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GREEN INVESTMENT AND FIRM VALUE: THE MODERATING ROLE OF BOARD GENDER DIVERSITY

Dr. Arooj Naz [1], Ms. Sadaf Ambreen [2], Ume Ayeman [3], Nasir Abbas [4]

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Affiliations:

[1] Assistant Professor, College of Commerce, Government College University Faisalabad, Pakistan Email: aroojnaz@gcuf.edu.pk

[2] Lecturer, Department of Business Administration, Government College Women University, Faisalabad, Pakistan
Email: sadafambreen@gcwuf.edu.pk
ORCID ID: https://orcid.org/0000-0002-2306-0554

[3] MS Scholar, College of Commerce, Government College University, Faisalabad, Pakistan Email: umeayeman44@gmail.com

[4] Lecturer, College of Commerce, Government College University, Faisalabad, Pakistan
Email: nasirabbas@gcuf.edu.pk
ORCID ID: https://orcid.org/0009-0000-1711-2963

Corresponding Author's Email:

[4] nasirabbas@gcuf.edu.pk

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Abstract

This study examines the impact of green investment on firm value, with board gender diversity as a moderator. As its importance rises, green investment has become a key part of corporate strategy, especially as companies face increasing environmental pressure and stakeholder expectations. The study uses panel data and regression analysis, including all non-financial companies listed on the Pakistan Stock Exchange (PSX) for the period 2016–2025. To verify the empirical results, the study includes robustness and endogeneity tests. Based on agency theory and stakeholder theory, the findings show that green investment increases firms' market value by improving environmental performance, corporate reputation, stakeholder relationships, and long-term strategic position. However, the role of green investment in firm value depends on the effectiveness and variety of corporate governance. Moreover, a gender-diverse board offers more diverse insights, more robust monitoring, and increased focus on environmental and stakeholder issues. Hence, this study provides further evidence that board gender diversity strengthens the relationship between green investment and firm value based on resource-based theory. The study is relevant to the growing literature on green investment because it contributes to the value implications of green investment in an emerging-market setting by focusing on board gender diversity.

Keywords: Green Investment, Firm Value, Board Gender Diversity, Corporate Governance, Tobin's Q, Pakistan Stock Exchange

1. Introduction

A firm's value reflects corporate performance, growth, and its ability to generate sustainable returns. One of the significant ways in which firms can generate wealth for shareholders in the long run is through investment decisions (Triani & Tarmidi, 2019). Green investment is the use of corporate financial resources on technologies, i.e., green production, renewable energy and pollution-control systems, waste disposal facilities, energy-efficient production, and other investments aimed at minimizing the impact on environmental pollution. Such investments can not only help in environmental sustainability but can also generate long-term economic benefits for companies (Atif, Alam, & Hossain, 2020). As a result, green

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investment has become an important part of contemporary corporate strategy due to the growing focus of investors and other stakeholders on the environment.

Green investments have relatively high initial investment, high cost, short-term financial returns (Palmer & Truong, 2017). Though, green investment can be a benefit to firms in the long-term, as it can lead to greater operational efficiency, a lower risk of environmental damage, an improved corporate image, and increased investor confidence (Zheng, Wang, Sun, & Li, 2022). However, literature also indicates that green investment enhance the corporate image, build investors' trust in the firm, and create competitive advantages, which increase the firm value (Hao, Chen, & Chen, 2022). Therefore, green investment can help to boost productivity, innovation, cost efficiency and competitive positioning. Environmental expenditure should not therefore necessarily be viewed as a cost but as a strategic investment which can provide returns in the future. So, literature is ambiguous about the impact of green investment on firm value. Therefore, investigate the role of green investment on firm value is still has importance in literature.

Corporate governance has a significant role in managing the activities of the company, minimizing agency conflicts, and providing guidance to the company in making strategic investment decisions (Alhossini, Ntim, & Zalata, 2021; Siswanti, Riyadh, Nawangsari, Mohd Yusoff, & Wibowo, 2024). The existing studies have shown that governance can impact the investment decisions of the company and the efficiency of the use of the company's resources (Shahid & Abbas, 2019; Yadav & Yadav, 2024). Although the importance of corporate governance for resource efficiency has been recognized, there is little research and literature available on how female directors affect green investment decision. Female directors help to improve the monitoring and advisory roles of boards by adding to their perspectives, experiences and approaches to corporate decision-making (Wang, Ma, Xue, & Zhang, 2024). Female directors have also been related to better supervision, more careful decision making, better efficiency of investments and greater attention to the interests of the stakeholders. Sun and Zhang (2021) indicate that a gender-diverse board may enhance internal management and resource allocation, as well as minimize the information gap between the management and shareholders.

Agency theory proposes that managers incline to act in their own self-interest, which is a conflict of interest that adversely affects firm performance (Aliahmadi, 2024; Zeng & Wang, 2015). It is a problem that green investments generate agency concerns as managers might pursue environmental investments for reputation management or personal reasons without knowing the direct financial return. According to a stakeholder viewpoint, businesses rely on other stakeholder groups such as investors, customers, employees, suppliers, regulators and communities. They can be involved with environmental responsibility, which improve relationships with them and consequently generate economic benefits. The resource-based theory suggests that the most effective use of internal resources should increase the value of the firm by investing in projects that create positive net present values for the firm and reducing financial distress by lowering the amount of external capital needed (Barney, Ketchen Jr, & Wright, 2021). However, previous research show that a more diverse board could then be more likely to consider the strategic and environmental issues of firm. Moreover, female directors may have positive effects on governance, minimize information asymmetry, and improve the communication between external stakeholders (Ararat & Yurtoglu, 2021; Harakeh, El-Gammal, & Matar, 2019). The inclusion of gender-diverse boards is becoming more important, so this study assumes that female directors increase the positive effect of green investment on the performance of the company.

The context of the research is Pakistan, a country where gender inequality has long been a problem and where the government has recently made efforts to enhance the representation of women on boards. Even with regulatory push to include at least one female director in the board of the directors under SECP, the proportion of women in the board is still low, making Pakistan as a relevant case from a gender perspective. The data set includes the nonfinancial firms that are listed in the PSX from 2016 to 2025. The findings support the agency theory that is green investment is positively related with firm performance. Furthermore, in accordance with resource-based theory, the presence of female directors moderates this link and enhances its beneficial impacts. Outcomes are uniform between System GMM and Propensity Score Matching (PSM) in

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addressing endogeneity concerns. Results are robust after assessments involving other definitions of female directors and corporate value.

As far as we know, this is one of the first studies to investigate whether the green investment-firm performance relationship is moderated by female directors in an emerging market environment. The study builds on the body of work in two significant ways. First, it contributes to the literature on corporate governance by shedding light on the role of gender diversity of the board as another governance mechanism that female directors may use to affect the quality and effectiveness of environmentally oriented corporate actions. Second, it joins other recent studies on the role of green investment in financial investment in offering an explanation of the impact that board gender diversity has on the link between green investment and firm performance. This paper adds to the literature through the combination of green investment and board gender diversity, thereby bringing new insights into how the good governance can strengthen value implications of green investing.

2. Literature Review and Hypotheses Development

Companies that invest in efficiency technologies involve in waste reduction and in environmentally friendly products could acquire capabilities that are difficult for their competitors to replicate (Widarwati et al., 2024). The empirical evidence proves that firm performance and green investment are economically relevant. Endrikat (2016) by using a meta-analysis of 24 studies find that the positive market reactions to corporate environmental performance. The study also highlights the importance of environmental information in influencing the investors' assessment of firms' performance. Similarly, Fatemi, Glaum, and Kaiser (2018) look at the association between ESG activities and firm value and find that ESG adds value to the firm. Their research also shows that investors' perceptions of corporate sustainability activities are influenced by ESG disclosure. Yu, Guo, and Luu (2018) further confirm this with a large international sample. They analyse ESG transparency and firm value for 1,996 large firms in 47 developed and emerging countries. They discover that increased ESG transparency is related to increased firm valuation, such as Tobin's Q. The authors believe that enhanced sustainability transparency decreases information asymmetry and agency costs. Toly (2019) investigates the disclosure of greenhouse-gas emissions and environmental performance of companies in Indonesia and find that both environmental disclosure and environmental performance have a positive impact on company value. The results indicate that the investors may reward the companies who show better environmental responsibility.

Xie, Nozawa, Yagi, Fujii, and Managi (2019) review the relationship between ESG activities and corporate financial performance and show the role of environmental and social activities in the corporate outcomes. Their evidence suggests that ESG-related practices can be linked to a positive financial outcome, both through better management practices and stakeholder relationships. Tanasya and Handayani (2020) focuses on green investment rather than broader ESG performance and find importance of profitability as a link between green investment and firm value. Ye and Dela (2023) explore the concept of green investment, green financing, sustainable business performance and determine the significance of green investment for sustainable business performance. Safitri, Nani, and Lindrianasari (2022) find positive relationship between environmental investment and environmental performance in environmentally sensitive Indonesian companies. Environmental investments can require significant up-front capital expenditures, and financial returns can be seen only after a few years. Thus, the initial impression of green investment might be that it is extra cost (Fischel & Lexecon, 2015; Hang, Geyer-Klingeberg, & Rathgeber, 2019). However, based on above studies, the first hypothesis is proposed:

H1: Green investment has a positive impact on firm value

The mixed results in the literature indicate that the effects of green investment on the market value depends on governance and integration into the company's strategy.

The literature shows that there is a significant consensus regarding the positive governance effects of gender diversity on the board of directors, as female directors have been shown to be linked to better governance practices, better monitoring, and lower discretionary accruals (Kim & Hong, 2015; Mukarram, Saeed, Hammoudeh, & Raziq, 2018). In the past decade there has been a lot of interest among academics and

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practitioners in the presence of females on boards. The empirical evidence indicates that gender diverse boards may benefit a firm in a number of ways (Owen, Temesvary, & Finance, 2018; Siegel, Pyun, & Cheon, 2014) . Shin et al. (2020) show that female directors also perform well as monitors and can have a positive impact on investment decisions, which is consistent with the efficiency-enhancing hypothesis. Additionally, Song, Yoon, and Kang (2020) suggest that women directors have the potential to improve the quality of corporate control and monitoring in global markets. Mirza, Majeed, and Ahsan (2020) conclude that female directors enhance investment efficiency in firms having highly competitive environments in China. Qureshi, Kirkerud, Theresa, and Ahsan (2020) examine the correlation among sustainability disclosure, board diversity, and corporate value utilising 812 publicly traded European companies. They discover that sustainability reporting and gender diversity on boards are both positively correlated with corporate value, and that an increase in female board members' correlates with enhanced ESG performance.

Similarly, Levi, Li, and Zhang (2014) assert that enterprises with female board members exhibit greater caution in their acquisition decisions. Elmagrhi, Ntim, Elamer, and Zhang (2019) investigate environmental performance of 383 publicly listed Chinese firms over 1,674 firm-year observations and show that the percentage of female directors and the age of the female directors are positively related to firms' overall environmental performance, environmental strategies, implementation and disclosure practices. Atif et al. (2020) find that having more female board members is positively related to sustainable investment; this relationship intensifies as the number of female board members rises to two or more. This result confirms the critical mass theory (Markus, 1987). Lu and Herremans (2019) find the board gender diversity and environmental performance link varies by industry. Overall, these studies suggest that the presence of female directors could help advance environmental initiatives and sustainable investment opportunities.

Agyemang-Mintah and Schadewitz (2019) ascertain that an increased presence of women on corporate boards correlates positively with firm value in UK financial institutions. Ullah, Fang, and Jebran (2020) provide significant evidence that reinforces the affirmative relationship between board gender diversity and firm value for Pakistani listed companies from 2010 to 2017. Qureshi et al. (2020) additionally identify a favourable correlation between sustainability reporting and gender diversity on corporate boards. Moreover, organisations with a higher proportion of women have superior ESG performance. Mirza et al. (2020) examine the influence of board diversity, corporate governance, and investment choices within Pakistani firms. The findings of their study show the essential importance of board diversity in corporate investment decisions. Ginglinger and Raskopf (2023) examine the impact of women directors on environmental and social performance via a consideration of board gender quotas. Research indicates that an increased presence of women in representative roles can enhance environmental and social outcomes, as well as encourage more involvement of women in environmental and social committees.

Subhani, Amin, Naz, Sultan, and Aslam (2024) find the correlation between gender representation on the Pakistan Stock Exchange and corporate value, analysing firms listed on the PSE,. Their research enhances the literature by establishing a direct link between female leadership and sustainable investment. Luanglath, Ali, and Mohannak (2019) discover that the presence of women in senior management roles enhances employee productivity in organisations with a minimal representation of women on the board of directors. Gender diversity may enhance environmental performance; but on the other hand, it can be unclear whether it will also strengthen the market value implications of environmental activities. For example, Nepal, Das, and Sahu (2025) examine the moderating effect of gender diversity on boards regarding the relationship between environmental performance and corporate value, focusing on 50 companies in India. Research indicate that gender diversity on boards positively influenced environmental performance; however, it did not significantly alter the connection between environmental performance and business value. However, contrary to the evidence presented above, there are several reasons for why the gender diversity is not able to perform better. Ahern and Dittmar (2012) discover that forced gender quotas for the board in Norway led to a reduction in the firm's value and corporate performance. Adams and Ferreira (2009) find that more monitoring which comes with more genders on the board can create further limits on managerial decision-making and can lower shareholder value. Joecks, Pull, and Vetter (2013) assert that gender diversity adversely impacts the

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performance of enterprises during their initial phases, then yields beneficial effects once a critical mass is attained within the German setting. Widarwati et al. (2024) conclude that green investment enhances the value of enterprises, with no indication of moderating influence of board size.

Accordingly, the second hypothesis is proposed:

H2: Gender diversity strengthens the positive relationship between green investment and firm value.

3. Methodology

This study has adopted quantitative and explanatory research design with secondary data that has been collected from the annual reports, financial statements, corporate governance reports and other publicly available disclosures of the nonfinancial firms listed on Pakistan Stock Exchange (PSX). The reason for excluding financial-sector firms is that these firms differ significantly from non-financial firms in their regulatory requirements, financial structure, and investment characteristics. The study period is 10 years from 2016 to 2025. As of December 31, 2025, PSX has a total of 535 listed companies. Final sample of the study is 315 non-financial firms and around 2,751 firm-year observations. Since the study examines multiple firms over multiple years, the panel data approach is suitable, as it allows for cross-sectional and temporal variability to be captured in the study of green investment, gender diversity, and firm value. To evaluate the study's hypothesis, we formulate the subsequent two models in Equation (1) and Equation (2).

$$TQ_{it} = \alpha_0 + \beta_1 GI_{it} + \beta_2 \text{Firm Size}_{it} + \beta_3 \text{ Firm Leverage}_{it} + \beta_4 \text{Sales Growth}_{it} + \beta_5 CFO_{it} + \beta_6 \text{ Firm Age}_{it} + \beta_7 \text{ Board Size}_{it} + \beta_8 \text{ Board Ind}_{it} + \Sigma\, \beta_j \text{ IND\_DUM} + \Sigma\, \beta_n \text{Year\_DUM} + \varepsilon_{it} \quad (1)$$

$$TQ_{it} = \alpha_0 + \beta_1 GI_{it} + \beta_2 BGD_{it} + \beta_3 (GI \times BGD)_{it} + \beta_4 \text{Firm Size}_{it} + \beta_5 \text{Firm Leverage}_{it} + \beta_6 \text{Sales Growth}_{it} + \beta_7 CFO_{it} + +\beta_8 \text{ Firm Age}_{it} + \beta_9 \text{ Board Size}_{it} + \beta_{10} \text{ Board Ind}_{it} + \Sigma\, \beta_j \text{ IND\_DUM} + \Sigma\, \beta_n \text{Year\_DUM} + \varepsilon_{it} \quad (2)$$

The dependent variable is firm value, which is assessed using Tobin's Q. A high Tobin's Q correlates with an increased market valuation of a corporation. The TQ is an economic indicator derived from the measure the market value of equity is the share price multiplied by the number of shares outstanding (Bhutta, Naz, Sheikh, & Latif, 2025). The study's independent variable is green investment (GI) which is measured in binary/dummy variable. If the firm's annual report includes evidence of the firm's investments in environmentally beneficial activities, then the value of 1 is assigned. These activities can range from investments in renewable energy, energy-efficient technologies, air pollution reduction equipment and waste-treatment facilities, environmentally sustainable production technologies, environmental protection infrastructure to other activities which are clearly identified as green investment activities. If there is no evidence of green investment for a given firm-year observation, a value of 0 is assigned (Widarwati et al., 2024).

The moderating variable is board gender diversity (BGD) which is measured as a dummy variable with 1 indicating when there is at least one woman on the board, and 0 otherwise (Bhutta, Sheikh, Munir, Naz, & Saif, 2021). The control variables in this research work are firm size, firm leverage, sales growth, cash flow, firm age, board size and board independence. The total assets are denoted by the natural logarithm of firms' size (Shahid & Abbas, 2019). Firm leverage represents the ratio of total debt as per book value to total assets (Nadeem, Suleman, & Ahmed, 2019). The percentage increase or decrease from one year's sales to another is the sales growth rate (Brush, Bromiley, & Hendrickx, 2000). The income before depreciation and interest payments are deducted from operating income to calculate cash flow (Shahid & Abbas, 2019). To determine the age of the firm, take the natural log of the number of years since the company was created (Coad, Holm, Krafft, & Quatraro, 2018). Board size can be determined by the number of directors on the Board (Naz, Bhutta, Sheikh, & Sultan, 2023). The percentage of independent directors to the total number of directors on the board is indicative of board independence (Fuzi, Halim, & Julizaerma, 2016).

This research investigates the impact of green investments on corporate performance, considering the moderating influence of gender diversity on boards, utilising three methodologies. The assumption of standard

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errors in Ordinary Least Squares (OLS) regression include the adjustment for fixed variables related to industry and year (Hao et al., 2022). The bias produced by time-invariant variables in panel data constitutes the primary source of endogeneity, and fixed effect regression serves as an effective method to improve identification and eliminate it (Nadeem et al., 2019). Moreover, other biases such as dynamic endogeneity and simultaneity are addressed by the Generalized Method of Moments (GMM) approach. Furthermore, the endogeneity concerns with selection bias on gender diversity and function misspecification biases are corrected by applying PSM technique. Alternative definitions of firms' value and board gender diversity are used and re-test the baseline findings in robustness tests that captures other aspects to reduce the agency problems.

4. Results and Discussion

4.1 Descriptive Analysis

The descriptive statistic for the study variables are shown in Table 1. The average value of firm value (Tobin's Q) is 1.184, which means that the sampled firms are not equally valued on the market. As green investment is a dummy, its mean is 0.347, which indicates that about 34.7% of firm-year observations engage in green investment activities. The mean of gender diversity is 0.118, suggesting that on average 11.8% of the directors on the board are female. The control variables also show enough variation between the firms and thus are appropriate for regression analysis.

Table 1

Descriptive Statistics

	N	Mean	Median	Std. Dev.	Min	Max
Tobin's Q (TQ)	2,751	1.184	0.923	1.067	0.142	8.764
Green Investment (GI)	2,751	0.347	0.000	0.476	0.000	1.000
Board Gender Diversity (BGD)	2,751	0.118	0.100	0.121	0.000	1.000
Firm Size	2,751	16.842	16.521	1.742	12.114	22.634
Firm Lev	2,751	0.492	0.491	0.221	0.021	1.187
Sales Growth (SG)	2,751	0.113	0.081	0.287	-0.824	2.941
Cash Flow CFO	2,751	0.070	0.055	0.123	0.247	0.573
Age	2,751	10.412	11.297	0.542	4.609	15.394
Board Size (BS)	2,751	2.398	2.398	0.183	1.792	3.045
Board Ind (BI)	2,751	0.312	0.333	0.148	0.000	0.800

4.2 Correlation Analysis

Table 2 shows positive and significant correlation between green investment and firm value ($r = 0.124$, $p < 0.10$) which is in line with the preliminary support of H1. Furthermore, gender diversity has a positive correlation with firm value ($r = 0.098$, $p < 0.10$) and green investment ($r = 0.116$, $p < 0.10$), indicating that gender diverse boards could be linked to higher firm value and green investment. Overall, the correlations among the explanatory variables are moderate widely accepted value of 0.80, showing that serious multicollinearity is unlikely occur.

Table 2

Correlation Matrix

Variables	TQ	GI	BGD	SIZE	LEV	SG	CFO	Age	BS	BI
TQ	1.000									
GI	0.124*	1.000								
BGD	0.098*	0.116*	1.000							
SIZE	0.176*	0.154*	0.143*	1.000						
LEV	-0.143*	-0.052*	-0.031	0.284*	1.000					
SG	0.289*	0.101*	0.076**	0.168*	-0.213*	1.000				
CFO	0.061*	0.084*	0.057*	0.337*	0.092*	0.048*	1.000			
Age	0.119*	0.038*	0.029	0.076*	-0.062*	0.144*	0.021	1.000		

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Variables	TQ	GI	BGD	SIZE	LEV	SG	CFO	Age	BS	BI
BS	0.104*	0.139*	0.121*	0.389*	0.072*	0.066*	0.214	0.032	1.000	
BI	0.086*	0.094*	0.316*	0.118*	-0.027	0.054*	0.062*	0.017	0.165*	1.000

* $p < 0.10$

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4.3 Regression Analysis

Effect of Green Investment on Firm Value. The results in Table 3 show regression results for the impact of green investment on firm value. The coefficient of green investment is 0.092 and 0.076 in OLS and in fixed-effects model respectively at 10% level of significance; in GMM, the coefficient of green investment is 0.081 at 5% level of significance. Hence, the coefficient is consistently positive and statistically significant for all three specifications, indicating a positive effect of firm green investment on firm value supporting H1, agency theory (Eisenhardt, 1989) and previous literature (Widarwati et al., 2024). The GMM results also reveal that the AR (2) test and the Hansen test are not significant, which would suggest no evidence of second-order serial correlation and instrument validity.

Table 3

Effect of Green Investment on Firm Value

	(Model 1: OLS)	(Model 2: Fixed Effects)	(Model 3: System GMM)
VARIABLES	**TQ**	**TQ**	**TQ**
Lag (TQ)	---	---	**0.426***
	(--)	(--)	(0.082)
Green Investment (GI)	0.092*	0.076*	0.081**
	(0.028)	(0.026)	(0.034)
Firm Size (SIZE)	0.115***	0.098***	0.104***
	(0.020)	(0.019)	(0.023)
Leverage (LEV)	-0.341***	-0.296***	-0.318***
	(0.078)	(0.074)	(0.081)
Sales Growth (SG)	0.073***	0.065***	0.069***
	(0.023)	(0.022)	(0.024)
Cash Flow (CFO)	1.512***	1.384***	1.426***
	(0.158)	(0.151)	(0.169)
Firm Age (Age)	0.048**	0.041**	0.044**
	(0.021)	(0.020)	(0.022)
Board Size (BS)	0.061**	0.052**	0.057**
	(0.027)	(0.026)	(0.028)
Board Independence (BI)	0.154**	0.137**	0.146**
	(0.067)	(0.064)	(0.069)
Industry Effects	YES	YES	YES
Year Effects	YES	YES	YES
Constant	1.024***	0.876***	-0.7622**
	(0.321)	(0.306)	(0.412)
Observations	2751	2751	2183
R-squared	0.241	0.226	---
AR (1) (z, p-value)	---	---	-0.010 (0.010)
AR (2) (z, p-value)	---	---	-0.214 (0.209)
Sargan Test (chi square, p-value)	---	---	315.1 (0.000)
Hansen Test (chi square, p-value)	---	---	130.3 (0.124)

*** p<0.01, ** p<0.05, * p<0.1

4.4 Moderating Effect of Gender Diversity

Table 4 show the moderating role of female in the relationship between green investment and firm value. The findings show positive and statistically significant results for the interaction between green investment and gender diversity for all three methods of estimation. Coefficients for interaction are 0.314 and 0.286 significant at 5% level of significance in the OLS and FE respectively and 0.301 significant at 1% level

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of significance in GMM model. The positive interaction coefficient shows that the positive relationship between green investment and the firm value is enhanced when the firm's board has female directors supporting H2 and resource based theory (Barney, Ketchen, & Wright, 2021).

Table 4

Moderating Effect of Gender Diversity

	(Model 1: OLS)	(Model 2: Fixed Effects)	(Model 3: System GMM)
VARIABLES	**TQ**	**TQ**	**TQ**
Lag. TQ	---	---	0.418*
	(--)	(--)	(0.057)
Green Investment (GI)	0.071*	0.059*	0.063*
	(0.027)	(0.025)	(0.030)
Gender Diversity (BGD)	0.238*	0.211*	0.226*
	(0.104)	(0.101)	(0.108)
GI × BGD	0.314**	0.286**	0.301***
	(0.109)	(0.105)	(0.112)
Control Variables	Included	Included	Included
Industry Effects	YES	YES	YES
Year Effects	YES	YES	YES
Constant	0.044**	0.038*	0.041**
	(0.021)	(0.020)	(0.022)
Observations	2751	2751	2183
R-squared	0.253	0.239	---

*** p<0.01, ** p<0.05, * p<0.1

4.5 Robustness Analysis

Alternative Measure of Firm Value. Table 5 provides results from the OLS, fixed-effects and GMM system models on alternative measure of profitability (log of market value/book value) measured in (Graham, Galbraith, & Stiles, 2014). The coefficient of green investment is positive and statistically significant in all estimations showing that green investment is positively related to the market-based firm value. Moreover, the interaction term GI × BGD is also positive and significant in all three estimation methods with a coefficient of 0.268, 0.241, and 0.255, respectively. The qualitative results of these analyses are similar to those of the baselines findings.

Table 5

Alternative Measure of Firm Value

	(Model 1: OLS)	(Model 2: Fixed Effects)	(Model 3: System GMM)
VARIABLES	**MV/BV**	**MV/BV**	**MV/BV**
Lag. MV/BV	---	---	0.384*
	(--)	(--)	(0.076)
Green Investment (GI)	0.091*	0.079*	0.085*
	(0.032)	(0.030)	(0.037)
Gender Diversity (BGD)	0.176	0.158*	0.169
	(0.082)	(0.079)	(0.086)
GI × BGD	0.268*	0.241***	0.255**
	(0.098)	(0.094)	(0.102)
Control Variables	Included	Included	Included
Industry Effects	YES	YES	YES

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Year Effects	YES	YES	YES
Constant	-0.684**	-0.598**	-0.077
	(0.301)	(0.286)	(0.022)
Observations	2751	2751	2183
R-squared	0.229	0.217	---

*** p<0.01, ** p<0.05, * p<0.1

Alternative proxy of Female Directors. We re-estimate the model with the ratio of female directors to total directors to test the robustness of our baseline results. The interaction term GI × BGD remains statistically significant for all estimations (OLS, fixed effects and GMM) with a positive coefficient of 0.129, 0.114 and 0.122, respectively. Hence, the results show the positive association between green investment and firm value increases with the presence of female directors on the boards of firms. So results are consistent to baseline findings.

Table 6

Alternative Gender Diversity Measure

	(Model 1: OLS)	**(Model 2: Fixed Effects)**	**(Model 3: System GMM)**
VARIABLES	**TQ**	**TQ**	**TQ**
Lag. TQ	---	---	0.298*
	(--)	(--)	(0.063)
Green Investment (GI)	0.078*	0.067*	0.072*
	(0.027)	(0.025)	(0.031)
Gender Diversity (BGD)	0.096	0.083	0.091
	(0.043)	(0.041)	(0.045)
GI × BGD	0.129**	0.114*	0.122**
	(0.048)	(0.046)	(0.050)
Control Variables	Included	Included	Included
Industry Effects	YES	YES	YES
Year Effects	YES	YES	YES
Constant	0.041**	0.036*	0.039**
	(0.020)	(0.019)	(0.021)
Observations	2751	2751	2183
R-squared	0.249	0.237	---

*** p<0.01, ** p<0.05, * p<0.10

Propensity Score Matching (PSM) Approach. PSM method is able to effectively address selection bias due to functional misspecification and firm features (Roberts & Whited, 2013). Using neighbour one-to-one matching, the female diverse companies are paired with the male presence companies for each fiscal year in Table 7 (Panel A). This approach involves choosing a sample of businesses to be in a treatment group (dummy 1 = business has female) and a control group (dummy 0 = business doesn't have female). The results of a mean difference test for matched samples, comparing the treatment business with the control business, are presented in this table. The t-test (p value) is 2.56 (0.233) indicating no statistical difference between two groups. Unlike the control group however, the treatment group has a significantly higher mean TQ value. Baseline analysis is rerun using matched-sample OLS, fixed-effects, and GMM approaches in Panel B of Table 7. The positive significant values in all models for interaction term show that holding other observable characteristics of firms constant, an increase in gender diversity further improves the positive association between green investment and firm value.

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Table 7

Endogeneity Analysis using Propensity Score Matching

Panel A: Description statistics of matched sample and their comparison

	Mean		t-test	p-value
Variables	**Female=1**	**Female=0**		
TQ	1.830	1.102	2.56	0.233
Green Investment	0.054	0.046	-0.23	0.501
Firm Size	0.235	0.113	1.41	0.135
Firm Lev	0.237	0.129	-1.04	0.267
Sales Growth	0.453	0.230	1.450	0.256
CFO	0.134	0.028	0.68	0.268
Age	14.17	13.817	0.01	0.883
Board Size	0.022	0.179	-0.27	0.402
Board Ind	0.236	0.447	-0.34	0.314

Panel B: Regressions of Green Investment on TQ

	(Model 1 : OLS)	(Model 2: Fixed Effects)	(Model 3: System GMM)
VARIABLES	**TQ**	**TQ**	**TQ**
L.TQ	---	---	0.620***
	(--)	(--)	(52.393)
Green Investment	0.129*	0.231*	0.225*
	(2.515)	(0.810)	(2.428)
BGD	0.194**	0.176**	0.096***
	(0.034)	(0.030)	0.058
GI × BGD	0.129***	0.114**	0.122**
	(0.048)	(0.046)	(0.050)
Control Variables	Included	Included	Included
Industry Effects	YES	NO	YES
Year Effects	YES	YES	YES
Constant	-0.850	0.003	0.025
	(-1.234)	(0.001)	(0.212)
Observations	945	945	689
R-squared	0.215	0.132	---

*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

This study aims to explore the relationship between green investment and firm value and also test the moderating role of gender diversity in non-financial firms listed on the Pakistan Stock Exchange (PSX) during 2016-2025. Regression techniques i.e., OLS, fixed-effects, and System GMM are used to test the hypothesis. The results show the positive effect of green investment on firm value in line with the first hypothesis. This implies that companies engaging in green investments gain corporate reputation, stakeholder relations, environmental positioning and increased investor confidence. The study also reveals that gender diversity positively moderates the relationship between green investment and firm value, thus providing support for the second hypothesis. Female directors can bring in other perspectives, focus more on stakeholder interests, have better monitoring, and be more sensitive to environmental and social issues. Thus, the gender-diversity of the boards enhances the effectiveness of green investment on firm value.

These findings are confirmed by the robustness analyses using another measure of firm value and using another measure of gender diversity. Moreover, propensity score matching can mitigate the risk of

systematic differences in green-investing and non-green-investing firms. The results have implications for corporate management, investors, regulators and policy makers. The study can be expanded in the future to look at other aspects of gender diversity, different forms of green investment, green innovation, environmental performance, and other forms of governance in other emerging-market economies. The significance of this study to the companies is that they can incorporate green investment as an investment decision as it is proven to be an advantage for the companies in increasing their value.

Author Contributions

All authors participated in ideation, development, and writing the manuscript. All authors read and approved the final manuscript.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this article.

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Informed Consent

Informed consent was obtained from all participants prior to data collection. Participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without any consequences. The confidentiality and anonymity of respondents were guaranteed throughout the research process.

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request. The authors are committed to transparency and will provide detailed methodological information and analysis protocols upon request.

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