

Gender diversity, R&D teams and patents: An application to Spanish firms

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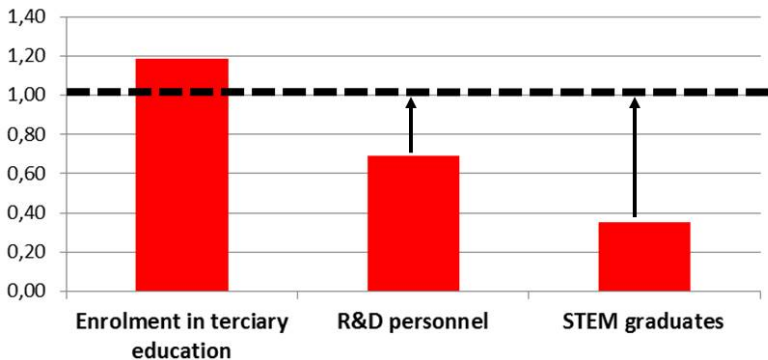
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Female/male ratio



Source: World Economic Forum (2017): The Global Gender Gap report (2016)

- Innovation has been conceived as a gender-neutral process (Alsos et al., 2013).
- The patent system is a channel which encourages new knowledge...
- ... but also may attract women to STEM careers (Burk, 2011).
- However, it is necessary to obtain empirical evidence of the relationship between gender diversity and the knowledge generation.

MAIN PURPOSE:

- We analyse the impact of gender diversity in R&D teams on the registration of patents.
- Empirical analysis of Spanish innovative firms.
- We classify patents depending on their territorial coverage

Advancing results: Gender diversity exerts a dual effect

Why does gender diversity matter in the patent system?

- Low presence of women in R&D labs. Why?
 - It may be due to common factors affecting the decision of women to follow STEM studies,
 - but also to factors affecting the decision to follow a career in a R&D department
- Importance?
 - Exclusion of women from full participation in the patent system
 - but also exclusion of knowledge (Burk, 2011)

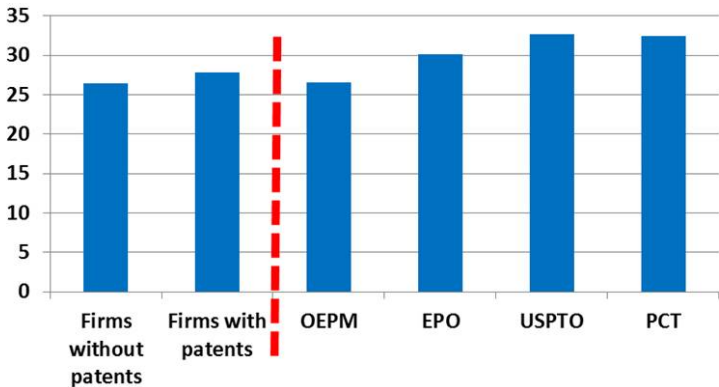
- Different skills and knowledge \Rightarrow useful to develop knowledge which may be valuable for patents.
- Gender diversity has positive impacts on tasks that require creativity (Polzer et al., 2009) , complex work (Wegge et al., 2008) and non-routinized tasks (Jackson, 1992).
 - Gender diversity exerts a positive impact
- But, gender diversity can generate less cohesion, less cooperation and more absentim and job turonover (Harrison et al., 1998; Chatman and Flynn, 2001; Chatman and Sparato, 2005).
 - Gender diversity exerts a negative impact

- PITEC - Panel de Innovación Tecnológica following the Oslo Manual guidelines (OECD, 1997). Period 2004-14
- Panel data of more than 12,000 Spanish innovative firms
- Patents: Spanish patent office, European patent office, US patent office and Patent cooperation treaty

SAMPLE SELECTION:

- Firms with full information.
- Firms without employment-related problems (high seasonality, bankruptcy,...).
- Final sample: 40,032 observations from 4,085 firms.

Percentage of women in R&D labs



Source: own elaboration from PITEC

We apply a two-step procedure to control for sample selection. Equation (1) estimates the probability that a firm has an R&D department.

$$y_{1i,t} = \begin{cases} 1 & \text{if } y_{1i,t}^* = f(X_{i,t-1}\beta_1 + \gamma_{1,t} + \epsilon_{1i,t}) > 0 \\ 0 & \text{otherwise} \end{cases}$$

where,

$y_{1i,t}$ is a dummy variable equal to 1 if the firm has an R&D department.

X are control variables: firm age and size, time and sector dummies. Exclusion restrictions: capital labour intensity, sectoral blau index.

β and γ are parameters and ϵ is the error term

Equation (2) estimates the capacity that a firm generates patents taking into account the sample selection:

$$y_{2i,t} = \beta_{20} + Z'_{i,t-1}\beta_{21} + \beta_{22} \text{ gender}'_{i,t-1} + \rho_{2,t} + \gamma_{2,t} + \epsilon_{2i,t}$$

where,

$y_{2i,t}$ is the natural log of patents

gender is the Blau Index

Z are control variables: age and size, group, export, internal and external R&D intensity, training intensity, R&D cooperation, size R&D department, human capital (males and females) and time and sector dummies.

It includes the Mills ratio

ρ , β and γ are parameters and ϵ is the error term

Potential reverse causality bias between gender diversity and patents:

- 1 Gender diversity may be a determinant of knowledge generation.
- 2 But a firm's knowledge capacity attracts researchers with more capacity to generate knowledge.
- 3 We adopt an instrumental variable approach to estimate Equation (2).
- 4 Instruments: sectoral average of the Blau Index, firm size and age, and three types of organizational innovations: organizational procedures in the firm, organizational methods, new managerial methods.

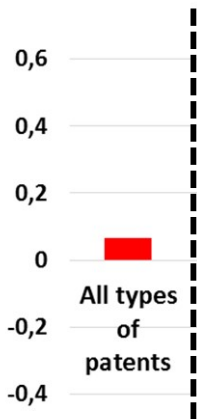
Table 1. Conditional estimates of the impact of gender diversity on the total number of patents.

	Patents	OEPM patents	EPO patents	USPTO patents	PCT patents
blau					
lsize	0.129	0.0874	0.0555	0.0305	0.0341
lage	-0.0029	-0.0004	0.0012	-0.0035	-0.0028
exp	0.0703	0.0244	0.0370	0.0246	0.0235
group	-0.0436	-0.0479	0.0028	0.0072	-0.0004
IRDext	0.0028	0.0017	0.0005	0.0005	0.0008
IRDint	0.108	0.0739	0.0373	0.0258	0.0329
ltraining	0.0026	0.0022	0.0006	-0.0009	-0.0002
coop	0.0303	0.0352	-0.0044	-0.0167	-0.0002
sizeRDdept	0.0026	0.0018	8.6×10^{-5}	-0.0001	0.0006
hcstockw	0.0070	0.0072	-0.0040	-0.0025	-0.0025
hcstockm	0.0057	0.0011	0.0057	0.0041	0.0042
hightech	0.337	0.167	0.277	0.162	0.151
kis	0.310	0.151	0.242	0.121	0.111
nonhightech	0.277	0.148	0.208	0.124	0.112
constant	-1.614	-0.904	-1.018	-0.607	-0.720

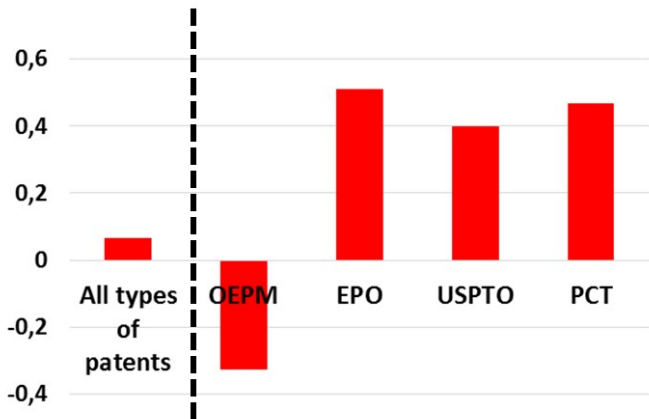
Table 1. Conditional estimates of the impact of gender diversity on the total number of patents.

	Patents	OEPM patents	EPO patents	USPTO patents	PCT patents
blau	0.0655	-0.325	0.511	0.398	0.467
lsize	0.129	0.0874	0.0555	0.0305	0.0341
lage	-0.0029	-0.0004	0.0012	-0.0035	-0.0028
exp	0.0703	0.0244	0.0370	0.0246	0.0235
group	-0.0436	-0.0479	0.0028	0.0072	-0.0004
IRDext	0.0028	0.0017	0.0005	0.0005	0.0008
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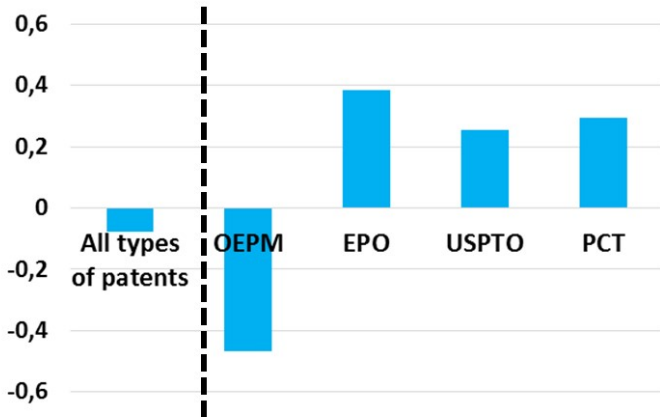
Does gender diversity have an impact on the production of patents?



Does gender diversity have an impact on the production of patents?



Which are the results according with the number of patents per researcher?



- Firms will be interested in protecting their most valuable innovations in larger markets (EU and US).
 - We observe a dual effect: Gender diversity exerts a different impact depending on the type of patent.
 - A larger gender diversity in the R&D team exerts a positive impact on the production of more valuable knowledge.
- ⇒ Complexity of managing a team and producing new knowledge.

Policy implications

- Necessity to design policies to improve organizational techniques
- Promote gender diversity in R&D careers in order to maximize firm's innovative capacity.

Project ECO2015-68061-R: “Gender diversity as a determinant of the innovation: an analysis of the impact of the gender diversity on firm' innovation”



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Table 5. Conditional estimates of gender diversity on the intensity of patents.

	Patents int.	OEPM patents int.	EPO patents int.	USPTO patents int.	PCT patents int.
blau	-0.0773	-0.467	0.384	0.255	0.295
lsize	-0.597	-0.639	-0.675	-0.696	-0.693
lage	0.0336	0.0360	0.0388	0.0329	0.0327
exp	0.0429	-0.0029	0.0086	-0.0027	-0.0031
group	0.0188	0.0145	0.0603	0.0696	0.0620
IRDext	-	-0.0011	-0.0022	-0.0023	-0.0019
	4×10^{-5}				
IRDint	-0.437	-0.471	-0.515	-0.519	-0.513
ltraining	-0.0005	-0.0008	-0.0022	-0.0039	-0.0031
sizeRDdep	-0.0062	-0.0069	-0.0078	-0.0089	-0.0082
hcstockw	0.0566	0.0568	0.0494	0.0471	0.0481
hcstockm	0.0608	0.0562	0.0649	0.0592	0.0591
coop	-0.0445	-0.0396	-0.0769	-0.0915	-0.0743
hightech	0.148	-0.0228	0.0960	-0.0277	-0.0483
kis	-0.288	-0.446	-0.348	-0.476	-0.496
nonhightech	0.312	0.184	0.252	0.160	0.141
Constant	3.398	4.108	4.022	4.405	4.327