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THE MODERATING EFFECT OF INNOVATION ON THE GENDER AND PERFORMANCE RELATIONSHIP IN THE OUTSET OF THE GENDER REVOLUTION

Abstract. The presence of women on boards of directors has become a social and economic demand. The relation between their presence on the board of directors and improved firm performance has already been studied. This paper aims to shed light on this topic by providing the first test as to how the level of innovation in the company may moderate this relationship. Our results, for a panel data of 231 European listed firms and based on GMM analysis, show that a critical mass of women positively affects firm performance, and that this effect increases as the firm's innovation activity increases. We situate the analysis in the outset of the gender revolution in the Western countries to understand the nature of the gender equality process.

Key words Board of directors, critical mass of women, performance, innovation

JEL code O16 Corporate Finance and Governance, M14 Diversity, P17 Performance and Prospects, Q55 Technological Innovation

1 Introduction

Over recent decades, the relation between good corporate governance practices and firm performance has been extensively analysed in the literature (Ravenscraft and Scherer 1987; Shleifer and Vishny 1997; Bhagat and Bolton 2008) providing evidence on the existence of a direct relation between both variables (Jensen and Murphy 1990; Bhagat and Bolton 2008). Among the analysed corporate governance factors we can highlight the level of ownership concentration, board members' ownership stake (Jensen and Meckling 1976; Shleifer and Vishny 1986; Beasley 1996), and certain board characteristics such as board size (Carter et al. 2003; Beiner et al. 2004), duality in the positions of Chairman and CEO (Brickley et al. 1997), the proportion of external or independent directors (Hermalin and Weisbach 2003; McDonald et al. 2008), and board composition and diversity, also referred to as the demographics of the board (Hutzschenreuter and Horstkotte 2013).

The current paper mainly focuses on gender diversity in board composition. Prior research, such as Murray (1989), Shrader et al. (1997), Richard (2000), Erhardt et al. (2003) and Rhode and Packer (2014), has examined how board diversity might affect performance, detecting large profits generated within the firm as a result of the presence of women on the board. Some of the main features pointed out by the literature are (i) the improvement in the quality of decision-making due to the greater cognitive diversity in multi gender boards, as well, as to the different values and attitudes to risk of males versus females (Milliken and Martins 1996; Adams and Funk 2012; Perryman et al. 2016), (ii) a more effective and stricter strategic oversight of the board (Nielsen and Huse

2010 and Adams and Ferreira 2009, respectively) and (iii) better financial performance (Carter et al. 2003; Campbell and Mínguez-Vera 2008; Terjesen et al. 2009). As stated by Post and Byron (2015) in their meta-analysis, women directors are likely to consider different opinions, to obtain information from all the members of the board and to adopt a cooperative approach to decision-making which encourages collaboration among the group, which improves performance when there are diverse approaches to problem-solving. This meta-analysis suggests, on the one hand, that women's presence on the board is positively related to book performance and that the greater shareholder protection the greater the book performance. On the other hand, even though the relation between women directors and market performance was close to zero, it is positive in countries with greater gender parity. Carter et al. (2010) also suggest that women directors hold more university qualifications and are more likely to have high-level qualifications than their male counterparts, women have more experience in marketing and sales, are more risk adverse and pay greater attention to corporate social responsibility and philanthropy (Burgess and Tharenou 2002; Post and Byron 2015).

However, although most studies find a positive link between gender diversity and firm performance, the empirical evidence is not always conclusive. Some studies provide evidence of a direct negative relation such as Adams and Ferreira (2009), Ahern and Dittmar (2012), and Matsa and Miller (2013). Carter et al. (2010) find no evidence of a negative relation between gender diversity on the board and financial performance nor do they find any causal relationship (either positive or negative). They only find evidence of a positive relation between board diversity and performance in the fixed-effects model that does not control by causality, but when more sophisticated econometric techniques (those controlling for causality) are used, there is no significant effect. Similarly, Jurkus et al. (2011) find that the positive effect of gender diversity on performance disappears once causality is controlled for. There is also evidence of a quadratic relation between the two variables, giving rise to the so-called critical mass theory: gender diversity may initially have a negative effect on firm performance and, only once a "critical mass" of women on the board has been achieved, the relation turns positive. According to Joecks et al. (2013), this critical mass amounts to an absolute number of three women.

In view of these mixed results, Miller and Triana (2009) consider the need to find out the nature and the origins of the relation between board gender diversity and performance. To do so, they first refer to Forbes and Milliken (1999), who consider that the relation between performance and diversity (in a broad sense, not necessarily referring to gender diversity) might be an indirect one. However, when Miller and Triana (2009) test it empirically, for a sample of Fortune 500 firms, they fail to detect either a direct or an indirect relation between gender diversity and performance. They thus conclude that this lack of significance could be due to the presence of a mediator, namely innovation. However, Miller and Triana (2009) never actually tested it empirically.

In this context, we go a step further and provide the first empirical test of the presence of innovation as a moderating variable between board gender diversity and firms' performance. We thus consider that the relation between a critical mass of women and firm performance might be influenced or "moderated" by the firm's innovation activity. We also incorporate some refinements in the tested model and the sample used to make sure that our results are trustworthy. Thus, we use a more complete sample from a panel of European firms, will teach us more about the direction and nature of such a relevant relation. Moreover, as far as we know, not many studies have analysed the effect of gender diversity on performance by measuring diversity based on the concept of a

critical mass of women to which we refer above. Actually, only Joecks et al. (2013) for Germany, Pedersen (2013) for Japan, Rossi et al. (2017) for Italy and Kramaric and Miletic (2017) for Croatia seem to have used such a measure and always for an individual country, rather than to a multi-country sample as the one we used. The concept of the critical mass stems from the critical mass theory, which suggests that up to a certain threshold -or critical mass of women- is achieved within a group, the group will be biased and will achieve a lower performance than that obtained by balanced or heterogeneous groups (Joecks et al. 2013). Actually the threshold is situated around the 20 to 40% of the members of the group, the board of directors in our case.

Moreover, our reasoning is that the relation between a critical mass of women directors and performance may be stronger if the firm has an innovative approach. In this way, we test if Miller and Triana (2009) wrongly consider a mediation role of innovation, while the expected relation between the two variables should actually be one of moderation. Although we are unaware of any paper analysing R&D as a moderating variable between board diversity and performance, in other fields of research, prior studies suggest that investment in R&D moderates different kind of relationships such as the relation between internationalisation and firm performance (Bausch and Krist 2007; Kotabe et al. 2007), or the relation between the acquisition of external technology and firm performance (Tsai and Wang 2008). In our paper, we thus take the lead of this potential moderating role and consider that the presence of women directors may affect performance, as well as innovation may determine the number of women on the board and as produce an environment that promotes creativity and initiative in the strategic decisions. All things together, innovation will be helping to maximising firm performance, when the corporation counts with a critical mass of women on the board.

Before going further, it is also worth noting the reason behind the selected time period in our analysis. As we will explain in the sample section, we chose the period from 2000 to 2010 which comprises a whole economic period for Western countries, in terms of economic growth, in terms of changes in the concept of corporate governance and it also represents the outset of the gender-equality movement (as stated in the title of the paper) demanding more equality in the composition of corporations' board of directors.

The results of the panel analyses carried out through GMM for a sample of European companies suggest that the presence of a critical mass of women directors increases firm performance and that this relation will expand as the firm's innovation activity increases. A moderating effect of innovation in the relationship between firm's performance and the presence of female directors on the board was detected.

The rest of the paper is structured as follows. We first develop the theoretical framework and pose the hypotheses to be tested. We then describe the sample, the methodology used and the results obtained. Finally, we draw some conclusions and consider possible avenues for future research.

2 Theoretical framework

2.1 The effect of the presence of women directors on firm performance

Over recent decades, researchers have studied the relationship between corporate governance and firm performance (Ravenscraft and Scherer 1987; Shleifer and Vishny 1997; Bhagat and Bolton 2008), considering, amongst others, the board of directors as a mechanism for controlling opportunistic behaviour within a firm

(Fama 1980; Fama and Jensen 1983). In general, the theoretical framework that explains the influence of board diversity on various corporate variables is very complex and extensive. There are at least seven theories that may explain the relationship between the presence of women in the boards of directors and firm performance: the agency theory, the theory of social identity, the resource-based theory, the stakeholder theory, the behaviour theory, the social role theory and the critical mass theory. However, as it will be shown later the critical mass theory has special relevance when examining the relationship between women as directors and firm performance.

The *agency theory* (Jensen and Meckling 1976) indicates that board gender diversity should be a decision-criteria only as long as it improves firm performance by aligning the interests of ownership and control. The *theory of social identity* (Tajfel 1978) suggests that individuals use demographic attributes to classify themselves and others in social groups (Turner et al. 1987), and as a result, individuals adopt behaviors in line with certain stereotypes (van Knippenberg and Schippers 2007), which may enhance a correct functioning of the group. The *resource-based theory* rises in the breast of the strategic direction under the fundamental premise of the existence of heterogeneity between the companies in which refers to resources and capacities. The theory suggest that firm performance is mainly explained by the possession of valuable, rare and inimitable resources (Barney 1991; Rugman and Verbeke 2002) and their immobility (Barney and Hesterly 2008). Therefore, the presence of women in the boards guarantees even more the diversity of resources by providing ideas, knowledge and contacts outside the traditional circle, different from those of men, and this positively affects boards' performance.

Referring to the impact of the *stakeholder theory* (Freeman 1984), boards of directors have to deal with a great variety of interests or demands associated with plurality, so a more diverse composition of the board will make it much more sensitive to the reality of the heterogeneous market in which the company operates. On the other side, the *behaviour theory* (Cyert and March 1963) claims that certain characteristics of board members, such as age and experience, seem to improve firm' s performance (Carter et al. 2003; Chapple and Humphrey 2014). A heterogeneous group is likely to give rise to a broader range of ideas and information as a result of the more diverse knowledge (Milliken and Vollrath 1991) and more varied ideas and perspectives (Miller and Triana 2009), thus enhancing the problem resolution capacity of the group. From the point of view of the *social role theory*, gender differences in social behaviour come up from the social division of labour between both sexes (Eagly 1987). Men and women being different, they will have more alternatives at their disposal when working together than those a single person acting individually (Krüger 2008). Thus, when the proportion of women on the board increases and women become leaders, it is more likely that some stereotypes that were commonly applied to women would also be applied to every member (West et al. 2012).

However, within this large range of theories, we highlight the *critical mass theory* as the most relevant theoretical framework for our specific research. This theory postulates that when the number of women on a board reaches a threshold of three women, the male directors show less group bias and more recognition of the achievements and tasks of women directors (Konrad et al. 2008; Torchia et al. 2011). Actually, the term "critical mass" originates in nuclear physics, as the smallest amount of fissile material needed to sustain a nuclear chain reaction (Marwell and Oliver 2013). This theory is one of the most relevant explanations for the impact of the

presence of women directors in corporate matters (Torchia et al. 2011). For example, on boards of directors, the majority often rules out or devalues the contribution of the minority (Turner 1987; Westphal and Milton 2000). In the same way, since women usually occupy only one or two positions on boards, they often have no significant impact on corporate decisions. However, the more women there are on the board, the greater their influence (Jia and Zhang 2013). In addition, the board dynamic changes significantly when there are three or more women directors because this number may improve the perception of the male directors that women have been selected for their talent and not for gender quotas (Jia and Zhang 2013).

In this way, this theory is also useful to explain how women influence corporations' decision making (Konrad et al. 2008), business innovation (Torchia et al. 2011), or corporate social responsibility (Bear et al. 2010; Post et al. 2011; Cabeza-García et al. 2018a). Thus, the presence of at least three women on the board seems to have a stronger effect on the results of the company than companies whose board of directors are composed for one woman only (Liu et al. 2014; Nguyen et al. 2015). In other words, if female representation increases the effectiveness of the board of directors and the company's results, that effect would be more noticeable as long as the number of women within the board of directors increases (Liu et al. 2014). An explanation is provided by Kramer et al. (2006) who mentioned that having a critical mass of female directors is good for corporate governance because the content of boardroom discussion is more likely to include the perspectives of the multiple stakeholders who affect and are affected by company performance, rather than focusing only on the shareholders' objectives. Then the company will also take into consideration the interests of the rest of stakeholders, such as employees, customers, suppliers, and the community at large are considered. Under this scenario, difficult issues and problems are considerably less likely to be ignored or brushed aside, resulting in a better decision-making. Finally, since the boardroom dynamic is more open and collaborative, it helps management hear the board's concerns and take them to heart.

In line with the above arguments and specifically referring to gender diversity, there is empirical evidence that women are more likely than men to act in a similar way to independent directors (Adams and Ferreira 2009), to carry out better oversight of decisions taken by CEOs (Valenti 2008), and to contribute to good governance (Rose 2007; Labelle et al. 2015). Some prior studies also point to a positive relation between the presence of women on the board and various proxies for firm performance such as return on assets (Mahadeo et al. 2012; García-Meca et al. 2015), return on equity (Bonn 2004; Lindstaedt et al. 2011), sales volume (Smith et al. 2006), market value (Bonn 2004; Campbell and Mínguez-Vera 2008; Fernández-Gago et al. 2016; Li and Chen, 2018) and the quality of the information revealed on earnings (Srinidhi et al. 2011). It has been also found that an increase in the number of women on the boards is positively related to higher economic results for the case of Spain (Reguera-Alvarado et al. 2017). Other studies, however, support a negative effect of gender diversity on firm value (Böhren and Ström 2010; Haslam et al. 2010; Anderson et al. 2011; Ahern and Dittmar 2012) and on firm performance (Böhren and Ström 2010; Haslam et al. 2010; Dobbin and Jung 2011)¹.

¹ Pucheta-Martínez et al. (2018) report that female institutional directors on boards enhance corporate performance, but when they reach a certain threshold on boards (11.72 %), firm value decreases. Besides, pressure-resistant female directors on boards also increase firm value, but only up to a certain figure (12.71 % on boards), above which they have a negative impact on firm performance. These findings are consistent with an inverted U-shaped relationship between female institutional directors and pressure-resistant female directors and firm performance.

The results of the study by Joecks et al. (2013) suggest that a more diverse gender composition will only improve performance if there is at least 10% diversity. Moreover, only for a threshold of 30% or higher women directors, will performance be greater than in a firm with a male-only board. At very low levels of gender diversity (less than 10% of women), an increase in diversity may even be associated with a reduction in performance. Similarly, the results obtained by Pedersen (2013), using a sample of Japanese companies, support a positive and significant relation between the presence of a critical mass of women on the board, that is three or more women, and performance. In addition, Kramaric and Miletic (2017), using a static panel for a sample of commercial banks in Croatia that operated from 2002 to 2014, find as their main result that when a critical mass of 20-40% of women on the board is achieved, the bank's performance improves when measured as ROA and also using other less common measures of financial profitability. Rossi et al. (2017), using a panel of Italian listed firms between 2005 and 2013, find that a critical mass of women has a positive and significant effect on Tobin's q. And, regarding performance of a social nature, Jia and Zhang (2013) find that when there are at least three women directors, the response of firms to natural disasters is more significant, and the results found by Cabeza-García et al. (2018a) support the idea that a critical mass of women on the board is associated with greater transparency in corporate social responsibility.

In line with the above theoretical foundations and the empirical evidence, we pose the following hypothesis:

Hypothesis 1: The presence of a critical mass of women directors positively affects firms' performance.

2.2 The moderating role of R&D expenditure on the relation between women directors and firm performance

Innovation is vital for business and is considered one of the most important predictors of firm performance in the literature (Torchia et al. 2011). It is also the cornerstone for helping firms to obtain a competitive advantage (Acs and Audretsch 1991; Hitt et al. 1996; Wind and Mahajan 1997; O'Regan et al. 2008), to expand their market share (Franko 1989) and to increase their sales (Morbey 1988). Moreover, from the point of view of the welfare economy, innovation is advantageous for the society because the usefulness of invention does not decrease when used by third parties (Arrow 1962). In recent decades, the number of studies on the relation between innovation and firm productivity has been increasing: i.e., studies on the introduction of new products (Eddy and Saunders 1980; Chaney et al. 1991), brand extension (Seltene and Brunel 2008; Sheinin et al. 2008) and product advertising (Eliashberg and Robertson 1988; Koku et al. 1997); the general conclusion being that, on average, the market rewards firms that introduce new products (Koku 2010).

Actually, the findings stress the importance of R&D as a determinant of economic performance (Goya et al. 2016), and there is consensus on the capacity of technology, innovation and entrepreneurship as determinants of enhanced productivity (Maté-García and Rodríguez-Fernández 2008). Innovation is capital for helping a firm become strategically competitive (Conner 1991), and produce more valuable and more differentiable products. All things together, innovation also leads to improved financial performance (Zahra et al. 2000).

Similar results are obtained by Lome et al. (2016), which study the effect of high-intensity R&D on performance during the most recent financial crisis for a sample of 247 Norwegian firms, finding a positive relationship

between them and encouraging the investment on R&D to fight financial crisis. Ruiqi et al. (2017) also found a positive relation between R&D expenditure and the firms' future performance for a sample of 772 listed companies in China over the period 2007 to 2012. Das et al. (2009) go further and state that once a firm makes large investments in R&D to create a new product or service, it will perform better, if the innovation can be commercialised on a large scale².

More recent studies, using accurate methodologies, have also uncovered the existence of relationships between one specific type of innovation like management innovation and enterprise performance (Krasnicka et al., 2018) and have found a positive effect of R&D intensity on sales growth, which is more intense in fast-growing firms and in high-technology sectors (García-Manjón and Romero-Merino 2012). In general, the existence of new ideas may generate greater productivity (Maté-García and Rodríguez-Fernández 2008) and, therefore, better firm performance. In addition, some researchers such as Sougiannis (1994), Toivanen et al. (2002), Pindado et al. (2010), Duqi and Torluccio (2011) and Vithessonthi and Racela (2016) stress that R&D efforts also increase firm value. In addition, changes in market values are associated positively with the announcement of new R&D initiatives (Chan et al. 2001; Eberhart et al. 2004).

It is necessary to highlight that the moderating role of different variables has already been addressed in the corporate governance literature when referring to performance. For example, the relation between institutional ownership and corporate social performance is moderated by variables such as the investment horizon, activism and coordination (Neubaum and Zahra 2006). The environment moderates the relation between CEO duality and firm performance (Boyd 2006), and the relation between CEO duality and accounting performance is moderated by the existence of family control (Lam and Lee 2008). Also headcount reduction has a negative moderating effect on the relation between the proportion of internal directors and firm performance (Zhang et al. 2014), and Li and Chen (2018) suggest that firm size significantly undermines the positive relationship between board gender diversity and firm performance for a sample of Chinese listed companies. Rhoades et al. (2001) also reveal a moderating role of certain remuneration systems in the relation between the leadership structure of the board and firm performance.

Besides, relationships including R&D are not always linear since this variable may also be affecting (as a moderator variable) extant relationships between company factors. Bausch and Krist (2007) find that R&D intensity positively moderates the relation between internationalisation and firm performance, and Kotabe et al. (2002), in a cross-sectional analysis of firms belonging to 12 different industries, find that R&D intensity also positively moderates the relation between multi-nationality and performance. After analysis of a sample of 341 electronics manufacturing firms in Taiwan from 1998 to 2002, Tsai and Wang (2008), show that the acquisition of external technology does not, in itself, make a significant contribution to firm performance; but the positive impact of the acquisition of external technology on firm performance increases as the degree of internal R&D efforts increases. In addition, Ghasemzadeh et al. (2018), based on the results of 625 questionnaires completed

² On the other hand, Vithessonthi and Racela (2016), on a sample of non-financial companies listed on US stock markets from 1990 to 2013, find that the level of expenditure on R&D is negatively associated with operational performance, and also find a clear negative effect of R&D intensity on ROS (return on sales) for high-intensity R&D firms, but not for firms with low investment in R&D.

by pharmaceutical companies, found a moderating role by the innovation culture in the relationship between organizational learning and innovation performance.

However, to our knowledge, no studies have been found that directly study the moderating role of R&D expenditure on the relation between the presence of women on the board and firm performance. There are some arguments explaining how innovative activity can expand the relation between the presence of a critical mass of women on the board and firm performance, such as (i) the innovation may be associated with a greater presence of women directors because they can provide different viewpoints, experience, working styles and values (Selby 2000; Del Brío and Del Brío 2009), (ii) the moderating influence that innovation exerts on other relations analysed, and the relevant role that a firm's innovation can play in its performance, or (iii) the personal skills in managing change and the creativity of women may expand in an environment of high firm innovation.

The *behavioural theory* of the firm represents a support for the above arguments, since it suggests that organisations are composed of multiple coalitions, or groups of decision makers, who may each have unique preferences (Cyert and March 1963); negotiation among these factions leads to the emergence of a dominant coalition whose colligated interests and preferences tend to guide the organization's responses to particular stimuli, such as performance (Cyert and March 1963; Gavetti et al. 2012; Gaba and Joseph 2013). For this reason, Greve (2003) considers that the behavioural theory of the firm offers a good platform for integrating development and decision-making ideas of innovations in organizations where diversity (and also gender diversity) characterised board composition. Although we do not aim to cover all the topics mentioned in the previous paragraph in this study, it does seem reasonable to expect that innovative activity will intensify the relation between the presence of a critical mass of women directors and performance, in line with the following hypothesis (Figure 1):

Hypothesis 2: A firm's expenditure on R&D positively moderates the relation between the presence of a critical mass of women directors and firms' performance.

[Figure 1]

3 Sample, variables and methodology

3.1 Sample

To test the above hypotheses, we studied listed firms in six European countries (Norway, Spain, France, Germany, Sweden and United Kingdom) over the period 2000-2010, resulting in a panel of 905 firms and 7,065 observations. For our sample, we chose a group of countries representing different legal environments, different systems of corporate governance and different degrees of regulation on equality. This led us to use the same countries and years as in Cabeza-García et al. (2019). However, in our estimations we ended up with an unbalanced panel of 1,856 observations on 231 groups because of missing values in some of the variables considered and because the econometric technique used, GMM, needs information for at least four consecutive years for each unit of analysis in order to test the lack of second-order series correlation. The data panel is the

result of combining data from corporate good governance reports and the Thomson database, which provides financial information for most countries in Europe.

The time period considered incorporates data from eleven calendar years, which comprises a whole economic period, in terms of economic growth, in terms of changes in the concept of corporate governance (after the Enron case in 2001) and incorporates the consolidation of good corporate governance codes in Europe. Moreover, from 2000 to 2010 are the years where the explosion of the feminist movement took place, which triggered out the existence of gender quota legislation in Europe. These years represent the outset of the gender-equality movement demanding equality also in the corporations' board of directors. The movement started in Norway and got its high peak in 2004 with the approval of the first gender quota law in the world, it was followed by Spain in 2007 and finished in 2010, when most European countries agreed to incorporate gender quotas in their legislation from 2011 on.

However, after 2010, the changes in R&D and gender quotas in Europe were most determined by the effects of the financial crisis whose effects still remained in most countries till 2012. For this reason, and since our time period already comprised a whole economic cycle, we dropped from the analysis the time period after 2010. Considering a longer time period still affected by the financial crisis of 2007 could be contaminating our results by the long-term effects of the financial crisis, which still remained and had strongly modified the evolution of both R&D expenses and gender quotas, whose increase slowed down drastically in that period. So, for the sake of the generalisation of our results, it seems wise to only include three years after the financial crisis of 2007.

3.2 Variables

Dependent variable

ROI: This variable is defined as the return on investment, that is, the earnings or losses generated by an investment in relation to the amount of money invested. More specifically, it is the quotient between net utility and the cost of the investment (x 100) (Table 1, Panel A). ROI is considered the most useful measure and the last "bottom line" of firm performance (Reese and Cool 1978; Jacobson 1992; Jahera and Lloyd 1992). In prior studies on corporate governance, it has been used as the measure of performance; for example, in Adams and Ferreira (2004), Francoeur et al. (2008), Miller and Triana (2009), Mínguez-Vera and Martín-Ugedo (2010), Schwizer et al. (2011), and Darmadi (2011). Among the traditional performance measures (Tobin's Q, return on assets (ROA), return on equity (ROE) or return on investment (ROI)), we chose ROI for our analysis since we focus on the effects over performance of a higher investment on R&D expenses. So our focus was on investment and ROI could be considered as the most exigent measure out of the four, since it refers not only to whether our assets or our equity give us some profitability, but ROI refers to whether our investment expenses are profitable and are producing net value for the firm. Tobin's Q was also excluded since we are not focusing on market values but on investment.

Explanatory variable and the moderating variable. As possible determinants of firm performance, we consider the following (Table 1, Panel B):

CMASS: The main explanatory variable is defined as the presence of at least three women directors (Burgess and Tharenou 2002; Carter et al. 2003; Kramer et al. 2006; Konrad et al. 2008; Labelle et al. 2010; Haslam et al. 2010; Torchia et al. 2011). This is based on the critical mass theory, one of the most relevant theories for explaining the impact of the presence of women on boards of directors (Torchia et al. 2011; Pedersen 2013; Kramaric and Miletic 2017).

R&D: Since expenditure on research and development is used as the indicator of firm innovation intensity (Hoskisson et al. 2002; O'Brien 2003), we measured this moderating variable as the quotient between expenditure on research and development and the firm's sales volume (which is also used in Miller and Triana (2009) and Nekhili and Gatfaoui (2013)).

Control variables. We considered the following control variables (Table 1, Panel B):

LEVERAGE: Proxy of the level of debt or risk, defined as the sum of short and long-term debt over total assets (Hu and Izumida 2008; Gul et al. 2011; Sun et al. 2011; Wintokia et al. 2012). The level of debt is often used in the literature on corporate governance and gender diversity to analyse the effect on performance (Campbell and Mínguez-Vera 2008; Ellwood and García-Lacalle 2015). On the one hand, greater financial leverage can lead to greater financial problems for the firm but, on the other, debt can be a mechanism for management discipline that has a positive effect on performance (González 2003).

SIZE: This variable is measured using the market capitalisation calculated by multiplying a firm's shares outstanding by the current market price of one of its shares (it has been introduced in the analyses in logarithm). It is simpler for large organisations than for small ones to improve their performance because of economies of scale and because they have more diverse boards of directors (Carter et al. 2003; Wang and Clift 2009).

BOARD_SIZE: This is measured as the total number of board members and is a control variable that is frequently used in the literature on corporate governance and gender diversity (Bozec and Dia 2007; Bennedsen et al. 2008; Cheng 2008; Guest 2009; Adams and Mehran 2012; Ellwood and García-Lacalle 2015). In principle, larger boards can exert a positive influence on firm performance because they have more collective information and are more likely to have more independent directors who can provide better oversight, have a broader set of specialist knowledge and external links and can improve decision-making (Pearce and Zahra 1992). On the other hand, large boards may face problems of coordination and communication, making it more difficult to achieve a consensus (Ellwood and García-Lacalle 2015), or may suffer from less group cohesion and greater levels of conflict (Goodstein et al. 1994). So, some studies support a positive effect (Carter et al. 2003; Kiel and Nicholson 2003), while others support a negative one (Dahya et al. 2008; O'Connell and Cramer 2010).

[Table 1]

3.3 Methodology

We use a panel data methodology to estimate our models, more specifically, the two-step GMM model devised by Arellano and Bond (1991) for dynamic panel data models. Unlike cross-sectional analysis, dynamic panel data analysis allows us to control for individual heterogeneity or non-observable individual effects (firm effects)

and for endogeneity. The GMM estimator uses internal instruments based on lagged values for the explanatory variables that may present problems of endogeneity (only the dummy variables for time and the country effect are considered exogenous). Specifically, we consider lags between 1 and 3 periods in the endogenous variables in our model. In our case, using a larger number of lags may lead to a larger number of instruments in comparison with the number of firms or groups, which might make the results less robust. We did, however, repeat the estimations considering a larger and smaller number of lags and the results do not vary significantly.

The consistency of the GMM estimator depends on the validity of the instruments used. Therefore, we consider the three specification tests suggested by Arellano and Bond (1991). The first is Hansen's over-identification, which tests for the lack of correlation between the instruments and the error term or, in other words, the joint validity of the instruments used. The second is the lack of second-order serial correlation in the first-difference residuals (m_2). The third are the Wald tests for joint significance of the explanatory variables (z_1) and the time variables (z_2). A possible problem of heteroskedasticity is also considered by using the robust option for the `xtabond2` command of the STATA program.

In addition, in line with the moderation analysis proposed and to test our hypotheses, we perform a hierarchical regression analysis. Firstly, in Model 1 we include the control variables. In Model 2, together with the control variables, we consider the main explanatory variable, namely, the existence of a critical mass of women directors. In Model 3, we introduce the former together with the moderating variable (firm innovation). In Model 4, we add a new interaction variable resulting from the product between the main explanatory variable and the moderating variable.

So, the dynamic general panel data model is as follows:

$$ROI_{it} = \alpha_0 + \beta_1 CMASS_{it} + \beta_2 R \& D_{it} + \beta_3 CMASSxR \& D_{it} + \beta_4 LEVERAGE_{it} + \beta_5 SIZE_{it} + \beta_6 BOARD_SIZE_{it} + \sum_{i=1}^{i=6} C_i + \sum_{t=2000}^{2010} Y_t + \gamma_i + \mu_{it}$$

where i refers to the group, t to the time, $\sum_{t=2000}^{2010} Y_t$ is a set of time variables, $\sum_{i=1}^{i=6} C_i$ is a set of dummies variables to

control the country effect and γ_i is the group effect, which we assume to be constant for firm i throughout μ_{it} period t , and is the error term.

4 Results

Table 2 shows the descriptive statistics for the variables used, and Table 3 shows their correlation coefficients. Although some variables show a statistically significant correlation, if we follow the empirical rule of Kleinbaum et al. (1998), analysis of variance inflation factors (VIF) shows no evidence of multicollinearity because no VIF is greater than 10.

[Table 2] [Table 3]

The results of the GMM analysis are shown in Table 4³. As can be seen from Model 2, the coefficient of the CMASS variable is positive and significant at 10% ($\beta = 9.211$, $p\text{-value} = 0.057$), indicating that there is a positive relation between a critical mass of women on the board and performance. So Hypothesis 1 is confirmed. These results are in line with those obtained by Kramaric and Miletic (2017) for a sample of banks in Croatia and by Pedersen (2013) for Japan. Rossi et al. (2017) also found a positive effect of the critical mass of women on firm value. Our results indicate that having “at least three women directors” makes boards more heterogeneous and allows for greater interaction between majorities and minorities while also guaranteeing that the board takes high-quality decisions (Torchia et al. 2011). The theory of behaviour stresses the importance of heterogeneity, assuming that people who differ among themselves will provide different approaches to problems and, therefore, the firm’s performance will improve (Torchia et al. 2011). Our results also corroborate, in this phase, the critical mass theory, because the presence of at least three women on the board adds value to the firm. Therefore, one of the contributions of our paper is that it strengthens the evidence in favour of having a minimum of about three women on the board.

Model 3 shows that the variable for R&D expenditure is not statistically significant. Although this result may not have been expected, it is in line with Sun and Anwar (2015), who suggest that, for China, R&D investments do not affect either profitability or market share. Similarly, Koku (2010) finds that the market does not react in a significant way to information on innovations or innovative activities in the industry. Stakeholders might consider such innovation to be a waste of resources because a positive future flow of revenue cannot be anticipated from the results of the innovation.

Regarding to the Model 4, which includes the moderating effect through the interaction term formed by the product of the CMASS variable and the R&D variable, this interaction term is both positive and significant (Baron and Kenny 1986). Therefore, as we predicted in our Hypothesis 2, expenditure on R&D seems to act as a moderating variable. The positive sign of the interaction coefficient in Model 4 ($\beta = 0.911$, $p\text{-value} = 0.061$), reflects the enlarging effect on the initial relation between the CMASS variable and performance (ROI). Moreover, the fact that R&D expenditure in itself is not significant in Model 3 indicates the presence of a pure moderation effect. That is, this variable does not directly affect performance, but it does affect the initial relation between the critical mass of women directors and firm performance.

Therefore, Model 4 amounts to an important contribution to the literature on corporate governance and on gender diversity by providing new evidence on the relation between gender diversity on the board of directors and firm performance, and shows how innovation activity can have an enlarging effect on this relation. Our results partly explain why Miller and Triana (2009) failed in their attempt to explain this relation through a mediating effect. Innovative firms may promote the existence of an environment in which there is no fear of change. This might also open the door to more women on the board, as suggested by the literature (Del Brío and Del Brío 2009), because an innovative firm will search for new ideas and, therefore, diverse thinking. In addition, women directors in such an environment may perceive how important it is to have sufficient resources to carry out innovation activity. Also, their personal skills or human capital (creativity, initiative) may be enhanced by the

³ Although not reported here, we repeated the estimations controlling for the industry effect, and the results do not vary significantly.

know-how they can acquire from the company in their everyday work, all of which can expand the effect of the critical mass of women on performance.

Regarding the control variables considered in the models, there is a positive and significant relation at 1% between firm size (SIZE) and performance in all three models presented, which is in line with the results of Yang and Chen (2009), Raymond and St-Pierre (2010), Serrasqueiro et al. (2010) and Cruz Milán et al. (2014). When the estimations are repeated measuring size as the logarithm of total assets, the moderating effect is still found.

The LEVERAGE variable has a negative and significant effect on all the models considered, so a higher level of debt reduces firm performance. This is in line with the argument given by Lome et al. (2016) that analysis of the agency costs of the diverging interests between shareholders and creditors shows a negative relation between debt and performance. This result is also in line with those of Kapopoulos and Lazaretou (2007) for Greece and Hu and Izumida (2008) for Japan. This negative effect can perhaps be explained by the opportunism of managers as they may be able to obtain funds from outside investors without investing in profitable projects, or it may be interpreted as the agency costs resulting from conflicts of interest between bondholders and shareholders (Hu and Izumida 2008).

Finally, the BOARD_SIZE variable is only negative and significant in Model 4, indicating that an increase in the number of directors has a negative effect on performance. This result is similar to those of Dahya et al. (2008), O'Connell and Cramer (2010) and Wintoki et al. (2012), and suggests that larger boards may face problems of coordination and communication, with more conflicts and less cohesion, which will ultimately affect their functioning and performance (Goodstein et al. 1994; Ellwood and García-Lacalle 2015).

[Table 4]

5 Conclusions and discussion

Corporate governance literature, entrepreneurs and legislators acknowledge that the presence of women on boards of directors is necessary for the positive effects of board diversity to result in success and economic benefits for the firm. In spite of the extensive literature on the topic, the lack of conclusive results leads us to consider it from a new perspective, based on the critical mass approach, taking a step further by proposing that the relationship between gender diversity on the board and firm performance should be analysed under the effects of the moderating role of a firm's innovation activity. Previous literature has unsuccessfully suggested the existence of a mediating relation, which led us to consider a different configuration in this relation. Our study shows that a moderating effect of R&D is the cornerstone to interpret and understand this relation.

The presence of a larger number of women directors in firms in most countries indicate that it is a management change and, to some extent, a form of innovation based on breaking with tradition and with traditional management methods. However, there are also firms that nominate women for the board only to comply with good governance recommendations, in order to increase their market value since it is deemed a relevant factor for investors. Others point women directors not to be left behind when other firms include female directors. Our results are in line with the first statement since they indicate that when firms invest on innovation and they are

willing to change, they effectively incorporate women on the board. The presence of a larger number of women directors is helping greater diversity to lead to greater creativity, more diverse opinions and better decision-making processes. So, an innovative environment at organisational level will allow decision-makers to realise that they have sufficient resources at hand to finance innovation activities, and will promote greater creativity and initiative, leading to improved performance.

The results of the panel data analysis performed suggest that there is a positive relation between a critical mass of women directors and performance, and that R&D expenditure has a moderating effect on this relation. So, R&D expenditure increases the positive effect of the relation between the presence of a critical mass of women directors and firm performance. There is also a positive and significant relation between firm size and performance, and a negative effect in the case of debt.

These results have important implications on the theoretical side, since they clearly support the theory of the critical mass, which demands a greater presence of women on boards of directors so the rest of the directors take female directors opinions into consideration. It also supports the theory of firm behaviour, whereby greater diversity on the board leads to more varied resources for decision-making because the individuals come from different backgrounds and have different profiles. They are also in line with the tenets of the resource-based theory, because the presence of women directors expands the network of contacts and resources available for improving decision-making and, therefore, for the growth of the firm. Finally, our results support the agency theory by stressing how monitoring of the firm can be improved through the board.

However, it is also relevant to stress that it is innovation (measured as R&D expenditure), being the factor that moderates the above relation, that strengthens the effect of the presence of women directors on performance. Our work also has important implications for corporate governance practice in Europe. In this economic area, in which great efforts are being made by governments to include women on boards of directors and to promote other types of diversity, firms can improve their performance by spending on R&D, which generates technology and innovative products and services that will be widely accepted on the market. Also, drawing up and adopting effective public policies on innovation may improve the relation between corporate governance and firm performance. It is not only important for firms to enhance their gender diversity but also to invest in R&D to gain the maximum benefit from the presence of women on the board.

The adoption of effective public policies on innovation can enhance the direct relationship between corporate governance and the performance of the company. Our results indicate that it is not only necessary to increase gender diversity in the management of our corporations, but they should also invest in R&D to maximise the profits derived from the presence of women on the board. For this reason, we encourage governments to create subsidies or credit facilities for companies which comply two conditions: intensive investment in R&D and promotion of parity in their board of directors. On the other hand, managers should be aware of the joint importance of incorporating women in boards and investing in innovation activities to maximise their decision making as well as their performance.

It would have also a direct impact on the development of new processes, products and services. The diversity of the board allows to modify the comfort zone of the company, generates a cognitive conflict among board

members, which generate new products, new processes and the development of innovations based on the knowledge of a heterogeneous group which better fits the market needs (in fact, women take the 70% of purchasing decisions in real life). The presence of women on boards and their search for a productive model based on innovation could be good news for the development and economic growth of the countries, as indicated by Cabeza-García et al. (2018b). Quite commonly, economic growth tends to be based on the use of low-cost female labor, seeking to compete at low costs, and this occurs despite clear evidence that the future of sustainable and inclusive economic growth should be based on higher R&D investment.

Finally, as a line of future research, it might be of interest to analyse the existence of other variables, such as organisational culture or business strategy which might also have a moderating effect on the relation between a critical mass of women on the board and firm performance. It would also be interesting to include countries from other economic areas in the study, in order to generalise the existence of the moderating effect presented in this paper.

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