

Article

Social Sustainability on Corporate Boards: The Effects of Female Family Members on R&D

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Abstract: There is growing institutional and social pressure for greater balance, parity, and equality at the highest levels of corporations. This is coupled with an increasing interest in analysing the effects of gender diversity on corporate boards. However, companies may only reap the benefits of gender diversity by achieving better qualified and more independent boards. This study aims to contribute to the open debate on the effects of board gender diversity on R&D, by taking into account the independence of female directors. Panel regression analyses were performed with data for 67 Spanish-listed companies during the 2003–2019 period. Our results confirm the positive effects of gender diversity on R&D. However, this positive influence is lower if female directors have family links with male members on the board. These findings have policy implications, regarding the need to increase gender equality in corporate boards for social and sustainability purposes, while the benefits are conditioned by the independence of female directors. The value of this research rests on the study of the effects, beyond the mere analysis of financial performance of the gender diversity of boards.

Keywords: corporate boards; female family members; gender diversity; innovation; R&D; social sustainability



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1. Introduction

In recent years, sustainability has emerged as a milestone in organization and management studies [1], underlining the need to make companies sustainable through the contribution of corporate strategies. Innovation is valued as one of the main contributors to sustainable business management, improving the firm's capabilities and competencies [2]. However, the understanding of innovation itself constitutes a whole field of research, given the multiple factors that influence and that can explain the innovation strategies adopted by companies [3].

Corporate governance, as it refers to how companies are directed and controlled [4], exerts a great influence on business strategies, including innovation. Effective corporate governance is essential to achieve corporate goals and fulfil stakeholder interests, but this effectiveness can be reached through different mechanisms that combine control, policies and regulations. Among them, different typologies can be observed, which distinguish between external and internal mechanisms, the former covering those related to the market, competitors, laws, and regulations, the latter those related to management and ownership structure [5]. Given the complex and broad scenarios that these mechanisms encompass, the literature addresses them separately. Previous research includes, among other topics, the role of industrial competition on good governance [6]; the monitoring role of the chief executive officer (CEO) and the mutual monitoring that top executives exert [7]; the influence of the incentive structure at the top [8,9], and the role of debt-like instruments on governance [10].

The ownership structure of companies, and the composition and independence of their boards, are at the heart of the internal mechanisms for corporate governance [11]. The analysis of this independence has been approached recently through the study of the role of female directors [12].

The issue of gender diversity on boards and, more specifically, the under-representation of women, has gained interest in the academic, social, and business fields, as a matter of social justice and equity, and has been widely discussed globally [13–15] within the framework of social sustainability. As Assefa and Frostell [16] noted, due to the difficulty of defining social sustainability and determining its specific ingredients, measuring sustainability and quantifying the social dimension of sustainability are challenging tasks [16,17]. The complex nature of social sustainability makes it exceedingly difficult to reach consensus about its effects. The solution applied by research is to focus on one of its dimensions [16,17], gender diversity on the board being the most discussed issue in corporate governance.

In recent years, business leaders and governments have been concerned about the need for gender balance and equality at the highest corporate levels. This concern has provoked legislative reforms worldwide, with notable differences between countries. Some countries, mostly in the sphere of the continental law, have implemented hard laws establishing quotas to balance female representation on the board. Other countries have chosen non-binding rules, mostly under common law, recommending female representation targets in their corporate governance codes [18], and the reporting of gender diversity recruitment efforts and gender diversity composition [19]. As a result of this worldwide movement, many countries, especially in Europe, have seen a significant growth in the percentage of women on boards in recent years, although, in most cases, it is still far below the recommended quota [20,21].

In the exploration of the effects of gender diversity on boards, among the countries imposing quotas, Spain is particularly interesting, because, since the mid-2000s, there has been a strong legislative movement to incorporate women in the workforce and in top corporate positions [22]. These regulations include the 2006 Unified Code of Good Governance, its updates or revised versions, and the Gender Equality Act. The objectives of these regulations are to avoid bias against the appointment of women to boards, and they include a recommendation to reach a balanced presence of women and men on governing bodies, establishing a female quota of 40% in the case of publicly traded companies with more than 250 employees [20]. Recent research shows that a few years after these reforms, the sparse representation of women on Spanish boards is changing [23], making Spain a suitable setting to analyse the influence of female directors.

The pursuit of gender diversity on boards is not questioned at a policy-making and institutional level, because the achievement of more gender diversity is considered as an end in itself [16], which could subsequently result in other social sustainability benefits [13]. However, from a scientific point of view, and also at the company level, there are many questions about the validity of assuming that appointing more women to boards is necessarily advantageous [24].

Academic research results are not clear-cut on the performance effects of an increased female representation on the board. In the specific case of innovation, the impact of female board directors has been discussed with mixed and inconclusive results.

Gender differences theories argued a negative link between gender diversity and innovation, based mostly on the different attitudes towards risks between men and women, arguing that women are more risk-averse and have less risk appetite than men [25]. However, these features have been mostly demonstrated in the general population, while in the subsample of managers, gender differences in financial risk preferences are smaller and often non-existent [26]. The degree of risk aversion in women may vanish once they have broken through the glass ceiling and have adapted to a male-dominant environment [27]. The balance of evidence also points to the positive influence of female directors on R&D and innovation. Different theories argue for such positive influences, mostly based on the consequences of having a higher independence and diversity on the board.

With regards to independence, agency theory points out that, among other factors, the independence of board members influences the board's ability to exercise its monitoring role over managers [28], to overcome agency problems, and to protect shareholders' interests [29], with positive expected outcomes on innovation. The role of women directors is crucial in this regard, since there is evidence that, as Ferreira [30] states, female directors are more independent from management than male directors, and better represent the level of board independence than do outside directors. Adams and Funk [27] also find that female directors are more independently minded, showing themselves less preoccupied about tradition, conformity, and security, and more open to change. This major independence of female directors improves their monitoring role as compared to male directors. They devote more effort to this function [31], which translates into better attendance at board meetings and a greater presence in monitoring committees, which may improve managers' risk management, and positively affect innovation [32].

In regards to diversity, board capital theory argues that board diversity implies a bundle of knowledge, skills, experiences and information that reflect the breadth of the resources that directors bring to the board [33]. These resources represent the human capital of the board, referring to the knowledge and expertise of directors at an individual level; and also include the social capital that emerges from the board members' networks and relationships [33,34]. In the specific case of gender diversity, as far as it involves good corporate social responsibility practices and improvements in the corporate image, it also implies the enhancement of the social capital of the firm, with positive influences on innovation [35]. Previous research also underlines the non-traditional backgrounds, new perspectives, experiences, and work styles provided by women directors, which differ from those provided by male directors, and which are relevant resources that are incorporated into the human capital of the board [36]. These valuable resources emerging from a greater feminisation of the board and the incorporation of different backgrounds may cause more creativity, better problem-solving abilities, more productive discussion [37], and more diverse questions and solutions emanating from the board [38]. These effects enhance the company's commitment to creating social value and competitive advantage in terms of innovation [39].

Previous studies have also established that female presence may enhance the board's deliberation as a consequence of women having more of a participative communication style [22], which relates to the inclusion of more innovative ideas on the board's deliberations. The appointment of women to the board also improves the image of the company [40], with positive effects on the firm's reputation, both inside and outside the organization, improving the social capital of the board through a wider network of connections that may positively affect the incorporation of innovative ideas from outside the organization.

In light of the greater empirical evidence and the relevance of the arguments in favour of a positive relationship between gender diversity and R&D, we formulate the following hypothesis:

Hypothesis 1 (H1). *Gender diversity exerts positive effects on R&D.*

Nevertheless, some scholars also warn that these positive effects are influenced, and perhaps jeopardized, by other matters. There are situations that moderate the impact of women on boards, for example interlocking directorates, where female directors perform differently than other regular females on the board [41]. There are also problems and situations that emerge in the absence of the necessary conditions that let women at the top create more equalitarian and sustainable firms, and exert a real influence [20]. After breaking through a glass ceiling by being appointed to the board, female directors might encounter a new glass ceiling if they do not have effective decision-making powers. Besides the ethical problem regarding the under-representation of women on boards, another ethical problem emerges when their appointment is forced in order to achieve a certain quota, and is not merit-based. This could provoke situations where the female directors might not have the necessary attributes to foster innovation [19].

Most of the positive influences of gender diversity at the highest levels can be only guaranteed as long as these women act independently [42,43], family links being one factor that could reduce this independence. The existence of family links makes a study of the influence of female directors relevant for several reasons. Firstly, being a family member is one of the factors that fosters the presence of women on boards. Female presence in family firms is high in most countries, representing a type of organization that offers women abundant labour opportunities [44]. Women perceive several advantages that make them to choose developing their professional careers in their family business. They find more opportunities to reach top positions, as managers or directors [22]; and at the same time, they find it easier to balance work and family responsibilities in family businesses [45]. These reasons imply that many women become board members on the basis of family ties [46], there frequently being family connections between women and men in such companies (although these family ties can also be observed in other non-family businesses). Secondly, family links could jeopardize female directors' independence, possibly acting as a barrier for women to be active directors and raise issues freely in board deliberations [22], especially given that they are under-represented and that their male counterparts, members of the same family, could potentially influence them.

In this regard, previous research has demonstrated that the presence of female directors in family owned companies does not influence firm performance, while in non-family owned companies, female directors exert a positive influence [22]. This result could be justified by the different characteristics required of female board members in family businesses as opposed to non-family businesses—such characteristics, often being associated with kinship in the former, and with qualifications in the latter cases [22,40]. Although these results refer to firm performance, similar effects might be expected for R&D investments and innovation. The incorporation of more women directors in the board may exert a positive influence on innovation, but if women are under the influence of male family members, their independence would not be guaranteed; thus, jeopardizing their monitoring role, and making the benefits of gender diversity unclear and weaker. Therefore, we propose the following hypothesis:

Hypothesis 2 (H2). *The positive influence of gender diversity on R&D is lower in companies that appoint female family members to their boards than in those without family female directors.*

2. Methods

2.1. Sample and Data Collection

This article examines the relationship between gender diversity and R&D using a data set of Spanish companies listed on the Madrid Stock Exchange. Three of its four basic sectors were included: energy and basic industry; consumer goods and services; and technology and telecommunications. The only basic sector excluded was financial and real estate services due to the accounting regulation that makes their annual accounts not comparable to those of the companies in other sectors.

The second requirement for companies to be included in this study was that, given the low number of women normally appointed to the board of directors, the firms should have at least one woman on the board, in one or more of the years considered in this research.

The information collected covers the period from 2003 to 2019. The final sample was an unbalanced panel data composed of 978 observations and the number of companies meeting our requirements was 67. Of the companies considered, 50.82% belonged to the energy and basic industry; 36.60% to consumer goods and services; and 12.58% developed technology and telecommunication activities.

To gather the data, we used secondary sources of information, such as the database of the CNMV (Spanish Security Exchange Commission), the SABI database (Analysis System of Iberian Account Balances), and the annual financial reports of each company.

2.2. Measurement of Variables

2.2.1. Dependent Variable

This study uses the R&D ratio, an innovation indicator directly related to innovative activity and its intensity, as the dependent variable. The R&D ratio (R&D) was measured by dividing R&D expenditures by total sales [47]. This measure, rather than the absolute amount of research and development expenditure, controls both for the size effect and for heteroscedasticity, allowing the firms' commitment to innovation to be better reflected, and permitting relative comparison between firms [47]. Moreover, to maintain the regression assumptions and avoid problems of skewness in the distribution of the variable, we added a very small constant (0.001; [48]) and transformed the variable by measuring its natural logarithm [49]. This transformation reduces asymmetries and standardises this variable.

2.2.2. Independent Variables

To analyse the influence that gender diversity on boards exerts on R&D, we include one explanatory variable (GEN), measured as the Blau Heterogeneity Index [50]. This index is frequently used in the research of diversity in demographic variables for categorical ones, and is calculated as $B = (1 - \sum(p_i^2))$, where p_i is the proportion of individuals in the i -th category [51].

To analyse possible changes in the effects of gender diversity on R&D; we decided to include the variable FAMFEM, which serves as a proxy to measure the independence of female directors. This was a dummy variable and took the value 1 if any of the females appointed to the board exhibited family links with any other member of the board, and 0 if not. It means that the identification of just one family female director on the board was enough to assign the value 1 to this variable. To consider whether the females on the boards were family members, we checked the family names of the women on boards, by looking for matches with other board members. Moreover, given that family relationships resulting from marriage are not always indicated in the corporate governance reports of Spanish companies, we searched for this information on the internet, to verify whether they were, or had been, the wife of any director on the board to which she belonged; in this case, the woman was considered as part of the family. Through these inquiries, we realised that a significant number of women on boards were married to significant shareholders of the company; thereby, as a double check, we also searched the internet for each of the significant shareholders of the family companies of our sample, to determine if they were married to any of the females on the board; this allowed us to discover new family relationships among directors not previously considered. Through all these steps, we determined the family condition of women on boards for 667 observations, where in 64.32% of the cases the females appointed to the board were not family members, and, in 35.68% of the cases, these women could be considered family members.

2.2.3. Control Variables

A variety of control variables were included to control for firm effects on R&D and minimize concerns about firm's heterogeneity. The total number of employees (SIZE), logged to correct for skewness, was used as a measure of firm size; this variable refers to the resources and capabilities of companies, which may influence their capacity for innovating, innovation being expected to be higher in bigger companies [52]. Firm performance was included as a factor that might influence the resources available for the innovative activity of companies [53], and was measured through return on assets (ROA) [54]. The possible industry effects are captured through the control variable sector (SECTOR), since the innovation strategy of companies could be strongly affected by the industry characteristics [55]. These industry effects are captured by a categorical variable with three levels, one for each of the economic sectors of the classification of the Madrid Stock Exchange, these were SECTOR 1 "Energy and basic industry", SECTOR 2 "Consumer goods and services", and SECTOR 3 "Technology and telecommunications". Finally, the potential influence of time was captured using a dummy variable (YEAR).

3. Results

The statistical analyses of this study were carried out by applying RStudio version 1.3.1093 [56].

Table 1 shows the analysis of variance for the explanatory variable, gender diversity (GEN), comparing both types of companies, those with and without female family members on their boards. Moreover, Figure 1 depicts how gender diversity has evolved in the last years and shows the increase in the number of women appointed to boards in the Spanish case.

Table 1. Mean values and ANOVA of gender diversity over time and by company type.

	Years	Company Type		ANOVA (Years) F Test		
		Companies with Female Family Members on the Board	Companies without Female Family Members on the Board			
GEN (gender diversity)	2003	0.26 (0.11)	0.22 (0.09)	25.84 ***		
	2004	0.27 (0.11)	0.23 (0.08)			
	2005	0.28 (0.10)	0.21 (0.07)			
	2006	0.28 (0.10)	0.19 (0.08)			
	2007	0.29 (0.12)	0.22 (0.10)			
	2008	0.28 (0.12)	0.23 (0.10)			
	2009	0.27 (0.11)	0.23 (0.10)			
	2010	0.30 (0.11)	0.23 (0.10)			
	2011	0.27 (0.13)	0.23 (0.10)			
	2012	0.29 (0.08)	0.24 (0.11)			
	2013	0.29 (0.10)	0.25 (0.12)			
	2014	0.30 (0.09)	0.26 (0.12)			
	2015	0.34 (0.09)	0.27 (0.11)			
	2016	0.33 (0.08)	0.28 (0.10)			
	2017	0.36 (0.09)	0.32 (0.10)			
	2018	0.39 (0.09)	0.33 (0.09)			
	2019	0.40 (0.07)	0.35 (0.11)			
	ANOVA (company type) F test		169.22 ***			

Mean values of gender diversity. Standard deviation in brackets. Significance codes: p -value 0.001 '***'; p -value 0.01 '**'; p -value 0.05 '*'; p -value 0.1 '+'.

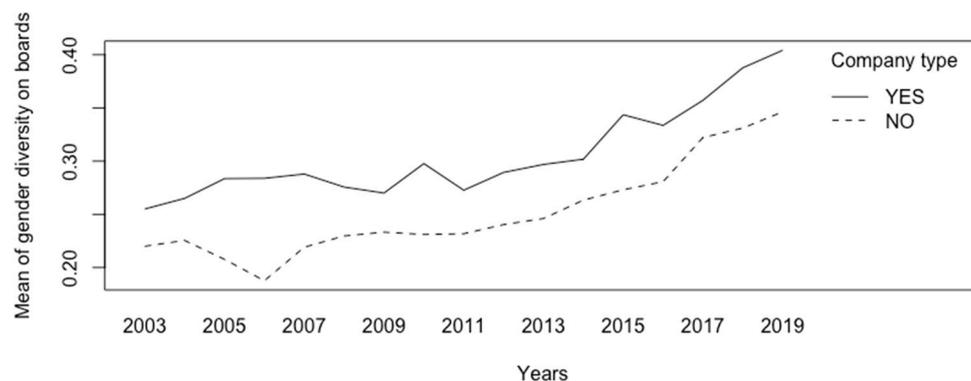


Figure 1. Plot of gender diversity over time for companies with and without female family members. Company type YES (companies with female family members on board). Company type NO (companies without female family members on board).

Table 1 and Figure 1 point out the growth in gender diversity in the period under consideration, which is statistically significant. Even so, the mean value of the number of female directors in our sample is only 1.23. This low value means that many companies in the sample only incorporate female directors in the latter years, and despite the growth,

the proportion of women on boards is still low (12.4% of women vs. 87.6% of men). This result also implies that when a family link is detected between female and male directors, given the low mean value of female directors in our sample, this is normally the sole female representation in the board. Despite this, a growth in the gender diversity in both types of companies is observed. The results also show that gender diversity is significantly much higher on the boards of companies with female family members acting as directors.

After this exploratory analysis, we proceeded to conduct some regression analyses to demonstrate the effects of gender diversity on R&D. Given that our database combines observations of the same firm at different points in time, we use panel data methodology in the estimation process.

As the literature frequently states, empirical analysis in corporate governance studies can be complicated because many of the variables may be determined endogenously, which means that they are correlated with the error term. Endogeneity results in the potential existence of reverse causality, which implies that more women on boards can positively influence R&D, but at the same time, companies with higher R&D and a long-term orientation might be inclined to appoint more women as directors, due to their major focus on long-term performance [57]. In order to avoid the influence of this potential reverse causality, the literature suggests two procedures for analysing the effect of endogeneity, the use of instrumental exogenous variables and the inclusion of lag effects as instruments [53,58]. On the one hand, we decided to consider a one-year interval; thus, the dependent variable (from 2004 to 2019) was regressed against the independent and control variables (from 2003 to 2018). This ensured that the direction of causality was from gender diversity to R&D and not the reverse, and also allowed the independent variables time to exert their impacts on companies' decisions [53]. On the other hand, it might be expected that gender diversity is an endogenous characteristic of the board that could be a function of other characteristics not included in the model, such as the board size, duality (understood as the CEO also acting as the board Chairman), and board composition in terms of outsiders or independent directors [22]. To check the suitability of these variables as exogenous instruments, we checked that the instrumental variables were not related to R&D ratio, and that they were related to gender diversity. Only two of the three variables considered accomplish these requirements, board size ($\beta = -0.425$, $p < 0.001$) and the proportion of outside directors ($\beta = 0.05$, $p < 0.05$), so we included both as exogenous instrumental variables in our analyses.

Table 2 presents correlation and descriptive statistics for all variables, excluding categorical ones and factors. The correlation coefficients are weak and do not violate the assumption of independence between the independent variables included in the same model.

Table 2. Correlation matrix and descriptive statistics.

Variables	Mean	S.D. ¹	R&D ²	GEN ³	SIZE ⁴	ROA ⁵
R&D	0.02	0.07	1			
GEN	0.19	0.16	0.099 **	1		
SIZE	7.63	2.32	−0.0178	0.155 ***	1	
ROA	0.04	1.15	−0.010	0.022	−0.007	1

¹ S.D. standard deviation. ² R&D measured through the R&D ratio. ³ GEN is gender diversity measured by the Blau index. ⁴ SIZE is the log of the total number of employees. ⁵ ROA is the return on assets. Significance codes: p -value 0.001 '***'; p -value 0.01 '**'; p -value 0.05 '*'; p -value 0.1 '†'.

We conducted F tests and Hausman tests to determine the choice between pooled Ordinary Least Square (OLS), fixed or random effects models. The most appropriate estimation method for the models depends on the properties of both the individual and the idiosyncratic errors [59]. The non-significant results of the Hausman tests (reported in Table 3) pointed out that the random effects model seemed to be the best estimation in our models. We also calculated Lagrange multiplier tests to determine the existence of individual and/or time effects based on the results of the pooling models and confirmed

the suitability of using individual effects. Thus, individual random-effects regression analyses using instrumental variables were used to test the hypotheses [59].

Table 3. Random effects regression analyses.

Variables	Model 1		Model 2		Model 3	
	B	Std. Error	B	Std. Error	B	Std. Error
Intercept	0.077	0.139	0.010	0.199	0.007	0.198
SECTOR 2	−0.415	0.212 *	−0.559	0.230 *	−0.559	0.229 *
SECTOR 3	0.395	0.317	0.123	0.339	0.124	0.337
SIZE	0.006	0.047	−0.050	0.092	−0.052	0.091
ROA	−0.005	0.018	−0.005	0.018	−0.005	0.017
GEN	0.129	0.025 ***	0.303	0.057 ***		
FAMFEM			−0.012	0.096		
GEN in FAMFEM (no)					0.304	0.064 ***
GEN in FAMFEM (yes)					0.295	0.086 ***
Time dummies	yes		yes		yes	
Adjusted R-square	0.031		0.066		0.066	
Chi-square	33.59 ***		66.99 ***		63.97 ***	
χ^2 Hausman test (<i>p</i> -value)	17.75 (0.515)		18.79 (0.470)		8.22 (0.975)	

R&D measured through the R&D ratio is the dependent variable. SECTOR 2 refers to “consumer goods and services” companies. SECTOR 3 refers to “technology and telecommunications” companies. SIZE is the log of the total number of employees. ROA is the return on assets. GEN is gender diversity measured by the Blau index. FAMFEM is a dichotomous variable that indicates whether companies include female family members on board. GEN in FAMFEM (no) refers to gender diversity in the case of companies that do not incorporate female family members on board. GEN in FAMFEM (yes) refers to gender diversity in the case of companies that do incorporate female family members on board. Significance codes: *p*-value 0.001 ‘***’; *p*-value 0.01 ‘**’; *p*-value 0.05 ‘*’; *p*-value 0.1 ‘+’.

The results from regression analyses appear in Table 3. Model 1 reports the effects of the explanatory variable gender diversity (GEN) and the control variables; it explains only 3.1% of the data variance. Model 2 adds, along with the variables of Model 1, the variable FAMFEM that categorizes companies in terms of having or not female family members on the board. This model explains 6.6% of the data variance. Finally, Model 3 estimates the effect of gender diversity (GEN), comparing companies with and without female family members on their boards—this is essentially similar to Model 2, but incorporating this comparison between types of companies. Model 3 also explains 6.6% of the data variance. This last model helps to determine in which of the two situations, companies with or without female family members on board, the influence of gender diversity on innovation is higher. The three models were statistically significant.

The results displayed in Table 3 allow us to support the two hypotheses of this study. H1 suggests a positive relationship between gender diversity and R&D, which is borne out in the first two models ($\beta = 0.129$, $p < 0.001$; $\beta = 0.303$, $p < 0.001$, for Models 1 and 2, respectively). Moreover, as predicted by H2, the positive influence of gender diversity on R&D is lower in the case of companies with female family members on their boards ($\beta = 0.295$, $p < 0.001$), compared to those that do not incorporate female family members ($\beta = 0.304$, $p < 0.001$). This is confirmed in Model 3.

Regarding the control variables only SECTOR 2 seems to influence the R&D ratio ($\beta = -0.415$, $p < 0.05$; $\beta = -0.559$, $p < 0.05$; $\beta = -0.559$, $p < 0.05$, for Models 1, 2, and 3, respectively). It means that companies in the consumer and services sector showed a significant lower R&D ratio in comparison to SECTOR 1 that refers to “energy and basic industry”. Non-significant results were found for SECTOR 3, the companies’ size and ROA. Finally, the influence of time does not seem to be significant.

4. Discussion

The complex nature of social sustainability and the multiple ingredients it involves result in the lack of a solid academic framework for its effects. Previous research addressed this topic by considering just one of its dimensions [16], gender diversity on the board being the most discussed issue of social sustainability in corporate governance. Therefore, the objective of this work was to contribute to previous research by supplying empirical evidence on the effects that board gender diversity exerts on R&D and, more specifically, to explore the effects resulting from the presence of female family members on boards. Gender equity at the highest corporate level constitutes a matter of social justice and a relevant ingredient of social sustainability [17], meaning that our results contribute to the field of how social sustainability impacts on R&D.

Most of the time, innovation requires that companies take risks and incur R&D expenses, which are not likely to be forthcoming unless the board understands their relevance, and overcomes its tendency towards short-sighted policies [52]. A diversified board might provide diverse perspectives and points of view as a means of enriching the strategic role of the board, and overcome risk-averse tendencies [52] that could jeopardize innovation. Gender is one of these characteristics related to the board composition, in which diversity could be translated into better governance [60]. It is also a topic that has recently been widely discussed because increasing the representation of women in the upper corporate echelons is considered a matter of social sustainability, entailing social justice and equity, and avoiding the restrictions on women occupying highly responsibility positions in companies. However, the benefits of incorporating more women on boards may only be realised under certain conditions; the independence of female directors from their male counterparts being one of these.

One relevant situation in which female directors may lose their independence is when family links exist with other members of the board, this often being the case rather than as a consequence of their qualifications and merits [22]. When these family links exist, their influence may be strong and force compliance with the opinion of the family men on the board, thereby avoiding the emergence of the positive benefits of gender diversity.

From the exploratory analyses conducted in this study, it is possible to observe a growth in board gender diversity and, therefore, in the number of women appointed to this governing body in Spain. The regulatory movement and legislation imposed worldwide, and in Spain, have improved the female presence on the boards, at least in listed companies, although this growth has not solved the problem of the under-representation of women on corporate boards. It means that, as other studies in this institutional setting recognise, female directors are still few, and much below the established objectives [22,23].

Our findings demonstrate the positive influence of gender diversity on R&D. This supports the positive effects associated with diversity highlighted by the board capital theory, which implies that better resources are brought by directors to the board in the form of more knowledge, skills, experiences, and information when directors' diversity grows [33,61]. Therefore, gender diversity provides non-traditional backgrounds, new perspectives, experiences, and work styles different from those of male directors, which may cause more creativity, abilities, discussion, and solutions with positive impacts on R&D and innovation [12,39,42,43,62]. This result, nevertheless, contrasts with the assumptions of gender differences theories based on the different gender roles toward risks, which point out that women are less likely to be comfortable with risky decisions [63]. As previous studies state, this assumption is not evident when women occupy top positions in companies, losing their risk aversion once they have broken through the glass ceiling [27,64].

In addition, our findings corroborate the lesser influence of female family members. The positive influence of gender diversity on R&D is lower in the case of companies with female family members on their boards, which constitutes a relevant contribution to previous research, and supports the influences associated with independence highlighted by agency theory. Similar results have been confirmed in the case of financial performance [22], comparing the influence of women on board in two sets of companies, family owned firms,

where no significant influence was found, and firms owned by corporations, where the influence on performance was positive. We think that the same arguments could be useful in understanding the results obtained in this study in reference to R&D. Our results underline the positive impact of directors' independence on R&D, but raise some questions about the source of this independence, as it is not guaranteed by the mere fact of gender diversity. Greater gender diversity on corporate boards rests on a sense of fairness, and discriminatory practices in the recruitment of directors should attract scrutiny by regulators due to their unethical nature and as a matter of social sustainability [65]. However, the effectiveness of appointing women to the board can be only achieved if additional requirements are considered, which foster their independence, while not neglecting their diversity [22,40].

5. Conclusions

This study makes several contributions. At a theoretical level, although gender diversity does not assure independence by itself, the positive influences of diversity and independence achieved by the board with the appointment of women are confirmed, giving support to board capital theory and agency theory.

This study also has policy-making implications and involves some suggestions for practitioners, related to the relevance of including women on boards to achieve greater innovation efforts in companies. The role of female directors has been widely analysed lately, in an effort to demonstrate their effect, mostly on firm performance [20,65], but also on corporate strategies, such as innovation [57], and to determine the critical mass needed to exert a real influence [12]. However, few studies have been devoted to identifying and demonstrating the characteristics and features that the female presence on the board should have to clarify and increase their influence. This study provides new insights and advances our understanding of this issue, pointing out that female directors with family links with other male members of the same board contribute less to innovation than female directors without these family links. The expected benefits of diversity on boards are not guaranteed just by appointing more women to boards [24], and this is also true when the focus is on innovation. The actual number is important because an extreme under-representation may hamper their contribution and disempower them, but it is not the only thing that matters. Features, such as merits, qualifications, and independence of women are essential to achieve the benefits related to the feminisation of boards. The recommendation that emerges from this research is to appoint female directors based on their merits and to avoid family links that might jeopardise their independence. This requirement avoids the ethical problem that emerges when the appointment to the board is motivated by reasons, which are not aimed at increasing the board's effectiveness.

Some recommendations for improving the current regulation in Spain also emerge. The latest Spanish good governance code, the Good Governance Code of Listed Companies revised in June 2020 [66], only mentions that "Director selection policy should seek a balance of knowledge, experience, age and gender in the board's membership" (p. 14), and that "measures that encourage the company to have a significant number of female senior managers are considered to favour gender diversity" (p. 26). The results of this research suggest that future codes also incorporate statements, emphasising not only the relevance of increasing the presence of women on the board, but also the need to guarantee the independence of those appointed, while explicitly listing the causes, such as family links, which could potentially limit this independence.

This study however has some limitations. Firstly, it considers the case of female family members appointed to the board, assuming their lack of independence in this case, and considering these family links as a proxy of their lack of independence; however, we are unable to ascertain the true level of independence of women appointed to the board. This limitation implies that the current research is only a first step, and that further studies are necessary to measure female directors' independence using more effective methods. Secondly, there are other situations in which the independence of female directors could be

damaged, and which could be explored. Additionally, the reasons behind these influences have not been proven. Thirdly, this study has considered only R&D as an indicator of the innovation effort of companies; other measures and indicators of innovation would offer a better understanding of the influence of gender diversity on corporate boards. Finally, the use of secondary data has limited the number of usable observations in our study, for example, limiting the family links that we considered, which means that some family relationships, such as unmarried partners, have not been detected.

Future research could fill these gaps to arrive at a better understanding of the influence of female representation on corporate boards, using other data enhancement sources. In addition, a more comprehensive view of the role that female directors exert on innovation could be obtained by analysing the interaction of female presence on boards with other governance mechanisms, such as the incentive structure at the top, characteristics and competitiveness of the industry to which these companies belong, or by observing and measuring the monitoring role exerted by the CEO and other top executives, and how this changes in the case of intervention by female directors. The inclusion of other variables that measure independence, the process related to the effects of women on boards, and the reasons behind their influence would provide future research directions to better understand the role of women in corporate governance.

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