GENDER DIVERSITY QUOTA, INNOVATION AND FIRM PERFORMANCE: EVIDENCE FROM EUROPEAN LISTED COMPANIES

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Abstract

The board gender diversity quota has gained substantial attention over the past decade in light of the growing regulatory pressure on companies to address the under-representation of women in the board. This study aims to explore the moderating effect of the gender diversity quota in the relationship between R&D investment and firm performance in 12 European countries over the 2011-2021 period. Our results, for a panel data of 589 European listed companies and based on GMM analysis, yield clear evidence that gender diversity quota regulations do not shape the relation between R&D investment and firm performance. Such a finding suggests that the percentage of companies that apply the quota regulations in the European context has remained too low to benefit from the advantages of gender diversity quota regulations.

Keywords: R&D investment. Board gender diversity quotas. Firm performance. European context

Introduction

The employment rate of women has increased in recent years although that woman has remained largely under-represented in economic decision-making bodies, particularly in senior management positions and on Boards of Directors (BoD) (Thomas e t al, 2018), in both private and public companies worldwide. Promoting a better equality in BoD between women and men is an important objective for various institutions in many countries. As far as European countries are concerned, the proportion of women on BoD of the largest listed companies across the 28 European Union Member States (EU) had more than doubled over the past decade-from 11.8% in 2010 to 30.6% in 2021 (European Institute for Gender Equality, 2023). This proportion greatly varies between different European countries. In fact, countries that have introduced legislative quotas have been driving significant progress. According to the European Institute for Gender Equality, only six EU-based countries have already introduced a system of legislative quotas to promote women presence on BoD, namely France, Italy, Germany, Portugal, Belgium and Austria. It is worth stressing that Norway has been the first European country in the world to impose the quota in the boards. Some countries have adopted soft measures such as Denmark, Spain, Netherlands, Ireland, Luxembourg, Poland, Slovenia, Finland, Sweden and UK where the representation of women rose, an average, from 12.4% in 2010 to 30.6% in 2021. However, gender balance has not made significant improvements in the countries that have not taken any action like Cyprus (8.5%), Estonia (9,1 %) and Malta (10.8%) in 2021. This large gender gap between EU countries made European Parliament to formally adopt a new EU law in June 2022 on gender balance on corporate boards. Such a law stipulates that by 2026 companies are required to have a minimum of 40% of the underrepresented sex among non-executive directors or at least 33% among all directors, and dissuasive sanctions will be imposed on companies that do not comply with the rules (Fernandez-Mandez and Pathan, 2023). The current economic environment has been hit by several adverse effects, i.e., the Covid-19 pandemic, the surge of inflation, the climate crisis and the Russo-Ukrainian war, which calls for more resilient companies. However, companies' resilience can only be enhanced through investing in R&D (Lv et al., 2019) and by pursuing good corporate governance (Chen et al, 2016; Alhares et al, 2020). The fulfillment of these two conditions guarantees the (post-crisis) recovery and sustainable performance of companies and the economy in general. R&D investment stands as one of the two crucial factors of economic prosperity of firms, industries and countries (Flayyih, 2015; Gonzalez-Fernández and Gonzalez-Velasco, 2018; Sharma et al, 2018). As the BoD is the beating heart and the nerve center where the company's major orientations are drawn up and decided (Rose 2007), the presence of women on BoDs has become a social and economic demand (Cabeza García et al. 2021). The effectiveness of gender quotas regulation is intensely debated. This paper aims to study the moderating effect of the gender diversity quota regulation in BoD on the relationship between R&D investment and firm performance in the European context over 2011-2021 period. More specifically, it purposes to answer the following question: How does gender quota regulation in the board shape the relationship between R&D investment and firm performance in European countries that have enacted hard quotas and those that have adopted soft measures? Our paper contributes to the literature in several ways. First, most of the research on board gender diversity quota has focused on the direct effect of gender diversity quota regulation on firm performance and stock market reaction (Ahern and Dittmar, 2012; Ferrari et al., 2022; Matsa and Miller, 2013; Greene et al. 2020; Fernandez-Mandez and Pathan, 2023; Eckbo et al. 2022), on boards (Bennouri et al, 2020; Bohren and Staubo, 2015; Eckbo et al., 2016; Martinez-Garcia, et al, 2021). Also, research has focused on the determinants of gender diversity quota regulation (Thomas et al, 2018; Mohring and Teney, 2020). However, research on the EU Directive on a gender quota for corporate BoD is limited (Fernande and Pathon, 2023). We contribute to the debate on gender quotas for corporate boards by examining the moderating effect of gender diversity quota regulation. Second, there is a wide consensus in the related literature (Chan et al. 1990; Sougiannis, 1994; Chan et al. 2007; Ehie et Olibe 2010; Gonzalez-Fernandez et GonzalezVelasco 2018) that R&D investment positively affects the firm performance (Alwan et al., 2023; Alyaseri et al., 2023; Flayyih & Khiari, 2023; Salman et al., 2023). However, R&D investment is highly uncertain in terms of relevance, intensive in sunk costs, and has a long payoff (Lee and O'Neill 2003; Driver and Guedes 2012). Moreover, the R&D investment is characterized by a strong information asymmetry and asset specificity (Rhee and Yoo 2013) and thus, the R&D strategy and decisions become particularly prone to conflicts of interest between shareholders and managers (Honoré et al. 2015). Such a situation makes them adopt an opportunistic behavior which translates into the expropriation of resources, the maximization of the benefits granted and the managerial entrenchment, which ultimately undermines the effectiveness of R&D activities and deplete the firm value. Simply put, the agency problems reduce the efficiency of the R&D investment. From the perspective of the managerial entrenchment theory, managers are motivated to overinvest in R&D to enhance their presence in the company by increasing the costs of their replacement and reducing the risk of revocation. Likewise, this theory suggests that managers adopt strategies, such as manipulating specific investments, i.e., R&D investment, to neutralize the control mechanisms imposed by the BoD. Chakraborty et al. (2014) held that antitakeover provisions that increased managerial entrenchment were associated with poor performance on innovation. We contribute to the discourse by going beyond empirically investigating the direct relationship between R&D investment and firm performance to discuss the board gender diversity quota's implementation to ensure the efficiency of R&D investment through female directors' ability to monitor activities and hold management accountable for performance. The rest of the paper is structured as follows. Section 2 develops the theoretical framework and poses the hypotheses to be tested. Section 3 provides details of the data and methodology. The empirical results and analysis are presented in Section 4. Finally, we draw some conclusions and consider possible avenues for future research.

Theoretical framework and hypothesis development

R&D investment and firm performance

The role played by R&D investment is crucial in many areas. The Covid-19 pandemic has shown how R&D investment is pivotal in finding remedies for the health crisis and curbing the danger of this virus that threatens humanity. R&D investment enables the introduction of new products, services and

Manuscrito recibido: 06/10/2023
Manuscrito aceptado: 20/10/2023

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processes (Honoré et al. 2015; Pindado et al. 2015), which is a key element in guaranteeing post-crisis recovery (financial crisis of 2008 and the Covid-19 health crisis). In their contribution, Lome et al. (2016) showed the importance of R&D investment to struggle financial crisis. In its 2016 report, the Organization for Economic Co-operation and Development (OECD) held that innovation stood as "an important driver of economic growth and development insofar as it helped address pressing social and global issues, i.e. changing demographics, health risks, resource scarcity and climate change. Several examples are at the heart of such a definition. However, without being exhaustive, we cite the new technologies example developed by the firm Airbus in January 2023. Much of the R&D literature has focused on the relationship between R&D investment and firm performance. The majority of studies have confirmed the positive impact of R&D investment on firm performance (Chan et al. 1990; Chan et al. 2007; Ehie and Olibe 2010; Rafiq et al. 2016; Sougiannis 1994; Gonzalez-Fernandez and Gonzalez-Velasco 2018). Focusing on the European context, Del Monte and Papagni (2003), using a sample of 500 companies for the period 1989-1997, showed that firms engaged in R&D had a much higher growth rate than firms in the same sector that were not engaged in R&D. Similarly, in their contribution carried out on a sample of Spanish companies during the 2007-2013 period, Fernández and Velasco (2018) found that corporate innovation had a positive impact on the firm performance, particularly on sales revenues. The authors noted that this positive relationship depended on the size and age of the firm. The study suggested that a positive relationship between R&D investment and firm performance was stronger when it came to large companies and start-ups or younger companies as well. Pindado et al. (2010), using data from Eurozone countries, demonstrated that R&D expenditure contributed to significantly increasing the value of the company. They concluded that the effectiveness of R&D investment was contingent on firm characteristics. Likewise, Lome et al. (2016) examined the effect of high intensity R&D on performance during the most recent financial crisis using sample of 247 Norwegian firms. The study came to the conclusion that R&D investment had a positive effect on revenue in good times with a two-year last effect. Hence, our initial hypothesis is stated as follows:

***H1**. Investment in R&D has a positive effect on the firm performance.*

Gender diversity quota and firm performance

A vast literature is interested in the study of the impact of gender diversity quota on the BoD on the firm performance. By and large, it stands out from the related literature the that studies carried out on this theme rationalize the nexus between gender diversity in the BoD and the firm performance by having recourse to the agency theory, the dependence on resources theory, the social psychological theory and the critical mass theory (see, among others, Arvantis et al., 2022; Cabeza-García et al., 2021; Pandey et al., 2022). It is commonly accepted that the main causes of the agency problems are the separation of the ownership and control function, the conflicts of interest, the risk aversion and the information asymmetry. The major contribution of the agency theory is to provide means to mitigate these problems through the implementation of various governance mechanisms. Having women directors on the BoD mitigates agency problems and enhances the board's monitoring abilities (Adams and Ferreira 2009; Francoeur et al. 2008), which ultimately enhances the firm's sustainable growth (Al Uin et al. 2022; Amin et al. 2022). Furthermore, gender diversity on the BoD may reduce the information asymmetry (Gul et al. 2011; Abad 2017) and ameliorates boards' ethical standards (Eagly et al., 2004) because women behave less opportunistically (Francoeur et al. 2008; Krichnan et al, 2008).

According to the dependence on the resources theory (Pfeffer 1972; Pfeffer and Salancik 1978), the BoD stands as an important source of advice and expertise insofar as it is expected to provide competence, experience and networking to help managers create new investment opportunities, and ultimately an value added. The presence of more women in the BoD contributed to mobilize specific cognitive resources resulting from different socialization process and education (compared to men) (Hillman et al, 2002; Helgesen, 1990), which ultimately raised the company's access to diversified networks. It has also improved the quality of its strategic decisions (Chatterjee and Hambrick 2007) and assured more value-added (Hillman et al. 2007). In a nutshell, integrating women on the BoD enables to create new perspectives (Hillman 2015; Torchia et al. 2018) and to identify new opportunities for innovation (Torchia et al. 2011), and thus contributes positively to the firm performance. Moreover, board gender diversity avails firms' legitimacy (Brammer et al. 2007; Singh and Vinnicombe 2004). According to the critical mass theory (Kanter 1977), below a critical threshold, female directors can be considered as mere tokens and have no influence to modify accepted behavior or decisions because of their scarce visibility, power, authority and legibility. The critical mass theory holds that the role of women becomes effective when the number of women directors reaches a certain critical point. In this regard, several studies have postulated that when the number of women on boards reaches three, their voices are being heard and they can effectively influence in the firm decision-making process (Kristie 2011; Kramer et al. 2007). Referring to this theory, Torchia et al. (2011) explored the Norwegian context and came to the conclusion that the necessary condition for the female presence in the BoD to contribute to innovating companies' internal functions and organizations was at least three women sitting in the BoD. Unlike the previous mentioned theories, another strand of literature tends to support the hypothesis that the presence of women in boardrooms has drawbacks. For instance, the social psychological theory predicts that more diversified boards may lead to more conflict (Mínguez-Vera and Martin 2011), makes the communication and decision-making process onerous and more difficult and has a greater potential for disagreement and lack of cohesion (Eulerich et al. 2014). The more gender diversity in boards would give rise to a lack of coordination and interest conflict among the board members, hence the sub-optimal decision making. Another branch of the socio-psychological theory highlights the greater risk aversion of women in decision making compared to their male counterparts. The main arguments hold are that female directors tend to limit risky projects such as R&D projects, which ultimately harms firm competitiveness (Faccio et al. 2016). Many empirical studies have highlighted the relationship between gender diversity quota on the BoD and firm performance (Boukattaya and Omri 2018; Greene et al. 2019; Master and Miller 2013; Ferrari et al, 2022). Their results have been mixed and inconclusive. Some authors showed that there was a negative effect, while others documented a positive or even no effect of gender diversity quota on firm performance. This obscurity of results was due to the choice of performance measures, the countries gender parities (soft quota or hard quota), the differences between the countries regarding how the public views government interventions concerning quota laws and time horizons (Magnanelli and Pirolo 2021; Pimentel et al. 2020; Post and Byron's 2015). In addition, these contradictory results can be explained by unobserved factors that affect both firm performance and the composition of the BoD, and by the problem of reserve causality insofar as firm performance can also be a determinant of BoD composition (Buchwald and Hottenrott, 2019). Ahern and Dittmar (2012) investigated the impact of gender quotas on the value of Norwegian companies by using 248 firms from 2001 to 2009. The gender diversity quota had a negative impact on company value measured by Tobin's Q. Similar results were obtained by Matsa and Miller (2013) on the binding-quota implementation on a sample of Norwegian firms. The authors concluded that there was a negative effect of gender quotas on the companies' financial performance measured by an operating profit. Likewise, by examining the causal effects of the gender quota in the Norwegian context, Yang et al. (2019) held that the gender quota negatively affected the firm performance. Greene et al. (2020) examined the impact of California's board gender diversity mandate (SB 826) using a sample of 602 public firms and highlighted the negative effect of the gender diversity quota on the firm value. Such a finding can be justified insofar as the law imposed a constrained optimization on the board composition. As far as the French case is concerned, Boukattaya and Omri (2018) showed, on the basis of a sample of French firms listed on SBF120 over the 2011-2016 period and performing the system GMM, that complying with the quota law had no effect on firm performance, as proxied by Tobin's Q. The authors held that the recency of the quota law in the French context explained to a great extent their finding. In the Italian context, Ferrari et al. (2022) concluded that the elections of new directors resulting from the introduction of the gender quota is associated with abnormal stock returns. Fernandez and Pathan (2023) examined the stock market reactions to the announcement of the new, June 2022 European Union (EU) regulation on board gender diversity over the period 3 August 2021 to 5 July 2022. They found positive market reactions to this announcement. Theses authors noted that investors view the quotas regulations as a beneficial tool, especially for firms exposed to a large gender imbalance. Based on the previously theoretical foundations and the empirical research, we may suggest the following hypothesis:

H2: Gender diversity quota has positive effect on firm performance.

Moderating effect of gender diversity quota on the R&D investment-firm performance nexus

The decision to invest in R&D is a decision full of bets insofar as an investment in R&D is specified by complexity, uncertainty and high risk, which is why the decision to invest in this type of project becomes more delicate and poses serious challenges (Sunder et al. 2016). It seems clear, from the related literature, that R&D investment provides distinctive advantages to the firm, preserves their sustainability in the market and improves their future performance (Sheikh, 2018). However, taking into account the opportunistic behavior of managers and the differences of interest between them and shareholders, the agency theorists argue that R&D investment may not principally be tracked by managers for the purpose of improving the firm value. Previous studies have empirically demonstrated that managerial opportunism affects the relationship between R&D investment and firm performance (Carpenter and Sanders 2003; Zahra 1996). As a result, the effectiveness of R&D investments may not be guaranteed following opportunistic behavior by managers, which could compromise the survival of companies. Thus, it is interesting to unveil the likely factors to guarantee the effectiveness of the investment in R&D. For companies investing in R&D, corporate governance mechanisms have a great utility. The role assigned to these mechanisms is to mitigate conflicts of interest related to investment in R&D, to ensure transparency and to guide the strategic decisions taken by the manager in the direction that improves the firm value. Several studies have examined the moderating effect of corporate governance on the linkage between R&D investment and firm performance (Chu et al. 2016; Chung et al. 2003; Berrone et al. 2007; Kor and Mahoney 2005; Kroll et al. 2006; Patel et al. 2017; Pindado et al. 2015). A commonly view shared by previous research is that good corporate governance significantly and positively impacts the efficiency of R&D investment (Patel et al. 2017; Pindado et al. 2015; Thraya et al. 2019).

Jensen (1993) found that R&D investment made by large companies elevated in the firm value, and such lack of effectiveness could be due to the malfunction of the internal control. In the same connection, Chung et al. (2003) showed how corporate governance affected the relationship between the firm value and the R&D investment. The authors held that the effect of R&D investment on the firm value depended in a significant and positive way on the composition of the BoD. Chu et al. (2016) confirmed the positive effect of governance mechanisms, which offered higher investor protection, on the efficiency of R&D. Pindado et al. (2015) inquired whether country-level governance characteristics moderated the market valuation of R&D. Analyzing a data from companies based in the European Union, the United States and Japan between 1986 and 2003, the authors revealed that the effectiveness of investor protection, the market valuation of R&D projects and the effective control mechanisms enhanced the positive impact of R&D on a firm's market value. Gender diversity on the BoD could be appreciated as a substitute mechanism for governance in poorly governed firms (Gul et al., 2011; Loukil et al. 2019) and contribute to good governance (Cabeza-Garcia et al. 2021). Related studies reported that women are more present in the control committees and remuneration committees. Women represent 36% in remuneration committees in STOXX Europe 600 companies, and their proportion is higher in control committees with 39%. The greater representation of women in this committee is associated with more effort on monitoring and enhance public and private disclosures (Adams and Ferreira 2009; Gul et al. 2011). Greater monitoring exercised by women directors is expected to mitigate the agency problem related to R&D investment, to bring down the opportunistic managerial conduct and to align the managers' behavior on pursuing value-creating projects (Chen et al. 2018). Pandey et al. (2022) examined the relationship between board gender diversity and firm financial performance through the theoretical framework of the complexity theory. They proved that greater gender diversity on boards would mitigate the negative effects of the CEO power on the firm's financial performance. Chen et al. (2018) found that firms with a greater representation of female directors invested more in innovation and achieved greater innovative success. This positive relationship was stronger when managers appeared more entrenched, which supported the hypothesis that gender diversity in the BoD would enhance the effectiveness of innovation by increasing executive oversight. Furthermore, Chen et al. (2018) noted that the female representation on the board did not, on average, improve the performance of the firm. They found that women on boards only affected the firm value for firms in innovation-intensive industries. By examining 227 public companies listed in the Indonesian stock exchange in 2015, Firmialy and Adhiutama (2020) held that firms with a high number of women directors on board and more focus on their R&D investment activities, could generate high financial performance measured by Tobin's Q than those firms with low gender diversity and R&D investments.

H3: Gender diversity quota has a positive effect on the relationship between RD investment and firm performance.

Empirical methodology

Sample description and data sources

Our sample consists of 589 non-financial firms from 12 European countries observed for the 2011-2021 period. The sample is an unbalanced panel of 4019 firm-year observations. In the sample, firms from France, Germany and the United Kingdom count for more 50% of the observations, and the most represented sectors are industrials, technology, consumer discretionary and health care with respectively 28.64%, 18.13%, 13.22% and 12.73%. The description of the sample is as follows: (Table 1)

The data are sourced from the Datastream database. The choice of the study period is justified for two reasons. Firstly, this period is characterized by the implementation of a large number of board gender quota regulations in Europe. The initiative came first from Norway, which promulgated a law aiming to achieve 40% female representation in the board. Spain followed in the footsteps of Norway and fixed a similar quota in 2007. Since 2011, most European countries have adopted similar measures, such as Iceland, France, Belgium, Italy, Netherlands, Denmark, Germany, Portugal. Finland and Austria. This massive introduction of quotas, both soft and hard, was encouraged by the European Commission that proposed a Directive with a target to reach 33 % female directors on boards (or 40% female non-executive directors) in 2012. The study period represents the peak of the BoD gender quota revolution. Therefore, this gives us more data to evaluate the moderate effect of the gender diversity quota on the relationship between innovation and firm performance. Secondly, this period has witnessed a change in R&D which has been determined by the effects of the financial crisis since innovation is the best possible long-term response to the crisis and. On the other hand, it was determined by the Europe 2020 strategy, adopted by the European Council in the end of 2010. This which set a target of investing at least 3% of EU GDP in R&D, of which 2% was achieved by firms. Only seven out of the 27 EU Member States spent a higher-than-average part of their GDP in R&D by 2020. With 3.5% of its wealth invested in R&D, Sweden topped the list. It was followed by Belgium, with 3.48%, Austria (3.2%), Germany (3.14%), Denmark (3.03%), Finland (2.94%) and France (2.35%). In the EU as a whole, this proportion was around 2.32%.

Variables

The outcome variable in our context is the firm performance, which is proxied by the Tobin's Q as a market value (*TobinQ)*. The Tobin's Q is the most used market-based measure because it is a proxy of the performance of the firm that reflects the expectations of the market about future profits and capture, albeit imperfectly information about the future implications of current decisions (Ahern and Dittmar, 2012; Pimental et al, 2020; Dezso and Ross 2012).

The explanatory variables: R&D investment intensity which we measure by the amount of R&D expenditures divided by total net sales of the firm (*RD*) (Lee and O'Neill, 2003; Cabeza García et al.,2021; Rodriguos et al., 2020).

The moderating variable: a dummy variable (GDQ) that takes 1 if the percentage of gender diversity in the BoD is greater or equal to the country's specific target ratio, and 0 otherwise.

The control variables consist of two sets relating to the firm characteristics and corporate governance. For the first set, it comprises the firm size as measured by the natural logarithm of the total assets (*Fsize*), the firm age which is the number of years since the inception of the firm (*Fage*), leverage (*Lev*) as a measure of a firm's financial risk, which is measured as the ratio of total debt to total assets. As for the second set of covariates, we include corporate governance variables, namely the board size as measured by the number of directors on the board (*Bsize*), the board independence calculated as the proportion of independent directors on the board (*Bind*), and the percentage of female executive directors on the board divided by board size (*EMGD*).

Empirical model

To examine how gender quota shapes the linkage between firm performance and innovation, we employ a panel data methodology insofar as it permits controlling for individual specific effects, endogeneity and reverse causality. The family of the Generalized Method of Moments (GMM) estimators used to estimate both dynamic and statistic panel models that can handle different statistical pathologies. Indeed, it appears the most relevant for estimating various specifications based on the following model that we consider in this research:

$$\pi_{it} = \alpha_i + \phi_t + \lambda_1 \pi_{it-1} + \alpha_1 RD_{it} + \alpha_2 GDQ_{it} + \alpha_3 \left(RD \times GDQ\right)_{it} + \Gamma_1^{'} X_{it} + \Gamma_2^{'} Z_{it} + \varepsilon_{it}$$

where π stands for a measure of the firm performance (i.e. Tobin Q or similar),

Table 1: Sample countries.

Countries with bending quota	Quota targets	Obs	Countries with soft measures	Quota targets	Obs
Austria	30%	116	Spain	40%	169
Belgium	33%	106	Netherlands	30%	157
Germany	30%	834	Sweden	40%	402
Italy	33%	165	UK	33%	973
France	40%	560	Denmark	40%	165
Norway	40%	117	Finland	40%	255

Notes: The classification of countries into countries with bending quota and countries with soft measures is based on the European Institute for Gender Equality. Obs stands for the number of observations.

RD denotes innovation which is measured by R&D investment, GDQ is a dummy variable such that GDQ_{it} scores 1 if firm i fulfills the gender quota for women on bords during year t and zero otherwise, X represents a $(k_1 \times 1)$-vector of control variables related to the firm characteristics (i.e. the firm size, the firm age, the leverage), Z is a $(k_2 \times 1)$-vector of control variables related to the firm board characteristics (i.e. the board size, the board independence). The interaction term (RD×GDQ), which is the main key variable besides innovation, is added to find out to what extent fulfilling the gender quota shapes the effect of innovation on the firm performance.

The presence of a lagged dependent variable as an explanatory variable violates the orthogonality, whose consequences of which can be alleviated by differencing Eq. (1). The difference GMM estimator has disadvantages and limitations, especially when some right-hand side variables are persistent over time, or when the lagged variable is very close to being persistent (Blundell and Bond 1998). The system GMM estimation can therefore be used insofar as it employs a set of difference equations instrumented with lags of the equations in levels and relates a set of equations in instrumented levels with lags of difference equations (Bond 2002). In short, the system GMM estimator, which comprises sufficient orthogonality conditions that are imposed to assure consistent estimates of the parameter even with endogeneity and not observed individual-country effects (Arellano and Bover 1995; Blundell and Bond 1998) is utilized. The results confirm the soundness of our methodological choice. A battery of panel-based specification tests has also been used to ensure that inference from our model is sufficiently reliable. The first test that has been run is the Hansen test of over identification, which tests for the join validity of the instrumental variable used. The second test we employ is the Arellano and Bond (1991) test of the lack of serial correlation.

Empirical results

Descriptive statistics

Table 2 shows the descriptive statistics of the variables used in this study. As it stands from this Table, the mean value of *TobinQ* is 2.082, which exceeds 1 indicates that European companies exhibit good investment opportunities on average. Again, such a variable has a large expanse, considering that the minimum is equal to 0.478 (which implies that there are companies whose assets are worth less than their replacement value) and the maximum equal to 41.338. On average, the firms in our sample spend 4.238% of their net sales on R&D expenditure. This means value exceeds the target set in 2010 by the EU, which was planned to devote at least 3% of the EU member States' GDP to R&D by 2020 of which 2% were achieved by firms. Regarding the board gender diversity variable, an overage of 27.082 is observed, with a minimum value of 0 and a maximum of 66.67%. This mean value is quite far from the directive proposal (40%) fixed by the European Commission in 2012. It stands out from Table 2 that in our sample 32.37% of the observations have female directors' proportion greater or equal to the country specific target ratio. Put it simply, such a view indicates that the percentage of Europe-based companies observing the gender quota regulations on their BoD is low so far. This shows that the proposal has failed to achieve its objectives, which has led the European parliament to issue a new directive obliging companies to implement the quota. In the same vein, Panel B of Table 2 indicates that the average R&D investment intensity reaches its high record for Denmark and a low one in Austria. Sweden has the highest firm performance (*TobinQ*) whereas Germany has the lowest firm performance. The highest average percentage of women on board is reached for both Norway and France whereas the lowest is reached for Austria. Italy has the higher percentage of firms that pursue the quotas, while Denmark has the lowest percentage.

Results and discussion

The results of the GMM analysis are summarized in Table 3. The regression results of Models (1) – (3) are reported in Columns (1) – (3). we include in the estimations the lagged values of *GDQ*, *RD* as additionally explanatory variable to test for the presence of their possible lagged effects on firm performance and to take into consideration that the effect of *GDQ* and *RD* may be a non-immediate effect. To unveil the influence of R&D investment on firm performance, we regress *TobinQ* on both *RD* and its one period-lagged *value* along with the control variables. Our results show that the coefficients of *RD* are not statistically significant in Models (1) and (2). The same results are obtained for the lagged *RD* variable. This finding is in line with Cabeza-García et al. (2021) in the European context and with Rafiq et al. (2016) in China context. This result suggests that the increase in R&D spending does not obviously mean the progress (Von Braun, 1996). Regarding the effect of the BoD gender diversity quota on firm performance, the coefficient of the *GDQ* variable is not significant throughout all models. Such findings, which is in line with the results of Pimental et al. (2020) in the European context, Bennouri et al. (2018) and Pandey et al. (2022), suggests that the regulations on gender quotas in corporate boards has no impact on firm performance. Regarding the results of the moderating impact of the BoD gender diversity quota on the

Table 2: Summary statistics.

Variables	NOBS	Mean	STD dev	Min	Max
Continuous variables					
TobinQ	4007	2.0820	1.9191	0.4780	41.338
R&D intensity	3918	4.238	6.460	0	83.98
Board gender diversity	3980	27.082	13.347	0	66.67
Board size	3980	10.612	4.062	3	28
Board independent	3977	57.231	25.360	0	100
Executive members gender diversity	3980	12.829	12.7981	0	100
Leverage	4017	23.528	14.537	0	126.12
Firm size	4017	6.722	0.875	0.768	9.093
Firm age	3989	81.730	69.206	1	832
Sales growth	4004	6.636	28.886	-85.41	1141.65
Dummy variables	Frequency 1			0	
Gender diversity quota			32.37	67.62	

Panel B: Descriptive statistics of key variables by country											
	TobinQ			RD			BGD			GDQ	
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	0	1
Austria	1.192	0.718	2.636	1.480	0	21.11	19.896	0	50	76.72	23.27
Belgium	1.685	0.710	9.819	6.201	0.02	29.34	26.353	0	60	66.04%	33.96%
Germany	1.802	0.478	13.449	4.315	0	34.36	24.255	0	57.14	59.23	40.77%
Italy	1.678	0.670	7.888	3.298	0	13.35	27.64	0	57.14	45.45%	54.55%
France	1.657	0.584	11.944	3.976	0	28.41	36.03	0	63.64	56.79	43.21
Norway	1.752	0.524	11.150	2.422	0.15	25.48	36.538	0	62.5	47%	53%
Spain	1.829	0.748	10.37	4.655	0	53.87	21.261	0	46.15	91.72	8.28
Netherlands	1.746	0.713	10.418	5.935	0.02	62.9	28.079	0	50	52.87	47.13
Sweden	3.175	0.550	41.338	5.794	0	48.34	32.29	0	66.67	72.64	27.36
UK	2.197	0.506	22.450	3.773	0	83.98	22.581	0	66.67	76.54	23.46
Denmark	3.894	0.770	17.057	6.144	0.02	76.65	22.467	0	50	93.33	6.67
Finland	1.909	0.749	6.050	3.001	0	21.84	31.087	7.41	60	73.73	26.27
Source: Authors' calculation**.**											

Table 3: Dynamic GMM-system estimates.

	(1)	(2)	(3)
TOBINQ $_{t-1}$	0.359	0.412*	0.352*
	(0.103)	(0.075)	(0.056)
RD	0.0397	0.00539	
	(0.345)	(0.834)	
RD$_{t-1}$			0.0331
			(0.190)
GDQ	0.299	-0.365	
	(0.228)	(0.134)	
GDQ$_{t-1}$			-0.268
GDQ× RD	-0.0637		
	(0.122)		
Fsize	0.986***	0.848**	0.686**
	(0.007)	(0.016)	(0.025)
Growth	-0.00835	-0.00745	0.00286
	(0.441)	(0.396)	(0.647)
Lev	-0.151**	-0.118*	-0.0456
	(0.035)	(0.091)	(0.186)
Fage	-0.00378	-0.00121	-0.00855
	(0.756)	(0.913)	(0.357)
Bsize	0.0157	0.00000353	0.0587
	(0.864)	(1.000)	(0.236)
Bind	-0.00466	0.000299	-0.00255
	(0.564)	(0.966)	(0.686)
EMGD	0.0895***	0.0933***	0.0748**
	(0.007)	(0.005)	(0.043)
Constant	-2.680	-2.725	-3.113
	(0.222)	(0.162)	(0.108)
Observations	3258	3258	2784
No. of instruments	25	22	22
AR1 (p-value)	0.00408	0.00408	0.00401
AR2 (p-value)	0.453	0.335	0.0798
Hansen-J (p-value)	0.740	0.593	0.0950

Notes: The dependent variable is TobinQ**.** *p*-values in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

relationship between R&D investment and firm performance, the result show that interaction term formed by *GDQ* and *RD* is not significant. This finding may be explained by many reasons. First, in the European context, a minority are companies that respect these regulations and apply the target ratio (only 32.37% of the observations in our sample that apply the target ratio). Furthermore, in 2021, women accounted for only 30.6% of BoD members of the EU's largest listed companies. This numbers remains low to allow companies to take advantage of the benefits of the gender diversity quota. Second, the implementation of the BoD gender diversity quota in itself is not sufficient to guarantee the improvement in the firm value. Bennouri et al. (2018) showed that the relation between BoD gender diversity and firm performance depended on different attributes of female directors such as independence, membership of relevant board committees and board chair. Pandey et al (2022) suggested that BoD gender diversity did not affect firm financial performance in isolation, but rather in combination with various board and firm characteristics. This result can be explained, likewise, by the fact that the market does not perceive gender diversity quota as a mechanism to improve the functioning of the board. Regarding the control variables, the *Firmsize* variable is positive and significant related to the *TobinQ* in all models presented, which is consistent with Cabeza-García et al. (2021). Larger compagnies tend to have a better financial and economic position than smaller ones due to their power on the market and their economies of scales.

Robustness checks

First, we examine whether the results depend on the type of the quota in place. Therefore, we create two subsamples consisting of (1) countries with legislative measures and (2) countries with soft measures. The results, depicted in Table 4, clearly indicate that, for the legislative sample, the coefficient of the interaction term GDQ*RD is non-significant. The same results are obtained for the soft sample (Table 4, Panel B, column 1), which once again confirms our result. The second robustness check is to assure whether the results obtained significantly change when using an alternative measure of firm performance, we use the market value suggested by Ehie and Olibe (2010), namely: MV= market capitalization / total sales. We re-estimate our baseline regressions (1)-(3) and report the results in Table 5. All the results for both subsamples are consistent with the benchmark regression results Overall,

Table 4: Sub-sample analysis per type of quota.

Panel A: legislative sample			
	(1)	(2)	(3)
	TOBINQ	TOBINQ	TOBINQ
TOBINQ $_{t-1}$	1.289***	1.478***	1.593***
	(0.000)	(0.000)	(0.000)
RD	-0.0115	-0.0269	
	(0.721)	(0.664)	
GDQ	-0.224	-0.211	
	(0.137)	(0.399)	
GDQ$_{t-1}$			-0.184
			(0.421)
GDQ*RD	0.0350		
	(0.186)		
RD$_{t-1}$			-0.0382
Fsize	-0.176	-0.423	-0.670
	(0.405)	(0.395)	(0.362)
Growth	-0.000627	0.00138	0.00942
	(0.926)	(0.904)	(0.622)
LEV	0.0505	0.0983	0.137
	(0.261)	(0.296)	(0.295)
Fage	0.00159	0.00894	0.0163
	(0.819)	(0.603)	(0.513)
Bsize	0.0566	0.0975	0.0989
	(0.122)	(0.203)	(0.273)
Bind	-0.000309	-0.000348	-0.00258
	(0.926)	(0.956)	(0.741)
EMGD	-0.0110	-0.0373	-0.0708
	(0.632)	(0.501)	(0.425)
Constant	-1.078	-1.622	-1.248
	(0.162)	(0.215)	(0.473)
Observations	1529	1529	1527
No. of instruments	25	22	22
AR1 (p-value)	0.000313	0.0278	0.0783
AR2 (p-value)	0.734	0.326	0.243
Hansen-J (p-value)	0.913	0.994	1.000
Panel B: soft sample			
	(1)	(2)	(3)
	TOBINQ	TOBINQ	TOBINQ
TOBINQ t-1	0.429	0.519	0.467
	(0.128)	(0.115)	(0.113)
RD	0.0531*	0.0475	
	(0.088)	(0.170)	
GDQ	0.145	-0.815*	
	(0.578)	(0.085)	
GDQ$_{t-1}$			-0.416
			(0.148)
GD*RD	-0.0508		
	(0.127)		
RDt-1			0.0413
			(0.139)
Fsize	2.833**	3.500**	2.962**
	(0.021)	(0.014)	(0.022)
Growth	-0.000766	-0.00619	-0.00322
	(0.950)	(0.628)	(0.772)
Lev	-0.0283	0.00486	-0.00569
	(0.660)	(0.946)	(0.932)
Fage	-0.00962	-0.0179	-0.0128
	(0.510)	(0.335)	(0.408)
Bsize	0.0458	0.00179	0.00563
	(0.802)	(0.993)	(0.976)
Bind	-0.0132	-0.0137	-0.0126
	(0.302)	(0.351)	(0.341)
EMGD	-0.00139	0.0154	0.00143
	(0.965)	(0.693)	(0.966)
Constant	-15.79	-20.13*	-16.58
	(0.060)	(0.034)	(0.055)
Observations	1729	1729	1726
No. of instruments	25	22	22
AR1 (p-value)	0.0153	0.0379	0.0287
AR2 (p-value)	0.0195	0.0127	0.0153
Hansen-J (p-value)	0.857	0.885	0.849

Notes: *p*-values in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

our results seem to be robust and hold, independently of the measure of firm performance. Finally, Since the quality of the estimates depends on the equation specification, it becomes crucial to carry out relevant specification tests to ensure that it has been well specified. To this end, we perform the Hansen-J test of over-identifying restrictions, which allows testing the validity of lagged variables as good instruments, in addition to the Arellano and Bond (1991) test of the lack of serial correlation. In all cases, the results for AR(2) are insignificant, which shows the absence of a serial correlation in the second difference. Furthermore, the results of the Hansen test are insignificant, which confirms the validity of instruments.

Table 5: Robustness test using alternative measure of firm performance.

Panel A: Legislative sample			
	(1)	(2)	(3)
	MV	MV	MV
MV t-1	0.579***	0.566**	0.576**
	(0.000)	(0.002)	(0.002)
RD	-0.0208	-0.0117	
	(0.561)	(0.796)	
GDQ	-0.123	-0.174	
	(0.659)	(0.576)	
GDQt-1			-0.254
			(0.302)
GDQ* RD	0.0206		
	(0.674)		
RDt-1			-0.0126
			(0.797)
Fsize	-0.478	-0.575	-0.596
	(0.273)	(0.319)	(0.462)
Growth	0.0455	0.0480	0.0481
	(0.229)	(0.243)	(0.250)
Lev	0.0350	0.0696	0.0833
	(0.540)	(0.462)	(0.605)
Fage	0.00643	0.00898	0.0109
	(0.734)	(0.695)	(0.593)
Bsize	-0.0878	-0.0375	-0.0194
	(0.352)	(0.726)	(0.883)
Bind	0.000727	0.000923	-0.000241
	(0.917)	(0.905)	(0.975)
EMGD	-0.0658	-0.0752	-0.0733
	(0.224)	(0.326)	(0.534)
L.GDQ*RD			
Constant	4.367	3.465	2.937
	(0.150)	(0.235)	(0.219)
Observations	1531	1531	1529
No. of instruments	25	22	22
AR1 (p-value)	0.0113	0.0111	0.0239
AR2 (p-value)	0.497	0.411	0.425
Hansen-J (p-value)	0.775	0.817	0.870
brackets			
Panel B: soft sample			
	(1)	(2)	(3)
	MV	MV	MV
MV t-1	0.705***	0.701***	0.698***
	(0.000)	(0.000)	(0.000)
RD	-0.0306	-0.0139	
	(0.314)	(0.569)	
GDQ	-0.124	0.237	
	(0.686)	(0.569)	
GDQt-1			0.145
			(0.580)
GDQ*RD	0.0442		
	(0.235)		
RDt-1			-0.0245
Fsize	0.979	1.030	0.859
	(0.304)	(0.303)	(0.340)
Growth	0.00374	0.00347	0.00420
	(0.434)	(0.502)	(0.420)
Lev	0.00230	-0.000808	-0.00809
	(0.954)	(0.983)	(0.839)
Fage	0.00471	0.00651	0.00770
	(0.588)	(0.595)	(0.517)
Bsize	0.126	0.152	0.134
	(0.487)	(0.426)	(0.432)
Bind	-0.000836	-0.000994	0.000436
	(0.938)	(0.928)	(0.969)
EMGD	-0.0640	-0.0724	-0.0631
	(0.071)	(0.066)	(0.093)
Constant	-6.268	-6.871	-5.659
	(0.301)	(0.252)	(0.299)
Observations	1726	1726	1722
No. of instruments	25	22	22
AR1 (p-value)	0.0000536	0.0000584	0.0000830
AR2 (p-value)	0.186	0.190	0.183
Hansen-J (p-value)	0.752	0.721	0.639

Notes: *p*-values in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Conclusion

The past decades have seen a diffusion of gender quota regulations for corporate boards in many European countries in order to increase women's representation on boards and improve their participation in decision-making in the economic area. It is commonly accepted that the different gender quota regulations are an effective policy for increasing the representation of women on corporate boards, and this effect is intense in countries with legislative quota (Bennouri et al. 2020). The aim of this paper has been to examine the moderate effect of gender diversity quotas on the relationship between R&D investment and firm performance for European countries. Regarding the impact of R&D investment on firm performance, our result has suggested that the R&D investment does not significantly affect firm performance- there is no direct effect of R&D investment on firm performance. The decision to invest in R&D is a decision full of bets. Indeed, an investment in R&D is specified by complexity, uncertainty, high risks and informational asymmetries. That is why the decision to invest in this type of project becomes more delicate and poses serious challenges. Investing more in R&D does not ipso facto lead to the enhancement of the firm value. Market investors do not significantly perceive R&D investment. They might consider such an innovation to be a waste of resources. Such a finding may help managers to understand that following the innovation war in order to beat the strong competition cannot significantly affect the firm value. The results our study puts forward imply that the decision to invest in R&D needs a thorough review to ensure the positive effect of R&D investment. In addition to that, several studies have shown that the efficiency of R&D investment depends on several factors. For example, a view commonly shared by previous research (Patel et al. 2017; Pindado et al. 2015; Thraya et al. al. 2019) is that good corporate governance has a positive and significant influence on the efficiency of R&D investment. We have found no influence of gender diversity quota regulations on firm performance measured by Tobin Q. In addition, our results yield clear evidence that gender diversity quota regulations do not shape the relation between R&D investment and firm performance Consequently, these regulations do not affect the relationship between R&D investment and firm performance. Such a finding suggests that the percentage of compagnies that apply the quota regulations in the European context has remained too low to benefit from the advantages of gender diversity quota regulations. On another side, this result is caused by the way the incorporation of women into the BoD has been achieved. Such regulations provide no guidance regarding the positions and roles that should be assigned to women directors. These companies may recruit new female directors only to meet quotas regulations rather than on the basis of voluntary appointments. Despite the positive effect of gender quota regulations on parity within the BoD, women administrators have remained confronted with a glass ceiling, which results in their exclusion often from the strategic decisions. Women face several obstacles in their access to the BoD including — but not limited to — the maintenance of the status quo and the lack of priority given to women in the BoD. Such obstacles are often based on gender stereotypes that associate ambition and leadership with masculinity and the idea that the capacities of women are limited. This result is caused by the unequal participation of women and men in decision-making and by the low percentage of compagnies that apply the quota regulations in the EU. This can undermine the expected positive effects of gender diversity quotas on firm performance. The quotas achieve only a symbolic change in gender equality, rather than a real change, because men continue to hold great power over the day-to-day management of business. To be able to bring about a real and lasting change, it is important to stick to the following four-step strategy: First, it is compulsory to improve the quota regulations to achieve real parity in the various committees in the BoD and to ensure women's representation among executive directors through the obligation to establish a quota to both executive and non-executive directors. Second, all member countries are compelling to realize the quota regulations and to put in place effective and dissuasive sanction measures. Third, the obstacles limiting women's access to BoD and their inclusion in the decision-making process should be overcome. Finally, the decision to appoint women within the BoD should be based on specific criteria (e.g. management experience and industry expertise) rather than on the blind implementation of a quota regulation. Policymakers must throw professional training tools to enhance skills of women and build up a rational competitive environment for women. These measures allow companies to benefit from the advantages of gender diversity, thereby assuring the positive impact of the BoD gender quota on the firm performance. Our study suggest that the adoption of a law imposed by the European parliament in November 2022 can bear fruit in the coming years, so the role of women becomes more effective in decision-making in the economic area in the EU. This directive aims to establish transparent recruitment procedures within companies, so that at least 40% of non-executive director positions or 33% of all director positions should be occupied by the under-represented gender by July 2026 and impose dissuasive sanctions on companies that do not comply with the rules.

Future research can analyze the moderate effect of the gender diversity quota in all director positions (i.e. to appoint a minimum of 33% female directors) in the next years in order to evaluate the effectiveness of the law imposed in the EU. It would also be interesting to include other regions that have quota regulations in the study to generalize the results put forward by our research.

Declaration of interest statement

The author declare that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

This study has not received any grant or funding from any agencies.

Data availability statement

The data that support the findings of this study are available from Thomson Reuter DataStream. They are also available from the corresponding author, upon reasonable request.

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