LUND UNIVERSITY
School of Economics and Management

BUSN79: Degree Project in Accounting and Finance

Spring 2023

Board Gender Diversity and Firm Performance:
A Study on European Firms

Does board gender diversity have an impact on the performance of European firms?

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Abstract   **JEL classifications:** M10, M14, G34

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Purpose: The purpose of this paper is to investigate the relationship between board gender diversity and firm performance through the lens of the critical mass theory. One further aim is to investigate and explain the moderating effect of leverage.

Methodology: The applied methodology is OLS modelling controlling for year, industry, and country fixed effects. The first two research questions are investigated by using three dummy variables as main explanatory variables. The third hypothesis is investigated by including the percentage of women on the board as main explanatory variable and an interaction term.

Theoretical perspectives: Agency theory, resource dependence theory and critical mass theory are the main theoretical perspectives applied. The first two are used to assess how increased board gender diversity can impact the effectiveness of the board and subsequently the firm's financial performance. Critical mass theory is used to interpret how that impact can be achieved.

Empirical foundation: A sample of 5 050 observations consisting of 574 unique European firms in the period of 2005-2021 is used to construct an unbalanced panel. All data has been downloaded from Bloomberg.

Conclusions: The positive relationship between board gender diversity and firm performance is in line with, and solidifies previous research. However, no evidence for the critical mass theory is presented, although European firms seem to arrange their board in accordance with the theory. Moreover, a moderating role of leverage on the impact of board gender diversity on firm performance is found, where firms with high amounts of leverage do not enjoy the same benefits of board gender diversity as less leveraged firms do. The negative moderating effect of leverage is argued to be due to the monitoring that creditors carry out which reduces the need for increased internal monitoring brought by female board members.

Acknowledgements

1. Introduction

The first chapter is used as an introduction to the topic and thesis at hand, covering a background of the field, motivation for the study and a problem formulation. This is followed by a short summary of the methodology, main findings and the paper's contribution, while the concluding paragraph is a brief outline of how the rest of the paper is structured.

1.1 Background

The United Nations' fifth sustainable development goal is to achieve gender equality, and it is an important part of the sustainable growth needed in the world (United Nations, 2022). One step towards reaching this goal can be through the world of business, more explicitly through incorporating more women in leading positions. This is also a part of the EU's general strategy towards a more gender-neutral world, and as of 2026, at least 40% of non-executive directors and 33% of executive directors on the board of listed firms within the EU must be of the underrepresented gender (European Commission, 2022).

In 2010, only 11,9% of board seats in the EU were occupied by women (European Commission, 2016). It has increased significantly since then, in early 2023, 32,2% of board seats in EU member countries were held by women. However, as of the latest report from the European Commission (2023), only 4 EU members meet the required quota, France, Italy, the Netherlands and Denmark. Therefore, there is still a lot of work to be done until the union can state that gender equality in the boardroom has been achieved. This underrepresentation of women could be important not only from a societal point of view, but also from the business perspective. Since women are believed to possess better monitoring abilities (Brahma, Nwafor and Boateng, 2021), are better decision-makers (Adams, 2016), and are generally better educated than men (European Commission, 2023), there is reason to believe that they are better board members as well. Thus, it is possible that firm performance is impacted by board gender diversity.

Although this field has been investigated previously, preceding studies have generally found varying results and have come to varying conclusions. One of the most famous of these studies was conducted by Adams and Ferreira (2009), who found that an increase of women on the board of directors had a negative impact on firm performance. Since then, various studies have

tried to find the ultimate answer to the question. For example Liu, Wei and Xie (2014), Brahma, Nwafor and Boateng (2021) and Gennaro, Bhagwat and Scott (2018) find a positive impact on firm performance, while Darmadi (2013) and Marinova, Plantenga and Remery (2015) do not find a relationship at all, and Adams and Ferreira (2009) and Wellalage and Locke (2014) find a negative relationship between the two.

1.2 Motivation and Research Question

While board gender diversity and its effect on firm performance has been studied extensively, the consideration of the cultural aspects of the board and the implications faced by women when joining a male-dominated board have not been considered to the same extent. For women to be able to have an impact on the decisions of the board, they have to overcome the cultural thresholds of a male-dominated board (Kanter, 1977; Nguyen, Ntim & Maligala, 2020). The quote "One woman on the board is a token, two is a presence, and three is a voice" (Kristie, 2011, p.1) is a simple yet effective summary of the critical mass theory. When few or a single female is present on the board, they are often viewed as tokens, meaning that they and their actions are primarily viewed through sex-role stereotypes which hinders acceptance and inclusion (Kanter, 1977). By reaching critical mass, the female board members can overcome the cultural thresholds through collaboration and their presence being normalized, creating opportunities for them to impact the work of the board and the performance of the firm.

The relationship between board gender diversity and firm performance has been studied through the lens of critical mass theory before (e.g. Brahma, Nwafor & Boateng, 2021; Liu, Wei & Xie, 2014; Joecks, Pull & Vetter, 2012). However, studies with an international scope are lacking (Nguyen, Ntim & Maligala, 2020). This research gap could prove detrimental as international considerations are important on the topic, since cross-cultural differences have been identified as one explanation as to why previous research has produced differing conclusions (Nguyen, Ntim & Maligala, 2020). Moreover, the new EU law on board diversity quotas is close to implementation and will require large structural changes by European firms. How these structural changes will affect the performance of European firms is of interest and motivates research on the topic.

Cultural differences are believed to be a part of the reason for the varying results in previous studies, differing consequences of increased monitoring is another. However, this has not been

tested empirically before. While Adams and Ferreira (2009) investigate the moderating effect of internal monitoring, the increased external monitoring caused by high leverage and its moderating effect on the impact of board gender diversity on firm performance has not been investigated and remains as a gap in the research, motivating further research on the topic.

The aim of this paper is to study the relationship between board gender diversity and firm performance of European firms, with regards to the critical mass theory and the moderating effect of leverage. More specifically, three research questions are formulated:

RQ1: *Does board gender diversity have an impact on the performance of European firms?*

RQ2: *How does critical mass theory affect the impact of board gender diversity on the performance of European firms?*

RQ3: *Does leverage have a moderating effect on the impact of board gender diversity on firm performance?*

1.3 Purpose and methodology

The purpose of this paper is to investigate the impact of board gender diversity on firm performance through the lens of the critical mass theory, and to investigate the moderating effect of leverage. In accordance with previous studies, the natural logarithm of Tobin's Q is used as a measure of firm performance. In order to conduct this research, financial data of firms included in the Stoxx Europe 600 index during the period of 2005-2021 has been gathered. The sample consists of 5 050 observations made up of 574 unique firms, creating an unbalanced panel. By using three variables on board gender diversity, the percentage of women on the board, Board size, CEO duality, Woman CEO, Bonus, Leverage and Size, we examine the impact of board gender diversity on firm performance and the moderating effect of leverage. Through this, the aim is to contribute to the existing literature on the topic.

Using this sample, a fixed effects regression analysis is conducted. Issues associated with endogeneity are addressed through the use of period, industry and country fixed effects. Furthermore, robust standard errors clustered by firm are used to mitigate heteroscedasticity.

In order to study the second research question, an interaction term between the percentage of women on the board and leverage is constructed and implemented. Results are then presented and analyzed, firstly the main regressions which investigate the impact of board gender diversity through the lens of the critical mass theory, and then the investigation regarding the moderating role of leverage.

1.4 Main findings

The empirical findings in this paper provide evidence that board gender diversity has a positive impact on European firms' performance, but the relationship seems to be near-linear and therefore no support for the critical mass theory is found. Moreover, leverage plays a moderating role in the relationship between board gender diversity and firm performance. Because of the increased monitoring brought by large amounts of debt, the impact of board gender diversity differs between firms, depending on their level of leverage. While firms with low leverage enjoy a rather large increase in firm performance from including more women on the board, this effect is reduced when firms assume more debt, until the relationship eventually shifts sign.

1.5 Contribution

We shed light on the issue of the time correlated nature of board gender diversity, showing that European firms to a larger extent structure their boards in accordance with the critical mass theory, although no evidence for critical mass theory itself is produced. Furthermore, the wider perspective of the EU is explored, in contrast to the majority of previous studies that focus on a single country, despite cross-cultural differences playing an important role. Moreover, we include an interaction term in order to explore the moderating effect of leverage and further investigate the hypothesis of Adams and Ferreira (2009), regarding the moderating role of pre-existing monitoring. Doing this, we extend their hypothesis by considering external monitoring, and provide evidence that a firm's leverage has a moderating effect on how increased board gender diversity affects the financial performance of the firm. Thus, this paper can be used to create a deeper understanding of the mechanisms behind the impact that board gender diversity has on firm performance.

1.6 Outline

The rest of the paper is structured as follows, chapter 2 presents empirical and theoretical literature, which is used to formulate the hypothesis. The sample and methodology is presented and discussed in chapter 3. The results are presented and the relationship between firm performance and board gender diversity is analyzed in chapter 4. Robustness is covered in chapter 5 before chapter 6 concludes the paper.

2. Literature Review

The aim of this chapter is to lay the foundation of the study by explaining the theoretical basis, and then use these theories to formulate the hypothesis. First, the empirical and related literature is presented, which consists of previous literature on board gender diversity's impact on firm performance, and psychological differences between men and women. This is followed by a section on theoretical literature, which consists of the agency theory, resource dependence theory and the critical mass theory. Lastly, the hypotheses are developed.

2.1 Empirical Literature

2.1.1 The Impact of Board Gender Diversity on Firm Performance

Arguably the most famous and influential piece of academic work in the field was conducted by Adams and Ferreira (2009). By analyzing a large sample of listed U.S firms during the period of 1996-2003, the authors investigate the impact of board gender diversity on firm performance. The method of choice is both probit and ordinary least square regressions, with the percentage of women on the board as dependent variable and both accounting based and market based firm performance measures as main explanatory variables. The paper dives into three main areas: (1) Does board gender diversity have an impact on board inputs? (2) Does it affect governance? (3) Does it have an impact on firm performance? These three questions lay the basis for analysis on the impact of board gender diversity on firms in general, and firm performance in particular.

A significant impact is found on board inputs and governance, but conflicting results are discovered on firm performance. Regarding board inputs, Adams and Ferreira (2009) found, among other things, that female board members are more likely to be part of monitoring-related

board committees, such as auditing and corporate governance committees. The authors also found that the level of monitoring intensity of the board, which is proxied by CEO turnover after poor stock performance, is higher in more gender diverse boards. When considering the impact on firm performance, Adams and Ferreira (2009) find evidence suggesting that board gender diversity could have both positive and negative consequences, and sometimes having no impact at all, depending on the dependent variable and modeling choices. These results lead Adams and Ferreira (2009) to the conclusion that increased board gender diversity has a positive impact only when more monitoring and improved governance is beneficial, but a negative impact overall.

A more recent example of literature on the subject of board gender diversity's impact on firm performance is the work of Brahma, Nwafor and Boateng (2021), who analyze FTSE100 companies in the UK. Contrary to the majority of studies on the subject, Brahma, Nwafor and Boateng (2021) use critical mass dummies instead of the percentage of women as main explanatory variables. Investigating the impact of a *critical mass* of women on the board, they find evidence that having three women or more on the board of directors, proved to have a significantly larger impact than having just one or two women on the board. This result is in line with the hypothesis of the critical mass theory, and with previous and succeeding studies using the critical mass theory (e.g. Karavatis, Kokas & Tsoukas, 2021; Liu, Wei & Xie, 2014; Joecks, Pull & Vetter, 2012).

Moving towards a wider perspective, there are a number of papers researching similar topics who reach different conclusions. Papers that find a positive relationship include, among others, Liu, Wei and Xie (2014), Brahma, Nwafor and Boateng (2021), Gennaro, Bhagwat and Scott (2018) and Campbell and Minguez-Vera (2008), while Rose (2007), Darmadi (2013) and Marinova, Plantenga and Remery (2015) fail to find a significant relationship, and Adams and Ferreira (2009) and Wellalage and Locke (2014) find evidence for negative relationship between board gender diversity and firm performance. The reason for these varying results is believed to be cross-cultural differences and attitudes (Nguyen, Ntim & Malagila, 2020), and varying impacts of increased monitoring (Adams & Ferreira, 2009).

2.1.2 Psychological Difference Between Men and Women

Exploring the relationship between board gender diversity and firm performance creates the need to include psychological aspects of the genders. In order for a difference to be visible, there must be some differences in the characters of men and women. Existing research provides mixed results in this field, some literature suggests that women tend to be less risk-taking than men (Byrnes, Miller & Schafer, 1999), less interested in competing (Niederle, 2014; Niederle & Vesterlund, 2007) and less over-confident when it comes to decision-making (Huang & Kisgen, 2013). Discussing differences between men and women in corporations, Adams (2016) states that the presence of these female characteristics in corporate boards might lead to improved governance and decision-making.

Moreover, Sila, Gonzalez and Hagendorff (2016) explores the subject in a literature review, in an attempt to explain psychological differences between women and men in regards to risk-taking and attitudes. While Sila, Gonzalez and Hagendorff (2016) recognise the findings of Byrnes, Miller and Schaffer (1999), the authors also take the findings of Adams and Funk (2012) into consideration, who state that general differences between men and women might be present, but these differences are not applicable to women who have risen in the ranks enough to reach the boardroom. Instead, it is argued that the women on the board of directors assume the male-dominated culture and are therefore no less risk-taking than men in similar positions (Adams & Funk, 2012). While the reasons for this is unknown, one possible explanation could be that specific risk-taking characteristics are required for such roles, and that the women who reach these positions have been required to take large risks to get there, and are therefore no less risk-taking than their male counterparts (Adams & Ferreira, 2009).

2.2 Theoretical Literature

2.2.1 Agency Theory

The board has two primary purposes according to Hillman and Dalziel (2003), to provide (1) monitoring and (2) resources. Both of these functions are important, and although it is quite uncommon, it is beneficial to include both when analyzing the board's impact on firm performance (Hillman & Dalziel, 2003). The extent of these functions, and the magnitude of the impact from them may vary between specific firms. In general however, the first of these two functions includes the board's role of supervising and monitoring top management. This

role is the most important from the standpoint of the agency theory, as this function facilitates cooperation between owners and management, mitigating discrepancies between the two (Jensen & Meckling, 1976).

The primary focus of the agency theory is on conflicts of interest between shareholders and management, and in what ways the board of directors can resolve such conflicts by being a mediator between them (Jensen & Meckling, 1976). By monitoring the work of top management on the behalf of shareholders, the board ensures that management works in a way that maximizes shareholder value and firm performance (Hillman & Dalziel, 2003). If this monitoring is insufficient, management might engage in value destroying behavior in order to increase their personal wealth or influence, resulting in agency costs and reduced firm performance.

Brahma, Nwafor and Boateng (2021) suggest that the monitoring role can be reinforced and made more efficient by introducing more diversity among the board members. This is believed to be the case due to women's relatively higher accountability and level of independent thinking (Brahma, Nwafor & Boateng, 2021), and their greater attendance and increased likelihood of taking on greater responsibilities (Adams & Ferreira, 2009), making them more suitable for monitoring duties than men. By reaching higher board gender diversity, firms are able to improve their monitoring of management, resulting in increased transparency and reduced agency costs (Karavatis, Kokas & Tsoukas, 2021). Both of which are positive for firm performance.

However, the cost of increased monitoring through changed board composition is an important aspect, as it can create a scenario where increased monitoring increases compensation costs more than it decreases agency costs, having a negative impact on firm performance (Jensen & Meckling, 1976). Adams & Ferreira (2009) find empirical evidence for this claim, suggesting that increased monitoring could have a negative impact on firm performance in firms where monitoring and governance was sufficient from the beginning, and the reduction of agency costs therefore does not outweigh the increased costs of monitoring. This means that there is support for the existence of an upper boundary where further increased internal monitoring no longer is beneficial for the firm.

Another source of monitoring which has not been studied to the same extent in relation to board diversity is leverage, which is of interest since creditors perform extensive monitoring in order to assess credit worthiness, which reduces agency costs. Diamond (1991) states that firms that issue private debt are often strictly monitored by the bank, reducing agency costs since the managers are prohibited from engaging in value destroying behavior. Furthermore, public debt allows for screening and monitoring by a credit rating agency and by the public domain (Bannier & Hirsch, 2010), which also reduces agency costs. Moreover, high leverage can work as a disciplining measure according to Jensen's (1986) free cash flow hypothesis. By increasing leverage, and thus increasing interest expenses, free cash flow is decreased and top management are less inclined to waste resources on value destroying projects (Jensen, 1986). Thus, firms can reduce agency costs, and therefore reduce the need for internal monitoring, by assuming high amounts of debt. This is partly due to monitoring being performed externally by creditors, and partly due to management being forced to take responsibility due to the financial pressure the required interest payments bring.

2.2.2 Resource Dependence Theory

The second purpose of the board of directors, as presented by Hillman and Dalziel (2003), is to provide the firm with valuable resources. Providing resources does not only cover physical assets, but an important part of the board's function is to contribute with social and financial capital, networks and general guidance (Hillman, Withers & Collins, 2009). This function can be explained and analyzed through the lens of the resource dependence theory, presented by Pfeffer and Salancik (1978). The resource dependence theory presents five main areas of interest, and among those is the board of directors. Since its publication in 1978, the theory has become widely influential in organizational theory, management and board studies (Hillman, Withers & Collins, 2009).

Board size and composition is shown to have a large impact on the resources gathered, and can have a significant impact on a firm and its profitability. Better diversity and increased board size have shown to create better linkages to the external environment, allowing the firm to secure additional resources and reducing uncertainty and transaction costs (Goodstein, Gautam & Boeker, 1994). By ensuring that the proper resources are available to the firm at every given moment, the firm is able to continue operations in the most efficient manner and thus, reach high profitability and firm performance (Hillman & Danziel, 2003). However, the composition

of the board needs to be carefully chosen, as different board members provide varying resources and competencies, and these assets are the most useful when they match the particular needs of the firm in question (Hillman, Withers & Collins, 2009). By increasing diversity in the boardroom, the firm can better its linkages to the external environment and make new and better resources, advice and guidance available. Therefore, increased board gender diversity should have a positive impact on a firm and its performance.

However, given that the firm already is sufficient in managing and acquiring the desired resources, then this effect can be negligible, removing the impact of board gender diversity. Furthermore, Gabrielsson (2007) and Lynall, Golden and Hillman (2003) find that the resource dependence theory is predominantly applicable to firms in the early stages of development, while Daily (1996) finds that it is also applicable in stages of decline. Mature and larger firms tend to be less dependent on the outside environment and less likely to struggle in gathering the needed resources, reducing the importance of a resource effective board and its impact on firm performance.

2.2.3 Critical Mass Theory
The critical mass theory and its relation to gender diversity was first discussed by Kanter (1977) who stated that for women to be recognized in the group, and subsequently have an influence on the outcome, multiple women had to be present. The reason, Kanter (1977) claims, is that when few women are present, they're considered tokens who are primarily viewed through sex-role stereotypes rather than their individual traits. This has three main impacts on the way that the tokens are viewed in the group, she writes. First, the tokens experience high visibility in the group where their actions attract heightened levels of scrutiny and can often be considered to be representative of women in general. This has the implication of performance pressures on the token. Second, there is a polarization issue where the contrasts between the token and the rest of the group is magnified which can lead to a stronger sense of collectivity in the majority group. Finally, female tokens tend to face role entrapment in women stereotypes due to assimilation by the men on the board. This limits the token's potential influence as she is bound by sex-role stereotypes.

When multiple females are included in the board, their presence is normalized and issues of tokenism tend to be reduced as the women are viewed through their individual traits rather than

through sex stereotypes (Kanter, 1977). Previous studies have shown that when three or more women are present on the board, they're no longer considered tokens by the rest of the board and are able to impact the decisions made in the board to a larger extent (e.g. Brahma, Nwafor & Boateng, 2021; Liu, Wei & Xie, 2014; Joecks, Pull & Vetter, 2012). Thus, due to the issue of tokenism, the advantages of including women on the board are enabled when three or more women are present on the board. In regards to firm performance, this has been shown to be true in firms based in the United Kingdom by Brahma, Nwafor and Boateng (2021), in Chinese privately controlled firms by Liu, Wei and Xie (2014) and in German firms by Joecks, Pull and Vetter (2012).

2.3 Hypothesis Development

Based on the theoretical literature and empirical findings discussed above, there is support for the notion that increased diversity on the board increases the board's ability to fulfill their duties, mainly in regards to monitoring of management and provision of valuable resources. Agency theory predicts that firm performance increases when agency costs are reduced, which might be possible through increasing board gender diversity due to certain characteristics in female board members, such as higher degree of accountability and independent thinking (Adams & Ferreira, 2009; Brahma, Nwafor & Boateng, 2021). Moreover, resource dependence theory covers the ability of the board to gather the necessary resources for the firm to function efficiently. This ability can be enforced by board gender diversity due to stronger external linkages, since the board composition better resembles that of the environment, leading to higher firm performance (Goodstein, Gautam & Boeker, 1994). With this as background, the first hypothesis is formulated:

H1: Board gender diversity has an impact on the financial performance of European firms.

The critical mass theory focuses on the composition of the board and how that can affect the board's ability to effectively perform its tasks (Kanter, 1977). When one or two females are present on the board, they are often considered tokens by the males on the board who view them primarily through sex-role stereotypes (Nguyen, Ntim & Maligala, 2020; Brahma, Nwafor & Boateng, 2021). This has the implication of limiting the females' ability to contribute to board decisions as they can't act freely but have to adapt to their status as a token (Nguyen,

Ntim & Maligala, 2020). However, when the females of the board reach critical mass, that is when three or more females are present on the board, they escape from the token status and are able to influence the decisions of the board to a larger extent (Nguyen, Ntim & Maligala, 2020; Brahma, Nwafor & Boateng, 2021; Torchia, Calbrò & Huse, 2011). With the critical mass theory in consideration, the second hypothesis is formulated:

H2: Board gender diversity has a non-linear impact on the financial performance of European firms, with an increased impact when critical mass is reached.

While women are better monitors and in general more suitable for board duties than their male counterparts, the consequences of these characteristics may be varying between firms. Adams and Ferreira (2009) argue that the impact of board gender diversity can vary due to the differing effects of increased board monitoring, as they find evidence suggesting that firms with high internal monitoring do not benefit as much from increased monitoring. Considering the findings of Diamond (1991) and Jensen (1986), firms with high leverage might not need the additional monitoring that women on the board would provide since they are already sufficiently monitored by creditors and credit rating agencies. Because of this, there is a possibility that firms with high leverage do not enjoy the same benefits of increased board gender diversity as firms with low leverage do, as they have high external monitoring. With this as background, a third hypothesis is formulated.

H3: There is a moderating effect of leverage on the impact of board gender diversity on firm performance.

3. Methodology

This chapter introduces the sample and the included variables, after which the econometric methodology is covered. Furthermore, potential issues with the sample and possible solutions are discussed. This is followed by a few statistical tests.

3.1 Sample Description

Financial data of firms included in the Stoxx Europe 600 index has been gathered from Bloomberg terminal in order to construct the sample. The dataset is then structured as an unbalanced panel, where the inclusion and exclusion of firms from the index is considered each

year. The use of Stoxx Europe 600 sets this paper apart from others in the field, since the index provides a good proxy for the European stock market, as it is made up of large, mid and small cap firms representing approximately 90% of the free float (Qontigo, 2023). As the future EU law comes into force in 2026, the study aims to assess its consequences on a larger scale than previous studies.

This study aims to be as comprehensive as possible, large amounts of data is therefore needed. However, as finance professionals and corporations did not realize the importance of gender diversity until recently, data covering female executives and board members before 2005 is not available on Bloomberg or Refinitiv Eikon. The constructed database therefore covers all of the data available, from 2005 to the latest reported year at the time of writing, 2021. Although, data in the early years of recording female participation is scarce but included when possible.

Financial and utility corporations have been excluded from the sample, as is customary in finance studies and done to increase validity and reliability, because of their distinct capital structure and regulation. After excluding financial and utility corporations, and removing firm years lacking some item of data, the sample consists of 5 050 observations made up of 574 unique corporations covering 16 years. The comparatively small number of observations compared to that of 600 firms and 16 years of data, is mainly due to the aforementioned lack of records of females in corporations in the beginning of the sample. The sample's distribution over time and countries is shown in table 1.

3.2 Variable Definition

In accordance with previous studies (Adams & Ferreira, 2009; Brahma, Nwafor & Boateng, 2021; Darmadi, 2013) and common practice, the natural logarithm of Tobin's Q is used as dependent variable to measure firm financial performance, which is a ratio of the market value of the firm where the market capitalization is divided by the firm's assets. In order to test the critical mass theory and whether the financial performance is affected by women, the three dummy variables Diversity 1, 2 and 3 are used as main explanatory variables. These dummy variables are constructed as follows, Diversity 1 is equal to one when there is exactly one woman on the board, Diversity 2 is equal to one when there are exactly two women on the board, and Diversity 3 is equal to one when there are three or more women on the board, while all three attain the value zero otherwise. This is in line with previous studies on critical mass

theory (Brahma, Nwafor & Boateng, 2021; Liu, Wei & Xie, 2014; Torchia, Calabrò & Huse, 2011) and the work of Kramer, Konrad, Erkut and Hooper (2007) who suggest that the critical mass is three.

In order to determine the appropriate control variables for the analysis, prior literature is looked to. Specifically, the work of Brahma, Nwafor and Boateng (2021) is used, as the paper is recent and investigates a similar topic. However, the use of control variables is somewhat similar in the different papers in the field (see for example Adams & Ferreira, 2009; Liu, Wei & Xie, 2014: Marinova, Plantenga & Remery, 2015). While some papers opt towards very large regressions using vast amounts of variables (e.g. Bernile, Bhagwat & Yonker, 2018; Karavatis, Kokas & Tsoukas, 2021), this analysis uses a smaller number of control variables explicitly needed for the regression. The final control variables included in the models are Board size, CEO duality, Woman CEO, Bonus, Leverage and Size. These variables have been chosen in accordance with Brahma, Nwafor and Boateng (2021), and are generally accepted as variables that have an impact on firm performance. Board size and CEO duality influence the monitoring ability of the board, while Bonus and Woman CEO impact the abilities and incentives for the management to perform. Leverage and Size are customary in corporate finance studies, and generally accepted as having an impact on firm performance.

Regarding the more specific construction of the control variables, they are calculated as follows, Board size is measured as the total number of directors on the board, CEO duality is a dummy that attains the value one if the CEO is chairman of the board and zero otherwise and Woman CEO is a dummy variable that is equal to 1 when the CEO is a woman, and zero otherwise. Furthermore, Bonus is a dummy variable that is equal to one when the firm has a performance-based incentives program and zero otherwise. Leverage is total debt divided by total assets and is winsorized at the 1st and 99th percentile in order to remove outliers, while Size is the natural logarithm of total assets. For the specific data field mnemonics, see appendix 1.

3.3 Econometric Models

In order to test the hypothesis whether board gender diversity has a long-term effect on firm performance, various methods have been considered. The most common choice of method in the field is pooled OLS and fixed effects regressions, although some studies introduce other methods, such as System GMM. The choice of method however, has been made in accordance

with many previous studies on the topic (e.g. Brahma, Nwafor & Boateng, 2021; Adams & Ferreira, 2009; Liu, Wei and Xie, 2014), and in accordance with the results from a Hausman test. Thus, a fixed effects regression analysis is conducted on the sample. Fixed effects for year, industry and country are applied, and standard errors are clustered at the firm-level. Clustering the standard errors is done in accordance with previous studies (Brahma, Nwafor & Boateng, 2021; Adams & Ferreira, 2009), and to address potential heteroscedasticity issues (Wooldrige, 2016). As will be discussed in further detail below, fixed effects are used in order to address potential endogeneity (Roberts & Whited, 2013). With this as background, the following equation is estimated:

$$Log(Tobin's\ Q) = \beta_0 + \beta_1 Diversity\ 1_{i,t} + \beta_2 Diversity\ 2_{i,t} + \beta_3 Diversity\ 3_{i,t} + \beta_4 Board\ size_{i,t} + \beta_5 CEO\ duality_{i,t} + \beta_6 Woman\ CEO_{i,t} + \beta_7 Bonus_{i,t} + \beta_8 Leverage_{i,t} + \beta_9 Size_{i,t} + \alpha_i + u_{i,t}$$

In this equation, the term β_0 is the intercept, β_1 through β_9 are the coefficients, α_i is the unobserved and time-invariant fixed effects and $u_{i,t}$ is the idiosyncratic error term.

To test the third hypothesis, whether leverage has a moderating effect on the impact of board gender diversity on firm performance, an interaction term is included. The interaction term consists of the percentage of women on the board, multiplied with leverage, and it is included in order to investigate the moderating effect of leverage. Instead of including the three diversity measures, the percentage of women on the board is used as the main explanatory variable, as the critical mass theory is not of interest in this regression. This results in the following equation being estimated:

$$Log(Tobin's\ Q) = \beta_0 + \beta_1 Percent\ women\ on\ the\ board_{i,t} + \beta_2 Leverage_{i,t} + \beta_3 Percent\ women\ on\ the\ board * Leverage_{i,t} + \beta_4 Board\ size_{i,t} + \beta_5 CEO\ duality_{i,t} + \beta_6 Woman\ CEO_{i,t} + \beta_7 Bonus_{i,t} + \beta_8 Size_{i,t} + \alpha_i + u_{i,t}$$

3.3.1 Endogeneity

Endogeneity can be characterized as correlation between the explanatory variables and omitted variables, and is a concern in every corporate finance study (Roberts & Whited, 2013). Omitted variable bias is particularly problematic in corporate finance studies, in which it can be difficult,

and sometimes impossible, to capture all qualitative and quantitative values that impact a specific variable, such as the number of women on the board of directors. In cases where panel data is used, fixed and random effects can be used to control for endogeneity (Roberts & Whited, 2013). By using a Hausman test, it is possible to determine which of the two controls is most appropriate for the sample.

Using a fixed effects method allows for arbitrary correlation between α_i, the time-invariant fixed effects, and the different explanatory variables included in the regression. The fixed effects will then remove all time-constant explanatory variables, resulting in the following equation being true: $\ddot{x}_{i,t} = x_{i,t} - \bar{x}_i = 0$ (Wooldrige, 2016). By this, the unobserved fixed effect α_i is removed, resulting in an unbiased regression and reducing the problems associated with endogeneity (Roberts & Withed, 2013). The drawback of this is that it can cause statistical issues if the explanatory variables are correlated with time or if the explanatory variables only have very small changes over the sample period, as the time effects are removed.

Furthermore, in fear of endogeneity being present, all board related variables are lagged by one period in the robustness checks. This is in line with Liu, Wei and Xie (2014) and Joecks, Pull and Vetter (2012) and is another measure to check for potential endogeneity issues.

3.4 Statistical Tests

3.4.1 Hausman Test

As previously mentioned, the Hausman test can be used to determine whether fixed or random effects are most appropriate for the sample at hand. The null hypothesis tested is that random effects are appropriate. The results of the statistical tests are presented in appendix 2, where both the first and the second regression is tested. Both tests result in the p-value being zero and the null hypothesis is therefore rejected. Thus, fixed effects are to be preferred in both regressions.

3.4.2 White Test for Heteroscedasticity

One of the assumptions in a multiple regression analysis is the assumption of homoscedasticity, in which the variance of the unobserved error term, *u,* is assumed to be constant. If this assumption does not hold, the p-values and t-values in the regression analysis are unreliable.

In order to test for this, the White test for heteroscedasticity is applied. While there are many other tests for heteroscedasticity, the White test is chosen because of its wide acceptance in the field, as well as its more general approach to heteroscedasticity. The results of these tests are presented in appendix 2, and both tests provide evidence suggesting that heteroscedasticity is present in the regressions. As stated above, the use of robust standard errors clustered by firm is used to control for heteroscedasticity. By introducing robust standard errors, p-values and t-values are more reliable, but the coefficients remain unchanged.

4. Results and Multivariate Analysis

In this section, some summary statistics and a correlation table are first introduced, after which the empirical results are presented, analyzed and discussed. The empirical results are divided into two sections, with the first one being the main regressions and the second is investigating the moderating effect of leverage.

4.1 Summary Statistics

Summary statistics for the full sample is presented in table 2, in which all variables used in the analysis are included. While Number of women and Total assets are not explicitly included as variables in the regression, they are used as underlying data for the Diversity and Size variables, respectively. Total assets is included instead of Size, since Size is logarithmized and therefore has lost its economic meaning in a summary statistics table. For the same reason, Tobin's Q is included instead of the natural logarithm of Tobin's Q. Generally, the summary statistics does not provide any surprises. Many of the variables assume the value 0 as minimum, which could be an indication of some fault in the data, however in this case the minimum values of 0 are expected. There is a wide range of both number and percentage of women on the board, with a maximum value of 9 and 75%, respectively. Furthermore, large variations in both Board size, Total assets and Tobin's Q becomes apparent, which is both expected and beneficial as the index represents both large, mid and small cap.

The share of firms with a female CEO is very small, only 3%, but the percentage of women on the board is large in comparison, with the mean of 24,79%. The number of women on the board is roughly a tenth of the percentage, which is not surprising considering the average board size is 10.96. The three diversity variables have a mean of 0,17, 0,23 and 0,51 respectively, showing that roughly half of the sample firms have reached critical mass in the boardroom.

Comparing these summary statistics to similar studies, such as Adams and Ferreira (2009) and Brahma, Nwafor and Boateng (2021), show little differences between the samples. Although, Adams and Ferreira (2009) find more extreme values in for example Tobin´s Q and Board Size, Brahma, Nwafor and Boateng (2021) find less extreme values in the same variables, perhaps due to the comparatively large sample size of Adams and Ferreira (2009), and small sample size of Brahma, Nwafor and Boateng (2021). Interestingly, comparing the percentage of women on the board to that of Adams and Ferreira (2009), it is possible to see an increase in the average percentage of women on the board since the paper was published, although their sample includes only US based firms.

In light of the increased awareness of board gender diversity, and of the increasing number of female board members compared to previous studies, the time pattern of board gender diversity is investigated. Graph 1 presents a plot of cross-sectional averages over time. As expected, and as the comparison of summary statistics to that of Adams and Ferreira (2009) show, the percentage of women has increased steadily over the years and is therefore correlated with time.

4.2 Correlation Table

A correlation table is presented in table 3, which allows for examination of potential multicollinearity issues and a preliminary inspection of the relationship between the variables. As the table shows, there is correlation between the variables but it is generally not very strong. The correlation between the many board gender diversity variables is strong, however this is not a problem nor very surprising. As all these variables are different ways of measuring the same thing, there should be strong correlation, and they are not included in the same regressions. No multicollinearity issues are therefore expected. Shifting focus towards the correlation between Log(Tobin's Q) and the diversity variables, there seems to be a positive and statistically significant correlation between Log(Tobin's Q) and all diversity variables except for Number of women and Diversity 3, which attains statistical significance but negative correlation. This is somewhat surprising and motivates further investigation.

4.3 Board Gender Diversity and Firm Performance

The regressions from the main model is presented in table 4, where the first is a univariate regression, followed by more advanced models concluding in a regression containing period, industry and country controls. Before adding year dummies, the main explanatory variables show high statistical significance, with all three being significant on the 1% level. Moreover, the coefficients of the three variables show that a larger presence of women on the board has a positive impact on the firm's performance. However, the results are not in line with the theory on critical mass, which suggests that when three or more women are present on the board, they are no longer considered tokens and should therefore be able to exert more positive influence on the board. This would suggest a non-linear increase when going from one or two females to three, with a significantly larger impact on firm performance when having three women on the board. This is however not the case as the result from the regression shows a more linear relationship.

As briefly discussed above, the introduction of period effects removes statistical significance. As the percentage of women on the board has increased steadily over the entire sample, this variable is correlated with time. By introducing period effects, time-specific factors are removed from the control variables and instead captured by the period effects. Since the percentage of women is correlated to time, as seen in graph 1, large parts of the board diversity variables are removed as well. This in turn removes large parts of the significance that was previously presented in the first regression. Since the significance changes, it is possible to state that the time pattern has a large impact on the sample.

The statistical significance of Diversity 3 sees a comparatively larger decrease than that of Diversity 1 and 2 when introducing year dummies. This is expected since Diversity 3 captures all firms that have 3 or more women on the board and as the percentage of women on the board increases over time the share of firms included in this dummy (the mean) increases. As seen in graph 2 the mean of Diversity 3 seems to exhibit a near-linear relationship with time from 2010 and onwards. When including time dummies, the time correlation discussed above is disproportionately targeting Diversity 3, resulting in severe reduction of statistical significance. Diversity 1 and 2 on the other hand only assume the value one if one or two women respectively are present on the board, which means that they do not possess the same linear relationship with time, as shown in graph 2. These dummies do not reflect the increase of the percentage of

women on board to the same extent, as gender diverse boards generally have three women or more and therefore attain a value of zero in Diversity 1 and Diversity 2.

An analysis of the pattern shows that the share of STOXX 600 firms having one or two women on their corporate boards has decreased during the period studied, while firms with three or more female board members has increased significantly. It can therefore be concluded that the firms in the sample, to a larger extent, structure their boards in accordance with critical mass theory, where the women on the board make up a consistent minority. According to critical mass theory this would allow them to escape tokenism and influence the outcomes of board decisions (Nguyen, Ntim & Malgiala, 2020; Torchia, Calabrò & Huse, 2011).

Both the agency theory and the resource dependence theory predict that there should be a positive impact of board gender diversity on firm performance. Women possess favorable traits making them better at monitoring and at gathering valuable resources, suggesting that board gender diversity should have a positive impact on firm performance. This is in line with the results of the regressions, as the diversity variables are significant, providing evidence that board gender diversity has a positive impact on firm performance. Given this, hypothesis one is accepted.

In order to be able to do any valuable analysis of the results, the remainder of this section focuses on regression A8, which has industry and country controls but not period controls. As discussed in the literature review, the primary purpose of the board is to provide monitoring and resources (Hillman & Dalziel, 2003). When the women on the board escape tokenism and are able to influence the board, theory suggests that they are able to increase the board's ability to fulfill these tasks. Female board members are able to improve the monitoring role of the board as they have higher accountability and independent thinking (Brahma, Nwafor & Boateng, 2021; Adams & Ferreira, 2009). In relation to the board's duty of providing resources, a diverse board is better fit to provide a wider set of resources to the firm (Goodstein, Gautam & Boeker, 1994). Thus, theory would suggest that the increased diversity of European boards and more female board members reaching critical mass should lead to those firms being better fit to accomplish their main tasks. However, while the impact on firm performance is higher when three or more women are present on the board compared to when there only is two, the increase of the coefficient going from one woman to two and two women to three or more suggests a near-linear relationship. Thus, hypothesis two is rejected as proof of any non-linear

relationship is absent. However, when considering the confidence intervals of the three coefficients, there is a possibility that critical mass theory holds in this context as well, but evidence for this claim is not presented in the results.

One reason for the lack of evidence could be a changing climate in European boardrooms. While the study does not investigate this, one possible explanation could be that the increased equality awareness has reached boardrooms. While there perhaps was a need for women to reach critical mass in order to have an impact previously, there is a possibility that this has changed, or at least started to change. The theory was first published by Kanter in 1977, and gender equality has come far since. However, Brahma, Nwafor and Boateng (2021) found evidence supporting the critical mass theory recently, and it is unlikely that any large shifts have occurred since.

4.3.1 Control Variables for Board Gender Diversity and firm performance

Focusing on the control variables included in the regression, all but CEO duality and Woman CEO gain statistical significance. The results show that Board size and Bonus has a positive impact on firm performance, while Leverage and Size has a negative impact. These results are in line with the findings of Brahma, Nwafor and Boateng (2021) in the regressions where they use Tobin's Q as dependent variable, except that they do not find statistical significance for Bonus.

Comparing the coefficients show only small differences between the studies, the signs are the same across all significant variables. A positive sign and significance at the 10% level is found on Board size, which is as expected and in line with Brahma, Nwafor and Boateng (2021) and Coles, Daniel and Naveen (2008). The dummy variable Bonus is found to be significant at the 10%, and to have a positive sign, which is in line with the large literature base on the topic (e.g. Mehran, 1995; Aggarwal & Samwick, 2006; Baker, Jensen & Murphy, 1988). The coefficient of Leverage is, although very small, negative and significant at the 5% significance level. This is in line with Liu, Wei and Xie (2014) and Brahma, Nwafor and Boateng (2021), but in contrast to the results of Campbell and Minguez-Vera (2008). However, Campbell and Minguez-Vera (2008) state that two components impact the relationship between firm performance and leverage, the reduced agency costs because of increased leverage and potential costs of future distress. Thus, the negative sign found in this regression suggests that the costs of future distress outweigh the benefits of reduced agency costs in the sample. In line with Brahma, Nwafor and

Boateng (2021) and Campbell and Minguez-Vera (2008), is Size negatively correlated with firm performance at the 1% level.

4.4 The Moderating Effect of Leverage

In order to test hypothesis 3, an interaction term between the percentage of women on the board and leverage is introduced. The interaction term is used to investigate the moderating effect of leverage on the impact of board gender diversity on firm performance. As in the previous section, the analysis starts with a basic regression, after which more variables and controls are included, this is presented in table 5. In line with previous regressions, increased board diversity has a positive effect on firm performance. However, as the table shows, there seems to be a moderating effect of leverage. This provides evidence that increased board diversity in highly leveraged firms does not increase firm performance to the same extent as in less leveraged firms.

The coefficients for the percentage of women on the board and the interaction term is shown in table 5. Having adjusted for the dependent variable being logged and the independent variable being in level terms, the coefficient for percentage of women on board suggest that a one percentage unit increase in women on the board yields a 0,36% increase in Tobin's Q. However, the interaction term must be considered, meaning that the coefficient cannot be interpreted in isolation. Table 6 shows the impact on Tobin's Q given a percentage unit increase in board gender diversity and the impact if a board with the sample average board size (11) and female board members (3) were to replace a man with a female which is shown in order to put the results into context, not taking the standard errors into consideration. The average partial effect of another female board member is 0,84 percentage units, meaning that a firm with sample average leverage would enjoy a small increase in firm performance. Firms leveraged on the 25th percentile enjoy an even larger increase, with the partial effect being 1,83 percentage units. However, firms leveraged on the 75th percentile would instead see a small decrease in firm performance, as the partial effect then is -0,07 percentage units. Thus, hypothesis 3 is accepted. Supported by the Jensen (1986) free cash flow hypothesis and the impact of leverage as a source for external monitoring (Diamond, 1991), the effect of the interaction term is negative.

The general assumption is that board gender diversity should have a positive impact on firm performance. Given the psychological traits that women possess, they are suitable for the work required on the board of directors. With high sense of accountability (Brahma, Nwafor & Boateng, 2021), less overconfidence in decision-making (Huang & Kisgen, 2013), as well as better monitoring abilities (Brahma, Nwafor & Boateng, 2021), agency costs should decrease and resource gathering become more efficient, leading to a more efficient firm and better financial performance. However, increased monitoring might not be beneficial for firms that already have sufficient monitoring (Adams & Ferreira, 2009). The results can be explained by Jensen's (1986) free cash flow hypothesis, which states that high leverage can work as a disciplining device, as the amount of cash available to managers is low and reduces agency costs, which in turn reduces the need for internal monitoring. Moreover, the findings of Diamond (1991), that firms with high amounts of debt are strictly monitored by creditors, further emphasizes the monitoring and disciplining consequences of high leverage. The results are in support of these claims, as the averagely leveraged firm would benefit from increased board gender diversity, but the highly leveraged firms do not. This suggests that the highly leveraged firms are already strictly monitored, and therefore do not benefit from increased monitoring.

The results are very much in accordance with the findings of Adams and Ferreira (2009) and the inconclusive results of the many previous studies, in the sense that they provide evidence that board gender diversity can have both a negative and a positive impact on firm performance. While Adams and Ferreira (2009) argue that the effect of increased board diversity is dependent on the pre-existing level of internal monitoring, the results presented here show that this is the case for external monitoring as well. Given that the firm has low leverage, and is therefore not monitored very strictly, increased monitoring by higher board gender diversity has a positive impact on its financial performance. However, firms that have high leverage, and therefore strict monitoring from creditors, do not enjoy the benefits of increased monitoring. Instead, the increased monitoring is value destroying and decreases firm performance. These findings can be used as partial explanation for the varying results in previous studies as well, as there is a possibility that the samples used have had different levels of leverage, since they consisted of firms from different regions and time periods. This is further emphasized by the findings of Campbell and Minguez-Vera (2008), who find that the coefficient of the control variable leverage is dependent on the balance between the costs of future distress and the benefits of reduced agency costs, as is discussed in the previous subsection. This balance is dependent on

how high leverage the specific firm has, and may be used as a part of the explanation to why previous studies find varying results.

4.4.1 Control Variables for the Moderating Effect of Leverage

As the same dependent variable and control variables are used as in the previous robustness checks, no large changes in statistical significance or coefficients occur. Bonus, Size and Board size remain significant and do not change signs, while no other control variables gain or lose statistical significance compared to the first regressions. No further analysis of the control variables is therefore needed.

5. Robustness Tests

This is a brief section consisting of robustness tests for the main regression and the regression using an interaction term, and follows the same structure as the previous chapter by first discussing the main regressions and then the moderating effect of leverage.

5.1 Robustness for Board Gender Diversity and Firm Performance

Robustness testing is done in order to ensure reliability of the results, and that it is not the specific specification used that produces these results. While the robustness of the main regressions is discussed in the analysis as well, some more robustness tests are done in order to establish reliability. Regressions A10-A15 are presented in table 7. Instead of including diversity variables to investigate the non-linear relationship of board gender diversity and firm performance, the percentage of women and the squared percentage of women are included in regression A10-A12. The purpose of this is to introduce a different measure of board gender diversity and a different way of measuring the non-linear relationship. The results of regression A10, A11 and A12 are very much in line with the findings from the main regressions, where evidence for board gender diversity's impact on firm performance is found when not controlling for period effects, but removed when introducing them. Furthermore, in line with the main results, no evidence for the critical mass theory is found.

In fear of the presence of endogeneity Liu, Wei and Xie (2014) and Joecks, Pull and Vetter (2012), lag all board related variables by one period. It is intuitively reasonable as well, as boards are generally focusing on long term goals and its impact therefore is long term. This is

also a common way of testing for robustness, and is therefore included in regression A13, A14 and A15, presented in table 7 as well. These specifications closely resemble results from the main regressions. Interestingly, Diversity 1 is not significant but statistical significance is found in Diversity 2 and Diversity 3. However, the coefficients provide no evidence supporting the critical mass theory. Introducing period fixed effects removes significance from the main explanatory variables, as it does in the main regressions.

The conclusion of these robustness tests is that the results are robust and reliable, as changing small parts of the specification does not change the results.

5.2 Robustness for the Moderating Effect of Leverage

As the second model already incorporates the percentage of women on the board instead of the diversity variables, the first version of the robustness checks is not applicable. However, the robustness check consists of regressions where the board related variables are lagged. Moreover, since this regression tests whether leverage has a moderating effect on increased board gender diversity, it has to be lagged as well to make economic sense. This is done due to the same endogeneity concerns of Liu, Wei and Xie (2014) and Joecks, Pull and Vetter (2012) as in the previous section.

Table 8 presents the results of these robustness checks. Comparing these results to the main results provides evidence for robustness. The variables remain significant and the coefficients are mostly unchanged, there is still evidence for the moderating effect of leverage on the impact of board gender diversity on firm performance.

6. Conclusion

Previous research has produced varying results, where for example Brahma, Nwafor and Boateng (2021) and Gennaro, Bhagwat and Scott (2018) found a positive impact from board gender diversity on firm performance, while Darmadi (2013) and Marinova, Plantenga and Remery (2015) find no impact, and Adams and Ferreira (2009) and Wellalage and Locke (2014) find a negative relationship. The reason for the large interest in the field is an increase of legislative and cultural changes on the topic, where the trend is that more women are incorporated on the board of directors. The consequences of this have been studied, as

mentioned, but the results are varying and no definitive conclusion can be drawn. The agency theory predicts that with increased monitoring, agency costs are reduced and firm performance increased, while the resource dependence theory suggests that firm performance increases the better the board is at acquiring the desired resource. However, if agency costs already are low and the board already is efficient in acquiring resources, then these effects might be non-detectable, or reversed, having a negligible or negative impact on firm performance. In more recent literature the critical mass theory has been investigated as well, which suggests that there is a threshold of three or more women where their impact on the board of directors significantly increases. This paper has investigated the impact of board gender diversity on firm performance, whether critical mass theory can be used to interpret a firm's financial performance and if leverage has a moderating effect on the impact of board gender diversity on firm performance.

The study uses 5 050 observations, covering 574 unique firms in Europe over a sample period from 2005 to 2021. Predominantly board related data has been gathered, and most important of these is the number and percentage of women on the board. As for the main regressions, the number of women on the board has been used to create diversity dummies, in order to test for the critical mass theory. While the percentage of women on the board and an interaction term with leverage has been used when testing the moderating effect of leverage.

This study has found that the number of women on the board has a positive relationship with the firm's financial performance. However, the results do not support the critical mass theory since there is a linear relationship between having one, two or three or more females on the board and firm performance, and no increased impact is observed when three or more females are included on the board. Finally, there is support for the hypothesis that leverage has a moderating effect on the impact of board gender diversity on firm performance. This paper shows that firms with low leverage benefit more from a board with higher presence of women than firms with high leverage, mainly because of the increased external monitoring from leverage reducing the need for internal monitoring.

Given the law that enters into force in the EU in 2026, vast amounts of companies are required to change their board dynamics and increase their board gender diversity. The effects of this are dependent on the particular firm. While board gender diversity seems to have an impact on firm performance, its impact is dependent on the level of leverage the particular firm has. Given

this, European firms need to evaluate both its board gender diversity and financing policy, as the board gender diversity's impact is affected by it.

A major limitation of this study is the rather recent nature of board gender diversity, making the available data limited to recent years, which does not allow for large datasets covering large periods of time. Another limitation is the lack of EU indexes, making it difficult for the study to be solely based on an EU sample. Instead, the sample includes firms from 17 European countries, including the non-EU members Switzerland, Norway and the UK. Although, all three of these non-EU countries have similar board gender diversity laws.

In regards to recommendations for further research, qualitative studies on the subject are lacking and more qualitative investigations on the theory of critical mass would be of interest. By for example analyzing the behavior of board members on boards with varying degrees of gender diversity, the critical mass theory could be investigated from a new perspective. Investigating the claims of Adams and Funk (2012) that women on boards are no less risk-taking and overconfident than men, in the context of boards where women have reached critical mass could be of interest. Since there is a possibility that women do not adapt to the male-dominated culture when they are no longer underrepresented to the same degree. Moreover, this paper opens up venues for further research on the moderating effect of leverage on the impact of board gender diversity on firm performance. For example by investigating whether the moderating effect of leverage differs between public and private debt, potentially in the USA where public debt is used to a larger extent.

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Graphs

Graph 1. Scatter plot over the percentage of women over time
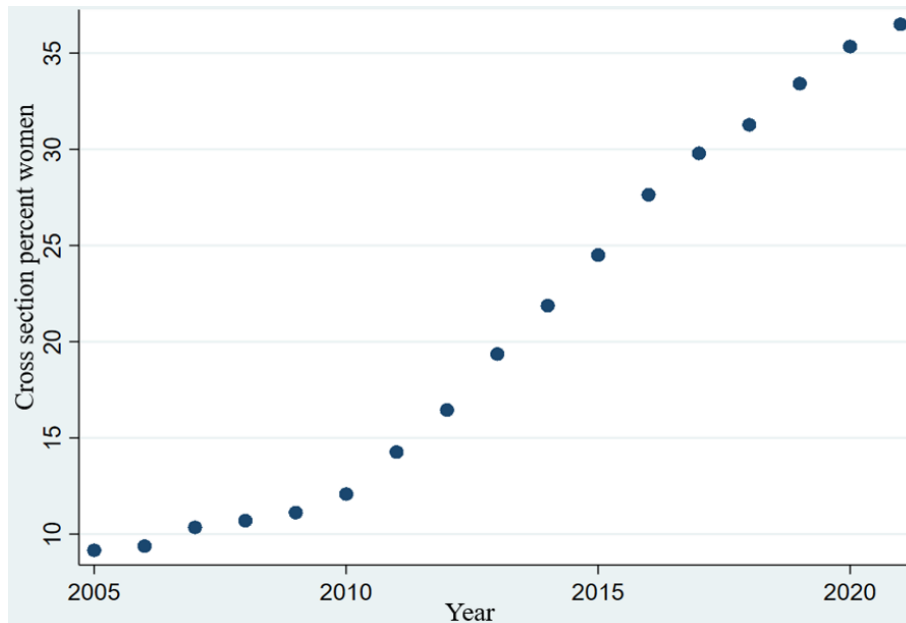
Note: This graph depicts cross section averages of the percentage of women on the board over time. It includes a sample consisting of 5 050 observations covering 574 unique firms and 16 years

Graph 2. Scatter plot showing the diversity groups over time
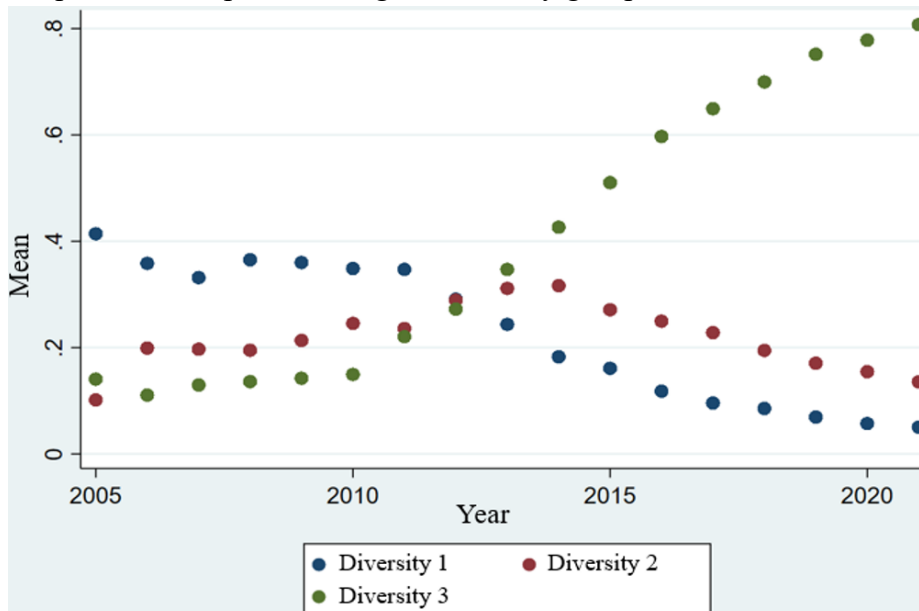
Note: This graph depicts cross section averages of Diversity 1, Diversity 2 and Diversity 3 over time. It includes a sample consisting of 5 050 observations covering 574 unique firms and 16 years

Tables

Table 1. Distribution of the observations over year and country.

Country	Year																	Total
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
Austria	0	1	2	2	1	2	3	2	4	4	5	6	5	5	6	5	5	58
Belgium	0	0	1	5	6	6	7	8	8	8	8	9	8	8	11	9	10	112
Switzerland	1	3	13	19	13	24	27	29	26	29	32	33	34	36	40	43	42	444
Germany	3	12	22	21	11	28	35	38	40	43	44	47	51	61	61	59	54	630
Denmark	1	1	2	2	4	4	8	7	10	11	13	15	14	16	16	16	16	156
Spain	0	1	1	1	7	1	8	10	11	13	16	15	16	17	17	16	16	166
Finland	1	3	9	7	8	8	12	12	11	12	12	12	12	13	14	14	15	175
France	6	20	35	45	25	49	52	55	56	57	59	59	65	68	69	62	60	842
United Kingdom	27	40	57	64	39	75	81	87	88	92	97	98	103	104	108	101	99	1360
Ireland	0	1	4	3	0	5	5	6	7	7	9	8	9	9	9	9	9	100
Italy	3	0	1	4	4	5	8	8	8	7	9	10	11	13	14	12	13	130
Luxem-bourg	0	0	1	1	3	1	2	2	2	2	4	4	4	5	4	5	5	45
Netherlands	3	5	12	13	8	14	16	17	18	19	20	21	23	24	25	25	29	292
Norway	1	2	5	5	3	7	8	8	8	8	8	7	8	11	11	14	12	126
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	2	2	10
Portugal	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2	2	25
Sweden	1	1	12	16	14	19	20	21	22	24	25	26	27	30	32	42	47	379
Total	47	90	177	208	147	250	294	312	321	338	363	372	392	425	442	436	436	5050

Note: This table presents the distribution of the observations over year and country. A total of 5 050 observations are included in the sample. All 17 countries included in the Stoxx Europe 600 index are included.

Table 2. Summary statistics

Summary statistics

	Mean	Median	SD	Min	Max	N
Diversity 1	.17	0	0.38	0	1	5050
Diversity 2	.23	0	0.42	0	1	5050
Diversity 3	.51	1	0.50	0	1	5050
Number of women	2.73	3	1.79	0	9	5050
Percent women	24.79	25	14.10	0	75	5050
Board size	10.96	10	3.53	3	25	5050
Tobin´s Q	2.04	1.58	1.41	.78	8.53	5050
CEO Duality	.13	0	0.34	0	1	5050
Woman CEO	.03	0	0.17	0	1	5050
Bonus	.94	1	0.24	0	1	5050
Leverage	25.68	24.73	15.03	0	71.07	5050
Total assets MEUR	23274.07	8247.35	45874.49	46.43	590424	5050

Note: This table reports summary statistics for the 5050 firm-year observations representing 574 unique firms in Europe during the years 2005-2021.The Included variables are: Diversity 1, Diversity 2, Diversity 3, Number of women on the board, Percent women on the board, Board size, Tobin's Q, CEO duality, Woman CEO, Bonus, Leverage, Total assets MEUR. In contrast to the variables used in the regressions, Tobin's Q and Total assets MEUR are not presented in natural logarithmic terms.

Table 3. Correlation table

Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Number of women	1.000											
(2) Percent women	0.851***	1.000										
(3) Diversity 1	-0.442***	-0.441***	1.000									
(4) Diversity 2	-0.221***	-0.106***	-0.249***	1.000								
(5) Diversity 3	0.800***	0.746***	-0.464***	-0.552***	1.000							
(6) Board size	0.456***	0.018	-0.114***	-0.161***	0.320***	1.000						
(7) Log (Tobin's Q)	-0.060***	0.092***	0.038***	0.031**	-0.035**	-0.297***	1.000					
(8) CEO duality	0.166***	0.062***	-0.006	-0.084***	0.102***	0.213***	-0.089***	1.000				
(9) Woman CEO	0.061***	0.103***	-0.002	-0.020	0.051***	-0.040***	0.028**	-0.055***	1.000			
(10) Bonus	0.006	-0.037***	0.004	0.019	-0.026*	0.052***	-0.004	-0.047***	-0.004	1.000		
(11) Leverage	0.088***	0.046***	-0.050***	-0.031**	0.076***	0.106***	-0.210***	0.031**	-0.011	-0.031**	1.000	
(12) Size	0.315***	0.073***	-0.131***	-0.085***	0.239***	0.557***	-0.557***	0.159***	-0.027*	0.014	0.192***	1.000

Note: This table reports the pairwise correlations for all variables included in the regressions. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Main regressions A1 - A9

VARIABLES	A1 Log (Tobin's Q)	A2 Log (Tobin's Q)	A3 Log (Tobin's Q)	A4 Log (Tobin's Q)	A5 Log (Tobin's Q)	A6 Log (Tobin's Q)	A7 Log (Tobin's Q)	A8 Log (Tobin's Q)	A9 Log (Tobin's Q)
Diversity 1	0.104***	0.157***	0.117***	0.131***	0.087***	0.050**	0.049*	0.086***	0.049*
	(0.031)	(0.030)	(0.026)	(0.040)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Diversity 2	0.090***	0.133***	0.133***	0.160***	0.133***	0.051*	0.049*	0.130***	0.048*
	(0.030)	(0.029)	(0.025)	(0.037)	(0.025)	(0.028)	(0.028)	(0.026)	(0.028)
Diversity 3	0.040	0.193***	0.205***	0.242***	0.201***	0.046	0.043	0.198***	0.043
	(0.028)	(0.027)	(0.024)	(0.043)	(0.028)	(0.032)	(0.032)	(0.028)	(0.032)
Board size		-0.050***	-0.001	-0.002	0.006	0.014***	0.013***	0.007*	0.014***
		(0.002)	(0.002)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
CEO duality		-0.048**	-0.009	-0.009	0.002	0.016	0.015	0.014	0.021
		(0.022)	(0.019)	(0.040)	(0.026)	(0.025)	(0.024)	(0.027)	(0.025)
Woman CEO		0.023	0.008	0.009	0.005	-0.022	-0.022	0.005	-0.021
		(0.043)	(0.037)	(0.078)	(0.033)	(0.039)	(0.038)	(0.033)	(0.038)
Bonus		0.031	0.007	0.009	0.030	0.035*	0.034*	0.032*	0.036*
		(0.031)	(0.027)	(0.043)	(0.018)	(0.019)	(0.019)	(0.018)	(0.019)
Leverage			-0.004***	-0.004***	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**
			(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Size			-0.220***	-0.220***	-0.177***	-0.229***	-0.222***	-0.173***	-0.219***
			(0.006)	(0.021)	(0.018)	(0.017)	(0.018)	(0.018)	(0.018)
Constant	0.503***	0.926***	5.559***	5.536***	4.370***	5.799***	5.561***	4.220***	5.605***
	(0.025)	(0.042)	(0.118)	(0.447)	(0.409)	(0.384)	(0.409)	(0.469)	(0.468)
Year controls	No	No	No	No	No	Yes	Yes	No	Yes
Industry control	No	No	No	No	Yes	No	Yes	Yes	Yes
Country control	No	No	No	No	No	No	No	Yes	Yes
Standard errors	Conventional	Conventional	Conventional	Cluster (firm)	Cluster (firm)	Cluster (firm)	Cluster (firm)	Cluster (firm)	Cluster (firm)
Observations	5,050	5,050	5,050	5,050	5,050	5,050	5,050	5,050	5,050
Number of firm	574	574	574	574	574	574	574	574	574

Note: This table presents the results of regression A1-A9 using unbalanced panel data consisting of 5 050 observations covering 574 unique firms and 16 years. The estimations investigate the impact of board gender diversity on firm performance. The included variables are: Diversity 1, Diversity 2, Diversity 3, Board size, CEO duality, Woman CEO, Bonus, Leverage and Size. A1 only includes the dependent and the main explanatory variables. A2 introduces board related control variables. A3 introduces all control variables. A4 introduces robust standard errors clustered by firm. A5 includes robust standard errors clustered by firm and industry controls. A6 includes robust standard errors clustered by firm and year controls. A7 includes robust standard errors clustered by firm, year controls and industry controls. A8 includes robust standard errors clustered by firm, industry controls and country controls. A9 includes robust standard errors clustered by firm, year controls, industry controls and country controls. Standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0,1

Table 5. Regressions B1 and B2 with leverage as moderating variable.

VARIABLES	B1 Log (Tobin's Q)	B2 Log (Tobin's Q)	B3 Log (Tobin's Q)	B4 Log (Tobin's Q)	B5 Log (Tobin's Q)	B6 Log (Tobin's Q)	B7 Log (Tobin's Q)
Percent women on the board	0.004***	0.007***	0.007***	0.007***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Leverage	-0.008***	-0.001*	-0.001	-0.001	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Percent women on the board X Leverage	0.000	-0.000***	-0.000**	-0.000**	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Board size		0.012***	0.012***	0.012***	0.014***	0.013***	0.015***
		(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
CEO duality		-0.001	-0.001	-0.003	0.010	0.009	0.015
		(0.018)	(0.025)	(0.025)	(0.025)	(0.025)	(0.026)
Woman CEO		-0.015	-0.015	-0.014	-0.023	-0.023	-0.022
		(0.026)	(0.034)	(0.034)	(0.038)	(0.037)	(0.037)
Bonus		0.033**	0.033*	0.033*	0.037**	0.036*	0.038**
		(0.016)	(0.018)	(0.018)	(0.019)	(0.019)	(0.019)
Size		-0.194***	-0.194***	-0.188***	-0.230***	-0.223***	-0.221***
		(0.009)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Constant	0.666***	4.771***	4.771***	4.528***	5.765***	5.530***	5.596***
	(0.029)	(0.186)	(0.387)	(0.411)	(0.387)	(0.411)	(0.472)
Year controls	No	No	No	No	Yes	Yes	Yes
Industry controls	No	No	No	Yes	No	Yes	Yes
Country controls	No	No	No	No	No	No	Yes
Standard errors	Conventional	Conventional	Cluster (firm)	Cluster (firm)	Cluster (firm)	Cluster (firm)	Cluster (firm)
Observations	5,050	5,050	5,050	5,050	5,050	5,050	5,050
Number of firms	574	574	574	574	574	574	574

Note: This table presents the results of regression B1-B7, using unbalanced panel data consisting of 5050 observations covering 574 unique firms and 16 years. The estimations investigate the moderating effect of leverage on the impact of board gender diversity on firm performance. The Included variables are: Percent women on the board, Leverage, Percent women on the board x Leverage, Board size, CEO duality, Woman CEO, Bonus and Size. B1 only includes the dependent and main explanatory variable, leverage and the interaction term. B2 introduces all variables. B3 includes robust standard errors clustered by firm. B4 includes robust standard errors clustered by firm and industry controls. B5 includes robust standard errors clustered by firm and year controls. B6 includes robust standard errors clustered by firm and year and industry controls. B7 includes robust standard errors clustered by firm and year, industry and country controls. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6. Impact of increased board gender diversity given different levels of leverage

	Impact on Tobin's Q given a one percentage unit increase in Women on the board	Impact on Tobin's Q given the average board replaces a man with a woman
PE %WoB 25th percentile leverage	0,2008	1,8250
APE %WoB	0,0924	0,8401
PE %WoB 75th percentile leverage	-0,0076	-0,0689

Note: This table presents the partial effect of increased board gender diversity on Tobin's Q, given the level of leverage. The average leverage is 24,72. The leverage at the 25th percentile is 15,28 and 35,28 at the 75th percentile. Column 2 shows the impact on Tobin's Q given a one percentage unit increase in women on the board. Column 3 shows the impact on Tobin's Q given that a firm with the average board size (11) and the average number of female board members (3) replaces a man on the board with a woman.

Table 7. Robustness checks A10-A15 for the main regression

VARIABLES	A10 Log(Tobin's Q)	A11 Log(Tobin's Q)	A12 Log(Tobin's Q)	A13 Log(Tobin's Q)	A14 Log(Tobin's Q)	A15 Log(Tobin's Q)
Diversity 1 lagged				0.041	0.040	0.009
				(0.026)	(0.026)	(0.027)
Diversity 2 lagged				0.107***	0.105***	0.031
				(0.028)	(0.028)	(0.030)
Diversity 3 lagged				0.172***	0.171***	0.027
				(0.029)	(0.029)	(0.033)
Board size lagged				0.009**	0.010**	0.015***
				(0.004)	(0.004)	(0.004)
CEO duality lagged				-0.021	-0.010	0.011
				(0.028)	(0.030)	(0.026)
Woman CEO lagged				0.027	0.026	-0.000
				(0.030)	(0.030)	(0.035)
Bonus	0.032*	0.034*	0.037*	0.012	0.014	0.021
	(0.018)	(0.018)	(0.019)	(0.021)	(0.021)	(0.022)
Size	-0.188***	-0.185***	-0.219***	-0.178***	-0.175***	-0.217***
	(0.018)	(0.018)	(0.018)	(0.019)	(0.019)	(0.019)
Leverage	-0.003***	-0.003***	-0.002**	-0.003***	-0.003***	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Percent women on the board	0.006***	0.006***	0.001			
	(0.002)	(0.002)	(0.002)			
Percent women on the board squared	-0.000	-0.000	-0.000			
	(0.000)	(0.000)	(0.000)			
Board size	0.012***	0.014***	0.015***			
	(0.004)	(0.004)	(0.004)			
CEO duality	0.001	0.013	0.020			
	(0.025)	(0.026)	(0.025)			
Woman CEO	-0.015	-0.016	-0.025			
	(0.035)	(0.035)	(0.039)			
Constant	4.576***	4.501***	5.607***	4.323***	4.285***	5.639***
	(0.410)	(0.471)	(0.469)	(0.430)	(0.505)	(0.515)
Year controls	No	No	Yes	No	No	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes
Country controls	No	Yes	Yes	No	Yes	Yes
Standard errors	Cluster (firm)	Cluster (firm)	Cluster (firm)	Cluster (firm)	Cluster (firm)	Cluster (firm)
Observations	5,050	5,050	5,050	4,419	4,419	4,419
Number of FirmId	574	574	574	512	512	512

Note: This table presents the results of regression A10-A12 using unbalanced panel data consisting of 5 050 observations covering 574 unique firms and 16 years, while A13-A15 include 4 419 observations consisting of 512 unique firms and 16 years. The estimations investigate the impact of board gender diversity on firm performance and are used as robustness checks. The included variables in A10-A12 are: Percent women on the board, Percent women on the board squared, Board size, CEO duality, Woman CEO, Bonus, Size and Leverage. The included variables in A13-A15 are: Diversity 1 lagged, Diversity 2 lagged, Diversity 3 lagged, Board size lagged, CEO duality lagged, Woman CEO lagged, Bonus, Leverage and Size. A10 includes industry controls. A11 includes industry and country controls. A12 includes industry, country and year controls. A13 includes industry controls. A14 includes industry and country controls. A15 includes industry, country and year controls. Standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1

Table 8. Robustness checks B8, B9 and B10 for the moderating effects regression

VARIABLES	B8 Log (Tobin's Q)	B9 Log (Tobin's Q)	B10 Log (Tobin's Q)
Percent women on the board lagged	0.006***	0.003**	0.003**
	(0.001)	(0.001)	(0.001)
Leverage lagged	-0.002	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Percent women on the board lagged X Leverage lagged	-0.000*	-0.000**	-0.000**
	(0.000)	(0.000)	(0.000)
Board size lagged	0.012***	0.014***	0.015***
	(0.004)	(0.004)	(0.004)
CEO duality lagged	-0.026	-0.003	0.003
	(0.029)	(0.027)	(0.029)
Woman CEO lagged	0.016	0.007	0.007
	(0.033)	(0.039)	(0.038)
Bonus	0.019	0.023	0.024
	(0.020)	(0.022)	(0.022)
Size	-0.189***	-0.224***	-0.220***
	(0.019)	(0.019)	(0.020)
Constant	4.525***	5.496***	5.336***
	(0.455)	(0.460)	(0.477)
Year controls	No	No	Yes
Industry controls	Yes	Yes	Yes
Country controls	No	Yes	Yes
Standard errors	Cluster (firm)	Cluster (firm)	Cluster (firm)
Observations	4,419	4,419	4,419
Number of FirmId	512	512	512

Note: This table presents the results of regression B1-B7, using unbalanced panel data consisting of 4419 observations covering 512 unique firms and 16 years. The estimations investigate the moderating effect of leverage on the impact of board gender diversity on firm performance and are used as robustness checks. The Included variables are: Percent women on the board, Leverage, Percent women on the board x Leverage, Board size, CEO duality, Woman CEO, Bonus and Size where all variables except Bonus and Size are lagged. All regressions include all variables and use robust standard errors clustered by firm. B8 include industry controls. B9 include industry and year controls. B10 include year, industry and country controls. Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, *$p<0.1$

Appendixes

Appendix 1. Variable source definition table.

Variable name	Data field mnemonic
Dependent variable	
Tobin's Q	TOBIN_Q_RATIO
Independent variables	
Number of women on the board	NUMBER_OF_WOMEN_ON_BOARD
Percent women on the board	PCT_WOMEN_ON_BOARD
Board size	BOARD_SIZE
CEO duality	CEO_DUALITY
Woman CEO	FEMALE_CEO_OR_EQUIVALENT
Bonus	TOTAL_BONUSES_PAID_TO_EXECUTIVES
Leverage	TOT_DEBT_TO_TOT_ASSET
Total assets	BS_TOT_ASSET

Appendix 2. Results of statistical tests

Hausman test for board gender diversity and firm performance.

Hausman specification test

	Coef.
Chi-square test value	74.802
P-value	0

Hausman test for the moderating effect of leverage.

Hausman specification test

	Coef.
Chi-square test value	64.787
P-value	0

White's test for heteroscedasticity board gender diversity and firm performance.

White's test	df	p
H0: Homoskedasticity		
Ha: Unrestricted heteroskedasticity		
chi2(44) = 1235.13		
Prob > chi2 = 0.0000		
Cameron & Trivedi's decomposition of IM-test		
chi2		
1235.130	44	0.000
411.360	9	0.000
29.020	1	0.000
1675.520	54	0.000

White's test for heteroscedasticity for the moderating effect of leverage.

White's test	df	p
H0: Homoskedasticity		
Ha: Unrestricted heteroskedasticity		
chi2(47) = 1017.52		
Prob > chi2 = 0.0000		
Cameron & Trivedi's decomposition of IM-test		
chi2		
1017.520	47	0.000
366.640	9	0.000
23.290	1	0.000
1407.450	57	0.000