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Gender diversity and innovation in manufacturing and service firms

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Abstract

Traditionally, researchers have considered the innovation process as being gender neutral. However, recently some studies have begun to take gender diversity into account as a determinant of firms' innovation. This paper aims to analyse how the effect of gender diversity on innovation output at firm level is sensitive to team size. Using the Spanish PITEC (*Panel de Innovación Tecnológica)* from 2007 to 2012 for innovative manufacturing and service firms, we estimate a multivariate probit model to analyse how gender diversity both in R&D teams and in the total workforce affect product, process, marketing and organizational innovations. Our results show that gender-diverse teams increase the probability of innovating, and this capacity is positively related team size. Gender diversity, in both the R&D department and the total workforce, has a larger positive impact on the probability of carrying out product and organizational innovations in larger teams than it does in smaller teams. This effect is less clear-cut in the case of marketing and process innovation, where the impact is only significant for micro and small firms. Finally, size effects are of greater importance when we distinguish between the manufacturing and service sectors.

JEL Code: O30, O31, J16

Keywords: gender diversity, innovation output, team size, human resources
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1. Introduction

A wide range of scholars consider the innovation process as a direct relationship between innovation inputs and outputs, without taking into account key agents that affect the dynamic nature of this process. In fact, those studies which analysed the determinants of innovation consider usually the innovation as gender neutral. However, gender diversity plays a significant role in the entire dynamics of learning-by-doing or learning-by-interacting. Despite the interest of this issue, few studies at the level of the firm have focused on the effects of gender diversity on innovation activities. (Díaz-García et al. 2013; Fernandez-Sastre 2015).

Following these recent findings, here we are interested in studying how gender diversity affects innovation capacity at firm level and how this relates to team size. To address this, we consider, on the one hand, staff in the R&D department and, on the other hand, the total workforce. Thus, we will consider how gender diversity may affect the propensity to innovate, not only in the R&D team, but also in the total workforce. We consider that the gender diversity of the R&D department may be more directly linked to a firm's capacity to carry out those research activities involved in new knowledge acquisition while the gender diversity of the workforce may be linked to the nature of a firm's technology and to the innovation objectives related to production and internal organization. In order to analyse if the gender diversity affects the capacity of firms to innovate, we use the PITEC database from 2007 to 2012. Our data set of Spanish manufacturing and service firms is exhaustive and consists of 5,392 innovating firms.

Given the nature of the data used in this work, it is appropriate to apply a multivariate probit model where the dependent variable for each type of innovation is a binary one. Our results confirm that team size is a relevant factor when considering the gender structure of a company and the gender diversity of R&D departments. Furthermore, our results also explain differences in innovation output, in particular when we distinguish between the manufacturing and service sectors.

This paper contributes to the previous empirical literature in four areas. Firstly, despite the increasing importance of service activities in modern economies, the empirical literature has traditionally focused on industrial manufacturing industries — we additionally obtain results for service sectors. Secondly, we analyse the impact of gender diversity on R&D teams and also gender diversity on the total workforce to compare different effects on a firm's innovation. Thirdly, analysis of the effect of gender diversity on innovation does not consider the effect of team size. Here, we consider the team size composition of the R&D department and total firm size. Finally, we consider non-technological (organizational and marketing) and technological (product and process) innovations.

The rest of the paper is organized as follows. Section 2 consists of a literature review, Section 3 explains the data and the methodology, Section 4 presents the results and Section 5 contains the conclusions.

2. Literature review

Innovation studies at the firm level have become more numerous in recent decades. Scholars have focused their research on the analysis of some key aspects of innovation, such as its determinants, the profile of innovative firms, the role of innovation on economic growth and the relationship between innovation and firm's productivity (Fagerberg and Verspagen 2009). Despite the increasing literature on the determinants of innovation at firm level, few scholars have paid attention to the link between gender diversity and innovation. In fact, innovation has been considered as a "gender neutral" phenomenon (Kvidal and Ljunggren 2010).

Authors such as Blake and Hanson (2005) have questioned this and have invited the scientific community to reconceptualise innovation. They argue that it is important to know how gender diversity affects the innovative capacity of firms at different levels, since the innovation process involves people; males and females. As highlighted by Crowden (2003), there are many possible sources of gender bias in studies that measure innovation because currently these ignore systemic barriers to the inclusion of women in the target survey populations. Additionally, Laursen and Salter (2006) point out that employees involved in a firm's innovation process interact with each other; consequently, gender may affect this interaction and thus may affect innovation.

In that sense, gender diversity may exert a positive impact on firm performance. First, gender diversity increases the creativity and innovation under a heterogeneous board due to a more diverse skills and competences (Lazear 1999; Baer et al. 2013). Finally, gender diversity may broaden the view of the firm's environment and, consequently, the firm may take better decisions. However, negative impacts may be expected when diversity increases the time required to make decisions. Consequently, performance of a firm may decrease in sectors that require a quick response to market shocks (Carter et al. 2003; Smith et al. 2005). Finally, some authors have pointed out various reasons for a mitigated impact of gender. For instance, Adams and Weiss (2011), in line with Metz and Simon's (2008) findings, find that men and women hold similar beliefs regarding the achievement of their aspirations in their current organization and how to bring this about. Therefore, these similarities may counterbalance the potential differences.

In regard to the impact of a gender-diverse team, Milliken and Martins (1996) suggest that a diverse team has access to a larger network and to a larger pool of information, skills, and support that fall within the network. Therefore, more gender-diverse teams may have a larger capacity to develop innovations. Furthermore, a greater diversity in working groups implies a better knowledge of the market and a better identification with customers and employees, thereby increasing the group's ability to develop market and product innovations. Similarly, the more diverse a group is, the wider the range of views and perspectives its members will have, as well as having more alternative solutions to a problem, thereby leading to more realistic decisions being adopted (Morrison 1992). Hence, gender diversity may increase creativity and innovation and may improve problem solving (Robinson and Dechant 1997).

Despite the great interest of these topics and their important impact, few works evaluate the impact of gender on innovation (Ljunggren et al. 2010; Danilda and Granat-Thorslund 2011; Alsos et al. 2013) Alsos et al. (2013) review the main literature that takes into account the relationship between innovation and gender in different fields, and show that this literature is scarce in business generally and, in particular, in Economics. The authors highlight the importance of carrying out further work in this line of research. This lack of interest of gender on the innovation process is manifest in the lack of works analysing the role of individuals on the innovation process (Alsos et al. 2013).

Recent empirical literature that analyses the impact of gender diversity on innovation from a business perspective includes Østergaard et al. (2011). These authors show that educational diversity and gender diversity positively affect innovation in Danish firms. Using data from French firms Galia and Zenou (2012) analyse how board diversity affects product, process, marketing, and organizational innovation. They obtain that the percentage of women on the board positively affects the probability of a firm carrying out marketing innovation. For instance, Torchia et al. (2011) analyse gender diversity on corporate boards and the relationship of this with innovation; their results show that gender diversity positively affects organizational innovation. Other authors, such as Pfeifer and Wagner (2012) for German manufacturing firms, focus their research on workforce composition and its relationship with innovation activity. These authors find that firms with more females in their workforce invest more in R&D activities.

Gender diversity has been mainly studied in relation to the total workforce and there is still a lack of studies analysing its impact on innovation in R&D teams. We argue that the gender diversity of R&D teams and the total workforce may have a different effect on the probability of innovation. One of the few papers dealing with this research topic is Turner (2009), which shows how the composition of R&D teams improves innovation in firms. This work, however, has some methodological limitations since the author uses data from only four firms.

As far as we are concerned, Díaz-García, et al. (2013) and Fernandez-Sastre (2015) are the only works which analyse the impact of gender diversity of R&D teams on the probability of innovating. Both works use PITEC database and are based on Spanish innovative manufacturing firms. On the one hand, the work of Díaz-García et al. (2013) analyses how the gender distribution of R&D teams affects radical and incremental innovation in 2007. The authors measure gender diversity using the Blau index and a logistic binary regression. They find a positive relationship between gender diversity in R&D teams and the probability of carrying out radical innovation. This work, though, presents some limitations concerning the causality of these variables, their proposed estimation strategy does not deal with simultaneity problem.

On the other hand, Fernandez-Sastre (2015) aims to analyse how the gender diversity of R&D teams impacts on product, service, process and organizational innovations for Spanish manufacturing firms. The data uses the information for the period 2008–2011. The measure of gender diversity is proxied by the Shannon-Weaver entropy index, which is commonly used to measure diversity, and is similar to the Blau index used by Díaz-García et al. (2014). However both indexes have some limitations; neither takes into account the effect of size teams. Additionally, the Shannon Index is expressed in a logarithmic form and it cannot be calculated when a category is not represented. Also, the author considers only three of the four types of innovation output do not taking into acountmarketing innovation. A specification based on the share of the most represented gender is used in this work and the models are estimated using a multivariate probit. The main results are that gender compositionaffects all the different innovation outputs, especially product and organizational innovations. Furthermore, the results show that a team composition of 80% to 90% of the same gender is optimal for the introduction of new products, services or processes.

Our aim is to determine whether firms with more gender-diverse teams have a greater probability of innovating according with the team size. We use the Oslo Manual (2005) classification of product, process, marketing and organizational innovation and argue that the impact may differ according with the type of innovation carried out by firms. The argument is that technological innovations (product or process innovations) are more closely related to the performance of the R&D department than are non-technological (organizational or marketing) innovations, which may be influenced by other departments more related with marketing, management, sales or production. Hence, we distinguish the effect of gender diversity taking into account the different labour areas and their impact on each type of innovation and also distinguishing between manufacturing and service sectors to detect differences between both sectors.

3. Data and methodology

3.1. Database and sample

The data used for the analysis comes from the *Panel de Innovación Tecnológica* (PITEC). This is a dataset which compiles the Spanish CIS questionnaire. PITEC consists of panel data and contains a large number of variables relating to innovation and economic activity. Data is available from 2003 to 2012. Since we lag our explanatory variables by one year and the variables concerning organizational and commercialization innovations are available only from 2008, our analysis is based on the data from 2007 to 2012. Firms included in the analysis are those that have available data for all the period— we thus obtaining a balanced panel with 5,392 firms and 26,960 observations.

Table 1. Gender composition (%) and innovation activity (percentage of firms innovating) by technological and knowledge intensity. Period 2007-2012

	Manufactures		Services	
	High-Tech	Low-Tech	KIS	Non-KIS
Gender Worker composition				
Total employees				
Women	12.58%	07.80%	17.75%	05.88%
Men	87.42%	92.20%	82.25%	94.12%
R&D department				
Women	25.10%	27.40%	34.38%	58.99%
Men	74.90%	72.60%	65.62%	41.01%
Percentage of firms carrying out each type of innovation				
Product	68.78%	49.78%	67.21%	34.33%
Process	58.69%	57.44%	52.80%	49.40%
Marketing	33.79%	29.41%	34.57%	23.36%
Organization	47.90%	40.22%	52.81%	45.05%

Source: author's elaboration from PITEC database

Table 1 shows the gender data composition for the total workforce and R&D employees. The data is classified, distinguishing the technological and the knowledge intensity of manufacturing and service sectors. As may be observed, firms belonging to high technological manufacturing sectors (High-Tech) employ more males than females in both cases, for the total employees and also for the R&D department.

Similar results are obtained for knowledge intensive services (KIS), where women are better represented than in manufacturing. Conversely, low technological manufacturing sectors (Low-Tech) employ also a larger percentage of men than women in both cases, however non knowledge intensive services (Non-KIS) employ more women for the R&D department. We must have in mind that Non-KIS sectors are labour intensive and traditionally developed by female labour.

Concerning the different types of innovations carried out by firms in regard to their technological and knowledge intensity, Table 1 shows that high-tech manufacturing firms and KIS firms carry out more product innovations, followed by processes innovations, while around the 50% of firms in non-KIS and low-tech manufacturing sectors carry out process innovations. However, low-tech firms are more prone to product innovation (49.78%), while firms in non-KIS sectors are more prone to develop organizational innovations (45.05%).

3.2. Econometric model specification

To estimate the impact of gender diversity on innovation output, we use an innovation production function where, inter alia, a firm's innovation output depends on gender diversity. Equation (1) specifies the estimated innovation production function

$$\Pr(Innovate)_{i,t} = \beta_0 + \beta_1 Z_{i,t-1} + \beta_2 gender_{i,t-1} + \eta_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

where Pr() is the probability of innovating and where $innovate$ is a dummy variable taking a value of 1 if a firm innovates and 0 otherwise. Four different dependent variables are considered and correspond to the four different types of innovation. $Product$ takes a value equal to 1 when a firm declares that it carries out product innovation (either goods or services) and 0 otherwise. $Process$ takes a value equal to 1 when a firm claims to have carried out process innovation and 0 otherwise, $marketing$ takes a value equal to 1 if a firm declares that it carried out an innovation related to an introduction in the marketand finally $organization$ takes a value equal to 1 if a firm declares that they carried out an innovation in the organization.The equation also includes a set of firm characteristics represented by $Z_{i,t-1}$ .Also, η_i industry dummy variables and δ_t temporal dummies are included to control by non-observable industry-specific factors and those factors that are common to all industries, but which are time-variant.

Due to the fact that the dependent variable in Equation (1) is a binary variable of innovation output, the use of a probit or logit model is recommended. However, the four different types of innovation considered in the analysis are likely to be driven by common unobservable factors, leading to the possibility that the error terms will be correlated across equations. This implies that the decision by a firm to engage in one type of innovation could be related to that same firm’s decision to engage other types of innovation. If this is the case, the estimation of a series of binary probit models for each different type of innovation output will be inefficient. For this reason, we use a multivariate probit model to estimate Equation (1). This uses information from the variance/covariance matrix of the estimated model to capture interdependencies between the series of probit equations and to provide efficient estimates of the coefficients and standard errors of the model (Greene, 2008). A Chi-square test of independence shows that the differences between the coefficients are statistically significant; hence it confirms a joint significance of the dependent variable, indicating that a multivariate probit model is preferred (see Table 2 and Table 3).

3.3. Explanatory variables

As explanatory variables, we include a common set of lagged control variables to avoid double causality. $lsize$ is the log of the average number of total employees and $lage$ is the log of the age of the firm. $lRDexp$ and $lRDint$ are the logs of the expenditure on external and internal R&D per employee respectively, as Cohen and Levinthal (1990) show the total expenditure on R&D improves the absorptive capacity of firms, thus affecting their ability to innovate. Another important control variable is $ltraining$, this variable measures the total expenditure on R&D training activities by employee —this training could improve employees skills and their absorptive capacity, affecting also firm innovation capacity. The literature shows that cooperation in innovation also affects firm innovation (Segarra-Blasco and Arauzo-Carod, 2008; Simonen and McCann, 2008; Chun and Mun, 2012), in this regard we include the variable $coop$ as a dummy variable that takes a value of 1 if a firm cooperates, and 0 otherwise. The variable exp is another dummy variable taking a value of 1 if a firm exports and 0 otherwise. International markets bring firms increased competition but also access to more and new sources of information and knowledge that increase their probability of innovating. Belonging to a company group also may affect the probability of innovating; for this reason we include the variable $group$ taking a value of 1 if a firm belongs to a group and 0 otherwise. The dummy variable $hightech-kis$ takes a value of 1 if a firm belongs to the high-tech and KIS sectors. We consider that knowledge intensive firms have a greater propensity to innovate than their counterparts. Finally, $lhcstock$ is a proxy for the education level of the R&D team and is measured as the average number of years of education. See Table A.1 in the Appendix for the summary statistics and Table A.2 for the Pearson correlations.

3.4. Gender diversity variables

To measure gender diversity we consider the Blau index, in line with Díaz-García et al. (2014). This index has been commonly used to measure demographic heterogeneity and it is accepted as the norm in the field. In addition to the Blau index, there are other options for measuring diversity, see Harrison and Klein (2007). However, the Blau index is preferred in our case, because the Shannon-Weaver entropy alternative index is expressed in a logarithmic form and it cannot be calculated when a category is not represented.

The formulation index is as follow,

$$B = \left[1 - \sum_{i=1}^{N} p_i^2\right] \qquad (2)$$

where *B* is the value of the Blau index, *p* is the proportion of the percentage of members in the i^{th} of the *N* categories. In our case, *N*=2 due to the fact that we have only two categories; men or women. The value of the index in our case ranges from 0 to 0.5, where 0 means single-sex teams and 0.5 means egalitarian teams. The value of the Blau index is represented by the variable $gender$. To compare gender diversity in R&D departments and gender diversity on total employees, we calculate the index twice. First, the index considers the information for the workforce in the R&D department. The index uses the percentage of women and men in the R&D department to analyse the impact of gender diversity of R&D teams on innovation outputs. Second, the index is estimated with the information for the total workforce in the firm. The index uses the percentage of women and men employed in the firm to analyse the impact of total gender diversity on innovation output.

A weakness of this index is that it does not take into account team size, giving the value 0.5 to 2-member teams composed of one woman and one man and also giving the same index value to bigger teams e.g. 50-member team of 25 women and 25 men. We argue that the effort of having a diverse workforce is more difficult in the second case than in the first, therefore we argue that diversity benefits must be different from bigger or smaller groups. Furthermore, we assume that the impact of gender diversity on innovation output must be sensitive to the team size. To deal with that, we additionally construct four variables $gender1$, $gender2$, $gender3$ and $gender4$, taking the Blau index value for different team sizes. The first, $gender1$, takes the value of the Blau index when group size is smaller than 10, $gender2$ takes the value of the Blau index when group size is between 10 and 49, $gender3$ takes the value of the Blau index if group size is between 50 and 249 and $gender4$ takes the value of the Blau Index if group size is larger than 250.[1] As in the previous case, we construct the variables taking values of the Blau index obtained from R&D teams when we test how R&D gender diversity affects firm innovation output and then we construct these four variables using the Blau index obtained from the total workforce when we test how gender diversity on total employees affect firm innovation.

4. Empirical results

The main results of the empirical analyses are presented in this section.

Table 2 presents the results for the whole database considering our index of gender diversity for the total workforce in the firm, Columns (1) to (8), and our index of gender diversity in the R&D department, Columns (9) to (16).

[1] We try with different team distributions obtaining similar results.

Table 2. Multivariate probit for gender diversity of the total workshop and of the R&D department

	Gender diversity of all employees								Gender diversity of employees in the R&D department							
	Product	**Process**	**Marketing**	**Organization**	**Product**	**Process**	**Marketing**	**Organization**	**Product**	**Process**	**Marketing**	**Organization**	**Product**	**Process**	**Marketing**	**Organization**
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**
$gender_{i,t-1}$	0.486***	0.212***	0.530***	0.512***					0.299***	-0.0150	0.0900	0.173***				
	(0.0647)	(0.0616)	(0.0644)	(0.0608)					(0.0669)	(0.0633)	(0.0594)	(0.0588)				
$gender1_{i,t-1}$					0.422***	0.199***	0.549***	0.457***					0.208***	-0.0599	0.103*	0.0991
					(0.0652)	(0.0623)	(0.0654)	(0.0614)					(0.0690)	(0.0656)	(0.0618)	(0.0610)
$gender2_{i,t-1}$					0.970***	0.349***	0.489***	0.821***					0.725***	0.179*	0.0354	0.490***
					(0.0959)	(0.0892)	(0.0861)	(0.0845)					(0.106)	(0.0976)	(0.0892)	(0.0899)
$gender3_{i,t-1}$					0.872***	0.0487	0.253*	0.904***					0.686***	0.0764	0.0174	0.676***
					(0.165)	(0.151)	(0.139)	(0.145)					(0.191)	(0.175)	(0.157)	(0.166)
$gender4_{i,t-1}$					1.632***	0.559	0.375	1.428***					1.032**	0.513	0.0565	0.803*
					(0.489)	(0.430)	(0.329)	(0.429)					(0.490)	(0.461)	(0.367)	(0.444)
$lRDext_{i,t-1}$	0.0067***	0.0043***	0.0057***	0.0073***	0.0062***	0.0042***	0.0059***	0.0070***	0.0010	0.0020*	0.0051***	0.0063***	0.0009	0.0020*	0.0051***	0.0063***
	(0.0010)	(0.0009)	(0.0009)	(0.0009)	(0.0010)	(0.0009)	(0.0009)	(0.0009)	(0.0011)	(0.0011)	(0.0010)	(0.0010)	(0.0011)	(0.0011)	(0.0010)	(0.0010)
$lRDint_{i,t-1}$	0.0435***	0.0315***	0.0234***	0.0243***	0.0421***	0.0311***	0.0237***	0.0232***	0.106***	0.00292	-0.0008	0.0433***	0.0837***	-0.0069	0.0025	0.0214*
	(0.0013)	(0.0013)	(0.0012)	(0.0012)	(0.0013)	(0.0013)	(0.0013)	(0.0012)	(0.0119)	(0.0113)	(0.0106)	(0.0105)	(0.0130)	(0.0124)	(0.0116)	(0.0115)
$coop_{i,t-1}$	0.352***	0.354***	0.176***	0.261***	0.340***	0.352***	0.178***	0.252***	0.239***	0.223***	0.138***	0.217***	0.234***	0.221***	0.139***	0.214***
	(0.0218)	(0.0208)	(0.0199)	(0.0194)	(0.0219)	(0.0209)	(0.0199)	(0.0195)	(0.0266)	(0.0249)	(0.0230)	(0.0229)	(0.0266)	(0.0250)	(0.0230)	(0.0229)
$ltraining_{i,t-1}$	0.0215***	0.0313***	0.0179***	0.0249***	0.0211***	0.0312***	0.0180***	0.0246***	0.0185***	0.0237***	0.0167***	0.0231***	0.0183***	0.0236***	0.0167***	0.0229***
	(0.0014)	(0.0014)	(0.0012)	(0.0012)	(0.0014)	(0.0014)	(0.0012)	(0.0012)	(0.0016)	(0.0015)	(0.0013)	(0.0013)	(0.0016)	(0.0015)	(0.0013)	(0.0013)
$lhcstock_{i,t-1}$	0.0053**	-0.0118***	0.0056**	-0.0043**	0.0055**	-0.0117***	0.0055**	-0.0042*	0.0039	-0.0091***	0.0092***	-0.0047**	0.0060**	-0.0081***	0.0089***	-0.0027
	(0.0025)	(0.0023)	(0.0022)	(0.0022)	(0.0025)	(0.0023)	(0.0022)	(0.0022)	(0.0026)	(0.0025)	(0.0023)	(0.0023)	(0.0027)	(0.0025)	(0.0024)	(0.0023)
$lnsize_{i,t-1}$	0.0802***	0.145***	0.0523***	0.153***	0.0656***	0.144***	0.0589***	0.141***	0.121***	0.167***	0.0406***	0.191***	0.0886***	0.153***	0.0455***	0.159***
	(0.0081)	(0.0077)	(0.0078)	(0.0075)	(0.0085)	(0.0081)	(0.0083)	(0.0079)	(0.0130)	(0.0123)	(0.0111)	(0.0115)	(0.0152)	(0.0145)	(0.0133)	(0.0134)
$lage_{i,t-1}$	-0.0042	0.0078	-0.0101	-0.0139	-0.0038	0.0080	-0.0104	-0.0131	0.0372*	-0.0113	-0.0237	-0.0623***	0.0380*	-0.0105	-0.0241	-0.0604***
	(0.0144)	(0.0137)	(0.0138)	(0.0132)	(0.0144)	(0.0137)	(0.0138)	(0.0132)	(0.0197)	(0.0188)	(0.0173)	(0.0174)	(0.0198)	(0.0188)	(0.0173)	(0.0174)
$exp_{i,t-1}$	0.157***	0.0572***	0.145***	0.0594***	0.157***	0.0568***	0.145***	0.0602***	0.116***	-0.0177	0.127***	0.0531**	0.117***	-0.0177	0.126***	0.0542**
	(0.0196)	(0.0188)	(0.0189)	(0.0182)	(0.0197)	(0.0188)	(0.0189)	(0.0182)	(0.0268)	(0.0254)	(0.0236)	(0.0236)	(0.0268)	(0.0254)	(0.0236)	(0.0236)
$group_{i,t-1}$	-0.0415*	-0.0229	-0.109***	-0.0114	-0.0472**	-0.0257	-0.109***	-0.0160	-0.135***	-0.0474*	-0.165***	-0.0943***	-0.137***	-0.0486*	-0.165***	-0.0936***
	(0.0214)	(0.0203)	(0.0204)	(0.0195)	(0.0215)	(0.0204)	(0.0205)	(0.0196)	(0.0285)	(0.0270)	(0.0251)	(0.0250)	(0.0287)	(0.0271)	(0.0252)	(0.0251)
$hightech\text{-}kis_{i,t-1}$	0.571***	0.243	-0.466***	0.0407	0.791***	0.0362	0.644***	0.404**	1.765***	-4.853	0.504	-0.0232	1.693***	-8.912	0.512	-0.0657
	(0.167)	(0.155)	(0.171)	(0.153)	(0.177)	(0.162)	(0.167)	(0.161)	(0.448)	(157.1)	(0.428)	(0.491)	(0.447)	(1.640e+06)	(0.429)	(0.487)
Constant	-0.810***	-0.804***	-0.799***	-0.817***	-0.794***	-0.809***	-0.820***	-0.787***	-1.754***	4.652	-0.0328	-0.0983	-1.441***	8.816	-0.0790	0.187
	(0.140)	(0.129)	(0.140)	(0.128)	(0.140)	(0.129)	(0.140)	(0.128)	(0.406)	(157.1)	(0.418)	(0.478)	(0.411)	(1.640e+06)	(0.425)	(0.477)
Observations	26,956				26,956				15,340				15,340			
ρ21	0.296***				0.296***				0.204***				0.203***			
ρ31	0.321***				0.322***				0.305***				0.306***			
ρ41	0.231***				0.230***				0.223***				0.222***			
ρ32	0.336***				0.336***				0.306***				0.307***			
ρ42	0.406***				0.406***				0.390***				0.390***			
ρ43	0.567***				0.568***				0.562***				0.563***			
$\chi 2$ (jointly significance)	7061***				7065***				3854***				3858***			
Wald $\chi 2$	15386***				15432***				4252***				4252***			
Log Likelihood	-56495				-56441				-33445				-33414			

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Time and sectorial dummies included.

First, gender diversity has a positive impact when considering the total workforce in a firm. These results are significant regardless the type of innovation. Furthermore, when considering the interrelationship between gender diversity and firm size we observe that there is a positive relationship between gender diversity and the probability of innovating. Hence, gender diversity in larger firms exerts a larger positive impact on the probability of innovating than it does in smaller firms. This trend is particularly clear for the probability of product and organizational innovation; although for micro (*gender1*) and small firms (*gender2*) gender diversity seems to be also significant for process and marketing innovation.

When taking a more direct approach to the gender composition in the R&D department, Columns (9) to (16), we observe that the impact is only significant for product and organizational innovations; for process and marketing innovations these variables are not significant. Hence, our results seem to confirm that the R&D department is more relevant to the capacity of the firm for generating product and organizational innovations than to the process and marketing innovations. The former types of innovations may be under the R&D department's influence and, hence, the gender composition may have a greater effect on a firm’s capacity to innovate. Finally, when considering the analysis of the team size in the R&D department our results are similar to the previous ones. Gender diversity in the R&D department shows a positive and increasing impact on the propensity to innovate, which is larger among larger firms than in smaller firms. When considering the process and marketing innovation, Columns (14)-(15), this effect is not so clear, the coefficient only being significant for small firms (*gender2*) in process innovations and for micro firms (*gender1*) in marketing innovations.

Second, when considering the whole database, in regard to those variables more closely related with innovation activity, we observe that external and internal R&D investment per employee shows a positive impact regardless of the type of innovation. However, the sign remains significant only for some types of innovations when considering those firms with a R&D department. In particular, we observe that external R&D investment is non-significant for the capacity to introduce product innovations, while the internal R&D investment is non-significant for the process and marketing innovations. These results are coherent given that process and marketing innovations may be more closely related to the acquisition of external knowledge, while for the product and organizational innovations their main source may come from the firm’s internal competencies. The cooperation activity in innovation also shows a significant and positive impact on the probability to innovate, regardless the type of innovation. Hence, cooperation will cause an increase in the capacity to generate all types of innovation due to the fact that cooperation seeks to innovate or because cooperation extends the sources of information.

Third, firms investing in training show a larger probability of innovating. Hence, the human capital stock shows a diverse impact. Firms with a larger human capital stock in the R&D department are more prone to introduce more product and marketing innovations, but fewer process and organizational innovations. These results may point to the fact that the level of R&D employee’s education exerts a positive influence on the capacity to introduce new products in the market and to innovate in marketing. Both types of innovations are closely related to the need for understanding how a market works and this may be closely connected with the capacity to interpret these market signals.

Finally, regarding with the impact of the firm characteristics, firm size (*lnsize*) shows a positive impact on the propensity to innovate, regardless of the innovation, therefore, larger firms have more capacity to generate innovation. Firm age (*lnage*) shows a non-significant impact when considering the whole sample, Columns (1) to (8), while it shows a positive sign on product innovation and negative sign on organizational innovation when considering only the firms with R&D department. This result suggests that older firms may be more prone to introduce product innovations but fewer organizational innovations. Hence, firms with more experience take profit from their learning experience in order to introduce new products, while this experience may make the introduction of organizational innovations more difficult due to the existence of internal routines on the company. Export activity shows a positive impact on the probability to innovate, regardless the type of innovation and whether we consider the whole sample or firms with a R&D department. The only exception is the non-significant impact on process innovation for firms with a R&D department. Regarding firms belonging to a group, these firms show a lower probability of introducing product and marketing innovations when considering the whole database, this impact becoming significant for all the types of innovations when considering only firms with an R&D department. This may suggest a trapping effect whereby company headquarters decides strategically where to invest the financial resources in order to focus the efforts of the different firms. As a consequence, the capacity to decide the efforts devoted to innovation projects is lower for firms belonging to groups.

The dummy variable for knowledge and technologically intensive firms (*hightech-kis)* always shows a positive and significant impact for product innovations while, for the rest of innovations, the impact differs depending on the sample. When we control for the impact of the firm size of the total workforce, high-tech and KIS firms are more prone to innovate in marketing and organization. However, when we control for the impact of the team size of the R&D department, firms in the high-tech and KIS sectors show a larger propensity to introduce product innovations.

Given the different nature of manufacturing and service sectors, we focus also on the differences that the gender diversity may exert on the probability of innovating. Table 3 shows the main coefficients of the gender diversity controlling for the main variables in Table 2. In line with Fernandez-Sastre (2015), our results show that for manufacturing industries, our index of gender diversity shows a positive and significant impact on the probability of innovating, regardless the type of innovation and sample. However, when taking firm size into account, we observed an increase and positive impact for product and organizational innovation in the gender structure of the whole company, Columns (5) and (8). Furthermore, gender diversity always shows a positive and significant impact on the probability to innovate for micro (*gender1*) and small firms (*gender2*).

Table 3. Multivariate Probit for Manufacturing and Service sectors

	Gender diversity of all employees								Gender diversity of employees in the R&D department							
	Whole				Firm size difference				Whole				Firm size difference			
VARIABLES	Product (1)	Process (2)	Marketing (3)	Organization (4)	Product (5)	Process (6)	Marketing (7)	Organization (8)	Product (9)	Process (10)	Marketing (11)	Organization (12)	Product (13)	Process (14)	Marketing (15)	Organization (16)
MANUFACTURES																
gender $_{i,t-1}$	0.352***	0.227***	0.835***	0.565***					0.273***	0.131**	0.315***	0.234***				
	(0.0652)	(0.0620)	(0.0643)	(0.0627)					(0.0684)	(0.0651)	(0.0599)	(0.0599)				
gender1 $_{i,t-1}$					0.294***	0.226***	0.869***	0.499***					0.184***	0.0876	0.303***	0.130**
					(0.0655)	(0.0630)	(0.0658)	(0.0637)					(0.0711)	(0.0683)	(0.0630)	(0.0638)
gender2 $_{i,t-1}$					0.838***	0.356***	0.778***	0.953***					0.707***	0.355***	0.360***	0.689***
					(0.110)	(0.101)	(0.0928)	(0.0939)					(0.122)	(0.112)	(0.0972)	(0.102)
gender3 $_{i,t-1}$					0.475**	-0.385**	0.348**	0.859***					0.533**	-0.132	0.334*	0.678***
					(0.227)	(0.190)	(0.171)	(0.191)					(0.251)	(0.221)	(0.194)	(0.217)
gender4 $_{i,t-1}$					0.554	1.239	0.655	1.880***					0.146	1.170	0.718	0.947
					(0.984)	(0.757)	(0.564)	(0.700)					(0.852)	(0.738)	(0.586)	(0.806)
Observations	21,573				21,573				12,337				12,337			
ρ21	0.269***				0.269***				0.154***				0.153***			
ρ31	0.324***				0.325***				0.301***				0.302***			
ρ41	0.239***				0.238***				0.191***				0.189***			
ρ32	0.323***				0.323***				0.286***				0.286***			
ρ42	0.411***				0.411***				0.378***				0.377***			
ρ43	0.548***				0.549***				0.553***				0.554***			
χ2 (jointly significance)	5354***				5364***				2981***				2983***			
Wald χ2	11027***				11053***				2506***				2563***			
Log Likelihood	-45644				-45593				-27250				-27219			
SERVICES																
gender $_{i,t-1}$	0.478***	0.484***	0.247	0.340**					-0.324**	-0.277*	-0.269*	-0.128				
	(0.145)	(0.146)	(0.153)	(0.146)					(0.155)	(0.146)	(0.144)	(0.143)				
gender1 $_{i,t-1}$					0.501***	0.468***	0.322**	0.312**					-0.287*	-0.383**	-0.114	-0.106
					(0.147)	(0.148)	(0.159)	(0.147)					(0.167)	(0.158)	(0.159)	(0.158)
gender2 $_{i,t-1}$					0.509***	0.542***	0.121	0.440**					-0.368*	-0.0513	-0.521***	-0.128
					(0.187)	(0.182)	(0.185)	(0.179)					(0.197)	(0.188)	(0.182)	(0.186)
gender3 $_{i,t-1}$					-0.0789	0.618**	-0.540**	0.588**					-0.827***	0.215	-1.105***	0.00590
					(0.245)	(0.241)	(0.229)	(0.237)					(0.293)	(0.288)	(0.268)	(0.288)
gender4 $_{i,t-1}$					1.147*	1.133**	-0.362	1.193**					0.104	0.518	-1.123**	0.545
					(0.591)	(0.487)	(0.402)	(0.513)					(0.670)	(0.544)	(0.499)	(0.614)
Observations	5,383				5,383				3,003				3,003			
ρ21	0.346***				0.348***				0.221***				0.224***			
ρ31	0.379***				0.379***				0.389***				0.387***			
ρ41	0.279***				0.281***				0.259***				0.260***			
ρ32	0.372***				0.376***				0.342***				0.348***			
ρ42	0.406***				0.407***				0.381***				0.382***			
ρ43	0.604***				0.610***				0.609***				0.613***			
χ2 (jointly significance)	1674***				1686***				892.5***				899.4***			
Wald χ2	2545***				2598***				803.9***				822.1			
Log Likelihood	-11434				-11411				-6667				-6651			

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Time and sectorial dummies included.

When considering the gender diversity of the R&D departments of manufacturing firms, (Columns (13) to (16)), our results show that for micro and small firms a more gender-diverse R&D department affects significantly and positively the propensity to innovate, regardless of the type of innovation. While, in firms with team between 50 and 249 workers, having a more diverse R&D team affects significantly and positively the propensity to innovate on product, marketing and organization.

Surprisingly, our results for the service industries show a different pattern depending on the sample. On the one hand, for the whole sample, our index of gender diversity shows a positive impact (Columns (1) to (4)), regardless the variable except for marketing innovations. On the other hand, for firms with an R&D department the gender diversity of this department shows a negative influence on the probability of innovating regardless the variable (Columns (9) to (12)), but which is not significant on the probability of carrying out organizational innovations. Furthermore, if we disentangle the impact of gender diversity according to firm size (Columns (5) to (8)), we observe that firms with less than 10 employees (*gender1*) with a gender-diverse structure show a positive and significant impact on the probability to innovate. For firms between 10 and 49 employees (*gender2*) having a more gender-diverse structure will have a positive and significant impact on the probability to introduce product, process and organizational innovations. Firms between 50 and 249 employees (*gender3*) will be more prone to carry out process and organizational innovations, but less so for marketing innovations. Finally, larger firms with a gender-diverse structure (*gender4*) show it having a positive and significant impact on the propensity to innovate in product, process and organization.

When considering the size of the R&D team, smaller firms (*gender1*) with a more gender-diverse R&D department show a significantly lower propensity for carrying out process innovations. Firms with R&D teams between 10 and 249 employees with a more gender-diverse R&D teams (*gender2* and *gender3*) will have a lower propensity to innovate in product and marketing. Finally, larger firms in the service sectors which present a gender-diverse R&D team will show a lower propensity to carry out marketing innovations.

Hence, our results highlight the existence of differences between manufacturing and service industries. Service industries which comprise a broad range of activities in which consumer-provider interaction has traditionally been very high (e.g., education and health services) are more prone to incorporate process innovations. So the advances in computer-mediated technology (including online access to information, two-way student-teacher communication, multimedia systems), for example, are significantly enhancing the effectiveness of long distance education. Our results seem to point out the highly intensive consumer-provider interaction where the R&D department may not be so important in generating a proper environment in the firm to innovate, while a more gender-diverse workforce structure has a positive impact on the probability of innovating. Therefore, there seems that it is not only necessary to take into account the gender structure in the R&D to analyse the probability of innovating, but it is also necessary to know the gender structure for the whole company.

5. Conclusions

Gender diversity on teams has been addressed recently as an important factor in generating positive synergies between groups and in increasing the innovative performance of firms. At a political level, gender diversity has been also addressed as a priority in the discourse regarding promoting the integration of women in the labour market. A more diverse workforce may have a positive effect, given that education and competencies may complement each other (Lazear1999; Berliant and Fujita,2011; Baer, et al. 2013). Regardless of the increasing interest in the relationship between gender and innovation, there are still few scholars focusing on innovation and gender diversity.

In this article, we analyse the relationship between gender diversity and the four types of innovation output considered into the Oslo Manual (2005), taking into account the team size.

Our study differs from the previous literature in several ways. Firstly, we consider that team size may modify the impact of gender diversity on the innovation output. Secondly, we consider gender diversity on R&D departments that are more related to innovation products, and also we include gender diversity in the firm's workforce. This approach is essential for our aim of determining disparities in the impact of diversity on the four types of innovation output. Our work is in line with Díaz-García et al. (2013) and Fernandez-Sastre (2015), however both those authors only consider gender diversity on R&D teams. Finally, our analysis includes manufacturing and service sector, allowing us to observe particularities related to the technological and the knowledge intensity in the sectors.

Our results demonstrate the importance of separately analysing gender diversity in R&D teams and in the total workforce, in particular when distinguishing between manufacturing and service sectors. Another important issue that emerged from our analysis is that team size matters, in both cases gender diversity on R&D teams or in total workforce had different effects if we take size team into account. For the pooled estimation we find that gender diversity in both the R&D department and the total workforce exerted a larger positive impact on the probability of carrying out product and organizational innovations for larger firms than in smaller firms. This effect it is less clear in the case of marketing and process innovation, where its impact is only significant for micro and small firms. These size effects are still more important when we distinguish between manufacturing and service sectors.

Hence we conclude that increasing gender equality, especially in the manufacturing industries, increases a firm's probability of innovating. Furthermore, we stress the importance of considering size when analysing gender diversity in works teams. Innovation is not a phenomenon that occurs exclusively on R&D departments; it is a process that involves the whole organization of the company. For this reason, aiming to explain how gender diversity affects the probability of all innovation types is not an accurate approach; we try to approximate it by distinguishing between the R&D team and the total workforce.

Finally, we have to comment on three limitations of our analysis which are due to data unavailability. Firstly, the data does not allow us to make a more accurate comparison of gender composition between different departments. Hence, our analysis is limited to the binary analysis of gender composition in the R&D department and in the whole company. Secondly, we could only control for the level of education of the R&D department and not of the total workforce. Thirdly, current definitions of innovations have remarkable restrictions when we aim to capture all of the contributions of gender diversity. The latest edition of the Oslo Manual (2005) show that innovation starts with R&D investments and finishes with innovation output, without remarking on the role of the innovation process. This definition conceptualizes innovation as gender neutral, without taking into account the effects of the interaction of women and men in R&D or in creative innovation process, in this regard, deeper analysis is needed.

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Table A.1. Summary statistics (mean and standard deviation in parenthesis). 2007-2012.

	High-Tech	**Low-Tech**	**KIS**	**Non-KIS**
Variable				
product $_{i,t}$	0.688	0.498	0.672	0.343
	(0.46)	(0.5)	(0.46)	(0.47)
process $_{i,t}$	0.587	0.574	0.528	0.494
	(0.49)	(0.49)	(0.49)	(0.5)
marketing $_{i,t}$	0.338	0.294	0.346	0.224
	(0.47)	(0.45)	(0.47)	(0.41)
organization $_{i,t}$	0.479	0.402	0.528	0.450
	(0.49)	(0.49)	(0.49)	(0.49)
lsize $_{i,t-1}$	4.000	4.055	3.524	5.100
	(1.39)	(1.35)	(1.59)	(1.86)
lage $_{i,t-1}$	3.149	3.167	2.493	3.227
	(0.65)	(0.64)	(0.54)	(0.87)
exp $_{i,t-1}$	0.660	0.525	0.239	0.046
	(0.47)	(0.49)	(0.42)	(0.2)
group $_{i,t-1}$	0.423	0.363	0.310	0.501
	(0.49)	(0.48)	(0.46)	(0.5)
lRDext $_{i,t-1}$	-8.181	-10.841	-7.863	-13.02
	(11.06)	(9.61)	(11.51)	(7.74)
lRDint $_{i,t-1}$	1.012	-4.774	3.280	-10.52
	(11.25)	(11.88)	(11.07)	(9.99)
ltraining $_{i,t-1}$	-13.147	-14.248	-11.182	-13.39
	(7.26)	(5.91)	(9.15)	(6.86)
hcstock $_{i,t-1}$	7.650	4.379	9.649	2.453
	(6.46)	(5.72)	(6.7)	(5.06)
coop $_{i,t-1}$	0.329	0.245	0.463	0.230
	(0.46)	(0.43)	(0.49)	(0.42)
hightech_kis $_{i,t-1}$	1.000	0.000	1.000	0.000
	(0)	(0)	(0)	(0)
R&D Department (Gender diversity index)				
gender $_{i,t-1}$	0.222	0.234	0.299	0.349
	(0.19)	(0.2)	(0.18)	(0.17)
gender1$_{i,t-1}$	0.119	0.158	0.103	0.175
	(0.18)	(0.2)	(0.17)	(0.21)
gender2 $_{i,t-1}$	0.082	0.068	0.129	0.134
	(0.15)	(0.14)	(0.18)	(0.2)
gender3 $_{i,t-1}$	0.019	0.008	0.058	0.027
	(0.08)	(0.05)	(0.14)	(0.1)
gender4 $_{i,t-1}$	0.002	0.000	0.009	0.008
	(0.02)	(0)	(0.06)	(0.05)
Total employees (Gender diversity index)				
gender $_{i,t-1}$	0.302	0.298	0.372	0.374
	(0.14)	(0.15)	(0.13)	(0.13)
gender1$_{i,t-1}$	0.214	0.257	0.201	0.326
	(0.18)	(0.17)	(0.2)	(0.17)
gender2 $_{i,t-1}$	0.072	0.034	0.117	0.040
	(0.14)	(0.11)	(0.18)	(0.12)
gender3 $_{i,t-1}$	0.015	0.003	0.047	0.006
	(0.07)	(0.03)	(0.13)	(0.05)
gender4 $_{i,t-1}$	0.002	0.000	0.007	0.002
	(0.02)	(0)	(0.05)	(0.03)
Observations				
all firms	9,114	12,463	3,312	2,071
firms with R&D department	6,381	5,960	2,506	497

**Differences between the number of observations of gender variables for R&D department and total employees it is due to the fact that when a firm declares that they have zero workers on R&D department the Blau Index could not be calculated nevertheless when we use this approach for the total employees, all firms declare that have 1 or more workers.

Table A.32. Pearson correlations. 2007-2012.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(1) product $_{i, t}$	1																							
(2) process $_{i, t}$	0.36*	1																						
(3) marketing $_{i, t}$	0.32*	0.28*	1																					
(4) organization $_{i, t}$	0.31*	0.38*	0.45*	1																				
(5) lsize $_{i, t-1}$	0.13*	0.22*	0.09*	0.21*	1																			
(6) lage $_{i, t-1}$	0.00	0.06*	0.02*	0.03*	0.34*	1																		
(7) exp $_{i, t-1}$	0.19*	0.12*	0.12*	0.10*	0.18*	0.19*	1																	
(8) grup $_{i, t-1}$	0.09*	0.12*	0.03*	0.13*	0.50*	0.09*	0.13*	1																
(9) lRDext $_{i, t-1}$	0.26*	0.20*	0.16*	0.22*	0.15*	0.00	0.14*	0.14*	1															
(10) lRDint $_{i, t-1}$	0.50*	0.31*	0.27*	0.30*	0.10*	-0.03*	0.22*	0.09*	0.39*	1														
(11) ltraining $_{i, t-1}$	0.20*	0.20*	0.17*	0.22*	0.11*	0.00	0.04*	0.06*	0.19*	0.22*	1													
(12) hcstock $_{i, t-1}$	0.43*	0.25*	0.24*	0.26*	0.14*	-0.04*	0.18*	0.13*	0.34*	0.82*	0.21*	1												
(13) coop $_{i, t-1}$	0.28*	0.24*	0.17*	0.23*	0.16*	-0.01*	0.10*	0.15*	0.39*	0.36*	0.20*	0.32*	1											
(14) hightech_kis $_{i, t-1}$	0.21*	0.00	0.06*	0.08*	-0.11*	-0.14*	0.09*	0.00	0.14*	0.29*	0.10*	0.31*	0.13*	1										
(15) gender $_{i, t-1}$	0.06*	0.05*	0.05*	0.10*	0.19*	-0.01	-0.01	0.16*	0.17*	0.17*	0.10*	0.08*	0.18*	0.00	1									
(16) gender1 $_{i, t-1}$	-0.03*	-0.02*	0.02*	-0.04*	-0.15*	-0.03*	-0.03*	-0.06*	-0.02*	-0.07*	-0.03*	-0.04*	-0.03*	-0.11*	0.60*	1								
(17) gender2 $_{i, t-1}$	0.07*	0.06*	0.02*	0.11*	0.23*	0.01	0.01*	0.20*	0.16*	0.16*	0.10*	0.08*	0.17*	0.06*	0.38*	-0.36*	1							
(18) gender3 $_{i, t-1}$	0.04*	0.03*	0.00	0.09*	0.27*	0.01*	0.01	0.11*	0.14*	0.22*	0.10*	0.12*	0.14*	0.11*	0.19*	-0.15*	-0.12*	1						
(19) gender4 $_{i, t-1}$	0.02*	0.02*	0.01	0.04*	0.19*	0.01*	0.00	0.05*	0.01	0.08*	0.03*	0.04*	0.06*	0.05*	0.05*	-0.05*	-0.04*	-0.02*	1					
(20) gender $_{i, t-1}$	0.11*	0.08*	0.12*	0.12*	0.11*	-0.01*	0.04*	0.06*	0.10*	0.13*	0.09*	0.15*	0.09*	0.03*	0.39*	0.19*	0.18*	0.13*	0.60*	1				
(21) gender1 $_{i, t-1}$	-0.13*	-0.08*	-0.02*	-0.10*	-0.17*	-0.02*	-0.05*	-0.13*	-0.18*	-0.22*	-0.10*	-0.20*	-0.18*	-0.15*	-0.02*	0.57*	-0.57*	-0.25*	0.38*	-0.36*	1			
(22) gender2 $_{i, t-1}$	0.23*	0.16*	0.13*	0.20*	0.21*	0.00	0.10*	0.19*	0.25*	0.34*	0.17*	0.31*	0.24*	0.16*	0.24*	-0.39*	0.87*	-0.13*	0.19*	-0.15*	-0.12*	1		
(23) gender3 $_{i, t-1}$	0.10*	0.07*	0.04*	0.11*	0.21*	0.01	0.04*	0.10*	0.17*	0.17*	0.11*	0.19*	0.16*	0.13*	0.17*	-0.15*	-0.12*	0.96*	0.05*	-0.05*	-0.04*	-0.02*	1	
(24) gender4 $_{i, t-1}$	0.05*	0.03*	0.02*	0.05*	0.14*	0.01*	0.01*	0.05*	0.03*	0.06*	0.04*	0.07*	0.07*	0.05*	0.05*	-0.05*	-0.04*	-0.02*	0.39*	0.19*	0.18*	0.13*	0.03*	1

* $p<0.05$

Table A.3 Variable description

Variables		Description	Type
Dependent variables	product $_{i,t}$	Takes a value equal to 1 if a firm declares to have carried out a product innovation from *t-2* to *t*.	Dummy
	process $_{i,t}$	Takes a value equal to 1 if a firm declares to have carried out process a innovation from *t-2* to *t*.	Dummy
	organization $_{i,t}$	Takes a value equal to 1 if a firm declares to have carried out an organizational innovation from *t-2* to *t*.	Dummy
	marketing $_{i,t}$	Takes a value equal to 1 if firm declare that at least some of these marketing innovations actions was carried out from t-2 to t.	Dummy
Firms' characteristics	$lsize_{i,t-1}$	Is the number of employees in t-1	Number (in logs)
	$lRDext_{i,t-1}$	Expenditure on external R&D per employee in logs	Number (in logs)
	$lRDint_{i,t-1}$	Expenditure on internal R&D per employee in logs	Number (in logs)
	$ltraining_{i,t-1}$	Training expenditure for innovation activities per employee in logs	Number (in logs)
	$coop_{i,t-1}$	Takes a value equal to 1 if the firm has cooperated with other companies from t -2 to t	Dummy
	$exp_{i,t-1}$	Takes a value equal to 1 if the firm exported from t -2 to t	Dummy
	$group_{i,t-1}$	Takes a value equal to 1 if the firm is part of a group from t-2 to t	Dummy
	$lage_{i,t-1}$	Is the age of the firm	Number (in logs)
	$lhcstock_{i,t-1}$	Average years of studies of the R&D department. Employees with a PhD have 21 years on average of education, licentiates have 17 years on average of education, bachelors have 16 years, and other studies 11 years)	Number (in logs)
	$hightech\text{-}kis_{i,t-1}$	Takes a value equal to1 for firms in manufacturing and service knowledge intensive sectors	Dummy
Gender diversity	$gender_{i,t-1}$	Blau Index using R&D employees for t-1 or Blau Index using total employees for t-1	Number
	$gender1_{i,t-1}$	Blau Index using R&D employees for t-1 for firms with R&D teams from 1 to 9 or Blau Index using total employees for t-1 for firms with 1 to 9 employees	Number
	$gender2_{i,t-1}$	Blau Index using R&D employees for t-1 for firms with R&D teams from 10 to 49 or Blau Index using total employees for t-1 for firms with 10 to 49 employees	Number
	$gender3_{i,t-1}$	Blau Index using R&D employees for t-1 for firms with R&D teams from 50 to 249 or Blau Index using total employees for t-1 for firms with 50 to 250 employees	Number
	$gender4_{i,t-1}$	Blau Index using R&D employees for t-1 for firms with R&D teams bigger than 250 or Blau Index using total employees for t-1 for firms with more than 250 employees	Number