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The Impact of Board Gender Diversity on Capital Structure and Risk-Taking: Evidence from Swedish Listed Companies

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Abstract
Using a panel of 3,468 Swedish listed firm–year observations from 2010–2023, this thesis examines how board gender diversity affects corporate risk-taking and policy decision making. Employing OLS with industry and year fixed effects, this study observes no significant correlation between female board representation and leverage or earnings volatility, however, there exists a robust negative relationship with capital expenditures. This investment-based risk reduction is driven by independent female directors; however, there is no evidence of a critical mass threshold. Robustness and validity checks, including instrumental variables, lagged regressors, and propensity-score matching, confirm the findings of capital expenditures. This study highlights the role of gender diversity in moderating investment risk, forming governance policy, and the broader literature on board composition.

Keywords:
Corporate Governance, Agency Theory, Critical Mass, Female Board Directors

JEL Classification:
C23, G32, G34, J16

Contents

1 Introduction

The purpose of this study is to deepen the understanding of how the presence and composition of female directors on corporate boards influence corporate risk-taking by studying the relationship between gender diversity and three risk variables. Over the past decades, gender diversity on corporate boards has emerged as an important focus in corporate governance research. Numerous countries have implemented efforts or policies to improve female representation in senior decision-making positions. *Gender Balance on Corporate Boards Directive* from the Council of the European Union (2022) stipulates that by 2026, a minimum of 40% of non-executive board seats in publicly listed companies should be allocated to women in order to reach a more balanced gender representation on the boards among all EU member states. This study limits the sample to Sweden, which in 2024 was the country with the highest gender equality in the EU, according to European Institute for Gender Equality (2024). Sweden have seen substantial increases in gender diversity on boards, as seen in Table 4, without the introduction of legislative action, while others have implemented regulatory binding quotas to promote gender equality. Against this background, it is of particular interest to examine how gender equality is reflected in Swedish corporate boards and what impact this has on corporate risk-taking.

As boardrooms have become more inclusive and gender-equal, the topic has become increasingly relevant, and researchers have examined the implications of gender diversity on firm outcomes such as performance, dividends, decision-making quality, and risk-taking. Some studies demonstrates the ability of women on a firm board to improve board monitoring, increase attendance and take less risk (Adams and Ferreira, 2009;Eckel and Grossman, 2008). Although some studies demonstrate a negative correlation between gender diversity and firm risk (Faccio et al., 2016;Mohsni et al., 2021), others find no significant effect or effects that vary based on institutional or cultural factors. Some argue that factors such as education and experience are more influential than the gender itself. (Sila et al., 2016;Harjoto et al., 2018).

This study contributes to the literature by examining how the gender composition of boards influences firm risk and policy decisions in a Swedish context. This geographical focus, characterized by a high degree of gender equality, sets it apart from the majority of existing literature. Furthermore, the combination of the three specific risk measures used; leverage, volatility of ROA, and capital expenditure is unique and allows for a broader, alternative, and more comprehensive assessment of risk-taking behavior among firms. Two of the variables are common in similar studies (Leverage & σROA). The third dependent variable capital expenditure (CapEx) is used as a measure of risk-taking from an investment perspective, a variable that has been used in previous research as a measure of risk, but has not been as common in studies investigating a pure relationship with gender diversity.

In order to investigate the effect that female board representation has on firms risk and policy decisions, this study includes a total number of 3468 observations, covering 371 different firms listed on the Swedish NASDAQ OMX Stockholm during the years 2010 to 2023. The main research question is formulated as; does gender diversity on corporate boards effect companies' risk-taking and policy decisions? To answer this question empirically, three hypotheses are tested. The primary hypothesis posits that a higher percentage of women on corporate boards is associated with reduced risk-taking and more conservative policy decisions in terms of capital structure and investments. However the expected outcome of the regressions is although difficult to predict because of mixed and context dependent findings.

The impact of female board representation on firm results is estimated using a pooled OLS with industry and year fixed effects, aligning with methods used in similar studies such as Faccio et al. (2016). In addition to analyzing the overall effect of women on board, this study also explores the potential presence of a critical mass threshold. Konrad et al. (2008) discuses whether having at least three women on the board leads to a more substantial impact rather than one or two which may be seen as tokens instead of members. The main point of the critical mass theory states that when it is less than three women in a decision making setting it is more difficult for them to break lasting group dynamics or get their voice heard.

The paper is organized as follows; the initial section consists of a background on the areas concerned to build and concretize the context and starting point that forms the basis for the study's investigation. This is followed by theory and previous research that describes the connection between gender diversity and risk-taking, as well as the essential ideas required to create an understanding of behaviors. Further, the subject concerned is problematized, which results in the hypotheses. The section thereafter covers the data and methodology used in the study, followed by main regression results and analysis together with multiple endogeneity and robustness tests. The study ends with a conclusion drawn from the previous sections.

2 Literature Review

The effects of gender diversity on corporate governance and firm performance have been extensively studied in existing literature. Adams and Ferreira (2009) in their study in US firms, suggests that gender-diverse boards are associated with more active monitoring, as seen in more attendance and participation by female directors. However, this may not necessarily lead to better financial performance. Further, they find no overall relationship between gender diversity and added firm value, consistent with the notion of over-monitoring. However, the study suggests that firms with weak governance benefit from increased gender diversity. Contradicting, Mínguez-Vera and Martín (2008) show, using panel data in their analysis, that the percentage of women on the board may have a positive effect on the finances of the firm. According to Yi (2011), a more diverse board of directors is more likely to raise questions, discover new opportunities, or question the status quo. Hiring women from diverse backgrounds is one way to quickly achieve most of it.

Gender diversity may influence the capital structure of firms, due to different priorities in the boardroom between women and men, results shown by Adams and Funk (2012) in their study on Swedish firms. Furthermore, studies highlight that women are more risk averse than men, which could impact the financial decisions of firms (Eckel and Grossman, 2008; Sapienza et al., 2009). Studies like Olsen and Cox (2001) and Fehr-Duda et al. (2006) have demonstrated that women are more sensitive to losses than to gains, which implies that gender-diverse boards might take a more cautious approach to financial decisions. In order to reduce the possibility of financial losses, this could come up as a preference for lower leverage.

The findings of the available research on gender diversity and corporate financing decisions are not exactly substantial and consistent. Certain studies suggest that female board members usually endorse less financial leverage, which may result in more sustainable capital structures. Faccio et al. (2016) conclude that companies with female CEOs has lower leverage and less volatile earnings, indicating a more cautious approach to capital structure. As stated by Croson and Gneezy (2009), this is consistent with established economic theory linking risk aversion to female leadership. Mohsni et al. (2021) examine the relationship between gender diversity and corporate performance and risk in developing countries. They find that having more women on boards is significantly associated with a lower business risk, using leverage and the volatility of ROA as proxies for financial and operational risk. Their results support the idea that women are more skilled at monitoring and less willing to take risks.

However, the notion that gender diversity has a causal effect on firm risk taking is opposed by Sila et al. (2016). Their study does not find significant evidence that female board representation affects firm risk and indicates that previous findings of a negative relationship may be driven by unobserved firm characteristics rather than a causal relationship. Furthermore, in their study, they find evidence that appointing female board members is a choice made by the company and that corporate risk is part of this decision.

The connection between financial risk-taking and gender diversity among firms remains debated. According to some research, the more cautious decision-making choices of female board members contribute to reduced total firm risk. According to Faccio et al. (2016), there is a significant decrease in firm risk when CEOs shift from male to female. This is particularly evident in firms that prioritize efficient capital allocation, potentially leading to lost investment opportunities in high-growth firms.

According to Bernile et al. (2018), a diverse board promotes more stable policies and lower volatility in stock returns, indicating better governance. Although diverse boards are less likely to take financial risks, they however exhibit more R&D expenditure, demonstrating that they are not afraid of actual risk-taking activities.

Other studies do, however, argue that board diversity based on gender, race, or age does not significantly impact risk-taking decisions within a company's policy decisions. Harjoto et al. (2018) looks at how board diversity, measured across both relation-based diversity (gender, race, age) and task-based diversity (tenure, expertise), influences board performance in overseeing corporate risk-taking and investment activities. The study uses a sample of 1,898 U.S. firms, covering 17 years from 1998 to 2014, excluding financial institutions due to their regulatory environment.

In their study, corporate investment oversight is assessed by analyzing capital expenditures, R&D expenditures, and acquisition expenditures. Their findings indicate that task-oriented diversity, particularly functional expertise and firm-specific experience, is associated with more effective monitoring and reduced deviations from expected investment levels. In contrast, relation-oriented diversity, including gender diversity, shows no significant association with investment oversight performance. Based on their findings, Harjoto et al. (2018) recommend promoting greater task-oriented diversity in corporate boardrooms to enhance investment oversight efficiency.

3 Theory and Hypothesis Development

3.1 Modigliani-Miller Theorem

Under perfect market conditions, a firm's capital structure has no impact on its value, according to the Modigliani-Miller Theorem. In other words, the market value is not affected by whether it is funded by debt or equity. However, including real-world imperfections such as taxes, costs associated with bankruptcy, and information asymmetry, the firm's decisions on the capital structure are affected by trade-off theory and pecking order theory. This suggests that companies weigh the advantages of debt against the potential costs of financial distress associated with debt when making leverage decisions, Modigliani and Miller (1958). The pecking order theory states that due to information asymmetry, firms prefer internal financing over debt and thereafter new issues to avoid signals that may be seen unfavorably by the market Myers and Majluf (1984).

3.2 Agency Theory

In larger companies, shareholders are usually not managers. Due to this distinction, the interests of the two groups may not always coincide. Agency theory, first developed by Jensen and Meckling (1976), describes the inherent conflicts between owners (principals) and managers (agents) and helps to understand the relationship between the board and the firm's risk-taking decisions. Conflicts between parties can cause agency costs. Being in control over financial resources, managers could put personal objectives, including risk aversion, ahead of shareholder value. This mismanagement can potentially lead to agency costs, such as inefficient capital allocation, excessive risk taking, and suboptimal financing decisions. In addition to the potential loss when complete alignment is not achievable, agency costs can include monitoring expenses, contracts that align managerial incentives with shareholder interests, and ensuring managerial alignment. According to Bathala and Rao (1995), using debt financing can serve as an effective tool in mitigating agency costs.

In the context of governance, boards of directors serve an essential function in mitigating agency costs. Bathala and Rao (1995) emphasize the role of board independence in strengthening oversight, particularly in firms facing greater agency concerns such as high risk or leverage. Boards composed of more independent members are better positioned to monitor management decisions and prevent excessive risk taking, influencing capital structure decisions.

The gender diversity on boards can further reinforce this monitoring function. Previous research has shown that female executives are generally more risk averse and careful in their decision making Faccio et al. (2016). These traits contribute to more conservative financial policies and stronger internal controls. As mentioned in the study by Adams and Ferreira (2009), gender-diverse boards can act as an internal governance substitute that can reduce agency cost. When combining the agency theory with the arguments in Bathala and Rao (1995), this stronger internal governance could potentially reduce the need for external discipline through debt.

3.3 Critical Mass

When discussing gender diversity and corporate governance, the concept of Critical Mass is an important idea to include in the discussion. Studied by Kanter (1977), the critical mass theory implies that having women on corporate boards isn't enough to make a real difference, there needs to be a sufficient number of them. When there are only one or two women on a board, they often struggle to be heard and are sometimes seen as "tokens", considered more as representatives of their category, rather than individuals. But when the number of women reaches a certain threshold, usually considered to be at least three, their influence becomes much stronger. This tends to lead to better governance and more balanced decision-making.

In their study, Konrad et al. (2008) emphasize how important it is to have at least three women on a board to ensure strong participation and influence. Their findings show that when women make up a minority on the board, their input often gets overlooked or dismissed. But once that critical mass is reached, women collaborate more effectively, and are taken more seriously by their male colleagues. This shift improves board dynamics and makes decision-making processes more balanced.

Their research also suggests that having multiple women on a board helps to increase a more inclusive and collaborative environment. It becomes easier for women to bring up difficult topics and offer different perspectives. They argue that achieving critical mass can help dismantle the 'old boys' club dynamic that often dominates male-heavy boards, resulting in richer and more comprehensive discussions.

Supporting this idea, Joecks et al. (2013) tested the critical mass theory with a sample of 151 German firms from 2000–2005. They found a U-shaped relationship between gender diversity and firm performance. Their research showed that when women are initially added to boards, performance can actually decline. But once boards reach the threshold of female representation (about three women), performance begins to improve beyond that of male-dominated boards. Their findings support the idea that there's a "magic number" when it comes to female representation on boards.

3.4 Hypothesis Development

Building upon the theoretical concepts and empirical evidence presented in Sections 3 and 4, this study develops three hypotheses that aim to examine the relationship between gender diversity and firm risk. Studies such as Modigliani and Miller (1958), critical mass theory (Kanter, 1977; Konrad et al., 2008), and agency theory (Jensen and Meckling, 1976; Bathala and Rao, 1995) provide insight into why companies may want to take on risk in the form of debt, why only one or two women do not have a greater impact on the boardroom, and why independent directors can strengthen important decisions related to capital structure. Furthermore, studies such as (Mohsni et al., 2021; Adams and Funk, 2012; Fehr-Duda et al., 2006; Faccio et al., 2016) highlight differences in risk aversion, priorities, and capital structure between women and men.

Based on the theoretical foundation and evidence in the field, the following hypotheses are developed to address, and build upon the research question presented in the introduction:

- **H1 (Female Representation and Risk):** Firms with a greater overall share of female directors will exhibit more conservative risk-taking behavior, as evidenced by lower leverage ratios, reduced earnings volatility (standard deviation of ROA), and more restricted capital expenditures.
- **H2 (Role-Specific Effects):** Independent female board members will have a stronger negative impact on firm risk-taking metrics compared to executive female directors, reflecting their enhanced monitoring role and decision-making independence.
- **H3 (Critical-Mass Threshold):** The effect of board gender diversity on firm risk-taking will not be significant until the board includes at least three female directors; once this critical mass is reached, a marked reduction in risk-taking will be observable.

4 Data and Methodology

4.1 Data Sample

The data used in this study is collected from two main data sources. The financial data is collected from LSEG, while data on board composition is gathered from annual reports accessed through Retriever Business. The dataset covers a time period from 2010 to 2023 and includes 308 Swedish firms listed on the Nasdaq OMX Stockholm exchange. To address survivorship bias, firms that were delisted during the sample period are also included in the analysis which allows for the addition of 63 additional firms. Following prior literature (Faccio et al., 2016;Chen et al., 2017; Ain et al., 2021;Sila et al., 2016), financial firms are excluded from the sample due to their regulatory environment and capital structure characteristics, which could otherwise affect the results. After applying the selection criteria, the final sample comprises 371 unique firms, resulting in 3,468 firm-year observations and forming an unbalanced panel dataset. A comprehensive overview of the sample distribution is presented in Section 4.3.

4.2 Measurement

Sila et al. (2016) shows no evidence of association between boardroom gender diversity and equity risk, however, gender disparities in risk appetite may still be reflected in business policy. In another sense, a board with more diversity in genders might approach risk taking differently than a board with a more male-dominated board, although these differences do not have an effect on the volatility of a firm's shares. Thus, this study will not examine stock volatility, but will instead focus on capital structure, investments, and returns linked to this. In order to appropriately capture the different types of board characteristics within gender diversity of the firms, this study will make use of three separate groupings of the boards with a focus of Female representation. The variables are: Fraction of Female Directors, Independent vs. Executive and lastly Critical Mass. (Marinova et al., 2010;Chen et al., 2017;Basuony et al., 2023; Sila et al., 2016)

4.2.1 Dependent Variables

To capture multiple dimensions of capital structure decisions made by companies, this study defines three dependent variables that have been widely utilized in previous studies. Within capital structure studies, leverage is one of the most widely used metrics, however, its definition varies across studies. Given the variation, it's critical to choose a metric that best suits the circumstances of this study. While Sila et al. (2016) defines the variable as the ratio of total liabilities to book value of equity, Faccio et al. (2016) defines it as the ratio of financial debt divided by the sum of total equity and financial debt, this study adopts the definition of leverage as the ratio of total debt to total assets, in line with Basuony et al. (2023). The debt-to-assets ratio was chosen as it represents a reliable and comprehensive indicator of overall financial risk and is less prone to fluctuations in equity compared to other definitions.

The volatility of returns is a commonly used proxy for risk in financial economics. BenSaïda (2017) shows that firm specific risk is driven by the firm specific information which highlights the limitations of stock return volatility as a proxy for corporate risk-taking. To capture a company's riskiness of investment decisions, this study utilizes the standard deviation of return on assets $\sigma(ROA)$, in line with Faccio et al. (2016). $\sigma(ROA)$ is calculated as the standard deviation of profit after taxes divided by total assets. By using $\sigma(ROA)$, this study provides a reliable indicator of firm-level risk-taking while in line with previous studies (Faccio et al., 2016; Mohsni et al., 2021).

Additionally, this study will incorporate capital expenditure (*CapEx*) as a dependent variable to analyze corporate investment risk-taking. While prior research has mostly associated gender-diverse boards with reduced or unaffected financial risk (Faccio et al., 2016; Sila et al., 2016), there are also literature associating risk with investment measures such as capital expenditure or R&D (Harjoto et al., 2018;Bargeron et al., 2010). While Bernile et al. (2018) have noted an increased focus on innovation through an increase in R&D, few studies have examined how board gender composition influences firms' capital expenditure decisions. Harjoto et al. (2018) include capital expenditure as a dependent variable in their analysis of board diversity and firm risk, justifying its relevance in capturing firms' investment risk behavior. This study contributes to the literature by explicitly analyzing capital expenditure as a consequence of gender diversity, providing new insights into the governance implications of board gender diversity. This measure captures how much a firm invests in new assets relative to its existing total assets, which allows us to normalize and measure investment behaviors for the different firms. A high capital expenditure would indicate a more aggressive investment strategy which can be used as a proxy for high risk-taking actions. By including capital expenditure alongside leverage and volatility of ROA, we can get a fuller picture of corporate risk-taking.

4.2.2 Independent Variables

The independent variables aim to capture the three different board characteristics in line with previous literature. This study includes a variable, *Fem*, measuring the fraction of women on corporate boards, calculated as the total number of female board members over total number of board members. In line with Chen et al. (2017), the second group is Independent vs. Executive (FemInd and FemExec) which aims to capture the differences between female executive board directors and independent female board directors. The variable FemInd is calculated as the total female independent board members over the total number of board members. FemExec is calculated as the total female executive board directors over the total number of board directors. In comparison to Yang et al. (2019), who concentrates specifically on non-executive female board members due to Norway's quota, this study chooses to distinguish between independent and executive roles. This distinction is motivated by the Agency Theory described in Section 3.2, which underscores the need of efficient monitoring to align the interests of managers and shareholders, for the benefit of the firm. Independent board directors may assume a stronger monitoring role, whereas executive board members engage more in daily operations. By braking it down by responsibilities, this allows the study to assess whether gender diversity influences risk differently based on the position within the governance structure. The last group characteristic is critical mass and according to the Critical Mass Theory described in Section 3.3 the effects of having women on boards is expected to be insignificant unless a threshold is met. According to Konrad et al. (2008), one or two women were unlikely to be sufficient to influence board dynamics because their involvement may be marginalized or perceived as symbolic. However, the influence of female directors becomes apparent once a threshold of three or more women is crossed. Three variables: FD1, FD2, and FD3 which are dummies for one, two or three females on the board are included in this study to test this theory empirically. For the theory to hold, the variables FD1 & FD2 should either have a negligible coefficient or be insignificant while FD3 should have a greater coefficient while being statistically significant.

4.2.3 Control Variables

This section describes the control variables included in the study, which are frequently found in existing literature to account for firm-level differences.

Firm size is used as a control variable in this study due to its expected influence on financing decisions, since studies (Titman and Wessels, 1988; Faccio et al., 2016) have shown that leverage ratios are associated with firm size of the company. According to Smith et al. (2005), smaller companies experience considerably greater costs when issuing equity and long term debt. Small companies may therefore have the preference for short-term borrowing and be more leveraged than large companies. This cost discrepancy highlights the difference in leverage and the influence of firm size.

Companies with female executives are found to be less likely to issue debt than companies with male executives (Huang and Kisgen, 2013). The control variable *FemCEO*, defined as a dummy variable equal to 1 if the company has a female CEO, is added for two of the regression models, excluding *Independent vs. Executive*.

ROA is included in this study, as (Faccio et al., 2016), since it is a good measure of profitability which may influence corporate risk-taking and investment decisions. A higher ROA may indicate stronger financial health, allowing firms to take more risks.

Tangibility, measured as the ratio of fixed to total assets, is included for the role of asset structure in financial decisions. According to some studies such as (Chen et al., 2017; Faccio et al., 2016), there is a positive relationship between tangibility and debt ratio, which makes it important to control when looking at the leverage ratio.

Sales growth and firm age, two variables that are commonly found in prior literature are also included in this study as they are expected to have an effect on risk taking (Mohsni et al., 2021;Faccio et al., 2016).

Leverage is included as a control variable in the capital expenditure regressions in order to account for the firm's capital structure. According to Modigliani and Miller (1958) firm value should not be affected by the capital structure under perfect conditions. But in real-world practices, firms weigh advantages against disadvantages of debt which makes leverage a potential important factor for capital expenditure. This could imply that companies prefer debt financing over equity in order to finance investments. A positive effect between leverage and capital expenditure may therefore support this notion. *Leverage* is also included as a control in the regressions of volatility of ROA, since a high level of leverage can lead to an increase in financial risk which in turn may create higher variations in the ROA.

Furthermore, this study incorporates board independence (*BInd*), board size (*LogBSize*), and firm age (Ln(1 + Age)) as control variables. Board independence and board size are commonly used in corporate governance research, due to its potential impact on decision-making and risk preferences (Chen et al., 2017). Firm age is included, following the model of Faccio et al. (2016), as it reflects of the firm, which may affect its risk-taking behavior and investment decisions.

Table 1: Descriptions of the Variables Used in the Analysis

Variable	Definition
Dependent Variables	
Leverage	Total debt divided by total assets
σROA	Standard deviation of return on assets
CapEx	Capital expenditure as a fraction of total assets
Independent Variables	
Fem	The fraction of female directors on the board
FemExec	The fraction of female executives on the board
FemInd	The fraction of independent female directors
FD1	Equals 1 if there is 1 female member on the board, otherwise 0
FD2	Equals 1 if there is 2 female members on the board, otherwise 0
FD3	Equals 1 if there are at least 3 female members on the board, otherwise 0
Control Variables	
FemaleCEO	Equals 1 if there is a female CEO, otherwise 0
ROA	Return on assets, net profit over total assets
Tangibility	Tangibility ratio, fixed assets divided by total assets
FirmSize	Natural logarithm of total assets
BInd	Independent directors divided by total number of board directors
LogBSize	Natural logarithm of total number of board directors
SalesGrowth	Sales growth, difference in sales from the previous period divided by the sales in the previous period
FirmAge	Natural logarithm of (1 + firmage)
Leverage	Total debt divided by total assets
Fixed Effects	
Industry	Dummies for each industry based on Fama-French 12 industry classification
Year	Dummies for each year from 2010 to 2023

Note: Definitions of the variables used in the analysis.

4.3 Sample Overview

Table 2 displays the study's sample of 3 468 firm-year observations, where firms carry a moderate amount of debt, with average leverage at just under 25% and extreme values trimmed at the 1st and 99th percentiles to keep outliers from skewing the picture. Profitability is fairly stable, with the typical firm's volatility of return on assets varying by 5.7% over rolling five-year periods.

Investments in plant and equipment runs at roughly 4.7% of total assets, again winsorized at the extremes.

Boards average about eight directors, and these companies tend to be well established, on average more than 25 years old, underscoring that the study is looking at mature and stable businesses. Analyzing the board composition, nearly a third of all directors are women with 30.2% on average, and that breaks down between independent directors which lies at 30.1%, and executives with a very small fraction of 0.1%. Looking at the critical mass variables, boards with exactly one female director (*FD1*) account for 21.4%, those with exactly two women (*FD2*) make up 33.2%, and boards with three or more female directors (*FD3*) represent 38.5%. Consequently, more than nine out of ten boards include at least one woman, roughly seven out of ten include at least two, while just under four out of ten meet the critical mass threshold of three or more female directors.

Profitability itself is modest, at about 1% return on assets, and sales tend to grow at around 12% a year. Sales growth and tangibility were winsorized at the 5th and 95th percentiles. Altogether, the figures from Table 2 paint a picture of fairly mature, well-governed firms with solid, but not excessive, debt levels, steady if unspectacular profits and growth, and boards that are approaching gender balance but have not yet reached a critical mass of women directors with only about 40% reaching it.

Table 2: Descriptive Statistics

Variable	**Obs**	**Mean**	**SD**	**Min**	**p25**	**Median**	**p75**	**Max**
Leverage	3059	0.249	0.177	0.000	0.105	0.230	0.358	0.702
σROA	2040	0.057	0.086	0.004	0.015	0.026	0.056	0.488
CapEx	2015	0.047	0.045	0.002	0.018	0.033	0.060	0.248
Fem	3468	0.302	0.146	0.000	0.200	0.300	0.400	0.800
FemInd	3468	0.301	0.147	0.000	0.200	0.300	0.400	0.800
FemExec	3456	0.001	0.011	0.000	0.000	0.000	0.000	0.200
FD1	3469	0.214	0.411	0.000	0.000	0.000	0.000	1.000
FD2	3469	0.332	0.471	0.000	0.000	0.000	1.000	1.000
FD3	3469	0.385	0.487	0.000	0.000	0.000	1.000	1.000
FirmSize	3345	18,800	47,700.0	1.029	701.0	2,860.0	13,500.0	674,000.0
LogFirmSize	3345	9.503	0.859	7.674	8.846	9.457	10.130	11.415
ROA	3341	0.010	0.185	-1.004	0.010	0.048	0.083	0.284
SalesGrowth	2898	0.119	0.215	-0.235	-0.001	0.083	0.192	0.699
Ln1Age	3468	3.247	0.832	0.000	2.708	3.219	3.850	4.844
BInd	3468	0.958	0.072	0.500	0.923	1.000	1.000	1.000
FemaleCEO	3401	0.084	0.277	0.000	0.000	0.000	0.000	1.000
BSize	3468	7.605	3.008	1.000	6.000	7.000	9.000	18.000
LogBSize	3468	1.955	0.386	0.000	1.792	1.946	2.197	2.890

Note: 1. FrimSize is expressed in millions of SEK. 2. The variables Leverage, σROA, ROA, CapEx, and LogFirmSize were winsorized at the 1^{st} and 99^{th} percentiles. SalesGrowth and Tangibility were winsorized at the 5^{th} and 95^{th} percentiles.

Table 3 illustrates how our data changes over time and how board characteristics evolve. In 2010, the sample consisted of 177 observations, representing just over 5% of the total sample and by 2022 that climbed to 311 observations, or nearly 9%, before dipping slightly to 308 in 2023. This growth reflects the addition of more companies that have listed on the Nasdaq OMX stockholm exchange over time. Despite the changing sample size, the average board size holds steady at around eight directors, with a slight increase from about 6.9 in 2010 to roughly 7.4 on average by 2023. In contrast, female representation on boards has increased noticeably, from 24% in the early years up over 34% by 2022 underscoring a clear upward trend toward greater gender balance even as board size itself remains stable.

Table 3: Sample Distribution by Year

Year	Obs	% Obs	Avg. Board Size	% Female Directors
2010	177	5.10	6.898	24.0%
2011	187	5.39	7.957	23.7%
2012	189	5.45	7.915	24.1%
2013	197	5.68	7.964	24.5%
2014	211	6.08	7.853	24.9%
2015	231	6.66	7.861	27.9%
2016	239	6.89	7.762	30.3%
2017	259	7.47	7.822	31.3%
2018	276	7.96	7.645	33.5%
2019	284	8.19	7.514	32.6%
2020	291	8.39	7.399	33.3%
2021	308	8.88	7.377	33.7%
2022	311	8.97	7.421	34.2%
2023	308	8.88	7.370	33.9%
Total	**3468**	**100.00**	**7.605**	**30.2%**

Note: The total row represents the average board size and average female board representation across the full sample of 3,468 firm-year observations.

Table 4 shows how the 3 468 firm-year observations are divided by industry and shows how board size and gender vary across sectors. The largest part of the sample falls in the "Other" category with 28% of observations, which is followed by Business & Software at 18%, Manufacturing and Healthcare both at 16% as well. Boards tend to be smallest in Energy, averaging about 5.8 directors, and largest in Consumer Durables, at nearly 9.9 directors. Women's representation ranges from a high of 37% in Consumer Non-Durables and 34% in Telecom to a low of about 25% in Chemicals and 24.7% in Energy. This highlights why the study includes industry controls in the analysis, board size and gender mix can differ from one sector to the next.

Table 4: Sample Distribution by Industry

Industry	**Obs**	**% Obs**	**Avg. Board Size**	**% Female Directors**
Business & Software	613	17.68	6.423	28.1%
Chemicals	19	0.55	8.053	25.8%
Consumer Durables	169	4.87	9.899	29.1%
Consumer Non-Durables	186	5.36	9.242	37.3%
Energy	63	1.82	5.762	24.7%
Healthcare	554	15.97	6.812	31.2%
Manufacturing	567	16.35	9.279	27.1%
Telecom	110	3.17	8.555	34.4%
Utilities	32	0.92	8.844	32.5%
Wholesale & Retail	175	5.05	6.994	31.7%
Other	980	28.26	7.191	31.3%
Total	**3468**	**100.00**	**7.605**	**30.2%**

Note: The total row represents the average board size and average female board representation across the full sample of 3,468 firm-year observations.

4.4 Models of analysis

Model 1: Fraction of Female Directors

$$\begin{aligned} Y_{it} = \beta_0 + \beta_1\, Fem_{it} + \beta_2\, FemaleCEO_{it} + \beta_3\, ROA_{it} + \beta_4\, Tangibility_{it} \\ + \beta_5\, FirmSize_{it} + \beta_6\, BInd_{it} + \beta_7\, LogBSize_{it} + \beta_8\, SalesGrowth_{it} \\ + \beta_9\, Leverage_{it} + \beta_{10} FirmAge_{it} + \text{Industry} + \text{Year} + \epsilon_{it} \end{aligned} \tag{1}$$

Model 2: Independent vs. Executive

$$\begin{aligned} Y_{it} = \beta_0 + \beta_1\, FemExec_{it} + \beta_2\, FemInd_{it} + \beta_3\, ROA_{it} + \beta_4\, Tangibility_{it} \\ + \beta_5\, FirmSize_{it} + \beta_6\, BInd_{it} + \beta_7\, LogBSize_{it} + \beta_8\, SalesGrowth_{it} \\ + \beta_9\, Leverage_{it} + \beta_{10} FirmAge_{it} + \text{Industry} + \text{Year} + \epsilon_{it} \end{aligned} \tag{2}$$

Model 3: Critical Mass

$$
\begin{aligned}
Y_{it} = {} & \beta_0 + \beta_1 \, FD1_{it} + \beta_2 \, FD2_{it} + \beta_3 \, FD3_{it} + \beta_4 \, FemaleCEO_{it} + \beta_5 \, ROA_{it} \\
& + \beta_6 \, Tangibility_{it} + \beta_7 \, FirmSize_{it} + \beta_8 \, BInd_{it} + \beta_9 \, LogBSize_{it} \\
& + \beta_{10} \, SalesGrowth_{it} + \beta_{11} \, Leverage_{it} + \beta_{12} \, FirmAge_{it} + \text{Industry} + \text{Year} + \epsilon_{it}
\end{aligned} \tag{3}
$$

Note: For each of the three models, the dependent variable Y in the *Leverage* regression is measured at $t + 1$, reflecting a one-year lead. In the σROA and *CapEx* regressions, the dependent variable Y is calculated as overlapping five-year periods that are matched against the explanatory variables in year t, the first year of each period.

In order to estimate the effect between the risk variables and the independent variables presented in Section 5.2, this study, like previous studies (Sila et al., 2016;Faccio et al., 2016), uses an OLS regression with fixed effects for industries and years to account for unobserved heterogeneity across industries and time. Standard errors are clustered at the firm level to take into account both possible heteroscedasticity and autocorrelation within firms throughout the years. To asses the possible presence of multicollinearity among the explanatory variables, a Variance Inflation Factor Test is performed.

It is observed that a reverse causal relationship between firm risk and director appointment may explain female directors on corporate boards Sila et al. (2016). In order to mitigate this concern, this analysis assumes a delayed temporal effect, a lag effect, in how gender diversity affects corporate risk. This is in line with the approach of (Chen et al., 2017; Faccio et al., 2016; Sila et al., 2016) and reduces the possibility that the current risk affects appointments of female directors.

The volatility of ROA is calculated over overlapping five-year periods that are matched against explanatory variables in the first year of each period, in similarity with Faccio et al. (2016). This is to enable the calculation of volatility in a robust manner, and to naturally include the lag effect. The data on CapEx is volatile over the years within the companies and a five-year average is matched against explanatory variables with overlapping periods, following the same approaches for volatility of ROA.

All variables used in the analysis are tested for stationarity using Fisher-type Augmented Dickey-Fuller (ADF) panel unit root tests. The null hypothesis of a unit root is rejected for all variables except FemaleCEO and FirmSize, suggesting that the majority of regressors are stationary and thus unlikely to introduce bias due to non-stationarity (see Table 12).

To evaluate the model specifications, Durbin–Watson tests across all models are conducted, which consistently indicated the presence of positive serial correlation. This supports the inclusion of time fixed effects to account for temporal dependencies in the data. In addition, Hausman tests are performed to compare fixed and random effects specifications. The null hypothesis of no systematic difference is rejected in all models, indicating that the fixed effects model is preferred (Table 13). Furthermore, tests for autoregressive conditional heteroskedasticity (ARCH) show strong evidence of heteroskedasticity across all specifications, with p-values below 0.0001. To address this, the study applies robust standard errors clustered at the firm level throughout the analysis. In line with previous literature, the natural logarithm of variables such as total assets, board size, and firm age is used, in order to reduce skewness and the influence of extreme outliers.

4.5 Tests for Validity

To ensure the validity of the study's findings, various endogeneity tests are used, including instrumental variable regressions, lagged regressions, and propensity score matching, together with robustness tests, validating the main results. The tests used in this study to control for potential endogeneity issues are in line with previous research (Liu et al., 2014; Sila et al., 2016; Faccio et al., 2016; Ain et al., 2021 and Gul et al., 2011).

5 Analysis and Results

5.1 Correlation

Table 11 reports the pairwise Pearson correlations for all of the explanatory variables. Following Field (2005), it is noted that coefficients above 0.8 can signal multicollinearity. In the correlation matrix, the standout observation is the near-perfect relationship between Fem and FemInd at 0.993, significant at the 1% level. This simply reflects the way in which these two metrics are constructed, but they pose no threat since both are never included in the same model. The correlations between *Fem* and the three critical-mass dummy variables (*FD1*, *FD2*, *FD3*) are (-0.419, 0.044 & 0.601), respectively. Each of these correlations is statistically significant at the 5% level and remains well below the conventional multicollinearity threshold of 0.8. Among the control variables, the strongest association occurs between *FirmSize* and *LogBSize* at 0.558 and between *Leverage* and *Tangibility* at –0.502, both significant at 1%. No other pair of controls exceeds an absolute correlation of 0.6, underscoring that the covariates for the analysis are broadly independent.

This study also make use of variance-inflation tests in all nine regression setups and finds no VIF near the usual concern threshold of five. The average VIF never exceed 2 and at the highest, industry dummies reach around 4.5, while governance measures stays under 1.8. Furthermore, it can be concluded that multicollinearity is not distorting the estimates.

5.2 Main Findings

5.2.1 Board Gender Diversity and Financial Leverage

Table 5 presents the main regression results from the regression models described in Section 4.4. The first set of analyses addresses the relationship between firm leverage and board gender diversity. The analysis finds no statistically significant association between leverage and the proportion of female board directors (Coef. = 0.008, t = 0.19). This indicates that simply the presence of women on boards does not significantly affect capital structure decisions, contradicting earlier literature, Mohsni et al. (2021) suggesting a negative correlation due to the premise that women exhibit more risk aversion. However, the results are in line with those of Sila et al. (2016), that found no significant correlation between leverage and board gender diversity. In contrast to the causal effects of board composition, they argue that previous studies that found negative associations may be flawed and motivated by unobserved business characteristics. This strengthens the interpretation that decisions on capital structure are not particularly effected by gender diversity. When the roles on the board are broken down, no clear relationship or impact of independent female directors or female executives directors on leverage is found. Furthermore, no significant effect emerges when the critical mass (FD1-FD3) concept is tested against leverage.

The results presented indicate that leverage is less sensitive to board gender composition than other aspects such as financial measures, broader market conditions, or firm fundamentals.

5.2.2 Board Gender Diversity and Volatility of Returns on Assets

In contrast, female board presence does appear to reduce the volatility in return on assets, which is in line with the hypotheses and Faccio et al. (2016), connecting women to a more stable firm performance and reduced risk, although not significantly (coef. = –0.002, t = –0.14). The stabilizing effect on the volatility observed, can be attributed to general underlying explanatory factors such as improved board monitoring, risk aversion, sensitivity to losses, and different priorities most often attributed to women (Adams and Ferreira, 2009; Eckel and Grossman, 2008; Olsen and Cox, 2001; Adams and Funk, 2012). However, the results contradict those found by Mohsni et al. (2021), who only found a negative relationship when women on boards reached a critical mass. Furthermore, this study does not find anything that indicates similar conclusions.

Analysis of critical mass effects indicates that the presence of one female director correlates with a slight but statistically significant increase in σROA (Coef. = 0.017, t = 1.66).

Independent female directors exhibit a negative correlation with σROA (Coef. = -0.001, t = -0.04), although this is not statistically significant.

It is noteworthy that there is a difference in signs of the coefficients between critical mass and the other variables (*Fem*, *FemInd*, *FemExec*). A possible explanation of the difference could be due to the critical mass variables being dummies, while *Fem*, *FemInd*, and *FemExec* are ratios. Critical mass may capture nonlinear behavioral shifts, while the other variables reflect average marginal effects. Furthermore, the study's results show that there is a positive significant relationship between female CEOs and volatility of ROA, contradicting Faccio et al. (2016) who finds a negative relationship. A possible explanation for this discrepancy could be the differing geographical focus of the studies.

5.2.3 Board Gender Diversity and Capital Expenditure

Column 3 shows a negative relationship between gender diversity and capital expenditure as the regression coefficient is negative (Coef. = -0.022, t = -1.79). Furthermore, the negative relationship found is statistically significant (at the 10% level). When the proportion of women on the board increases by one percentage point, capital expenditure in the company decreases by 0.022 percentage points. The result thus supports hypothesis 1, that gender diversity reduces capital expenditure.

Only the independent female directors among board roles exhibit a statistically significant and negative correlation with capital expenditure (Coef. = -0.021, t = -1.77) suggesting that their presence may result in more cautious or alternative investment choices, possibly as a result of their increased monitoring, risk aversion, and other priorities.

When looking at how the critical mass variables affect capital expenditure, the results show that already after reaching two women on board, the test shows a significant effect on capital expenditure (Coef.= -0.018, t= -1.93) & for three or more women the effect still holds (Coef. = -0.018, t= -1.96). The effect is negative, implying that a more conservative investment stance gets implemented after reaching at least two women on board. However, these findings contradict the critical mass theory which states that the effects from adding more women on a board should not appear before the threshold of three females has been met. Furthermore, the study reveals an interesting finding where only one woman on the board is perceived as a token rather than an individual with her voice heard, in line with Kanter (1977).

Furthermore, when leverage is added as a control variable in the capital expenditure regressions, it accounts for firms capital structure and financing behavior. This study finds that leverage has a positive and significant effect on capital expenditure across all three independent models. Confirming that firms often use debt when financing is needed for investment, leverage becomes a key factor influencing capital expenditure.

This study's negative correlation between female board presence and capital expenditure reflects the existing literature that associates board diversity to a less risk taking and different investment approach (Eckel and Grossman, 2008;Sapienza et al., 2009). Although this may seem to suggest a decrease in willingness to invest among women, Bernile et al. (2018) find that diverse boards, including gender diversity, emphasize greater expenditures on R&D. This suggests that the observed reduction in capital expenditure may not indicate underinvestment, but rather a shift in priorities, from physical assets to intangible innovation, reflecting a more strategic allocation of resources.

Overall, this underscores the importance of not only having women on boards, but ensuring that their presence is large enough to influence the group's decision-making in investment policy and risk taking, however, potential side effects of this are not observed.

Table 5: Regression Results

	Fraction of Female Directors			Independent vs. Executive			Critical Mass		
	Leverage	σROA	CapEx	Leverage	σROA	CapEx	Leverage	σROA	CapEx
Fem	0.008 (0.19)	-0.002 (-0.14)	-0.022* (-1.79)						
FemExec				-0.099 (-0.47)	-0.008 (-0.07)	0.289 (1.13)			
FemInd				0.032 (0.73)	-0.001 (-0.04)	-0.021* (-1.77)			
FD1							0.004 (0.17)	0.017* (1.66)	-0.010 (-1.05)
FD2							-0.003 (-0.11)	0.005 (0.49)	-0.018* (-1.93)
FD3							-0.005 (-0.19)	0.011 (0.94)	-0.018* (-1.96)
FemaleCEO	0.021 (1.32)	0.023** (2.35)	0.002 (0.34)				0.022 (1.37)	0.023** (2.38)	0.002 (0.35)
ROA	-0.072* (-1.81)	-0.318*** (-14.30)	-0.002 (-0.12)	-0.071* (-1.77)	-0.320*** (-14.03)	-0.001 (-0.05)	-0.071* (-1.73)	-0.321*** (-14.31)	0.002 (0.10)
Tangibility	-0.012*** (-11.01)	0.002** (2.28)	0.002*** (5.22)	-0.013*** (-11.23)	0.002** (2.38)	0.002*** (5.22)	-0.012*** (-10.98)	0.002** (2.29)	0.002*** (5.06)
LogFirmSize	0.082*** (7.93)	-0.017*** (-3.97)	0.003 (0.88)	0.078*** (7.57)	-0.018*** (-4.00)	0.003 (0.86)	0.083*** (8.10)	-0.017*** (-3.99)	0.002 (0.77)
logBSize	-0.105*** (-5.06)	0.002 (0.31)	-0.005 (-0.54)	-0.095*** (-4.58)	0.001 (0.10)	-0.005 (-0.54)	-0.101*** (-4.17)	0.002 (0.26)	0.001 (0.13)
BInd	0.051 (0.65)	-0.020 (-0.62)	-0.032 (-0.77)	0.026 (0.33)	-0.010 (-0.30)	-0.028 (-0.67)	0.056 (0.72)	-0.020 (-0.62)	-0.034 (-0.81)
SalesGrowth	0.055*** (2.94)	0.037* (1.79)	0.013* (1.85)	0.051*** (2.70)	0.035* (1.67)	0.015** (2.08)	0.055*** (2.92)	0.037* (1.82)	0.012* (1.69)
LogFirmAge	-0.019* (-1.77)	0.005 (1.65)	-0.003 (-1.09)	-0.017 (-1.62)	0.005 (1.66)	-0.003 (-1.09)	-0.019* (-1.77)	0.005 (1.71)	-0.004 (-1.18)
Leverage		-0.015 (-0.82)	0.054*** (3.80)		-0.014 (-0.72)	0.055*** (3.85)		-0.017 (-0.90)	0.054*** (3.88)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.402	0.533	0.226	0.393	0.527	0.231	0.402	0.538	0.231

Note: t-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Leverage is included as a control in the σROA and CapEx regressions.

5.3 Endogeneity

Since the majority of the independent variables becomes insignificant with tiny coefficients, it becomes important to show that those results are not a result of misspecified models or hidden bias. Therefore, several alternative tests with a focus on the fraction of female directors variable are conducted. The alternative tests used in this study to control for potential endogeneity issues are in line with previous research such as (Liu et al., 2014; Sila et al., 2016; Faccio et al., 2016; Ain et al., 2021 and Gul et al., 2011). The first test to be utilized is instrumental variable regressions, which are used to manage omitted variable bias, then lagged independent variable regressions to address reverse causality concerns, and lastly propensity score matching to control for self-selection bias. All regressions are made using the same fixed effects and control variables, with clustered standard errors on firm-level, as displayed in Section 5.2, Table 5.

5.3.1 Omitted Variable Bias

Since the estimated regression models may still suffer from omitted variables that jointly influence board gender diversity and corporate risk-taking. In order to address this potential bias and isolate the exogenous variation in board gender composition, this study employs a two-stage least squares (2SLS) instrumental variable approach. Following prior research such as (Ain et al., 2021;Liu et al., 2014), the study utilize two instruments for the fraction of female board directors (Fem): the industry average excluding the focal firm (IAFem) and the lagged value of Fem (LFem).

In line with Sila et al. (2016), who address endogeneity concerns when studying the relationship between board gender diversity and firm risk, the iv-tests treat the proportion of female directors as an endogenous variable. However, unlike Sila et al. (2016) who use director network connectedness as an instrument, this study adopts a simpler and alternative approach, employing industry averages and lagged values to mitigate concerns about instrument weakness or exogeneity violations. Theoretical arguments support the use of these instruments. Liu et al. (2014) argue that the board composition of firms within the same industry may influence individual firm decisions through spill-over effects. However, the industry average is unlikely to directly effect firm-specific risk-taking behaviors such as capital structure, earnings volatility, or investment policy, thereby satisfying the exclusion restriction. The industry average of female board directors *IAFem* is calculated as follows:

$$IAFem_{i,t} = \frac{\text{Female board directors}_{\text{Industry}} - \text{Female board directors}_{i,t}}{\text{Total board directors}_{\text{Industry}} - \text{Total board directors}_{i,t}} \tag{4}$$

where i and t represent each firm observation and year, respectively.

Further, this study employs the lagged value of *Fem*, in similarity with Ain et al. (2021), as an instrument for *Fem*, named *LFem*. The first-stage regressions confirm the strong relevance of both instruments, with first-stage F-statistics exceeding 700 (not reported), indicating that the instruments are highly predictive of board gender diversity. The specifications for the first-stage and second-stage regressions are given by:

First Stage (IAFem)

$$\begin{aligned} Fem_{it} = {} & \beta_0 + \beta_1 IAFem_{it} + \beta_2 BInd_{it} + \beta_3 LogBSize_{it} + \beta_4 ROA_{it} \\ & + \beta_5 FirmSize_{it} + \beta_6 Leverage_{it} + \beta_7 FemaleCEO_{it} + \beta_8 Tangibility_{it} \\ & + \beta_9 SalesGrowth_{it} + \beta_{10} FirmAge + \text{Industry} + \text{Year} + \epsilon_{it} \end{aligned} \tag{5}$$

First Stage (LFem)

$$\begin{aligned} Fem_{it} = {} & \beta_0 + \beta_1 LFem_{it} + \beta_2 BInd_{it} + \beta_3 LogBSize_{it} + \beta_4 ROA_{it} \\ & + \beta_5 FirmSize_{it} + \beta_6 Leverage_{it} + \beta_7 FemaleCEO_{it} + \beta_8 Tangibility_{it} \\ & + \beta_9 SalesGrowth_{it} + \beta_{10} FirmAge + \text{Industry} + \text{Year} + \epsilon_{it} \end{aligned} \tag{6}$$

Second Stage

$$\begin{aligned} Y_{i,t+1} = {} & \beta_0 + \beta_1 F\hat{e}m_{it} + \beta_2 BInd_{it} + \beta_3 LogBSize_{it} + \beta_4 ROA_{it} \\ & + \beta_5 FirmSize_{it} + \beta_6 Leverage_{it} + \beta_7 FemaleCEO_{it} + \beta_8 Tangibility_{it} \\ & + \beta_9 SalesGrowth_{it} + \beta_{10} FirmAge + \text{Industry} + \text{Year} + \epsilon_{it} \end{aligned} \tag{7}$$

The results from the instrumental variable regressions are presented in Table 6. Using either *IAFem* or *LFem* as an instrument, the coefficient on the fitted values of Fem is small and statistically insignificant across all three dependent variables: *Leverage*, σROA, and *CapEx*. For example, the coefficient on $F\hat{e}m$ using *IAFem* is 0.015 for *Leverage*, 0.002 for σROA, and –0.022 for *CapEx*, none of which are statistically significant at conventional levels. Similar patterns are observed when using *LFem* as an instrument. The lack of significance in the IV regressions suggests that the main results are unlikely to be driven by omitted variable bias, although they also do not establish a strong causal effect. This consistency across different instruments and outcome variables provides some reassurance about the validity and robustness of the OLS results reported in Section 5.2.

Table 6: Instrumental Variable Regressions (2SLS)

Variable	Leverage		σROA		CapEx	
	IAFem	LFem	IAFem	LFem	IAFem	LFem
$\hat{\text{Fem}}_{IAFem}$	0.015		0.002		-0.022	
	(0.058)		(0.018)		(0.017)	
$\hat{\text{Fem}}_{LFem}$		0.016		0.003		-0.024
		(0.058)		(0.018)		(0.016)
Controls, Industry & Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,238	2,242	1,430	1,434	1,420	1,424
R-squared	0.402	0.402	0.533	0.533	0.226	0.226

Note: Second stage regression coefficients for the fitted variable *Fem*, using *IAFem* and *LFem* as instruments. Robust standard errors clustered at the firm level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

5.3.2 Reverse Causality

The estimated effect of female board directors on corporate risk-taking measures may not be entirely coincidental. It is possible that firms with stronger governance structures and more conservative financial policies are more likely to appoint female board directors. Moreover, newly appointed directors may require time to influence corporate decisions effectively.

To address concerns of reverse causality, this study follows (Ain et al., 2021; Gul et al., 2011) by including one-, two-, and three-period lags of the fraction of female board directors *Fem* as explanatory variables. This method allows for testing whether female board representation affects firm outcomes with a delay, thus mitigating simultaneity bias. The regression results are presented in Table 7. For *Leverage* and σ*ROA*, the lagged *Fem* variables are not statistically significant across any of the periods. However, for *CapEx*, the coefficients on the two- and three-period lags are negative and marginally significant at the 10% level. These results suggest that reverse causality is unlikely to explain the main findings. While no delayed effects are observed for leverage or earnings volatility, the modest significance for capital expenditures implies that the influence of female board representation on investment decisions may develop gradually over time.

Table 7: Lag of Female Board Representation

Variable	**Leverage**	**σROA**	**CapEx**
Fem_{t-1}	-0.005	0.002	-0.019
	(0.040)	(0.015)	(0.013)
Fem_{t-2}	0.004	0.001	-0.024^{*}
	(0.045)	(0.014)	(0.014)
Fem_{t-3}	-0.007	0.017	-0.028^{*}
	(0.049)	(0.017)	(0.016)
Controls, Industry & Year FE	Yes	Yes	Yes
N	2,594 / 2,326 / 2,069	1,434 / 1,235 / 1,051	1,424 / 1,226 / 1,043
R-squared	0.464 / 0.467 / 0.472	0.533 / 0.501 / 0.494	0.225 / 0.222 / 0.226

Note: Robust standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels.

5.3.3 Self-Selection Bias

Female board directors may be more inclined to join firms with particular characteristics, rather than being appointed randomly. This may create self-selection bias, where firms with gender-diverse boards systematically differ from those without, in ways unrelated to risk-taking outcomes (Ain et al., 2021; Chen et al., 2017). To address this concern, this study applies a propensity score matching (PSM) approach, similar to the methodology used by Faccio et al. (2016), although adapted to board composition rather than CEO changes, which aligns with Ain et al. (2021). Specifically, the treatment group consists of firm-year observations with at least one female board director, while the control group consists of observations without female board members. A treatment indicator variable (*Treat*) is constructed, taking the value one if a firm-year observation has female board representation and zero otherwise. A logit regression is calculated to predict the probability of treatment based on observable firm-level characteristics, including return on assets, firm size, board size, board independence, leverage, tangibility, sales growth, and firm age, controlling for industry and year fixed effects. Nearest-neighbor matching with a caliper of 0.001 and without replacement is incorporated into the logit regression. The strict caliper enables for accurate similarity between matched treated and control units. Three separate tests are conducted for each of the dependent variables where 66 *(Leverage)*, 28 *(σROA)* and 27 *(CapEx)* matched pairs were obtained.

Post-matching diagnostics confirm that the treated and control groups are well-balanced across covariates and no statistically significant differences in the matching variables (see Table 8). Furthermore, Table 9 presents the average treatment effects. In the matched sample, there are no statistically significant differences in leverage, earnings volatility of ROA, or capital expenditures between firms with and without female board representation. These results indicate that, after controlling for observable firm characteristics through matching, the presence of female board members does not significantly influence the selected risk-related variables in this sample.

Overall, the PSM results indicate that this paper's main model specification potentially suffers from some level of self-selection bias. The PSM results are aligned with the results of leverage and volatility of ROA in the main regression, but show that the previous capital expenditure results might be due to unobserved factors. The lack of significance found in the matched sample implies that the associations found in the OLS regression should be interpreted with caution, especially regarding causality.

Logit regression

$$\begin{aligned} Treat_{i,t} = \beta_0 &+ \beta_1 BInd_{i,t} + \beta_2 \ln BSize_{i,t} + \beta_3 ROA_{i,t} + \beta_4 Tangibility_{i,t} \\ &+ \beta_5 FirmSize_{i,t} + \beta_6 Leverage_{i,t} + \beta_7 SalesGrowth_{i,t} + \beta_8 FirmAge_{i,t} \\ &+ \text{Industry} + \text{Year} + \varepsilon_{i,t} \end{aligned} \tag{8}$$

Table 8: Post-Match Estimates

Variable	**Treated**	**Controls**	**Difference**	**t-stat**
BInd	0.965	0.952	0.013	0.95
LogBSize	1.635	1.665	-0.030	-0.72
ROA	-0.036	-0.069	0.033	0.86
Tangibility	2.345	3.015	-0.670	-1.01
FirmSize	9.032	8.953	0.079	0.76
Leverage	0.256	0.231	0.025	0.78
SalesGrowth	0.154	0.154	-0.000	-0.01
FirmAge	3.147	3.209	-0.062	-0.54

Note: Observed differences in control variables between the treatment group and the control group after matching.

Table 9: Average Treatment Effects

Variable	**Treated**	**Controls**	**Difference**	**t-stat**
Leverage	0.256	0.231	0.025	0.78
σROA	0.076	0.060	0.016	0.61
CapEx	0.042	0.048	-0.006	-0.68

Note: Average treatment effect on the treated (ATT) using nearest neighbor matching with a caliper of 0.001 and no replacement. T-statistics based on robust standard errors. *, **, and *** indicate significance at the 10%, 5%, and 1% levels.

5.4 Robustness Tests

To assess the robustness of the results presented in Section 5.2, several additional tests are carried out using alternative estimation methods and variable definitions. Following the approach of Chen et al. (2017), Fama-MacBeth regressions, Tobit regressions, and alternative specifications are employed to validate the findings. The Fama-MacBeth regressions, estimated with Newey-West adjusted standard errors to correct for potential autocorrelation and heteroskedasticity, confirm the main results. The coefficient on *Fem* remains negative and statistically significant at the 1% level for *CapEx*, while remaining small and insignificant for *Leverage* and σROA. Tobit regressions are also used to account for potential censoring of the dependent variables, with standard errors clustered at the firm level. These results align closely with the main findings, with the coefficient on *Fem* remaining negative and statistically significant at the 10% level for capital expenditure. In addition, to test for possible non-linear effects, the squared term of Fem is included as an independent variable, but the coefficients are insignificant across all three models, suggesting no meaningful non-linear relationship.

Importantly, across all specifications, the coefficient on *Fem* remains robust and consistent with the main results. Overall, the robustness checks reported in Table 10 confirm that the relationship between female board representation and corporate risk taking measures is maintained across alternative estimation methods and variable definitions, supporting the conclusions drawn in the main analysis and consistent with the methods of Chen et al. (2017).

Table 10: Robustness Tests

Method	**Leverage**	σ**ROA**	**CapEx**
OLS regressions			
Fem	0.008 (0.850)	-0.002 (0.887)	-0.022* (0.075)
Fama-MacBeth regressions			
Fem	0.006 (0.803)	0.003 (0.811)	-0.024*** (0.001)
Tobit regressions			
Fem		-0.002 (0.886)	-0.022* (0.071)
Non-linearity			
Fem^2	0.027 (0.661)	-0.008 (0.740)	-0.020 (0.231)

Note: Robustness regressions using alternative methods and definitions. T-statistics in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels.

6 Conclusion

The empirical results of this study show that significant relationships between female board representation and corporate risk-taking are identified only in relation to capital expenditure. The study finds that a higher proportion of women in the board is not significantly associated with lower financial risk, either in the form of leverage or volatility of return on assets, aligning with the results of Sila et al. (2016). However, a significant negative association is found between female board representation and capital expenditures, which can be interpreted as an expression of more cautious risk-taking in the company's investment decisions, in line with prior literature (Eckel and Grossman, 2008;Sapienza et al., 2009) and providing partial support to H1, although it could be due to different investment priorities.

In light of previous research, which indicates that women on boards are associated with increased investments in research and development, the results may indicate a shift in the direction of investments, from physical assets towards more intangible and innovation-oriented projects. This could suggest that companies with higher female representation on the board tend to adopt a more long-term investment strategy. When disaggregated by role, independent female directors are significantly associated with lower capital expenditure, whereas their executive equivalents reveals no such correlation, hence providing partial support for H2.

The analysis related to hypothesis H3, which suggests that female representation on boards does not affect corporate risk-taking until a critical mass of at least three women has been reached, finds no significant support. Further, this suggests that there is no evidence that women's influence on boards increases with a threshold effect at three women. However, the results indicate, in line with Kanter (1977), that only one woman on the board is perceived as a token and does not have her voice heard in the context of capital expenditure investments. Overall, the results indicate that the hypothesis of a critical mass of three women cannot be confirmed in this sample.

To ensure the validity of the study's findings, various endogeneity tests are employed, including instrumental variable regressions, lagged regressions, and propensity score matching. This OLS results suggest a significant negative association between female board representation and capital expenditure, however, this effect is insignificant in the propensity score matching analysis. The PSM results indicates that the observed relationship may partly reflect underlying firm characteristics rather than a causal effect. Alongside additional robustness tests, these checks strengthen the reliability of the findings by addressing potential selection bias, even though they slightly weaken the case for a direct causal interpretation.

One possible explanation for the study's findings being somewhat different from certain previous studies could be the geographical context. As this study is based on Swedish listed firms, institutional factors such as corporate governance practices, cultural norms and gender equality policies may influence both the composition of the board and its actual influence on corporate decisions.

In light of the current EU proposal to introduce gender quotas on corporate boards, based on the empirical findings of this study, it is important to note that increased female representation does not automatically lead to changes in corporate behavior or risk profile. The focus should be on creating inclusive environments that allow all board members, regardless of their gender, to contribute meaningfully to decision making. Although the results do not show clear risk effects, they suggest that increased gender balance may be important for certain aspects of strategic firm decisions. This reinforces the need for continued research on the role of gender diversity in corporate governance, especially with a focus on long-term investments.

Limitations include the potential for unobserved firm-specific shocks and the relatively low prevalence of female executive directors. Future research might extend the framework to include other risk proxies such as R&D investments. Furthermore, explore the potential effect from task-oriented diversity, e.g., tenure and experience, in addition to the relation-oriented diversity which this study focuses on. The sample is limited to Sweden, which means that the study's results cannot be generalized with certainty to other geographical contexts.

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7 Appendices

Table 11: Pearson Correlation Matrix of Key Variables

	Fem	FemExec	FemInd	FD1	FD2	FD3	FemaleCEO	ROA	Tangibility	logTA	BInd	lnBSize	SalesGrowth	Leverage	Ln1Age
Fem	1														
FemExec	0.040*	1													
FemInd	0.993*	−0.035*	1												
FD1	−0.419*	−0.022	−0.423*	1											
FD2	0.044*	0.016	0.045*	−0.368*	1										
FD3	0.601*	0.015	0.601*	−0.414*	−0.558*	1									
FemaleCEO	0.113*	0.270*	0.078*	−0.038*	0.017	0.035*	1								
ROA	0.058*	0.007	0.063*	−0.037*	0.004	0.097*	−0.060*	1							
Tangibility	−0.079*	0.005	−0.080*	0.082*	−0.018	−0.087*	−0.002	−0.135*	1						
logTA	0.223*	0.022	0.225*	−0.242*	−0.103*	0.421*	−0.024	0.318*	−0.260*	1					
BInd	0.152*	−0.107*	0.174*	−0.121*	0.030	0.118*	0.100*	−0.058*	−0.060*	−0.055*	1				
lnBSize	0.150*	0.018	0.156*	−0.303*	−0.111*	0.549*	−0.048*	0.180*	−0.104*	0.558*	0.101*	1			
SalesGrowth	−0.003	−0.028	−0.003	0.030	0.031	−0.067*	−0.049*	0.091*	0.065*	−0.051*	−0.043*	−0.126*	1		
Leverage	0.095*	0.005	0.094*	0.001	0.007	0.032	0.046*	0.084*	−0.502*	0.393*	−0.037*	0.004	0.018	1	
Ln1Age	0.011	−0.033*	0.014	−0.070*	−0.089*	0.200*	−0.040*	0.141*	0.009	0.287*	0	0.373*	−0.149*	−0.094*	1

Note: The table displays Pearson correlation coefficients. * *indicates significance at the 5% level.*

Table 12: Fisher-type ADF Panel Unit Root Tests (No Trend)

Variable	**Test Statistic (Z)**	**Reject H_0 (Unit Root)**
Leverage	-6.2830	Yes
σROA	-3.4189	Yes
CapEx	-3.6557	Yes
Fem	-3.1211	Yes
FemExec	-4.2228	Yes
FemInd	-2.8697	Yes
FD1	-3.9429	Yes
FD2	-6.2421	Yes
FD3	-2.9177	Yes
FemaleCEO	0.6482	No
ROA	-9.0776	Yes
Tangibility	-9.2006	Yes
FirmSize	6.9746	No
SalesGrowth	-24.0560	Yes
FirmAge	-135.2418	Yes
BoardSize (lnBSize)	-7.6726	Yes
BInd	-1.9788	Yes

Table 13: Output from Hausman test, Durbin–Watson test, and ARCH test

Variable	**Fraction of Female Directors**			**Independent vs. Executive**			**Critical Mass**		
	Leverage	σROA	CapEx	Leverage	σROA	CapEx	Leverage	σROA	CapEx
Hausman test									
Chi^2 statistic	62.98	49.30	175.68	53.23	154.25	2542.32	72.26	166.29	56.30
Reject H_0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Durbin–Watson test									
d-statistic	1.591	1.553	1.454	1.605	1.590	1.478	0.377	0.420	0.134
Serial correlation	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive
ARCH test									
Chi^2 statistic	961.35	426.85	873.57	957.45	418.30	757.13	957.99	435.90	878.92
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Reject H_0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

ADF: H_0: All panels contain unit roots (non-stationarity). We reject H_0 in 15/17 variables. The two exceptions (*FemaleCEO* and *FirmSize*) are used only as control variables, reducing the risk of biased estimates.

Hausman Test: H_0: The difference in coefficients between fixed and random effects is not systematic. The null hypothesis is rejected in all models, indicating that fixed effects estimation is appropriate.

Durbin–Watson Test: The d-statistic tests for autocorrelation in the residuals. A value below 2 indicates positive serial correlation, equal to 2 indicates no autocorrelation, and above 2 indicates negative serial correlation. All models report d-statistics well below 2, implying the presence of positive autocorrelation in the residuals.

ARCH Test: H_0: No ARCH effects are present (i.e., homoskedastic residuals). All models return highly significant chi-squared statistics with p-values of 0.0000. We reject the null hypothesis in all cases, indicating potential heteroskedasticity in the data.