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Gender diversity in corporate boards and firm risk-taking: Evidence from Pakistan

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Abstract

Using annual data from 49 publicly listed non-financial firms from January 2011 to December 2022, this study investigates how board gender diversity affects firm risk-taking behaviour in Pakistan. We use the exogenous shock introduced by the Securities and Exchange Commission of Pakistan (SECP) through the Companies Act in 2017, mandating the inclusion of at least one female director on corporate boards in Pakistan. To address endogeneity, we employ the Two-stage Least Squares (2SLS) and Two-stage Residual Inclusion (2SRI) estimations and validate the findings with the Difference-in-Differences (DiD) and Markov Switching (MS) models. The results indicate that greater female board representation correlates significantly with lower financial leverage and reduced earnings volatility. These results suggest that mandated gender diversity can shape strategic decisions that can help mitigate firm-level financial risk.

Keywords

- board diversity
- risk
- leverage
- capital allocation efficiency
- Difference-in-Differences
- Markov Switching

JEL codes: G32, G34, J16

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Introduction

Gender diversity in boardrooms has often concerned regulators, leading them to mandate quotas for women (Labelle et al., 2015). In 2017, the Securities Exchange Commission of Pakistan (SECP)[3] passed the Companies Act, mandating publicly listed firms in Pakistan to have at least one female director on their corporate boards within a three-year time frame.[4] However, there is limited research on the effect of board gender diversity in the Pakistani market on the risk-taking behaviour of businesses, particularly in the aftermath of this legislation. This study investigates how an increase in the proportion of female members on corporate boards affects firm risk-taking in Pakistan.

Why would a gender-diverse board take more or less risk compared to a board with no gender diversity? We attribute this to the Group Dynamics theory (Lewin, 1947; Murphy & McIntyre, 2007), which suggests that the interactions, behaviours, and decision-making processes taking place within a group are influenced by its composition, roles, and group norms. In the context of businesses, this theory helps explain how the inclusion of female directors in corporate boards can influence firm risk-taking. Gender-diverse boards may introduce different perspectives and decision-making styles, leading to more comprehensive discussions and potentially more cautious or balanced risk assessments. Therefore, it is likely that gender-balanced boards would display less extreme risk-taking behaviour, due to greater diversity in viewpoints.

We sample annual data from January 2011 to December 2022 of all public companies (excluding financial sector firms) listed on the Pakistan Stock Exchange (PSX). To evaluate the magnitude of the risk-taking behaviour of firms, we employ four key variables: (1) leverage, (2) earnings volatility, (3) capital allocation efficiency, and (4) idiosyncratic return volatility. Financial leverage is widely used in the literature as a proxy for risk[5]. This is because higher leverage may lead to the management taking additional risks to placate shareholders. Similarly, a smooth earnings pattern may reflect low firm risk-taking (Jayaraman, 2008). In addition, a firm's efficiency of capital allocation may reflect its risk-taking nature. This is because firms that are too risk-averse may fail to invest in positive net present value projects. As such, we follow the literature by taking the ratio of capital investments to total assets as a measure of firm risk (Faccio et al., 2016; Wurgler, 2000). Finally, we include a market-based measure, i.e. idiosyncratic volatility to measure firm risk (Huang & Kisgen, 2013; Lenard et al., 2014).

[3] The Securities and Exchange Commission of Pakistan (SECP) is the primary regulator of the corporate sector and capital markets in Pakistan.

[4] The Companies Act, 2017 governs the regulation of companies in Pakistan. See (Securities and Exchange Commission of Pakistan, 2017).

[5] See (Baxter, 1967; Leland, 1998; Matsa & Miller, 2013; Sila et al., 2016).

Results reveal that the enhanced female board membership in Pakistani firms after enforcement of the Companies Act 2017 led to a significant decline in leverage and earnings volatility. The findings are consistent with prior studies stating that board gender diversity is associated with lower firm risk. However, we do not find a significant impact of female board participation on capital allocation efficiency and idiosyncratic volatility. The outcomes could be attributed to two main factors. Firstly, capital allocation decisions typically unfold over several years. Secondly, while boards typically oversee major capital allocation policies, the detailed investment decisions and factors influencing stock return volatility are often managed by the firm's executive management and shaped by market dynamics, limiting the board's direct involvement.

To address endogenous omitted variable bias, we apply the Two-Stage Least Squares (2SLS) and Two-Stage Residual Inclusion (2SRI) models. Furthermore, we test our results for robustness by using the Difference-in-Differences (DiD) method, which compares firm risk from periods before and after enforcement of the Companies Act 2017. Additionally, we use the Markov Switching (MS) model to evaluate whether the introduction of the Act leads to separate regimes, each having significantly different levels of firm risk. The results remained consistent after applying each model, underscoring the importance of gender diversity in corporate boards in the context of firm risk.

This study contributes to the literature by extending Group Dynamics theory to a regulatory and emerging market context. We argue that mandated gender diversity not only changes board composition but also alters boardroom interaction and decision-making processes. By focusing on mandated diversity rather than voluntary adoption, our study offers a new theoretical perspective on how external regulatory shocks interact with internal board dynamics to influence firm behaviour. We further integrate board diversity into classical frameworks of capital structure and risk-taking, such as those introduced by Baxter (1967) and Leland (1998), which emphasise the role of leverage in firm risk. While studies like Faccio et al. (2016) and Bernile et al. (2018) have explored gender and risk, this is the first to examine how regulatory reforms that mandate board diversity shape capital structure decisions in Pakistan. Our study addresses this gap and opens new lines of inquiry into how diversity impacts boardroom risk management.

Building on this theoretical foundation, our study contributes empirically by analysing how a regulatory mandate for board gender diversity influences firm-level risk-taking, using a natural experiment in a developing market. Most prior studies have focused on firm performance in developed markets; we shift attention to firm risk outcomes, namely, leverage, earnings volatility, capital allocation efficiency, and idiosyncratic return volatility. This focus allows us to evaluate whether gender-diverse boards influence not just how firms perform, but also how they manage and absorb risk, thereby enriching the current understanding of board governance mechanisms.

Section 1 reviews the literature and develops hypotheses on the proportion of female directors on corporate boards and its impact on leverage and capital allocation efficiency. Section 2 presents the sample and summary statistics of the variables. Section 3 elaborates on the models and discusses the initial results. Next, Section 4 presents the results of the robustness tests. Finally, we conclude and summarise the implications of this study and discuss its limitations.

1. Literature and hypothesis development

Women are less likely than men to take risks (Byrnes et al., 1999; Hinz et al., 1997; Weber et al., 2002). According to Weber et al. (2002), women avoid risky behaviour and perceive higher risk in the "financial, ethical, safety, health, and recreational domains" than men. On the other hand, women believe that the social domain is less risky.

Recent psychological research affirms that women exhibit greater risk aversion than men across financial and strategic domains. For instance, Filippin and Crosetto (2016) conduct a meta-analysis confirming consistent gender differences in risk preferences, particularly in contexts involving ambiguity and loss. Buser et al. (2017) show that women are less likely to engage in competitive environments due to higher sensitivity to risk and uncertainty. Moreover, a recent neuroimaging study by Chen et al. (2025) highlights that emotional states may be more significant drivers for females in their reasoning tasks, which could partially explain divergent responses to risk-related stimuli across genders. These psychological insights support the premise that gender-diverse boards may adopt risk-averse financial strategies, a tendency that is shaped in part by board culture, which plays a critical role in firm performance (Evans, 2010).

In the context of Pakistan, few studies directly explore the relationship between board gender diversity and firm risk. For instance, Tabassum et al. (2023) examine the influence of CEO gender on corporate risk-taking and capital allocation efficiency in Pakistan, finding that female CEOs are associated with more conservative decision-making. Similarly, Nadeem et al. (2019) report that female board representation in Pakistani firms moderates the risk-return relationship, suggesting a risk-reducing effect of board diversity. Umer et al. (2020) find evidence of a negative relationship between board gender diversity and earnings management. In turn, Amin et al. (2022) show that female presence on board helps mitigate principal-agent conflict. Despite these contributions, most studies overlook the regulatory context introduced by the Companies Act 2017. This study addresses this gap by examining risk-taking behaviours considering mandated board diversity, thus offering a regulatory perspective.

Schopohl et al. (2021) assert that female CFOs can effectively reduce leverage in firms with diverse boards. Levi et al. (2014) suggest that male-only boards are more likely to engage in riskier activities, such as mergers and acquisitions. This is complemented by Sila et al. (2016) finding a negative impact of women directors on firm risk. According to Faccio et al. (2016), companies with female CEOs exhibit lower levels of debt and less volatile earnings, making them less risky. In contrast, Krystyniak & Staneva (2024) do not find evidence that female CFOs influence capital structure decisions. Consequently, we hypothesise the following:

H1: An increase in the proportion of female directors on corporate boards in Pakistan leads to a decline in firm leverage.

Another important measure of firm risk-taking is earnings volatility (Jayaraman, 2008). Peni & Vahamaa (2010) show evidence of decreased earnings management by firms with female CFOs. Earning management may be a key driver of earnings volatility, as it can disrupt the stability of a firm's earnings pattern. Krishnan and Parsons (2017) conclude that gender diversity in senior management helps improve earnings quality. In a similar study, Srinidhi et al. (2011) find that female participation in boards improves the quality of earnings. Attia et al. (2024) complement the findings by investigating the Egyptian market. Given the evidence in the literature on the impact of female board participation on earnings quality and stability, we expect a similar relationship to hold in the context of Pakistani firms. Accordingly, we propose the following hypothesis:

H2: An increase in the proportion of female directors on corporate boards in Pakistan leads to a decline in firm earnings volatility.

Several studies analyse the correlation between board gender diversity and capital allocation efficiency. Guizani & Abdalkrim (2022) examine firms in the Malaysian market and find that board gender diversity is positively associated with efficient cash flow allocation. Nadeem et al. (2017) show that the efficiency of intellectual capital in Chinese firms is not significantly affected by gender diversity in the boardroom. According to the study, stereotypes about gender are still prevalent in China, and the country's regulators would be advised to consider enforcing limited gender-related laws. Baik et al. (2024) use a global catalog of 83 board gender diversity interventions that were put into place in 59 countries between 1999 and 2021 to examine the impact of diversity on investment outcomes. Their findings suggest that interventions, like mandatory quotas, enhance investment outcomes by diminishing inefficient investment and augmenting the probability of above-median investment efficiency.

Hence, we investigate whether board gender diversity in Pakistani firms impacts capital allocation efficiency, which we take as the third measure of risk. Given the findings of prior studies, we hypothesise the following:

H3: An increase in the proportion of female directors on corporate boards in Pakistan leads to a decline in firm capital allocation efficiency.

While the preceding three hypotheses examine the impact of board gender diversity on internal firm outcomes—namely leverage, earnings volatility, and capital allocation efficiency—we also assess whether governance dynamics extend to how firms are perceived in financial markets. Idiosyncratic volatility, a market-based measure of firm-specific risk, captures how investors respond to firm-level information beyond broader market movements. Bekaert et al. (2025) discuss how the literature on expected idiosyncratic volatility should be helpful in risk management. Cho et al. (2024) find mixed results regarding board diversity and stock price crash risk. Studies by Huang and Kisgen (2013) and Lenard et al. (2014) suggest that female participation in boards is associated with lower variability of stock market return. Accordingly, we propose the following hypothesis:

H4: An increase in the proportion of female directors on corporate boards in Pakistan leads to a decline in firm's idiosyncratic return volatility.

2. Data and statistics

2.1. Sample

The sample for this study was constructed by initially selecting all non-financial firms listed on the Pakistan Stock Exchange (PSX) during the period from January 2011 to December 2022. We excluded firms in the financial, utilities and real estate sectors to maintain consistency in financial reporting structures and also because firms in these sectors operate under different regulatory environments. This initial screening focuses the scope of the study on non-financial firms only.

From this refined group, we further excluded firms with missing governance data, particularly those without available information on the percentage of female directors and governance pillar scores, which were obtained from Bloomberg Professional. Financial data such as leverage, return on assets, and capital expenditure were retrieved from Refinitiv Eikon. The records from both databases were matched using firm identifiers. After excluding firms with incomplete records across the key variables used in the analysis, our final sample comprised 49 firms, resulting in 221 firm-year observations used in the main multivariate analysis. The number of observations varies across different parts of the analysis depending on data availability for each risk measure.

2.2. Variables

To capture firm risk-taking, we use four proxies: leverage ratio ($LRATIO$), earnings volatility (ROA_vol), capital allocation efficiency ($CAPEX$), and idiosyncratic return volatility (Ret_vol). The leverage ratio is a widely employed financial risk indicator, as higher leverage may incentivise riskier strategies to satisfy equity holders (Faccio et al., 2016; Nadeem et al., 2019; Sila et al., 2016). Earnings volatility (ROA_vol), reflecting the 2-year standard deviation of the annual return-on-assets ratio, serves as an indicator of internal performance risk and is linked to the firm's earnings management behaviour. Greater earnings smoothness typically reflects lower risk-taking and more conservative financial policies (Jayaraman, 2008; Peni & Vähämaa, 2010; Srinidhi et al., 2011).

Capital allocation efficiency, measured as the ratio of capital expenditure to total assets ($CAPEX$), reflects the firm's willingness to invest in potentially high-return projects. Firms that are excessively risk-averse may underinvest, thus lower $CAPEX$ may signal conservative risk-taking behaviour (Faccio et al., 2016; Wurgler, 2000). Finally, idiosyncratic return volatility (Ret_vol), based on residuals from a CAPM regression, captures market-perceived firm-specific risk. This measure has been used to proxy investor uncertainty and firm-level risk independent of market trends (Huang & Kisgen, 2013; Kim & Kim, 2016; Lenard et al., 2014). We follow Kim and Kim (2016) by using the equation below to calculate idiosyncratic volatility:

$$R_i - R_f = \beta_i (R_m - R_f) + \xi_i \quad (1)$$

Ret_vol is calculated by taking the 1-year rolling standard deviation of the error term, ξ_i. The reason for keeping a 1-year rolling window for Ret_vol (versus a 2-year window for ROA_vol) is twofold: (1) the Ret_vol is calculated using daily data from stock and market index returns, and (2) ROA_vol is based on accounting records that depend on management efficiency, which tends to change more gradually.

Our primary independent variable is WDIR, representing the number of female directors as a ratio of total board members. For robustness, we add a binary variable (WoB), indicating the presence of a female director. We control for firms' governance practices by taking the governance pillar score (GS) of their Environmental, Social, and Governance (ESG) rating. This is calculated by taking the weighted sum of the scores from board diversity, executive compensation, and risk management performance[6]. Variables definitions are presented in Table 1.

[6] Bloomberg Governance Scores' calculation methodology can be seen in Bloomberg (2021).

Table 1. Variable definitions

Variables	Descriptions
WDIR	percentage of women on boards of directors in sample firms
WoB	binary variable indicating the presence of female director(s) on board
LRATIO	measure of firm financial risk; calculated as follows: $LRATIO = \frac{total\ debt}{total\ assets}$
ROA_vol	earnings volatility calculated by taking the 2-year standard deviation of ROA
CAPEX	measure of firm capital efficiency; calculated as follows: $CAPEX = \frac{capital\ expenditure}{total\ assets}$
Ret_vol	idiosyncratic volatility calculated by taking the 1-year rolling standard deviation of residuals from the CAPM model shown in Equation 1
AIR	annual interest rate in percentage
PUR	annual political uncertainty level in Pakistan extracted from index by Choudhary et al. (2020)
ROA	annual return-on-assets ratio extracted from financial statements
MBV	annual market-to-book ratio extracted from financial statements
GS	governance pillar score generated from the cumulative ESG score
GROWTH	firm growth measured by change in total assets; calculated as follows: $GROWTH = \frac{total\ assets_{t+1}}{total\ assets_t} - 1$
TANG	asset tangibility measured by the ratio of plant, property, and equipment to total assets
TAX	annual tax rate applicable to the respective firm

Source: own work.

2.3. Summary statistics

Table 2 displays the variables' summary statistics. The variable WDIR has a mean of 11.17, suggesting that, on average, firms in Pakistan employed around 10.6% women on boards. There is also little variation in this trend, evident from standard deviation of 8.5. This is an indication of weak tendency of having female directors among businesses in the country.

The *LRATIO* variable has a mean of around 36% albeit with wider variation. This is an indication that the leverage ratio might have fluctuated during the sample period potentially after the enforcement of the Companies Act 2017. Similarly, the measure for earnings volatility (*ROA_vol*) displays a high

Table 2. Descriptive statistics

Variable	Observations	Mean	Standard deviation	Min	Max
Dependent variables					
LRATIO	395	35.805	64.462	0	354.7
ROA_vol	368	4.112	3.959	0.085	23.341
CAPEX	302	0.049	0.048	0	0.387
Ret_vol	450	0.019	0.005	0.008	0.035
Independent variables					
WDIR	489	10.583	8.496	0	50
WoB	489	0.755	0.431	0	1
AIR	477	9.063	3.295	5.5	16
PUR	477	96.198	40.713	52.128	198.529
ROA	408	10.837	9.489	–14.48	70.26
MBV	408	3.541	12.604	–61.54	133.3
GS	320	3.497	0.516	2.1	4.77
GROWTH	409	0.162	0.252	–0.33	1.275
TANG	393	0.343	0.2	0	0.856
TAX	384	32.153	50.842	0.01	924.05

Note: Summary statistics of dependent and independent variables used in the study with annual data starting January 2011 until December 2022 of sample firms from Pakistan. The statistics are based on the final set of 49 non-financial firms using all available firm-year observations. Variable definitions are given in Table 1.

Source: Refinitiv Datastream, Bloomberg Professional.

degree of variation. In contrast, the variables *CAPEX* and *Ret_vol* show little variation. This could imply that the inclusion of females on corporate boards may not have had a significant effect on factors determined by management, although this needs further analysis to validate. For the purposes of brevity, we do not discuss the other variables.

To examine how board gender diversity evolved over the sample period, we present the proportion of firms with no female directors, compared to those with at least one female director and those with multiple female directors in Table 3. The first column (no female directors) shows a declining trend, particularly from 2015 onward, when the ratio falls below 50%. This suggests that by 2015, more than half of the sample firms had appointed at least one female director. We conclude that the years leading up to 2017 witnessed a gradual increase in the female presence on corporate boards in Pakistan, a period during which the proposed law was likely under deliberation.

Table 3. Board gender diversity

Year	Board diversity		
	no women	1 woman	multiple women
2011	37 (75%)	8 (17%)	4 (8%)
2012	36 (73%)	9 (19%)	4 (8%)
2013	35 (71%)	9 (19%)	5 (10%)
2014	26 (54%)	20 (40%)	3 (6%)
2015	22 (44%)	23 (48%)	4 (8%)
2016	13 (27%)	32 (65%)	4 (8%)
2017	10 (21%)	35 (71%)	4 (8%)
2018	6 (13%)	39 (79%)	4 (8%)
2019	5 (10%)	38 (77%)	6 (13%)
2020	3 (6%)	39 (79%)	7 (15%)
2021	2 (4%)	39 (79%)	8 (17%)
2022	4 (8%)	34 (69%)	11 (23%)

Note: Table shows board composition in the sample by listing the number and proportion (in parentheses) of firms with either no female directors, only one female director, or multiple female directors on the respective boards.

Source: Bloomberg Professional.

3. Multivariate analysis

3.1. Empirical model

To investigate the effect of female directors on our measures for firm risk-taking, we employ the following regression model:

$$(Risk\text{-}taking)_{it} = \alpha + \beta_1 X + \gamma + \psi_{it} \quad (2)$$

The dependent variables in Equation 2 are the four risk-taking measures, namely leverage ratio ($LRATIO$), earnings volatility (ROA_vol), capital allocation efficiency ($CAPEX$), and idiosyncratic volatility (Ret_vol) for firm i at in year t. Matrix X includes the independent variable $WDIR$ along with control variables. Matrix γ represents year fixed effects and ψ_{it} represents the error term. The models employ robust standard errors, which are clustered across industry.

Our methodological choices are guided by the need to address endogeneity, regulatory shocks, and non-linear dynamics. The 2SLS approach accounts for omitted variable bias by instrumenting board diversity with governance scores (GS), which influence diversity but are plausibly exogenous to risk decisions. For binary diversity measures, we use 2SRI, following Terza et al. (2008).

3.2. Results

Table 4 reports 2SLS and 2SRI regression results using Equation 2, taking *LRATIO* as the proxy for risk-taking. We also estimated the model using the Generalised Method of Moments (*GMM*). Since *GMM* estimates were consistent with those of 2SLS, we do not present them here for brevity.[7] Column 1 lists the coefficients under 2SLS estimation, showing a negative and significant

Table 4. Regression analysis for H1

Variables	*LRATIO* (2SLS)	*LRATIO* (2SRI)
WDIR	–4.055**	
	(1.863)	
WoB		18.167
		(30.209)
AIR	–27.924	3.796
	(28.497)	(8.695)
PUR	1.743	–0.279
	(1.774)	(0.542)
MBV	2.987***	–1.114**
	(0.417)	(0.487)
ROA	–1.590**	3.027***
	(0.806)	(0.498)
GROWTH	11.991	10.350**
	(8.506)	(4.648)
TANG	139.933***	103.316***
	(25.844)	(29.453)
TAX	–0.031	0.019
	(0.138)	(0.038)
λ		–8.837
		(15.010)
Constant	154.459	–20.214
	(133.219)	(50.914)
Observations	221	221

Note: Results from 2SLS (Column 1) and 2SRI (Column 2) panel regressions using the model in Equation 2. Standard errors are clustered across industry. Year fixed effects are applied. *LRATIO* is the dependent variable. Variable *GS* is used as an instrument determining *WDIR* and *WoB*. Variable λ represents the control function (Mills ratio) from the 2SRI model. Probability of estimates greater than standard test statistics is provided in parentheses with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: own calculations.

[7] The results are available upon request.

relationship between *WDIR* and *LRATIO*. The result suggests that a higher female proportion on corporate boards has coincided with a decline in firms' leverage. Specifically, a 1% increase in board gender diversity corresponds to a 0.04 unit (or 4%) reduction in the leverage ratio, on average. The results support H1 and the findings from Sila et al. (2016), Nadeem et al. (2019), and Faccio et al. (2016).

Column 2 in Table 4 reports 2SRI estimation results. The coefficient of *WoB* is not statistically significant. In conjunction with Column 1 results, we conclude that while the proportion of female directors on corporate boards has a significant effect on firm risk-taking behaviour, the presence of merely a single female director has no impact.

Table 5. Regression analysis for H2

Variables	*ROA_vol* (2SLS)	*ROA_vol* (2SRI)
WDIR	–0.765*	
	(0.430)	
WoB		–23.711**
		(10.628)
AIR	0.396*	–0.693
	(0.234)	(0.801)
PUR	–0.022	0.045
	(0.016)	(0.050)
MBV	–0.011	0.021
	(0.106)	(0.036)
L.ROA	0.049	–0.051
	(0.057)	(0.033)
L.GROWTH	0.625	0.538
	(2.027)	(1.091)
TANG	1.140	–1.104
	(3.253)	(2.402)
TAX	0.023	0.002
	(0.019)	(0.004)
λ		13.370**
		(6.185)
Constant	13.624**	26.153**
	(6.170)	(10.316)
Observations	197	197

Note: Results from 2SLS (Column 1) and 2SRI (Column 2) panel regressions using the model in Equation 2. Standard errors are clustered across industry. Year fixed effects are applied. *ROA_vol* is the dependent variable. Variable *GS* is used as an instrument determining *WDIR* and *WoB*. Variable λ represents the control function (Mills ratio) from the 2SRI model. Probability of estimates greater than standard test statistics is provided in parentheses with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: own calculations.

Table 5 reports the results using earnings volatility as the measure for risk-taking. The two columns show negative and significant estimates for *WDIR* and *WoB*. Specifically, a 1% increase in the proportion of women directors is associated with a 0.765% decrease in the 2-year *ROA* volatility, on average; in addition, firms with at least one woman on board have, on average, a 23.7% lower *ROA* volatility than firms with no female directors. The results from both measures (*LRATIO* and *ROA_vol*) suggest that board gender diversity influences factors directly shaped by board decisions, such as firm leverage level and earning management.

Table 6 reports regression results using 2SLS and 2SRI estimations applied using Equation 2. Column 1 shows an insignificant estimate for *WDIR*, while

Table 6. Regression analysis for H3

Variables	*CAPEX* (2SLS)	*CAPEX* (2SRI)
WDIR	0.0194	
	(0.0313)	
WoB		0.1569*
		(0.0882)
AIR	0.0815	–0.0100
	(0.1859)	(0.0196)
PUR	–0.0050	0.0008
	(0.0116)	(0.0012)
MBV	0.0028	–0.0002
	(0.0070)	(0.0010)
L.ROA	–0.0024	0.0000
	(0.0042)	(0.0004)
L.GROWTH	0.0289	–0.0010
	(0.0509)	(0.0195)
TANG	–0.0429	0.1266**
	(0.2480)	(0.0645)
TAX	0.0001	0.0000
	(0.0003)	(0.0001)
λ		–0.0900*
		(0.0464)
Constant	–0.5085	–0.0994
	(1.0225)	(0.1010)
Observations	160	160

Note: Results from 2SLS (Column 1) and 2SRI (Column 2) panel regressions using the models in Equation 2. Standard errors are clustered across industry. Year fixed effects are applied. *CAPEX* is the dependent variable. Variable *GS* is used as an instrument determining *WDIR* and *WoB*. Variable λ represents the control function (Mills ratio) from the 2SRI model. Probability of estimates greater than standard test statistics is provided in parentheses with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: own calculations.

Column 2 shows a positive *WoB* coefficient significant at the 10% level. This indicates that the proportion of female directors has no significant effect on capital allocation efficiency, with only weak evidence suggesting an increase. Most coefficients are not statistically significant, potentially owing to little variation in *CAPEX*. We conclude that the results do not support H3.

Next, we use the model in Equation 2 to estimate the effect of board gender diversity on idiosyncratic volatility of stock returns. Table 7 illustrates that the relationship is insignificant i.e., the proportion of female directors does not affect the stock return volatility. The results from Tables 6 and 7 suggest that board gender diversity is not a significant determinant of factors that are likely not directly influenced by board decision, such as capital allocation effi-

Table 7. Regression analysis for H4

Variables	*Ret_vol* (2SLS)	*Ret_vol* (2SRI)
WDIR	–0.018	
	(0.025)	
WoB		–0.006
		(0.006)
AIR	–0.096***	–0.011
	(0.016)	(0.037)
PUR	0.006***	0.001
	(0.001)	(0.002)
MBV	0.007	0.0001
	(0.006)	(0.000)
ROA	–0.018***	–0.0002***
	(0.005)	(0.0001)
GROWTH	0.162	0.001
	(0.145)	(0.001)
TANG	0.061	–0.002
	(0.574)	(0.005)
TAX	0.002	0.000
	(0.001)	(0.000)
λ		0.004
		(0.003)
Constant	2.317***	0.063
	(0.371)	(0.13)
Observations	201	201

Note: Results from 2SLS (Column 1) and 2SRI (Column 2) panel regressions using the models in Equation 2. Standard errors are clustered across industry. Year fixed effects are applied. *Ret_vol* is the dependent variable. Variable *GS* is used as an instrument determining *WDIR* and *WoB*. Variable λ represents the control function (Mills ratio) from the 2SRI model. Probability of estimates greater than standard test statistics is provided in parentheses with *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: own calculations.

ciency and idiosyncratic volatility. While capital efficiency may be considered in board meetings, it takes several years to evolve. Thus, further evidence is needed to better understand this relationship.

We note that the number of observations differs across results presented in regression estimations. In the case of the specification using the 2-year rolling standard deviation for ROA_vol as the dependent variable presented in Table 5, the sample size is reduced. In Table 6, we attribute this to missing data. Specifically, the $CAPEX$ variable has relatively more missing observations, leading to a smaller effective sample size in that regression. Similarly, some of the missing annual beta records led to reduced observations in Table 7. We ensure that each regression includes only complete cases for all variables involved.

There are two key takeaways from the multivariate regression results. Firstly, board gender diversity leads to lower firm risk when it is measured by financial leverage and earnings volatility. Secondly, both governance and macroeconomic factors make little impact on firms' capital allocation and their idiosyncratic returns, which is evident from the insignificant coefficients in Tables 6 and 7. Given the results, we infer that gender diversity is an effective determinant of factors directly affected by board decisions.

4. Robustness tests

To ensure the reliability of our results, we conduct additional robustness tests, including the Difference-in-Differences method and the Markov Switching model. The former helps isolate the causal impact of the Companies Act 2017 by comparing treated and control groups over time, while the Markov Switching model accounts for potential regime shifts in firm risk-taking behaviour.

4.1. Difference-in-Differences (DiD)

We employ the Difference-in-Differences (DiD) method as an additional empirical test. The DiD approach allows us to compare changes in firm risk before and after the Companies Act 2017 while controlling for time-invariant firm characteristics and macroeconomic environment. DiD helps mitigate concerns about endogeneity and omitted variable bias. This robustness check strengthens our causal interpretation by isolating the effect of the regulation from broader trends that could independently influence firm risk-taking. The

DiD method compares the variations in outcome means between the control and treatment groups over time to determine the average treatment effect on the treated group. This method accounts for variables such as group composition and unobservable time that may affect how the treatment affects the result.

We first apply the DiD model to LRATIO to assess whether there is a significant difference in the leverage ratio after the mandate of having at least one female director. The control group has no female directors on board, while the treatment group has at least one. The chosen period included the sample years prior to and following the year 2019.

While the Companies Act 2017 and SECP's Code of Corporate Governance mandated the inclusion of at least one woman on the board, firms were allowed until the end of their current board term to comply. Since board terms in Pakistan typically span three years, it is reasonable to treat 2019 as the first post-treatment year in our DiD analysis, given that the three-year term would be completed by the end of year 2019 or early 2020 (since the law was passed in May 2017). This timing reflects the period during which a significant number of firms would be transitioning to compliance, allowing us to capture meaningful changes in governance outcomes. Some firms would have complied early, some in 2019, and others just before the final compliance deadline in May 2020 (also evident from Table 3). Hence, the treatment year 2019 represents a reasonable point in the compliance window.[8]

We generate three variables for this test: *Time*, *Treated* and *did*. The binary variable *Time* indicates the period before and after treatment; here, it takes the value 0 for years before 2019 and 1 otherwise. The binary variable *Treated* identifies firms affected by the regulation. Hence, it equals 1 for firms with more than 1 female director and 0 for the remaining firms. The variable *did* is an interaction term between *Time* and *Treated*, capturing the differential change in firm risk-taking behaviour for treated firms relative to control firms after the enforcement of the Act starting in 2019.

$$(Risk\ taking)_{it} = \alpha + \beta_1\, Time_t + \beta_2\, Treated_i + \beta_3\, did_{it} + \beta_4\, X_{it} + \gamma_t + \delta_{it}$$

The *did* coefficient represents the causal effect of the regulation on firm risk-taking measures. X_{it} is the vector of firm-level control variables. Year-fixed effects and industry-wise clustering are applied.

Table 8 reports the findings of the DiD regression. Column 1 shows the effect on leverage. The coefficient for variable *Time* is not significant. This suggests that external factors like macroeconomic trends or firm characteristics did not affect firm leverage significantly during the sampled period. However,

[8] We obtain broadly consistent results, albeit with minor variations, when estimating the DiD model using 2020 as the treatment year. The results are available upon request.

the variable *Treated* has a positive and significant coefficient. This implies that, on average, firms with female directors prior to the passing of the Companies Act 2017 had a significantly higher leverage compared to control firms. The *did* term is negative and significant at the 5%, suggesting that treated firms significantly lowered their leverage levels post the regulation.

Table 8. Difference-in-Differences (DiD) testing H1–H4

Variables	*LRATIO*	*ROA_vol*	*CAPEX*	*Ret_vol*
Time	2.960	1.7716	–0.0272	–0.0863
	(17.686)	(2.5980)	(0.0178)	(0.2458)
Treated	15.585**	–1.1058**	–0.0117	0.1781*
	(7.616)	(0.4762)	(0.0149)	(0.1012)
DiD	–16.389**	–1.6267	0.0368	–0.1159
	(7.812)	(1.1999)	(0.0224)	(0.2224)
Constant	74.896**	4.8949	–0.0543	2.2625***
	(30.207)	(3.3628)	(0.0885)	(0.3671)
Observations	221	210	160	214

Note: DiD results show the average difference in risk-taking measured by firm leverage (Column 1), earnings volatility (Column 2), capital efficiency (Column 3), and idiosyncratic volatility (Column 4) before and after the implementation of the Companies Act 2017 mandating women directors on corporate boards. Control variables are not shown for brevity. The difference is observed after 2019 given the flexibility by the SECP.

Source: own calculations.

In Column 2, the estimates show the effect on earnings volatility. The *Time* variable continues to have insignificant estimate, while the *Treated* variable has a positive and significant coefficient. Although the *did* coefficient is not statistically significant at the conventional 10% level, it attains significance at the 15% level, providing weak evidence of a decline in earnings volatility. Given the negative sign of the *did* variable, we find limited support for H2.

Columns 3 and 4 show the estimates after applying the DiD method to test for potential changes in variables *CAPEX* and *Ret_vol* after the mandate for diverse boards. The table shows mostly insignificant coefficients for each of the variables, namely *Time*, *Treated* and *did.* The insignificant estimator for *did* shows a lack of change in the variables *CAPEX* and *Ret_vol* in the treated group after the law's enactment.

To complement the regression results presented in the DiD table, we illustrate the findings graphically. Figure 1a shows the mean leverage ratio over the sampled periods, including pre-treatment and post-treatment years. The leverage ratio of firms without female directors (treated group, represented by a blue line) before the treatment is higher than the control group (dotted red line). After 2019, the treated group's leverage ratio declines sharply.

Figure 1a. Leverage

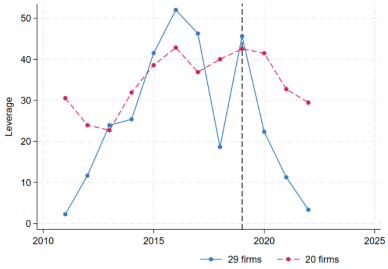

Figure 1b. Earnings volatility

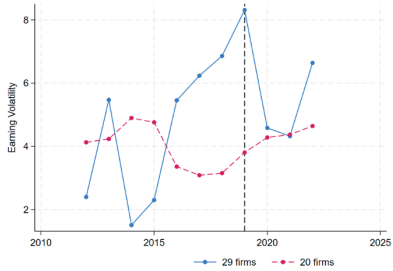

Figure 1c. Capital efficiency

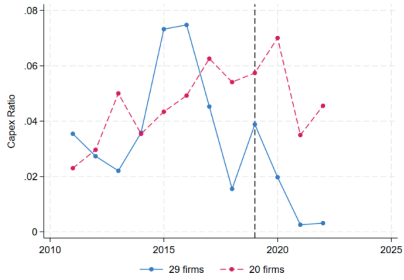

Figure 1d. Idiosyncratic volatility

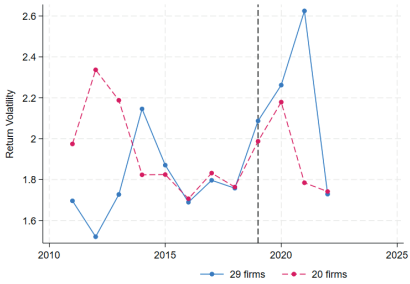

Figure 1. DiD testing H1–H4

Note: The figure shows the risk-taking behaviour measured by leverage (Figure 1a), earnings volatility (Figure 1b), capital efficiency (Figure 1c), and return volatility (Figure 1d) in firms with at least one woman as a director on their corporate boards (dotted red line) and those with none (blue line). The vertical line represents the year of enforcement of the Companies Act 2017, i.e. 2019.

Source: own work.

The interpretation for the treated group is straightforward: the enforcement of the Companies Act 2017 led to a decline in firm leverage for firms that previously lacked gender-diverse boards. Notably, the control group also witnessed a decline in leverage. This may be attributed to certain firms voluntarily increasing female board representation beyond the minimum requirement. Overall, the trends suggest that firms with more gender diverse boards exhibited lower leverage levels.

Figure 1b shows how the earnings volatility levels differed significantly across the treated and control groups prior to 2019, with the treated group exhibiting higher volatility. This disparity narrowed after the treatment period, before rising again in 2022 for the treated group. This potentially explains the weak *did* coefficient in Column 2 of Table 8.

Figure 1c shows the mean values for variable *CAPEX* over the sample period. Both the treated and control groups show a similar trend of drop in expenditures after the Companies Act 2017 took effect. Trends after the year

2019 indicate that both groups experience comparable patterns. This may be attributed to strategic changes and investment opportunities available to firms, particularly owing to COVID-19 effects on investment activity originating in the year 2020. Finally, Figure 1d shows that the difference in idiosyncratic volatility between the two groups remains largely unchanged after the treatment year. This is evident from the convergence of the two lines throughout most of the sample period.

Overall, the results from DiD analysis are robust and support H1 and H2. We note that the number of observations in Columns 2 and 4 are relatively higher than in the 2SLS and 2SRI estimations. The difference stems from the estimation approach: the two-staged regression models yielded smaller samples owing to missing GS records, which are required in the first stage regressions.

4.2. Markov Switching (MS)

We apply the Markov Switching (MS) model as a second robustness test. The model allows for regime shifts in firm risk dynamics. Unlike traditional linear models, MS can capture structural breaks and nonlinear patterns, distinguishing between different risk regimes (e.g., high vs. low leverage periods). By estimating the probability of transitioning between regimes before and after the implementation of the Companies Act 2017, this approach helps determine whether the policy induced a shift in firm risk-taking behaviour.

Column 1 in Table 9 reports the results of the MS model testing regimes of firm leverage. The model finds two states of the dependent variable: *State_1* and *State_2*, with leverage levels of 26.9 and 40.6, respectively. This is an indication that the leverage levels may have switched owing to the mandate for female directors.

The difference in states can be interpreted as the representation of a significant drop in average debt levels held in firms after the regulation. Furthermore, the volatility in *State_1* (represented by variable φ_1) is relatively higher. The variables p_{11} and p_{21} represent the transition probabilities between the two states. The probability of staying in *State_1* for firms already in this state is 86.5%, while the switching probability from *State_2* to *State_1* is 21.8%. We can infer that the leverage ratios of firms in *State_1* are lower and less likely to rise, while *State_2* firms have higher leverage ratios, which may fall. This adds evidence that leverage ratios declined after a certain event (i.e. the passing of the Companies Act 2017). The estimates for *ROA_vol* in Column 2 show a similar trend. *State_1* has a smaller earnings volatility as compared to *State_2*, indicating firms with diverse boards managed lower fluctuations in earnings.

Column 3 reports the results for capital allocation efficiency. Although the model identifies two states, *State_1* and *State_2* coefficients do not differ sig-

Table 9. Markov Switching testing H1–H4

Variables	*LRATIO*	*ROA_vol*	*CAPEX*	*Ret_vol*
State_1	26.883***	3.597***	0.0349***	0.0179***
	(1.919)	(0.096)	(0.0018)	(0.0003)
State_2	40.566***	4.391***	0.0569***	0.0202***
	(1.105)	(0.092)	(0.0022)	(0.0008)
p_{11}	0.865	0.582	0.863	0.715
	(0.141)	(0.265)	(0.143)	(0.203)
p_{21}	0.218	0.243	0.217	0.471
	(0.157)	(0.159)	(0.156)	(0.270)
φ_1	4.592	0.182	0.004	0.006
	(1.399)	(0.070)	(0.001)	(0.000)
φ_2	2.611	0.230	0.005	0.001
	(0.866)	(0.070)	(0.002)	(0.001)
Observations	12	11	12	12

Note: Results from Markov Switching model testing the variation of risk-taking measures during the sample period. Variables *State_1* and *State_2* represent two states for values of firm leverage (Column 1), earnings volatility (Column 2), capital efficiency (Column 3), and idiosyncratic volatility (Column 4).

Source: own calculations.

nificantly (0.04 vs. 0.06). This implies that the system has a higher likelihood of remaining in *State_1*. Likewise, estimates for *Ret_vol* in Column 4 show little variation in magnitude across the two states.

Conclusions

Weak and ineffective corporate governance practices have caused numerous corporate scandals and failures. Recent studies emphasise the role of boards of directors in firms' governance: Castellanos and George (2020) underscores their role in strategic leadership, while Alatassi and Pillai (2024) highlight their responsibilities in effective risk management. Literature identifies gender diversity on corporate boards as a significant governance mechanism. The SECP introduced the Companies Act in 2017 in Pakistan, requiring corporate boards to have at least one female director per board. Using a sample of Pakistani firms from January 2011 to December 2022, this study investigates whether board gender diversity in Pakistani firms (introduced by this legislation) led to significant changes in firm risk-taking behaviour.

We apply 2SLS and 2SRI estimations to account for endogeneity. In addition, we perform the DiD test to control for time-invariant unobserved heterogeneity by testing firm risk levels before and after the implementation of the Act. We also use the MS model to identify regime shifts in firm risk. We find evidence that an increase in the proportion of female board directors is associated with lower firm leverage and reduced earnings volatility in Pakistan. The findings complement existing literature asserting that gender-diverse boards are linked to lower firm risk. However, we do not find a significant relationship between gender diversity and capital allocation efficiency or idiosyncratic volatility. We conclude that while board composition may influence high-level financial policies (like leverage), other risk dimensions—such as investment efficiency or market-based volatility—depend on managerial discretion or evolve over longer horizons.

This study contributes to the theoretical discourse by showing that exogenously imposed board diversity can have measurable governance effects in an emerging market. Unlike studies from developed countries focusing on voluntary diversity, our experiment captures how a regulatory mandate alters boardroom dynamics. The results of this study are important for policymakers, particularly the SECP. The decline in firm leverage after the legislation implies potential for the regulator to indirectly influence firm debt levels. Hence, capital market regulators might consider using gender diversity for attaining financial stability objectives.

While this study provides evidence that board gender diversity is associated with reduced firm-level risk in Pakistani firms, we acknowledge several limitations. Firstly, the sample includes only 49 firms over 12 years, forming a relatively small and potentially unbalanced panel. Secondly, due to the limited number of firms in several sectors, we are unable to include industry fixed effects in our regression models without encountering multicollinearity and estimation issues.

Thirdly, although we use multiple econometric techniques to address endogeneity and validate our results, our evidence remains correlational rather than strictly causal. Lastly, data limitations—particularly with respect to governance variables—restricts the scope of our analysis in some robustness tests. Future research could explore these relationships using broader samples, alternative risk proxies, and longer post-regulation timeframes to assess the robustness of the observed effects.

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