

Exploring the Role of Green Innovation and Corporate Governance in Enhancing Firm Performance Evidence from the Green Industry

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Abstract:

Green innovation has become increasingly important for firms seeking to improve economic performance while addressing environmental challenges. This study examines the effect of green innovation on firm performance and investigates whether ESG performance affects green-industry companies. Using panel data for 93 companies identified through the NIFTY ESG 100 Index over 2019–2026, the study employs correlation analysis and panel regression models. Green innovation is measured through a Green Innovation Adoption Index comprising five green-practice indicators, while firm performance is assessed through Current Ratio, Debt Equity Ratio, Turnover Ratio, ROA, and Tobin's Q. Governance characteristics include Board Diversity, Women Director Proportion, Independent Director Proportion, and Board Size. The results show that green innovation significantly improves operational efficiency and reduces financial leverage, whereas its effects on liquidity, profitability, and market performance are statistically insignificant in the preferred panel models. The analysis of individual green practices further shows heterogeneous effects across performance dimensions. Governance characteristics also moderate selected green innovation–performance relationships: Board Diversity strengthens the leverage effect, Women Director Proportion strengthens the efficiency effect, while Board Size weakens the profitability effect. ESG Score does not significantly moderate the relationships. The study demonstrates that the financial value of green innovation is conditional on both the type of green practice and governance structure.

Keywords: Corporate Governance; ESG Performance; Firm Performance; Green Innovation; Green Industry; Sustainability

1. Introduction

Environmental degradation, climate change, and resource scarcity have completely changed the business environment, obliging companies to follow sustainability-oriented strategies which involve balancing economic growth and environmental concerns. The conventional approach of business based on resource-intensive production and carbon-intensive activities is deemed inadequate for solving current sustainability-related problems (Augustin-Behravesh et al., 2025; Dogah et al., 2024). Thus, sustainability-oriented business models are becoming a solution for companies to integrate environmental considerations in their innovation process and operations. The concept of green innovation is one such strategy that helps organizations to create environmentally friendly products, processes, and technologies that are beneficial both for the environment and for competitive advantage (Liu, 2023; Xu et al., 2022). Recent research underlines the necessity of the integration of sustainability goals and technological innovation to ensure sustainable competitiveness of the industry (Chen et al., 2024; Liu et al., 2024).

Sustainable business transformation has been further facilitated by corporate governance. Corporate governance mechanisms, such as the independence of the board, diversity of the board, ownership structure, and good governance practices, affect decision-making and motivate organizations to engage in environmentally friendly innovation (Arif et al., 2026; Khan et al., 2023). Good governance ensures reduced conflicts of interest, efficient resource distribution, stakeholder trust, and success in implementing sustainability strategies (Tang, 2022). As regulatory pressure on ESG

performance increases and stakeholder expectations grow, corporate governance has become an important institution in promoting green innovation and improving the performance of firms (Zhao et al., 2025; Nusratova, 2025; Alkaraan et al., 2025).

However, despite the vast body of research on the topic, several research gaps still exist. The current literature is mainly concerned with the relationship between green innovation and firm performance, or corporate governance and the organization's outcomes separately (Zhang & Jiang, 2025; Zheng et al., 2022). Very few studies investigate the ways in which corporate governance can help or hinder the efficiency of green innovation in achieving firm performance, especially in the context of the green industry (Bashir et al., 2025; Le & Govindan, 2024). In addition, the previous empirical literature has mostly used traditional analytical methods and produced inconsistent findings about the nature of these relationships, due to the complicated interplay between the aspects in question (Ma & Appolloni, 2025; Chen et al., 2024).

This study attempts to bridge this gap by analyzing the impact of green innovation and corporate governance on improving firm performance in the green industry. In particular, the paper assesses the effect of green innovation on firm performance, the effect of corporate governance on organizational performance, the determinants of governance and innovation that have significant effects on firm performance, and the joint effect of governance and innovation in contributing to sustainable competitive advantage. The analysis of firms in the green industry provides empirical evidence on how governance and innovation contribute to superior organizational performance.

There are several contributions of the study, both theoretical and practical. From a theoretical perspective, the research adds to the literature in the field of resource-based view, stakeholder theory, and corporate governance by bringing together the concepts of green innovation and governance mechanisms into one framework that seeks to explain firm performance (Lu et al., 2025; Singh et al., 2021). In terms of practice, the findings of the study can be of great use to corporate managers, investors, and policymakers who need to develop governance and innovation systems to foster competitiveness and sustainability (Li et al., 2024; Sun et al., 2023). In this context, the study seeks to examine the effect of green innovation practices on firm performance in green industry companies and the effect of ESG Score and Governance characteristics as moderating factors on the firm performance of green industry companies.

2. Review of Literature

The review of literature provides the conceptual and empirical foundation for the present study. It examines the existing theoretical perspectives and previous empirical studies related to green growth, green innovation, corporate governance, and firm performance. The literature is organized systematically to establish the theoretical basis of the study and to identify the relationships among the major variables.

Theoretical Framework

The theoretical framework of the study is based on Green Growth, Resource-Based View (RBV), and Institutional Theory, which together provide a foundation for understanding the relationships among green innovation, corporate governance, and firm performance.

Green Growth concept refers to the ability to ensure both economic growth and environmental protection at the same time. The concept of green growth can be associated with the idea of circular economy, as well as with the Sustainable Development Goals (SDGs). In this way, green growth can be seen as a means to promote resource efficiency, cleaner production and innovations for low-carbon emissions that result in wellbeing and competitive advantages of the country (Basheer et al., 2022; Houssam et al., 2023). Analyzing the concept of green growth with regards to sustainable development in developing countries, it is possible to say that it implies not only environmental policy but also development policy regarding productivity and inclusiveness (Balland et al., 2022; Liu et al., 2024).

According to the Resource-Based View (RBV), competitive advantages arise due to valuable, rare, non-substitutable and inimitable (VRIN) resources. Green innovation is an example of a strategic resource that contributes towards operational efficiencies, environmental sustainability, product differentiation and competitive advantage. Companies that succeed in developing green innovation capabilities are better able to enhance their performance and maintain a competitive advantage in the green industry (Khanra et al., 2022).

According to Institutional Theory, the activities of the organization are determined by the regulations, stakeholder demands, and social norms. Governance is a concept that supplements the Resource-Based Approach in terms of having control mechanisms that make the optimal usage of the firm's resources possible, including green innovation. With proper governance, an organization can make sound decisions, allocate resources effectively, and improve its performance (Risi et al., 2023).

The three theoretical perspectives collectively provide the foundation for the present study. Green Growth establishes the broader sustainability perspective by emphasizing the balance between economic development and environmental protection. RBV explains how green innovation can function as a strategic resource that enhances efficiency, sustainability, competitive advantage, and ultimately firm performance. Institutional Theory explains how corporate governance, regulations, stakeholder expectations, and social norms influence firms' adoption and effective utilization of green innovation. Thus, the integration of these theories provides a comprehensive basis for examining the relationship between green innovation, corporate governance, and firm performance, with green innovation representing a strategic organizational capability and corporate governance providing the mechanisms through which such resources are effectively managed to achieve improved firm performance.

Corporate Governance and Firm Performance

Corporate governance is widely recognized as an important mechanism influencing firm performance through effective oversight, transparency, accountability, risk management, and efficient resource allocation. A sound governance structure enables firms to improve managerial decision-making, align the interests of managers and stakeholders, and utilize organizational resources effectively, thereby supporting improved organizational outcomes. In sectors where sustainability, innovation, and strategic responsibility are increasingly important, corporate governance assumes an even greater role. In the context of the green sector, sustainable development requires not only economic growth but also responsible decision-making and coordination among multiple stakeholders. Frempong et al. (2021) emphasized that sustainable development involves aligning economic activities with broader social and environmental objectives.

Effective corporate governance can also enhance the performance implications of green innovation by facilitating the efficient utilization of organizational resources and enabling firms to create value from innovation. Firms operating in sustainability-oriented environments face various internal and external pressures, including regulatory requirements, stakeholder expectations, technological developments, and changing market conditions. Liu et al. (2023) and Majali et al. (2022) highlighted the importance of organizational stability and risk awareness in maintaining sustainable economic performance over the long term. Effective governance can therefore contribute to organizational stability, risk management, and performance orientation while supporting the adoption and effective utilization of green innovation.

Furthermore, firm performance is influenced by multiple organizational and interdependent factors that evolve with changes in the business environment. This is because performance depends not only on internal factors such as governance practices, organizational resources, and innovation capabilities, but also on external factors such as regulations, stakeholder expectations, technological developments, and market conditions. The interaction among these factors determines how effectively firms respond to environmental and competitive pressures and transform their resources and capabilities into improved performance. Bhat et al. (2023) and Zada et al. (2025) highlighted the

increasing complexity of organizational and economic environments, particularly for firms undergoing green transformation. Similarly, Sahoo et al. (2022) and Zhang et al. (2024) emphasized the importance of considering strategic and contextual factors when examining firm performance.

Therefore, examining corporate governance alongside green innovation provides a broader perspective for understanding firm performance in green-oriented industries. Corporate governance not only facilitates compliance, accountability, and effective resource allocation but also creates an organizational environment in which green innovation can be effectively developed and utilized. Consequently, the interaction between corporate governance and green innovation may be important in explaining variations in firm performance, providing a basis for further empirical examination in the present study.

The existing literature has established the importance of green innovation, corporate governance, ESG performance, sustainability, and firm performance; however, these research strands have largely been examined independently. Green innovation studies have primarily focused on environmental and innovation-related outcomes, whereas corporate governance research has concentrated on governance mechanisms, organizational control, and efficiency (Zhang & Liu, 2023; Majali et al., 2022). Similarly, firm performance studies have mainly examined financial and operational outcomes, with comparatively limited attention to the combined influence of green innovation and corporate governance on firm performance (Ahmed et al., 2023; Sarfraz et al., 2022). Although existing evidence suggests a positive relationship between green innovation practices and firm performance, empirical evidence on how corporate governance and ESG performance influence this relationship remains limited, particularly in green industry companies (Yu et al., 2024; Wu et al., 2024; Padilla-Lozano & Collazzo, 2021). Moreover, much of the existing research has focused on developed economies and specific industrial contexts, limiting the generalizability of findings to developing-country settings where institutional, regulatory, and resource conditions may differ. Therefore, a research gap exists in understanding the interrelationship between green innovation, firm performance, ESG performance, and corporate governance. The present study addresses this gap by examining the relationship between green innovation practices and firm performance and investigating the role of ESG performance and corporate governance characteristics as moderating factors in green industry companies.

3. Research objectives

- To examine the effect of green innovation practices on firm performance in green industry companies.
- To examine the moderating effects of ESG score and corporate governance characteristics on the relationship between green innovation practices and firm performance in green industry companies

4. Methodology

The research methodology chosen for this investigation is a combination of an explanatory and quantitative approach to assess the impact of green innovation, ESG performance, and Governance characteristics on firm performance within the context of green industry firms. It is important to emphasize that this research was conducted using a deductive approach. The study uses solely secondary data gathered from annual reports, business responsibility and sustainability reports (BRSRs), corporate governance reports, as well as financial databases like Moneycontrol, Screener. in, and Bloomberg, covering the period 2019–2026. This is because these databases have uniform data on green innovation efforts, ESG performance, Governance characteristics, firm financial performance, and other unique traits of firms. The analysis utilizes quantitative panel data, which are annual observations on certain green industry firms during the study period. The data set comprises firm-level data concerning green innovation, ESG performance, Governance characteristics, firm performance, and control variables. This study uses a quantitative research approach to analyze the link between green innovation, ESG Score, Governance characteristics, and organizational performance. Statistical tools are used to test the hypotheses formulated and determine the significance of the

relationships between the variables under study. Panel Regression, Robustness Check etc. The sampling frame is made up of 88 companies that have been identified through the NIFTY ESG 100 Index as they have consistent reporting on their sustainability efforts, corporate governance practices, ESG performance, and financial performance. Companies were chosen depending on how complete their information is in the chosen study period. This sampling frame provides a representative sample of Indian companies that engage in sustainable businesses. This sampling frame follows your thesis sampling frame.

The study measures green innovation using a Green Innovation Adoption Index based on five green policy indicators: GBP, ESP, SPP, WRP, and CCP. ESG score is measured using the ESG performance score reported in the companies' Business Responsibility and Sustainability Reports (BRSRs) or other ESG disclosures. Governance characteristics are measured through board diversity, the proportion of women directors, the proportion of independent directors, and board size. Firm performance is assessed using five indicators—Current Ratio, Debt–Equity Ratio, Turnover Ratio, Return on Assets (ROA), and Tobin's Q—which capture different dimensions of firm performance and are examined as dependent variables in separate regression models. Firm size and firm age are included as control variables to account for firm-specific characteristics that may influence performance.

Before statistical analysis, the data are subjected to cleaning, coding, and preliminary sorting to ensure consistency and accuracy. Correlation analysis is conducted to examine the direction and strength of relationships among the study variables, while regression analysis is employed to examine the effects of green innovation, ESG score, and governance characteristics on firm performance after controlling for firm-specific characteristics.

The direct-effect regression model is specified as:

$$FP_i = \beta_0 + \beta_1 GI_i + \beta_2 FS_i + \beta_3 FA_i + \beta_4 LEV_i + \varepsilon_i$$

where FP represents firm performance, GI represents green innovation, ESG represents ESG score, GOV represents governance characteristics (board diversity, women director proportion, independent director proportion, and board size), FS represents firm size, FA represents firm age, and LEV represents leverage. Since the Debt–Equity Ratio (DER) represents the leverage dimension, it is treated as a dependent variable when used as a measure of firm performance, and the corresponding regression model is estimated separately.

For Objective 1, regression models are used to examine the effect of green innovation practices on the respective measures of firm performance. For Objective 2, moderation regression models are employed by introducing interaction terms between green innovation and ESG score ($GI \times ESG$) and between green innovation and individual governance characteristics ($GI \times GOV$). The significance and direction of these interaction terms are used to determine whether ESG score and governance characteristics moderate the relationship between green innovation practices and firm performance.

5. Results and Discussion:

This section presents and discusses the empirical findings of the study in accordance with the stated research objectives. The analysis examines the effect of green innovation practices on firm performance and further evaluates the moderating roles of ESG score and corporate governance characteristics in this relationship. The findings are interpreted in relation to the existing literature and theoretical framework to provide a comprehensive understanding of the relationships among the study variable.

5.1. Results:

Firm performance was assessed using five dimensions: liquidity through Current Ratio, leverage through Debt Equity Ratio, efficiency through Turnover Ratio, profitability through ROA, and market performance through Tobin's Q. Green Innovation was represented primarily through the Green Innovation Adoption Index, while the five individual policy indicators—GBP, ESP, SPP, WRP, and CCP were also analysed separately.

Table 1. Correlation Between the Green Innovation Adoption Index and Firm Performance

Firm Performance Dimension	Firm Performance Measure	Pearson Correlation	Pearson p-value	Spearman Correlation	Spearman p-value	Interpretation
Liquidity	Current Ratio	0.070	0.116	0.065	0.144	Positive but insignificant
Leverage	Debt Equity Ratio	-0.093	0.037	-0.095	0.034	Negative and significant
Efficiency	Turnover Ratio	0.173	<0.001	0.188	<0.001	Positive and significant
Profitability	ROA	0.221	<0.001	0.270	<0.001	Positive and significant
Market Performance	Tobin's Q	0.239	<0.001	0.245	<0.001	Positive and significant

The correlation results provide preliminary evidence of a favorable relationship between Green Innovation and several dimensions of firm performance. The Green Innovation Adoption Index was positively and significantly correlated with Turnover Ratio, ROA, and Tobin's Q. The strongest Pearson correlation coefficient was observed for Tobin's Q ($r=0.239$), followed by ROA ($r=0.221$) and Turnover Ratio ($r=0.173$). The relationship with Debt Equity Ratio was negative and statistically significant ($r=-0.093$, $p=0.037$). Since a lower Debt Equity Ratio generally represents lower financial leverage, this negative association can be interpreted as financially favorable. Firms with stronger Green Innovation adoption therefore tended to exhibit slightly lower dependence on debt financing. Current Ratio showed a weak positive correlation with Green Innovation ($r=0.070$), but the relationship was statistically insignificant ($p=0.116$). Thus, Green Innovation does not appear to have a reliable bivariate association with short-term liquidity. The Spearman results broadly confirm the Pearson findings, which provides additional confidence that the identified relationships are not purely dependent on linear association assumptions.

Table 2. Panel Regression Results for the Green Innovation Adoption Index

Firm Performance Dimension	Dependent Variable	Preferred Model	Coefficient	Standard Error	p-value	Decision
Liquidity	Current Ratio	Random Effects	0.135	0.138	0.326	Positive but insignificant
Leverage	Debt Equity Ratio	Random Effects	-0.283	0.139	0.042	Favourable, negative and significant

Efficiency	Turnover Ratio	Random Effects	0.319	0.077	<0.001	Positive and significant
Profitability	ROA	Two-Way Fixed Effects	3.027	2.100	0.150	Positive but insignificant
Market Performance	Tobin's Q	Random Effects	0.832	0.878	0.344	Positive but insignificant

The panel-regression results provide the principal inferential evidence for Objective 1 because they account for the longitudinal structure of the firm-level data and relevant control variables. For liquidity, the Green Innovation Adoption Index had a positive coefficient of 0.135, but the effect was statistically insignificant ($p=0.326$). Thus, the analysis does not provide evidence that greater Green Innovation adoption significantly improves firms' Current Ratio. For leverage, the coefficient was negative and statistically significant ($\beta=-0.283$, $p=0.042$). This is a favourable result because stronger Green Innovation adoption was associated with a reduction in Debt Equity Ratio. The finding suggests that firms with greater green-practice adoption may exhibit a more favourable capital structure and lower dependence on debt. The strongest panel result was obtained for operational efficiency. Green Innovation had a positive coefficient of 0.319 for Turnover Ratio and was highly significant ($p<0.001$). Therefore, firms with greater Green Innovation adoption demonstrated significantly stronger operational efficiency. For ROA, the coefficient was positive at 3.027, but it was not statistically significant ($p=0.150$). Similarly, Tobin's Q coefficient was positive at 0.832 but insignificant ($p=0.344$). These results indicate that, after accounting for the panel structure and controls, the positive bivariate relationships with profitability and market valuation were not sufficiently strong to establish independent effects at the conventional 5% significance level. Overall, Green Innovation demonstrated significant favourable effects on leverage and efficiency, while the effects on liquidity, profitability, and market valuation were positive in direction but statistically insignificant. Therefore, H1 receives partial support.

Table 3. Separate Regression Results for Individual Green Policy Indicators

Policy	Liquidity: Current Ratio	Leverage: Debt Equity Ratio	Efficiency: Turnover Ratio	Profitability: ROA	Market Performance: Tobin's Q
GBP	0.024, insignificant ($p = 0.833$)	-0.206, significant ($p = 0.004$)	0.147, marginal ($p = 0.079$)	1.859, marginal ($p = 0.059$)	0.274, insignificant ($p = 0.544$)
ESP	0.084, insignificant ($p = 0.395$)	-0.124, marginal ($p = 0.053$)	0.081, insignificant ($p = 0.138$)	1.268, insignificant ($p = 0.322$)	0.491, insignificant ($p = 0.351$)
SPP	0.002, insignificant ($p = 0.989$)	0.004, insignificant ($p = 0.958$)	0.141, significant ($p = 0.013$)	1.123, insignificant ($p = 0.284$)	1.268, significant ($p = 0.013$)

WRP	0.180, insignificant (p = 0.110)	-0.024, insignificant (p = 0.850)	0.175, significant (p = 0.007)	2.041, insignificant (p = 0.130)	-0.072, insignificant (p = 0.878)
CCP	0.028, insignificant (p = 0.758)	-0.098, insignificant (p = 0.270)	0.046, insignificant (p = 0.553)	0.298, insignificant (p = 0.749)	-0.473, insignificant (p = 0.222)

The individual-policy regressions indicate that different Green Innovation practices influence different dimensions of firm performance. GBP produced the clearest leverage effect. Its coefficient for Debt Equity Ratio was negative and statistically significant (beta=-0.206, p=0.004), suggesting that GBP adoption was associated with lower financial leverage. GBP also showed marginal positive relationships with Turnover Ratio and ROA. ESP showed a marginal favorable relationship with Debt Equity Ratio (beta=-0.124, p=0.053), but its effects on the remaining performance indicators were statistically insignificant. SPP emerged as one of the strongest individual Green Innovation practices. It had significant positive effects on Turnover Ratio (beta=0.141, p=0.013) and Tobin's Q (beta=1.268, p=0.013). Thus, Sustainable Procurement Practices were associated with both greater operating efficiency and stronger market performance. WRP had a statistically significant positive relationship with Turnover Ratio (beta=0.175, p=0.007), suggesting that Waste Reduction Practices may improve firms' operational efficiency. CCP did not produce statistically significant effects on any of the five performance dimensions in the separate models. The policy-specific results demonstrate that Green Innovation should not be regarded as a completely homogeneous phenomenon. GBP was most relevant to capital structure, while SPP and WRP were more strongly associated with operational and market outcomes. Objective 1 was achieved by evaluating Green Innovation across five dimensions of firm performance using both a composite index and individual policy indicators. The results show that the Green Innovation Adoption Index was significantly associated with a favourable reduction in leverage and a significant improvement in operational efficiency. The individual-policy analysis further identified GBP, SPP, and WRP as the most relevant individual practices.

Accordingly: H1 is partially supported.

The evidence confirms that Green Innovation contributes positively to selected dimensions of firm performance, but the effect is not statistically significant across all five financial outcomes.

In the available data, ESG Score was used as the principal sustainability-related measure, while Board Diversity, Women Director Proportion, Independent Director Proportion, and Board Size represented governance characteristics. The revised analysis evaluates their effects across the same five firm-performance measures used for Objective 1.

Table 4. Correlation Between ESG, Governance Characteristics and Firm Performance

Predictor	Current Ratio	Debt Equity Ratio	Turnover Ratio	ROA	Tobin's Q
ESG Score	-0.009	-0.033	0.082*	0.107	0.092
Board Diversity	0.040	-0.036	0.259*	0.047	0.090

Women Director Proportion	-0.003	-0.021	0.152*	0.084*	0.106
Independent Director Proportion	-0.016	0.021	0.084*	0.101	0.076*
Board Size	0.007	-0.099	0.059	0.054	0.033

The correlation analysis demonstrates that ESG and governance characteristics are more strongly related to efficiency, profitability, and market performance than to liquidity. ESG Score had significant positive correlations with ROA and Tobin's Q and a marginal positive association with Turnover Ratio. Thus, firms with stronger ESG performance tended to exhibit better profitability and market valuation. Board Diversity showed its strongest relationship with Turnover Ratio ($r=0.259$, $p<0.01$), indicating that more diverse boards were associated with higher operational efficiency. Board Diversity was also positively and significantly correlated with Tobin's Q. Women Director Proportion showed positive associations with Turnover Ratio and Tobin's Q and a marginal positive relationship with ROA. This suggests that female board representation may be associated with favorable operating and market outcomes. Independent Director Proportion was significantly correlated with ROA and marginally related to Turnover Ratio and Tobin's Q. Board Size showed a significant negative relationship with Debt Equity Ratio ($r=-0.099$, $p=0.028$). Since lower leverage is favorable, this indicates that larger boards were modestly associated with lower leverage. Overall, the preliminary results indicate that ESG and governance characteristics are associated with several favorable dimensions of firm performance, although the relationships are not uniform across all five outcomes.

Table 5. Direct Effects of ESG and Governance Characteristics on Firm Performance

Performance Measure	Significant / Relevant Predictor	Coefficient	p-value	Interpretation
Current Ratio	None	—	—	No significant direct ESG/governance effect
Debt Equity Ratio	Women Director Proportion	-1.126	0.085	Favorable negative effect, marginal at 10%
Debt Equity Ratio	Board Size	-0.027	0.034	Significant favorable reduction in leverage
Turnover Ratio	Board Diversity	0.799	0.027	Positive and significant
Turnover Ratio	Board Size	0.032	0.014	Positive and significant
ROA	None	—	—	No significant direct ESG/governance effect
Tobin's Q	Board Diversity	-3.687	0.086	Negative and marginal at 10%

The preferred panel models indicate that the direct effects of ESG and governance characteristics are selective rather than universal. For liquidity, none of the ESG or governance predictors significantly affected Current Ratio. Thus, the analysis does not indicate that governance structure or ESG performance produces an immediate direct effect on short-term liquidity. For leverage, Board Size had a negative and statistically significant coefficient ($\beta = -0.027$, $p = 0.034$). Since a lower Debt Equity Ratio represents lower leverage, larger boards were associated with a more favourable financing structure. Women Director Proportion also showed a negative coefficient ($\beta = -1.126$), but this was significant only at the 10% level ($p = 0.085$). For operational efficiency, Board Diversity had a positive and statistically significant coefficient ($\beta = 0.799$, $p = 0.027$). Board Size was also positively significant ($\beta = 0.032$, $p = 0.014$). These findings indicate that governance characteristics were particularly relevant to firms' operating efficiency. For ROA, none of the ESG and governance predictors showed a statistically significant direct effect in the preferred model. Similarly, no predictor produced a statistically significant positive effect on Tobin's Q at the 5% level. Board Diversity showed a marginal negative coefficient, but this finding should be treated cautiously. Thus, the direct-effect analysis identifies three statistically significant effects: Board Size on leverage, Board Diversity on efficiency, and Board Size on efficiency.

Table 6. Moderating Effects of ESG and Governance Characteristics on Firm Performance

Performance Dimension	Moderation Relationship	Interaction Coefficient	p-value	ΔR^2	Decision
Liquidity	ESG $\times$ Board Diversity	-0.004	0.706	<0.001	Not significant
Liquidity	Green Innovation $\times$ ESG	0.003	0.510	0.001	Not significant
Liquidity	Green Innovation $\times$ Board Diversity	-0.344	0.732	<0.001	Not significant
Liquidity	Green Innovation $\times$ Women Directors	-0.975	0.458	0.002	Not significant
Liquidity	Green Innovation $\times$ Independent Directors	0.176	0.739	<0.001	Not significant
Liquidity	Green Innovation $\times$ Board Size	0.021	0.550	0.001	Not significant
Leverage	ESG $\times$ Board Diversity	-0.009	0.491	0.001	Not significant
Leverage	Green Innovation $\times$ ESG	-0.005	0.320	0.002	Not significant
Leverage	Green Innovation $\times$ Board Diversity	-2.167	0.023	0.010	Significant negative moderation
Leverage	Green Innovation $\times$ Women Directors	-1.252	0.318	0.002	Not significant
Leverage	Green Innovation $\times$ Independent Directors	-0.631	0.348	0.003	Not significant

Leverage	Green Innovation × Board Size	-0.015	0.682	<0.001	Not significant
Efficiency	ESG × Board Diversity	0.020	0.104	0.005	Not significant
Efficiency	Green Innovation × ESG	0.001	0.763	<0.001	Not significant
Efficiency	Green Innovation × Board Diversity	2.013	0.075	0.007	Marginal at 10%
Efficiency	Green Innovation × Women Directors	2.676	0.011	0.009	Significant positive moderation
Efficiency	Green Innovation × Independent Directors	0.983	0.068	0.005	Marginal at 10%
Efficiency	Green Innovation × Board Size	-0.069	0.092	0.006	Marginal at 10%
Profitability	ESG × Board Diversity	0.146	0.209	0.002	Not significant
Profitability	Green Innovation × ESG	0.022	0.628	<0.001	Not significant
Profitability	Green Innovation × Board Diversity	10.177	0.265	0.001	Not significant
Profitability	Green Innovation × Women Directors	6.426	0.556	<0.001	Not significant
Profitability	Green Innovation × Independent Directors	0.330	0.955	<0.001	Not significant
Profitability	Green Innovation × Board Size	-1.054	0.001	0.010	Significant negative moderation
Market Performance	ESG × Board Diversity	0.052	0.463	0.001	Not significant
Market Performance	Green Innovation × ESG	0.007	0.764	<0.001	Not significant
Market Performance	Green Innovation × Board Diversity	7.603	0.146	0.003	Not significant
Market Performance	Green Innovation × Women Directors	8.913	0.066	0.003	Marginal at 10%

Market Performance	Green Innovation × Independent Directors	3.777	0.178	0.002	Not significant
Market Performance	Green Innovation × Board Size	-0.346	0.062	0.004	Marginal at 10%

The moderation analysis identified three statistically significant interaction effects at the 5% level. First, Board Diversity significantly moderated the relationship between Green Innovation and leverage. The interaction coefficient was negative ($\beta = -2.167$, $p = 0.023$). Because the dependent variable was Debt Equity Ratio, a stronger negative effect can be financially favourable: greater Board Diversity strengthened the association between Green Innovation and reduced leverage. Second, Women Director Proportion positively moderated the relationship between Green Innovation and operational efficiency. The interaction coefficient was 2.676 ($p = 0.011$), while the interaction increased (R^2) by approximately 0.009. Thus, Green Innovation was more strongly associated with Turnover Ratio when female representation on boards was higher. Third, Board Size significantly moderated the Green Innovation–ROA relationship, but the coefficient was negative ($\beta = -1.054$, $p = 0.001$). This indicates that larger boards weakened rather than strengthened the profitability effect of Green Innovation. No statistically significant moderation effects were identified for Current Ratio. The Tobin’s Q moderation terms were also not significant at the 5% level, although interactions involving Women Director Proportion and Board Size were marginal at the 10% level. The findings demonstrate that governance characteristics can influence the effectiveness of Green Innovation, but their role is outcome-specific. Board Diversity appears particularly relevant to leverage, Women Director Proportion strengthens operational-efficiency benefits, while larger boards may weaken the profitability effect of Green Innovation.

Objective 2 was evaluated through both direct-effect models and moderation models. The direct-effect analysis identified significant favourable effects of governance primarily for leverage and operational efficiency. Board Size significantly reduced Debt Equity Ratio and improved Turnover Ratio, while Board Diversity significantly improved Turnover Ratio. The moderation analysis further demonstrated that Board Diversity, Women Director Proportion, and Board Size can alter the effectiveness of Green Innovation. Board Diversity strengthened the favourable leverage effect of Green Innovation, while Women Director Proportion strengthened its operational-efficiency effect. In contrast, larger Board Size weakened the relationship between Green Innovation and ROA. The results therefore do not show a uniform positive effect of ESG and governance across all five performance measures. Instead, their effects vary depending on the governance characteristics and financial outcome.

Accordingly:

H2 is partially supported.

The evidence supports the importance of governance characteristics, particularly Board Diversity, Women Director Proportion, and Board Size, but the effects are not consistently positive and significant across liquidity, leverage, efficiency, profitability, and market performance.

5.2. Discussion

Results partially support the statement about a positive impact of green innovation on firm performance. Green Innovation Adoption Index had a significant effect on Turnover Ratio ($\beta = 0.319$, $p < 0.001$) and on Debt Equity Ratio ($\beta = -0.283$, $p = 0.042$), but not on Current Ratio, ROA, and Tobin’s Q in the panel models. Therefore, the influence of green innovation on financials seems to be more pronounced in operational efficiency and financial structure rather than in profitability, liquidity or value of the company. This is aligned with the results of Liu et al. (2024), which revealed that high-quality green innovation contributes to the financial performance of companies through greater

competitiveness. In addition, this study adds the dimension of operational efficiency as the major performance channel.

As regards the significant Turnover Ratio effect, it implies that green innovation may enhance resource utilization and operational efficiency. This inference is supported by the individual practice effects as well, as SPP and WRP significantly enhanced Turnover Ratio. Similarly, Jiang et al. (2025) found that the impact of green innovation depended on its type and intensity since various types of innovation produced different financial outcomes. Hence, the current finding suggests that the financial value of green innovation depended on the particular practice employed and not on its adoption per se. The negative impact of Green Innovation on the Debt Equity Ratio demonstrates its possible contribution to the financial resilience of organizations. The firms with a greater green innovation adoption had a lower debt ratio, which is in line with the findings of Safiullah et al. (2024) stating that green innovation reduced corporate default risks by means of lower cash flow volatility and risk-taking of managers. While the measures are different, the findings prove that green innovation might be helpful for achieving financial stability instead of just being profitable.

It should be interpreted with caution that panel effects on ROA and Tobin's Q are insignificant. While correlation analysis revealed a significant relationship with ROA ($r = 0.221$, $p < 0.001$) and Tobin's Q ($r = 0.239$, $p < 0.001$), these relationships turn out to be insignificant after considering panel structure and firm features. It may mean that some initial relationships are partially explained by some other features of firms implementing green practices. Han et al. (2025) reveal the connection between climate-risk disclosure, green innovation, and enterprise value through information-related channels. Thus, market valuation depends not only on green innovation but also on the quality and credibility of green innovation and its future benefits. The results specific to each policy show that green innovation is heterogeneous. GBP was highly effective in reducing Debt Equity Ratio, while SPP contributed to improving both Turnover Ratio and Tobin's Q, whereas WRP was effective in improving Turnover Ratio. However, no such improvements were observed for ESP and CCP. The findings corroborate with the claims made by Liu et al. (2024) on innovation quality and Jiang et al. (2025) on different types of green innovation. The results from Xu & Liu (2025) suggest that green-finance policies can enhance green innovation and financial performance, even when there may be some trade-off in terms of resource constraints. This may be one of the reasons why the improvements in operations of the current research did not lead to improvement in ROA.

From the findings related to governance, it becomes evident that the effectiveness of green innovation also depends on governance. In particular, Board Diversity positively moderates the association between Green Innovation and Debt-Equity Ratio ($\beta = -2.167$, $p = 0.023$) and Women Director Proportion positively moderates the association between Green Innovation and Turnover Ratio ($\beta = 2.676$, $p = 0.011$). These findings support the results obtained by An et al. (2024), who argue that the effectiveness of green innovation requires independent director participation, and by Hao & He (2022), who identify governance mechanisms influencing the relationship between CSR performance and green innovation. The findings reported by Yu et al. (2022) about the negative effect of governance uncertainty on corporate green innovation also confirm this idea. Nevertheless, governance was not uniformly beneficial. Board Size negatively moderated the Green Innovation–ROA connection ($\beta = -1.054$, $p = 0.001$). This indicates that although having a large board might give more expertise, it can also lead to coordination problems in decision-making. Hu & Hong (2023) stressed the significance of incentive structures and research and development spending in transforming an organization's assets into green innovations, indicating that the effectiveness of governance is dependent on how the governance process operates rather than on its scale. In the same vein, Chu et al. (2025) revealed that governance monitoring can alleviate agency problems and foster green innovation.

One noteworthy result is that the ESG Score is not a significant moderator for the association between Green Innovation and firm performance with respect to all five performance measures. This suggests that the use of an aggregate ESG Score might not be able to fully capture the link between green innovation and financial performance.

More specifically, the various governance mechanisms such as Board Diversity and Women Director Proportion have a greater moderation effect in this current study. In general, the results reveal that green innovation does not contribute to all aspects of firm performance in the same way. Its highest impacts are found in operational efficiency and leverage, whereas its impact on profitability and market valuation is less clear after controls.

6. Conclusion

Conclusively, green innovation positively impacts firm performance, but the impacts are multidimensional and heterogeneous across all aspects of performance measured. Green Innovation Adoption had a positive impact on operational efficiency through Turnover Ratio and lowered the debt equity ratio, implying a positive effect on the financial structure of firms. However, the impact on liquidity, profitability, and market performance was statistically insignificant in panel models. The study revealed that the analysis of individual green practices revealed that Sustainable Procurement Practices and Waste Reduction Practices were significant in operational efficiency, while Green Business Practices were linked to lower leverage. The study also confirms that corporate governance is an important determinant in translating green innovation into performance. The more diverse the board is, the more pronounced the impact of green innovation on leverage. On the other hand, the greater the proportion of women directors is, the higher the impact of green innovation on operational efficiency. The larger the board size, the lower the effect of green innovation on ROA.

The research has theoretical, managerial, and policy implications. From a theoretical perspective, the findings indicate that the link between green innovation and organizational performance is not always positive and depends on the specific financial metric and the governance context. Thus, the study contributes to the relevant literature by highlighting corporate governance as a contextual factor that can enhance or diminish the financial effects of green innovation. From a managerial perspective, the results of the research indicate that green innovation should not be separated from operational and financial management but combined with it. Sustainable procurement, waste minimization, and other efficiency-oriented green innovations can contribute to tangible financial performance. Moreover, boards should focus on diversity and specifically female presence since these traits can enhance particular aspects of green innovation. Increasing the size of the board alone is not expected to boost performance. For policymakers, the research implies that policymakers should pursue a policy that favors green innovation among corporations, while at the same time improving the quality of their governance and reporting of sustainability. The research may also be useful for investors to assess the nature of the firm's greenness and governance separately from its overall ESG rating. Overall, the findings emphasize the importance of combining environmental innovation with effective governance to achieve sustainable financial performance.

There are several limitations associated with the research. Firstly, the research considers firms chosen based on NIFTY ESG 100, which may hinder the ability to generalize the results for small firms or for other firms that are not included in the index and operate in other sectors of industry rather than in the chosen green industry. Secondly, the research is based on secondary data and, thus, the reliability of the results depends on the quality and consistency of the information disclosed by firms. Thirdly, the 2019-2026 period might not cover the impact of green innovation on the financial performance of the companies. Finally, the ESG Score and governance factors might not fully reflect the qualitative aspects of sustainability practices and board effectiveness.

Future research can be continued in the direction of expanding the analysis sample by involving a larger number of firms of different types, such as SMEs, non-index firms, as well as firms in different countries or industries. It would be possible to conduct a comparative study of emerging and developed countries in order to find out how the institutional and regulatory environment affects the relationship between green innovation and performance of a firm. Future research should focus on longer periods of observation as the financial effects of green innovation appear slowly. Future research may also be focused on distinguishing incremental and radical green innovation and checking whether the quality of innovation is more important than its adoption when it comes to the financial outcome. In

addition, further research should include other types of corporate governance, such as characteristics of CEOs, ownership concentration, institutional ownership, audit committee, and incentives for executives. Future research could also analyze the effect of quality of ESG disclosure, green finance, or environmental regulation as a mediator or moderator of the studied relation.

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