.141) | (0.149) | (0.146) |
| HIGHTECH | -0.020 | 0.113 | -0.045 | -0.053 | 0.031 | -0.097 | -0.055 | 0.032 | -0.096 |
| | (0.378) | (0.347) | (0.378) | (0.373) | (0.350) | (0.375) | (0.375) | (0.351) | (0.376) |
| RD_SALES | 0.293*** | | 0.166* | 0.266*** | | 0.148+ | 0.257*** | | 0.145+ |
| | (0.070) | | (0.084) | (0.070) | | (0.081) | (0.070) | | (0.080) |
| RD_EMP | | 0.094*** | 0.061** | | 0.086*** | 0.056** | | 0.084*** | 0.055** |
| | | (0.019) | (0.024) | | (0.016) | (0.021) | | (0.017) | (0.021) |
| **DIVERSITY** | **-0.290** | **-0.286** | **-0.298** | **-0.368** | **-0.376** | **-0.375** | **-0.062** | **-0.097** | **-0.125** |
| | **(0.352)** | **(0.344)** | **(0.350)** | **(0.360)** | **(0.353)** | **(0.358)** | **(0.528)** | **(0.541)** | **(0.542)** |
| **UTC** | | | | **0.944*** | **0.944*** | **0.904*** | **1.232*** | **1.196*** | **1.134*** |
| | | | | **(0.380)** | **(0.377)** | **(0.378)** | **(0.537)** | **(0.530)** | **(0.536)** |
| **DIVERxUTC** | | | | | | | **-0.534** | **-0.475** | **-0.431** |
| | | | | | | | **(0.708)** | **(0.711)** | **(0.719)** |
| Nº observations | 732 | 731 | 731 | 732 | 731 | 731 | 732 | 731 | 731 |
| Log likelihood | -136.3816 | -135.7827 | -134.0976 | -133.2737 | -132.6723 | -131.2983 | -132.9827 | -132.4425 | -131.1119 |
| Wald $X^2$ | 51.07*** | 51.07*** | 53.69*** | 51.7*** | 56.82*** | 57.52*** | 51.82*** | 57.47*** | 57.73*** |

Notes: Robust standard errors in brackets; +, *, **, *** denote significance at the 10, 5, 1, and 0.1% levels. As a robustness check, we re-estimated all these models measuring the patent innovation as a count variable which accounts for the number of patents registered in Spain and abroad in the study year and using a negative binomial regression model. In general, the results did not change in terms of significance and sign of the effects found in the main explanatory variables.

Source: Authors own creation

Table A.2 Product innovation (INNOPROD): logit estimation

| | **Model 1.1** | **Model 1.2** | **Model 1.3** | **Model 2.1** | **Model 2.2** | **Model 2.3** | **Model 3.1** | **Model 3.2** | **Model 3.3** |
|---|---|---|---|---|---|---|---|---|---|
| CONS | -4.556*** | -4.906*** | -4.852*** | -4.086*** | -4.401*** | -4.373*** | -4.070*** | -4.379*** | -4.348*** |
| | (0.442) | (0.462) | (0.458) | (0.441) | (0.459) | (0.455) | (0.437) | (0.456) | (0.451) |
| LNEMP | 0.594*** | 0.653*** | 0.639*** | 0.420*** | 0.481*** | 0.474*** | 0.421*** | 0.483*** | 0.476*** |
| | (0.099) | (0.102) | (0.101) | (0.103) | (0.107) | (0.106) | (0.104) | (0.108) | (0.107) |
| HIGHTECH | -0.132 | -0.104 | -0.143 | -0.172 | -0.173 | -0.197 | -0.173 | -0.173 | -0.197 |
| | (0.241) | (0.238) | (0.241) | (0.244) | (0.248) | (0.248) | (0.244) | (0.248) | (0.248) |
| RD_SALES | 0.254** | | 0.066 | 0.205* | | 0.043 | 0.207* | | 0.044 |
| | (0.081) | | (0.100) | (0.080) | | (0.098) | (0.082) | | (0.100) |
| RD_EMP | | 0.103*** | 0.091** | | 0.085*** | 0.077** | | 0.086*** | 0.078** |
| | | (0.024) | (0.030) | | (0.023) | (0.028) | | (0.023) | (0.028) |
| **DIVERSITY** | **0.339** | **0.338** | **0.332** | **0.262** | **0.254** | **0.253** | **0.218** | **0.188** | **0.180** |
| | **(0.227)** | **(0.228)** | **(0.228)** | **(0.232)** | **(0.235)** | **(0.235)** | **(0.312)** | **(0.310)** | **(0.311)** |
| **UTC** | | | | **1.103*** ** | **1.032*** ** | **1.021*** ** | **1.040** ** | **0.937* ** | **0.917* ** |
| | | | | **(0.244)** | **(0.256)** | **(0.258)** | **(0.392)** | **(0.388)** | **(0.395)** |
| **DIVERxUTC** | | | | | | | **0.101** | **0.153** | **0.168** |
| | | | | | | | **(0.470)** | **(0.465)** | **(0.469)** |
| Nº observations | 732 | 731 | 731 | 732 | 731 | 731 | 732 | 731 | 731 |
| Log likelihood | -288.1298 | -280.2213 | -279.827 | -277.8095 | -271.52 | -271.3553 | -277.7849 | -271.4644 | -271.2888 |
| Wald $X^2$ | 62.36*** | 72.95*** | 71.92*** | 85.65*** | 100.91*** | 100.33*** | 87.03*** | 102.07*** | 101.65*** |

Notes: Robust standard errors in brackets; +, *, **, *** denote significance at the 10, 5, 1, and 0.1% levels.
Source: Authors own creation

Table A.3 Process innovation (INNOPROC): logit estimation

| | **Model 1.1** | **Model 1.2** | **Model 1.3** | **Model 2.1** | **Model 2.2** | **Model 2.3** | **Model 3.1** | **Model 3.2** | **Model 3.3** |
|---|---|---|---|---|---|---|---|---|---|
| CONS | -2.552*** | -2.641*** | -2.657*** | -2.286*** | -2.380*** | -2.404*** | -2.356*** | -2.441*** | -2.469*** |
| | (0.300) | (0.303) | (0.304) | (0.307) | (0.310) | (0.310) | (0.310) | (0.312) | (0.313) |
| LNEMP | 0.459*** | 0.470*** | 0.474*** | 0.365*** | 0.382*** | 0.388*** | 0.362*** | 0.378*** | 0.385*** |
| | (0.072) | (0.073) | (0.074) | (0.076) | (0.077) | (0.077) | (0.077) | (0.077) | (0.077) |
| HIGHTECH | -0.127 | -0.149 | -0.141 | -0.155 | -0.179 | -0.165 | -0.155 | -0.181 | -0.164 |
| | (0.177) | (0.177) | (0.178) | (0.178) | (0.179) | (0.179) | (0.179) | (0.179) | (0.180) |
| RD_SALES | 0.131+ | | -0.022 | 0.091 | | -0.041 | 0.082 | | -0.046 |
| | (0.075) | | (0.088) | (0.070) | | (0.084) | -0.07 | | (0.080) |
| RD_EMP | | 0.067** | 0.072* | | 0.054* | 0.062* | | 0.053* | 0.062* |
| | | (0.023) | (0.029) | | (0.021) | (0.028) | | (0.022) | (0.027) |
| **DIVERSITY** | **0.461**** | **0.454**** | **0.456**** | **0.425*** | **0.421*** | **0.423*** | **0.615**** | **0.596**** | **0.602**** |
| | **(0.165)** | **(0.167)** | **(0.167)** | **(0.166)** | **(0.168)** | **(0.168)** | **(0.193)** | **(0.193)** | **(0.193)** |
| **UTC** | | | | **0.689**** | **0.623**** | **0.635**** | **1.159***** | **1.059**** | **1.079***** |
| | | | | **(0.212)** | **(0.218)** | **(0.220)** | **(0.325)** | **(0.323)** | **(0.327)** |
| **DIVERxUTC** | | | | | | | **-0.774*** | **-0.721+** | **-0.731+** |
| | | | | | | | **(0.392)** | **(0.391)** | **(0.392)** |
| Nº observations | 732 | 731 | 731 | 732 | 731 | 731 | 732 | 731 | 731 |
| Log likelihood | -452.1259 | -445.6139 | -445.5645 | -446.6002 | -441.242 | -441.0691 | -444.5727 | -439.502 | -439.282 |
| Wald $X^2$ | 70.82*** | 80.3*** | 81.31*** | 78.63*** | 88.37*** | 89.39*** | 86.89*** | 94.92*** | 95.64*** |

Notes: Robust standard errors in brackets; +, *, **, *** denote significance at the 10, 5, 1, and 0.1% levels.

Source: Authors own creation

Table A.4 R&D based product innovation (INNOPROD_RD): logit estimation

| | **Model 1.1** | **Model 1.2** | **Model 1.3** | **Model 2.1** | **Model 2.2** | **Model 2.3** | **Model 3.1** | **Model 3.2** | **Model 3.3** |
|---|---|---|---|---|---|---|---|---|---|
| CONS | -6.264*** | -7.114*** | -7.012*** | -5.883*** | -6.637*** | -6.583*** | -5.738*** | -6.491*** | -6.428*** |
| | (0.638) | (0.694) | (0.684) | (0.635) | (0.674) | (0.669) | (0.621) | (0.667) | (0.657) |
| LNEMP | 0.791*** | 0.937*** | 0.910*** | 0.626*** | 0.768*** | 0.754*** | 0.634*** | 0.778*** | 0.763*** |
| | (0.127) | (0.136) | (0.133) | (0.132) | (0.142) | (0.140) | (0.131) | (0.143) | (0.140) |
| HIGHTECH | 0.057 | 0.153 | 0.074 | 0.012 | 0.039 | -0.013 | 0.013 | 0.034 | -0.019 |
| | (0.322) | (0.318) | (0.322) | (0.320) | (0.330) | (0.330) | (0.321) | (0.332) | (0.330) |
| RD_SALES | 0.355** | | 0.114 | 0.306* | | 0.082 | 0.318* | | 0.090 |
| | (0.122) | | (0.152) | (0.119) | | (0.148) | (0.126) | | (0.156) |
| RD_EMP | | 0.137*** | 0.118** | | 0.120*** | 0.107** | | 0.122*** | 0.107** |
| | | (0.031) | (0.036) | | (0.030) | (0.036) | | (0.030) | (0.036) |
| **DIVERSITY** | **0.369** | **0.342** | **0.342** | **0.313** | **0.262** | **0.268** | **-0.054** | **-0.127** | **-0.137** |
| | **(0.304)** | **(0.309)** | **(0.310)** | **(0.307)** | **(0.315)** | **(0.316)** | **(0.469)** | **(0.477)** | **(0.477)** |
| **UTC** | | | | **1.144*** ** | **1.069** ** | **1.038** ** | **0.712** | **0.635** | **0.581** |
| | | | | **(0.323)** | **(0.354)** | **(0.357)** | **(0.516)** | **(0.488)** | **(0.512)** |
| **DIVERxUTC** | | | | | | | **0.712** | **0.734** | **0.767** |
| | | | | | | | **(0.658)** | **(0.637)** | **(0.649)** |
| Nº observations | 614 | 613 | 613 | 614 | 613 | 613 | 614 | 613 | 613 |
| Log likelihood | -163.455 | -154.1703 | -153.4293 | -157.0178 | -148.8942 | -148.5015 | -156.363 | -148.2198 | -147.7713 |
| Wald $X^2$ | 52.68*** | 66.38*** | 64.94*** | 66.8*** | 92.06*** | 91.35*** | 69.6*** | 94.06*** | 94.08*** |

Notes: Robust standard errors in brackets; +, *, **, *** denote significance at the 10, 5, 1, and 0.1% levels.

Source: Authors own creation

Table A.5 R&D based process innovation (INNOPROC_RD): logit estimation

| | **Model 1.1** | **Model 1.2** | **Model 1.3** | **Model 2.1** | **Model 2.2** | **Model 2.3** | **Model 3.1** | **Model 3.2** | **Model 3.3** |
|---|---|---|---|---|---|---|---|---|---|
| CONS | -5.727*** | -6.329*** | -6.257*** | -5.393*** | -5.958*** | -5.925*** | -5.614*** | -6.206*** | -6.173*** |
| | (0.499) | (0.522) | (0.508) | (0.508) | (0.532) | (0.520) | (0.525) | (0.543) | (0.530) |
| LNEMP | 0.879*** | 0.983*** | 0.962*** | 0.750*** | 0.856*** | 0.847*** | 0.754*** | 0.859*** | 0.851*** |
| | (0.106) | (0.113) | (0.110) | (0.111) | (0.118) | (0.115) | (0.112) | (0.118) | (0.115) |
| HIGHTECH | 0.247 | 0.294 | 0.248 | 0.216 | 0.248 | 0.219 | 0.222 | 0.256 | 0.231 |
| | (0.253) | (0.258) | (0.258) | (0.256) | (0.270) | (0.265) | (0.257) | (0.269) | (0.267) |
| RD_SALES | 0.382** | | 0.107 | 0.320* | | 0.073 | 0.310* | | 0.061 |
| | (0.134) | | (0.163) | (0.125) | | (0.166) | (0.125) | | (0.162) |
| RD_EMP | | 0.147*** | 0.129** | | 0.129*** | 0.117** | | 0.130*** | 0.120** |
| | | (0.035) | (0.040) | | (0.034) | (0.041) | | (0.035) | (0.041) |
| **DIVERSITY** | **0.290** | **0.280** | **0.272** | **0.252** | **0.239** | **0.236** | **0.640*** | **0.661*** | **0.652*** |
| | **(0.243)** | **(0.251)** | **(0.250)** | **(0.245)** | **(0.255)** | **(0.254)** | **(0.315)** | **(0.319)** | **(0.319)** |
| **UTC** | | | | **0.955***** | **0.854**** | **0.828**** | **1.545***** | **1.490***** | **1.459***** |
| | | | | **(0.273)** | **(0.293)** | **(0.299)** | **(0.418)** | **(0.417)** | **(0.429)** |
| **DIVERxUTC** | | | | | | | **-1.003*** | **-1.090*** | **-1.073*** |
| | | | | | | | **(0.510)** | **(0.521)** | **(0.524)** |
| Nº observations | 614 | 613 | 613 | 614 | 613 | 613 | 614 | 613 | 613 |
| Log likelihood | -237.6383 | -224.8919 | -224.2322 | -230.8958 | -219.8046 | -219.5085 | -228.8211 | -217.4734 | -217.2612 |
| Wald $X^2$ | 86.99*** | 108.22*** | 112.47*** | 102.67*** | 122.67*** | 128.05*** | 104.09*** | 125.97*** | 131.07*** |

Notes: Robust standard errors in brackets; +, *, **, *** denote significance at the 10, 5, 1, and 0.1% levels.
Source: Authors own creation