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The influence of green board, board size, ROA, and leverage ratio on green innovation

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ABSTRACT

This study examines the influence of the green board committee, board size, return on assets, and debt ratio on green innovation in 79 Indonesian companies listed on the stock exchange. Data analysis used multiple linear regression using STATA and showed that green board committees and larger board size encourage green innovation, while a high ROA also contributes positively. In contrast, a high debt ratio inhibits green innovation. These findings indicate that firms need to balance between good governance, solid financial performance, and debt risk management to effectively adopt green innovation. Previous studies tend to focus on non-financial factors such as the Green Board Committee and Board Size, while research examining the interaction between non-financial and financial factors in driving GI is still very limited, especially in Indonesia. In fact, a comprehensive understanding of the combined influence of non-financial and financial factors is essential to effectively drive GI adoption.

Introduction

In response to the increasingly urgent threat of climate change, Green Innovation (GI) has evolved from a mere ethical choice into a core strategy for ensuring business sustainability across various sectors (Coppola & Blohmke, 2019). Furthermore, firms' ability to adopt environmentally friendly processes has been shown to be positively correlated with overall sustainability performance, as GI significantly enhances productivity and operational efficiency (Chang, 2011; Sarfraz et al., 2022). Consequently, investment in GI has become a key parameter within the Environmental, Social, and Governance (ESG) framework, shaping corporate competitiveness in the eyes of global investors (Busco et al., 2020; Cao et al., 2021).

In Indonesia, the push toward sustainable business practices has been initiated through the mandatory implementation of Corporate Social Responsibility (CSR) as stipulated in Law, UU No. 40 of 2007; however, its implementation often remains confined to philanthropic and donation-based activities (Andayani et al., 2023). This phenomenon calls for a paradigm shift toward deeper integration of Green Innovation (GI), in which green technological innovation catalyzes for firms to achieve the Sustainable Development Goals (SDGs) (Zhu et al., 2024). The adoption of GI in the domestic market is increasingly driven by changing consumer preferences that prioritize ecological considerations, compelling firms to embed environmental knowledge into their organizational routines (Guinot et al., 2022). By integrating GI into good corporate governance (GCG) practices, Indonesian firms can not only enhance firm value in the capital market but also establish a solid foundation of responsible behavior that supports long-term economic growth (Lazaretti et al., 2020; Minggu et al., 2023).

The implementation of transformative Green Innovation requires structured internal governance mechanisms to ensure that sustainability practices are effectively executed. In this regard, the presence of dedicated departments or committees within an organizational structure is crucial for overseeing corporate green agendas. In line with Elmaghrabi (2021), firms that establish specialized committees, such as CSR or sustainability committees, tend to exhibit more stable strategic performance and lower levels of controversy. Studies by Velte and Stawinoga (2020), along with several others (Baraibar-Diez & Odriozola, 2019; Hörisch et al., 2020), further confirm that such committees positively influence ESG reporting quality and overall firm performance. However, most of these studies are limited to examining administrative CSR performance or financial outcomes alone. Therefore, a significant gap in the literature persists, as no study has explicitly linked the role of these committees to firms' capacity to generate Green Innovation. However, these committees are expected to function as strategic decision-makers in allocating resources for the research and development of environmentally friendly technologies that lie at the core of future sustainability.

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In another context, board size also plays a role in influencing green innovation decisions. Research conducted by Zhao et al. (2022) examines the relationship between board size and green innovation and finds a positive effect. This study was carried out on companies listed on the China Stock Exchange during the 2015–2020 period. Consistent with this finding, Asni and Agustia (2022) state that corporate governance mechanisms, including board size, positively impact green innovation. Their research was conducted on companies operating in Indonesia.

Meanwhile, from a financial perspective, green innovation requires sufficient funding, which can be sourced internally through company profits. A company's profitability is commonly measured using the Return on Assets (ROA) ratio (Kayakus et al., 2023). However, Siminica et al. (2019) found that ROA negatively affects the environmental dimension of CSR. In line with this, Khan et al. (2021) argue that lower ROA levels tend to increase green innovation activities. Conversely, this finding is challenged by Li et al. (2017), who report that profitability positively affects green innovation products. Similar results were also identified by Kartika and Utami (2019), who found that financial performance measured by ROA has a positive influence on firm value. Comparable findings were presented by Husna and Satria (2019) as well as Wang and Ahmad (2024). Furthermore, firm value subsequently influences sustainability disclosure and sustainability-oriented innovation (Zhang et al., 2020). These differing perspectives indicate that the effect of ROA on sustainability and, ultimately, on green innovation remains inconclusive.

Another source of funding for green innovation is external financing. In China, the government provides subsidies to encourage green innovation. However, the role of debt financing in strengthening green innovation diminishes over time (Chen et al., 2022; Xiang et al., 2022). Other studies reveal that although high levels of debt involve greater risk, effective management can enhance innovation performance and enable firms to operate efficiently (Nemlioglu & Mallick, 2021). According to Azim Khan (2023), debt levels do not necessarily create a negative relationship between leverage and the innovation scale. Instead, leverage becomes a relevant factor depending on whether the firm is below or above its target leverage. Thus, previous studies have presented mixed findings regarding the role of leverage in influencing sustainability outcomes.

Research on Green Innovation (GI) and corporate governance has been extensively conducted in developed countries such as China, Germany, and France (Velte & Stawinoga, 2020). However, Indonesia presents a distinct context characterized by developing environmental regulations, varying levels of public awareness, an economic structure dominated by MSMEs, and limited availability of sustainability-related information. These conditions may result in different dynamics in the implementation of GI practices (Mazaj et al., 2022). Previous studies have largely focused on non-financial factors such as the Green Board Committee and Board Size. Research examining the interaction between governance factors and financial performance in driving GI remains limited, particularly in the Indonesian context. In fact, a comprehensive understanding of the combined influence of governance mechanisms and financial performance is crucial for effectively promoting green innovation adoption (Pfeffer & Salancik, 2015).

This study addresses an important gap in the literature by comprehensively examining the combined effects of governance factors (Green Board Committee and board size) and financial performance indicators (ROA and Leverage Ratio) on green innovation in Indonesian companies. This research is grounded in stakeholder theory and decision-making theory, which emphasize the importance of considering the interests of various stakeholders, including environmental concerns, in corporate decision-making processes. The findings of this study are expected to contribute theoretically to the development of green innovation literature in developing countries and offer practical implications for Indonesian companies in formulating effective GI strategies, policymakers in designing regulations that support green innovation, and investors in evaluating corporate sustainability performance.

Literature Review

This study adopts the stakeholder theory perspective to examine the influence of the Green Board Committee, Board Size, ROA, and Leverage Ratio on Green Innovation. Stakeholder theory emphasizes the role of interested parties, including directors, employees, shareholders, consumers, communities, and other groups, in affecting a company's performance in achieving its objectives (Freeman & McVea, 2005). This theory incorporates various ethical principles, such as cooperation, trust, and managerial trustworthiness, which can create competitive advantages for organizations (Jones, 1995). Beyond ethical considerations, stakeholder theory emphasizes the principle of fairness, which is rooted in mutually beneficial cooperation. Companies have responsibilities toward stakeholders in return for the contributions they provide, ensuring that both parties obtain benefits (Phillips, 1997). Therefore, achieving corporate sustainability requires balancing the interests of all stakeholders (Freeman, 1984). However, not all stakeholders and sustainability issues exert equal influence on companies. Consequently, firms must identify and select sustainability practices that are appropriate for their activities and organizational goals (Hörisch et al., 2020). Stakeholders play a significant role in shaping corporate decisions regarding environmental responses (Murillo-Luna et al., 2008). Moreover, environmentally conscious stakeholders encourage and drive the development of eco-friendly innovations (Wagner, 2007).

Decision-Making Theory

This study also adopts the perspective of decision-making theory to examine the influence of the Green Board Committee, board size, ROA, and leverage ratio on Green Innovation. Decision-making theory explains how individuals make rational decisions, in which the decisions taken are beneficial and acceptable to both decision-makers and society (Edwards, 1954). This theory is closely related to the rationale underlying decision-making processes (White, 2018). It further helps in understanding the underlying reasons behind decisions, whether they are driven by beliefs, desires, or values (Steele & Stefansson, 2015). Effective decision-making is reflected in outcomes that can be presented transparently, where information and perceptions of various stakeholders are integrated into the process (Martin, 2015). Through the flow of information, innovation-related decisions are screened and evaluated, and the most effective alternatives are ultimately selected (Wincent et al., 2010).

Hypothesis Development

Green Board Committee in Green Innovation

The Green Board Committee (GBC) is tasked with formulating strategies and policies, managing risks, and overseeing and monitoring sustainability practices related to both social and environmental aspects (Shahzad et al., 2020). The role of the GBC is inherently aligned with Stakeholder Theory, which argues that a company's long-term survival and success depend on its ability to fulfill the needs of a broad range of stakeholders—not only shareholders—but also by addressing social and environmental concerns (Chams & García-Blandón, 2019). This responsibility encourages firms to implement tangible green practices, such as Green Innovation (GI), and establish formal sustainability policies to manage complex environmental and business challenges (Guinot et al., 2022). Over time, this committee has developed from a mechanism focused solely on maximizing shareholder value to one that also responds to the expectations of a wider group of stakeholders. Although the GBC may be referred to by different names across companies, such as the CSR Committee, Sustainability Committee, or ESG Committee, its fundamental roles and responsibilities remain consistent.

The importance of establishing a GBC is supported by empirical evidence. The presence of a dedicated CSR or Sustainability Committee has been shown to support the formulation of accurate and strategic business strategies (Elmaghrabi, 2021) and to reduce the risk of failure in sustainability initiatives (Gennari, 2019). Research conducted in various contexts demonstrates that comprehensive and transparent CSR activities, when supervised by such committees, positively contribute to environmentally sustainable development and actively promote Green Innovation (Kraus et al., 2020; Shahzad et al., 2020; Mukhtar et al., 2023).

Within this framework, the GBC functions as a key governance driver of the GI. By institutionalizing the supervision of environmental performance, the GBC allows firms to move beyond mere reactive compliance. In particular, the GBC applies the principles of Decision-Making Theory by ensuring that significant investments in GI are supported by careful observation, risk evaluation, and appropriate resource allocation. Through this mechanism, external stakeholder pressures, as emphasized in Stakeholder Theory, are translated into internal, strategic, and focused corporate actions. This provides the organizational structure and strategic momentum required for the costly and complex implementation of Green Innovation. Therefore, the hypothesis proposed in this study is as follows:
H_1: The Green Board Committee has a positive influence on Green innovation.

Board Size on Green Innovation

The Board of Directors functions as the company's main governance body, bearing the responsibility of supervising and managing operations, including strategic and technological decision-making (Usman et al., 2020). Board size is directly associated with its representational capacity within the framework of Stakeholder Theory. A larger board is more capable of accommodating diverse stakeholder pressures, ranging from employees and competitors to government authorities and the broader public, particularly in relation to environmental sustainability issues (Guoyou et al., 2013; Weng et al., 2015). This wider representation ensures diversity in board members' skills, experiences, and external networks, which subsequently enhances the board's overall capability to address complex decisions such as the adoption of Green Innovation (GI) (Yousaf et al., 2024; Veronica et al., 2020; Feng et al., 2022).

Empirical evidence consistently demonstrates a positive relationship between large board size and sustainability-related outcomes. Prior studies indicate that an increase in the number of board members allows firms to access more diverse knowledge, greater resources, and broader experience, all of which support the effective implementation of strategic initiatives. In the context of environmental strategy, research conducted in Indonesia shows that strong corporate governance practices, including board size, positively influence green innovation (Asni & Agustia, 2022). Similar findings are evident in emerging market settings, where studies in China reveal a significant positive relationship between board size and green innovation activities (Lee et al., 2021).

From the perspective of decision-making theory, a larger board size enhances the quality and scope of strategic choices concerning GI. When the board is larger, it inherently possesses a greater volume of knowledge

and resources needed to evaluate the high costs and risks associated with environmental innovation (Feng et al., 2022). Moreover, a larger board enables the utilization of a broader external network, allowing for more targeted and efficient identification of GI opportunities and reducing information asymmetry. This collective wisdom, driven by diverse perspectives, ensures that the decision-making process for resource-intensive sustainability practices is robust, well-vetted, and effectively aligned with stakeholder expectations. Consequently, a larger board size is better positioned to approve, resource, and execute sophisticated Green Innovation strategies. Therefore, the hypothesis proposed in this study is as follows:
H_2: Board size has a positive influence on Green innovation

Return on Assets (ROA) on Green Innovation

Stakeholders may pressure companies to adopt sustainable practices through green innovation. Although such initiatives can potentially reduce company profitability in the short term, the alignment between stakeholder expectations and the actions taken by the firm can create a balance between financial performance and environmental responsibility (Mazaj et al., 2022; Weng et al., 2015). Return on Assets (ROA), on the other hand, represents the efficiency of company management in utilizing economic resources to generate profits (Puspitasari et al., 2021). Companies that achieve high ROA while simultaneously emphasizing green innovation are generally more attractive to investors concerned with environmental issues (Wan et al., 2022; Zhao et al., 2023).

ROA has been shown to be positively associated with firm value (Husna & Satria, 2019). This finding is also supported by Kartika and Utami (2019), who demonstrate that financial performance measured by ROA has a positive and significant effect on firm value. Firm value influences sustainability disclosure and sustainability-oriented innovation (Zhang & Wang, 2020). The implementation of green innovation also feeds back into financial performance, including ROA (Wang & Ahmad, 2024). Furthermore, Li et al. (2017) state that strong profitability encourages the development of environmentally friendly product innovations

ROA is a measure of financial performance. The high value of ROA attracts potential investors. A high ROA value also indicates that the company has a good level of operational efficiency. This efficiency can be obtained from green innovation, which increases operational efficiency. Therefore, the hypothesis proposed in this study is as follows:
H_3: Return on Assets (ROA) has a positive impact on Green innovation

Leverage Ratio on Green Innovation

The leverage ratio is commonly used as an indicator of financial risk because it reflects the proportion of a company's debt in its financing structure (Acosta-Smith et al., 2024); (Mukhammedova & Akromov, 2021). Creditors concerned with sustainability issues may encourage firms to engage in green innovation to mitigate long-term environmental risks (Wang et al., 2021). Companies with high leverage experience greater financial pressure; however, this pressure can also drive operational efficiency and stimulate the development of new green innovations that attract support from other stakeholders (Appiah, 2023 ; Li et al., 2017).

Nemlioglu and Mallick (2021) state that high leverage entails significant risk. Nevertheless, with effective management, innovation activities can continue to operate successfully. Furthermore, Khan (2023) argues that the level of debt does not necessarily exert a negative influence on innovation. Instead, its effect depends on whether the firm's leverage is below or above its targeted threshold.

The leverage ratio is one of the ratios that can identify the amount of debt a company has to run its operations. A company with a high leverage value will operate under pressure, especially from creditors. Creditors want the loan money back in a certain amount, and the company agrees to it. Therefore, the company will take more careful steps to reduce the risk of default. Companies tend to make decisions that are efficient for their financial and sustainability surroundings, in this case, green innovation, which supports sustainability. Therefore, the hypothesis proposed in this study is as follows:
H_4: Leverage ratio has a positive influence on Green innovation

Based on the previous hypothesis, Figure 1 shows the conceptual framework of this study and the relationship between independent and dependent variables.

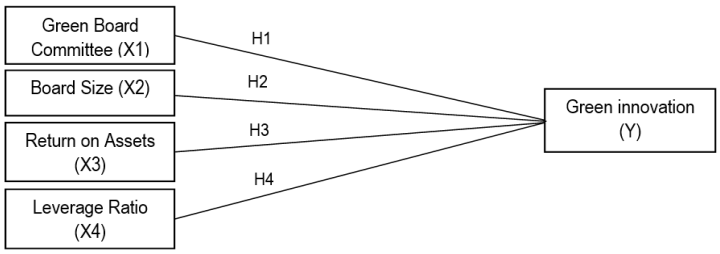

Figure 1. Conceptual Framework

Research Method

This study employs a quantitative-associative method, utilizing secondary data obtained from annual and sustainability reports. This quantitative approach was chosen to measure the effect of the Green Board Committee (GBC), Board Size, Return on Assets (ROA), and Leverage Ratio on Green Innovation using data that will be measured on a numerical scale and analyzed using statistical data. An associative method was used to determine the cause-and-effect relationships between the variables.

The study sample was selected using purposive sampling. This was chosen because the sample results obtained would be more in line with the aims and objectives of this study (Campbell et al., 2020). Sampling uses company data that are available or listed on the Indonesia Stock Exchange on the idx.co.id website. The reason for choosing this sample on the IDX is that the IDX is an official institution that oversees companies that go public in terms of reporting obligations and transparency, whereas the IDX is also a stock information center for the public.

The availability of data in this sampling method is also a consideration. In this study, the availability of the ESG Score will better ensure that the company is interested in and concerned about sustainability. Therefore, this study uses samples from companies that have an ESG Score in 2023 and have been verified by IDX.co.id. Data related to annual and sustainability reports are also needed to analyze variables. This study deliberately selected 2023 as the sole observation period based on strategic considerations related to data quality and availability. The year 2023 represents a critical milestone in sustainability reporting practices in Indonesia, following the broader adoption of digital ESG reporting, facilitated by the integration of electronic reporting systems at the Indonesia Stock Exchange (SPE-IDXnet). This shift toward standardized digital reporting reduced inconsistencies arising from manual disclosure formats in prior years, thereby enhancing the reliability, transparency, and cross-firm comparability of green innovation-related data. The sample selection process and final sample characteristics are presented in Table 1.

Table 1. Sample Selection Characteristics

No.	Criteria	Total
1	Companies listed on the IDX until December 2023	810
2	Companies without ESG-Score from IDX	(731)
3	Company does not publish annual report 2023	(0)
4	The company does not publish a sustainability report for 2023	(0)
	Total sample	79

This study included both independent and dependent variables. The independent variables in this study are the Green Board Committee (GBC), Board Size, Return on Assets (ROA), and Leverage Ratio. The calculation of the Green Board Committee (GBC) adopts the suggestions from the study of (Shah et al., 2022). For the measurement of board size, the number of board members presented in both the annual report and the sustainability report was used.

The collected data is analyzed using multiple linear regression in STATA, accompanied by robustness regression testing. The test results will show positive/negative results and significance. Significance using values of 0.05 and 0.1. This test will see the significance of the influence of the independent variable on the dependent variable. The independent variables are the Green Board Committee, Board Size, ROA, and Leverage Ratio, and the dependent variable is Green Innovation. For the test, the following model was used:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Description:
Y = Green Innovation
α = Constant
β1 - β4 = Regression Coefficient
X_1 = Green Board Committee
X_2 = Board Size
X_3 = Return on Assets (ROA)
X_4 = Leverage
ε = Error Term

The operational definitions and measurement approaches for each research variable are summarized in Table 2, providing clarity regarding how green innovation, green board commitment, board size, return on assets, and leverage ratio are defined and measured in this study.

Table 2. Variable Definition and Measurement

Variables	Definition	Measurament
Green Innovation	Green innovation includes policies and practices aimed at improving economic and social outcomes while reducing environmental degradation. These innovations are closely linked to sustainability and are considered essential for addressing environmental challenges in today's business environment (Guinot et al., 2022)	If reporting at least one product or service made for the company's concern for the environment, or products marketed are labeled as environmentally friendly, then 1. If not, then 0.
Green Board Committee	The Green Board Committee is the committee responsible for setting strategies and policies, managing risks, controlling, and monitoring sustainability practices related to people and the environment (Rashed & Shah, 2021)	Suppose there is information on strategy and policy, risk management, supervision, and control, then 1. If incomplete, then 0. If there is a sustainability report, then 1. If incomplete, then 0. If all data is presented completely, then 2.
Board Size	The board of directors is the central body of a modern company. Its duties include supervision and management of operations. Operational efficiency plays an important role in the company's strategic decision-making, business performance, and technological innovation. (Sana et al., 2023)	Number of board members
Return on Assets	Return on Assets is a profitability ratio that shows how much profit a company can generate from its assets. (Puspitasari et al., 2021)	$\frac{Net\ profit}{Total\ assets} x100\%$
Leverage Ratio	The leverage ratio (debt ratio) is an indicator of a company's financial condition that characterizes the ratio of an organization's debt to its total assets (Mukhammedova & Akromov, 2021)	$\frac{Total\ debt}{Total\ euqity}$

Results and Discussion

Table 3. Descriptive statistics of the whole sample

Variable	Obs	Mean	Std. dev.	Min	Max
GBC	79	1.518987	.527713	0	2
Board	79	6.506329	2.635426	2	15
ROA	79	.291519	1.571187	0	13.85
Lev	79	.4640506	.2275484	.03	.99
GI	79	.8227848	.3842907	0	1

Source: processed data

Based on Table 3 is a descriptive statistics table that shows the distribution of data across the sample. The results show that the average score for the Green Board Committee (GBC) is 1.52 (with a minimum value of 0 and a maximum of 2). This figure indicates that the majority of the sample companies have formally established a Green Board Committee (GBC) responsible for environmental and sustainability initiatives. The average score for Green Innovation (GI) is 0.82 (with a maximum value of 1). This high value suggests that the sample companies collectively possess a strong level of Green Innovation implementation or are already operating close to the optimal level. The average size of the Board of Directors (Board) is 6.51 members, with the number of members varying widely between 2 and 15. This demonstrates a diverse corporate governance structure within the sample, although the average board size remains within a common range (around 6-7 members) for strategic oversight and decision-making. The average Return on Assets (ROA) for the companies is 0.29%. However, the wide variation (standard deviation of 1.57) and the range from a minimum of 0 to a maximum of 13.85% are notable. This extreme difference implies a significant gap in profitability among the sample companies, with some firms being highly profitable while others report very low or neutral profitability. The average Leverage Ratio (Lev) is 0.46 or 46%. This figure indicates that, on average, approximately 46% of the companies' total assets are financed through debt. With a range from a minimum of 3% (0.03) to a maximum of 99% (0.99), it is clear that the companies' financing strategies vary significantly, from those with minimal debt to those highly reliant on external financing.

As shown in Table 4, the bivariate analysis using the Pearson Chi-Square test examined the relationship between the Green Board Committee (GBC) as the independent variable and Green Innovation (GI) as the dependent variable. The Pearson chi-square statistic was 6.1176 with a significance level (p-value) of 0.047. Since the p-value is below the 0.10 threshold, the findings indicate a statistically significant association between Good Corporate Governance and Green Innovation. This result suggests that variations in the level of Good Corporate Governance across firms are associated with differences in the extent of Green Innovation adoption.

Table 4. Bivariate Test of GBC (X1) on GI (Y)

GBC	GI=0	GI=1	Total
0	1 (0.2)	0 (0.8)	1 (1.0)
1	8 (6.4)	28 (29.6)	36 (36.0)
2	5 (7.4)	37 (34.6)	42 (42.0)
Total	14 (14,0)	65 (65,0)	79 (79,0)
	Pearson chi2(2) = 6.1176		Pr = 0.047

Source: processed data (STATA)

As shown in Table 5, the bivariate analysis using the Pearson Chi-Square test examined the relationship between Board Size as the independent variable and Green Innovation as the dependent variable. The Pearson chi-square statistic was 11.4793 with a significance level (p-value) of 0.404. Since the p-value exceeds the 0.1 threshold, the findings indicate that there is no statistically significant association between Board Size and Green Innovation.

Table 5. Bivariate Test of Board Size (X2) on GI (Y)

Board Size	GI = 0	GI =1	Total
2	1	0	1
3	1	5	6
4	3	6	9
5	3	13	16
6	1	14	15
7	3	10	13
8	0	4	4
9	1	2	3
10	1	2	3
11	0	3	3
12	0	5	5
15	0	1	1
Total	14	65	79
	Pearson chi2(11) = 11.4793		Pr = 0,404

Source: processed data (STATA)

Table 6. Bivariate Test of ROA (X3) on GI (Y)

ROA	GI=0	GI=1	Total
.00	2	7	9
.01	1	14	15
.02	0	4	4
.03	1	7	8
.04	2	0	2
.05	0	3	3
.06	2	1	3
.07	2	4	6
.09	0	3	3
.10	0	4	4
.11	0	2	2
.12	0	1	1
.13	0	1	1
.15	1	2	3
.16	1	0	1
.18	0	1	1
.20	0	1	1
.22	1	1	2
.23	0	1	1
.26	0	1	1
.32	0	1	1
.33	1	0	1
.38	0	1	1
.43	0	2	2
.50	0	1	1
2.43	0	1	1
13.85	0	1	1
Total	14	65	79
	Pearson chi2(26) = 34.2119		Pr = 0.130

Source: processed data (STATA)

As shown in Table 6, the bivariate analysis, conducted using the Pearson Chi-Square test, examined the relationship between Return on Assets (ROA) as the independent variable and Green Innovation as the dependent variable. The analysis yielded a Pearson chi-square value of 34.2119 with a corresponding p-value of 0.130. Since the p-value exceeds the conventional threshold of 0.05, the results suggest that there is no statistically significant association between Return on Assets and Green Innovation. Consequently, a firm's profitability, as measured by ROA, does not appear to have a meaningful impact on the adoption of Green Innovation practices.

Table 7. Bivariate Test of Leverage (X4) on GI (Y)

Leverage	GI = 0	GI = 1	Total
.03	0	1	1
.08	1	0	1
.10	0	1	1
.11	0	2	2
.12	0	2	2
.13	1	1	2
.15	0	1	1
.18	0	1	1
.20	0	1	1
.22	1	0	1
.23	0	1	1
.25	0	1	1
.27	0	1	1
.28	1	1	2
.29	0	3	3
.30	0	1	1
.34	3	2	5
.36	0	1	1
.38	0	1	1
.39	0	2	2
.41	1	1	2
.42	1	0	1
.44	0	3	3
.45	0	3	3
.46	0	3	3
.47	0	1	1
.48	0	1	1
.49	0	1	1
.51	0	1	1
.53	1	1	2
.54	0	3	3
.55	0	1	1
.56	0	1	1
.57	0	1	1
.58	0	1	1
.59	0	1	1
.60	3	0	3
.61	0	1	1
.65	0	1	1
.70	0	2	2
.71	1	0	1
.73	0	1	1
.74	0	2	2
.75	0	1	1
.76	0	2	2
.80	0	1	1
.82	0	1	1
.83	0	1	1
.84	0	1	1
.85	0	1	1
.86	0	1	1
.87	0	1	1
.99	0	1	1
Total	14	65	79
	Pearson chi2(52) = 57.0536		Pr = 0.293

Source: processed data (STATA)

As shown in Table 7, the bivariate analysis using the Pearson Chi-Square test was conducted to examine the relationship between Leverage (independent variable) and Green Innovation (dependent variable). The test yielded a Pearson chi-square value of 57.0536 with a corresponding p-value of 0.293. As the p-value is greater than 0.05, the result suggests that there is no statistically significant association between Leverage and Green Innovation. This indicates that a company's leverage level does not have a significant impact on its implementation of Green Innovation.

Table 8. Robustness Regression

GI	Coefficient	Robust Std. err.	t	p>|t|	[95% cof.	Interval]
GBC	.1516784	.0862581	1.76	0.083**	-.0201945	.3235513
Board	.026094	.0153882	1.70	0.094**	-.0045677	.0567557
ROA	.0151963	.007354	2.07	0.042 *	.0005431	.0298495
Lev	.1053914	.1724825	0.61	0.543	-.2382874	.4490702
_cons	.3692742	.1918573	1.92	0.058	-.0130098	.7515582
F (4,47)	(3,54)					
R-Squared	0,0846					

*significant at 0.05; **significant at 0.1.
Source: processed data (STATA)

As shown in Table 8, this regression table aims to measure the extent to which various internal corporate factors influence the level of Green Innovation (GI) undertaken by companies. The study employs the Robustness Regression method as its primary analytical tool. The use of this method is critical because it ensures that the resulting findings are stable and unbiased, even in the presence of extreme data points or outliers (i.e., companies with performance levels significantly higher or lower than the average). Overall, the model (with an R^2 value of 0.0846) is only capable of explaining approximately 8.46% of the total variation in Green Innovation. This figure suggests that while the factors under examination, such as the Green Committee, Board of Directors, and Financial Performance, are indeed influential, other factors outside the model play a more dominant role in driving firms towards green innovation.

In this study, significance levels are set at 10% (0.1) and 5% (0.05). The Green Board Committee (GBC) and Board of Directors Size (Board) both demonstrate a positive influence on Green Innovation (both are statistically significant at the 10% level). The presence of the Green Committee (GBC) has a larger positive impact (Coefficient of 0.152) compared to the Board size (Coefficient of 0.026). This finding indicates that having a formal, dedicated unit focusing on environmental issues, coupled with an adequate number of Board members, provides a structured and legitimized impetus for companies to actively engage in environmentally friendly projects.

The Return on Assets (ROA) variable, representing Financial Performance, exhibits the strongest positive and most significant influence on Green Innovation (p=0.042). This is the most robust finding, implying that companies that are currently profitable or possess high profitability levels are more inclined to pursue Green Innovation. Simply put, Green Innovation often requires substantial capital investment, and only firms with strong financial capacity are likely to have the necessary resources and incentives to undertake these costs. Conversely, the company's Leverage (Lev), or debt ratio, shows no significant influence on Green Innovation (p=0.543). This suggests that a firm's decision to pursue green innovation is neither encouraged nor deterred by the amount of debt it holds.

The regression results support the findings from the bivariate analysis, indicating that the Green Board Committee (GBC) plays a significant role in driving Green Innovation at the 10% significance level. Interestingly, Board Size, which was previously insignificant in the bivariate test (p=0.404), became significant in the regression model. This suggests that while the number of board members alone does not directly promote innovation, their presence contributes to the effectiveness of formal structures like the GBC. The impact of the GBC is notably higher (coefficient 0.152) than that of Board Size (0.026), highlighting that a specialized environmental committee has a stronger influence on ensuring strategic commitment to green initiatives than simply increasing the number of board members.

Furthermore, the robust regression shows that ROA is the most significant factor driving Green Innovation (p=0.042), serving as the company's "financial engine." Although the initial bivariate analysis did not show a significant relationship (p=0.130), the regression model reveals that profitability becomes an important determinant once governance factors are taken into account. In contrast, Leverage remains insignificant in both the bivariate (p=0.293) and regression (p=0.543) analyses. Overall, these findings indicate that Green Innovation in Indonesian listed companies is primarily influenced by internal financial capacity and "slack resources," rather than external debt financing, which may limit the company's ability to undertake high-risk environmental investments.

Effect of Green Board Committee on Green Innovation

The presence of a Green Board Committee (GBC) within contemporary corporate governance structures should not be interpreted merely as a symbolic response to regulatory expectations. Rather, it represents a strategic governance

mechanism that shapes firms' long-term environmental orientation. Rashed and Shah (2021) emphasize that GBCs play a critical role in identifying risks associated with the transition toward a green economy and in monitoring the effectiveness of sustainability-related controls. Through this function, the GBC serves as an institutional link between the board's environmental vision and managerial execution, ensuring that investment decisions remain aligned with environmental preservation objectives.

This governance role is well aligned with Stakeholder Theory as articulated by Freeman et al. (2021), which posits that firms are accountable not only to shareholders but also to a broad range of stakeholders, including regulators, environmentally conscious investors, and civil society. The establishment of a GBC provides a formalized platform through which firms can systematically respond to these stakeholder pressures. In the absence of such a committee, green initiatives are often overshadowed by short-term financial priorities. Conversely, a dedicated GBC facilitates sustained resource allocation toward Green Innovation (GI), positioning it as a legitimacy-enhancing strategy amid growing global demand for environmentally responsible products and practices.

From a decision-making perspective, the existence of a GBC enhances the rationality and technical depth of strategic choices related to sustainable innovation (Shah et al., 2021). Green Innovation initiatives, whether product- or process-based, are typically capital-intensive and subject to considerable uncertainty. The GBC mitigates these risks by incorporating expert evaluation and informed judgment into the decision-making process. As a result, the innovations pursued are more likely to reflect substantive environmental improvements rather than symbolic actions or greenwashing, contributing to waste reduction and energy efficiency in a tangible manner.

Moreover, empirical evidence suggests that embedding a GBC within the organizational structure reduces the likelihood of sustainability-related failures (Elmaghrabi, 2021; Gennari, 2019). Acting as an oversight body, the committee proactively assesses potential environmental and social risks before they escalate into legal or reputational challenges. This observation is consistent with Velte and Stawinoga (2020), who find that governance specialization through sustainability committees is positively associated with higher transparency and improved sustainability reporting quality. Enhanced disclosure, in turn, strengthens investor confidence and lowers firms' cost of capital, thereby expanding their capacity to finance green research and development (R&D) activities.

More specifically, the GBC's focus on eco-friendly innovation extends across the entire product life cycle, encompassing low-emission design, efficient production processes, and sustainable after-sales services. By emphasizing technological efficiency and waste minimization, the committee ensures that Green Innovation delivers both environmental benefits and competitive advantages through product differentiation in global markets. Accordingly, the strategic alignment between the GBC's mandate and the operational implementation of green innovation provides a robust theoretical and empirical foundation for testing Hypothesis 1 in this study.

Effect of Board Size on Green Innovation

Corporate governance structures, particularly board size, play a pivotal role in shaping firms' strategic responses to environmental challenges. From a theoretical standpoint, a larger board does not merely indicate an increase in headcount but reflects an expansion of cognitive capacity and diversity of viewpoints within the organization. Drawing on Decision-Making Theory, a broader composition of board members enhances deliberative processes by enabling more thorough, rational, and evidence-based evaluations before innovation-related decisions are made (Steele & Stefansson, 2015). This is especially relevant for Green Innovation initiatives, which often involve high technical complexity and substantial financial risk. In such contexts, larger boards are better positioned to provide critical scrutiny, thereby reducing the likelihood of project failure.

From the perspective of Stakeholder Theory, board members serve as key representatives of diverse stakeholder interests that firms must balance. Jones (1995) argues that stakeholder trust increases when companies demonstrate robust oversight mechanisms. A larger board offers a more effective forum for capturing and responding to external sustainability-related expectations. When board members collectively prioritize environmental concerns, they create strong institutional pressure on management to adopt low-carbon technologies and environmentally responsible production processes (Veronica et al., 2020). Active board engagement with global ecological trends further ensures that Green Innovation efforts remain aligned with genuine sustainability principles rather than symbolic compliance.

Empirical evidence supports this theoretical framework. Studies by Asni and Agustia (2022) and Lee et al. (2021) document a positive association between board size and the intensity of environmental innovation. Larger boards provide broader supervisory capacity, allowing for more specialized oversight mechanisms, including subcommittees dedicated to monitoring green research and development (R&D) activities. This result clarifies the significance of Board Size in the regression model, as an adequately sized board allows for the establishment of specialized subcommittees, including the GBC. By leveraging the collective knowledge and networks of board members, firms are better equipped to overcome technical and market barriers in developing green products. This interplay between intellectual capital and strategic resource access strengthens the argument that an increase in

board size enhances firms' likelihood of successfully pursuing Green Innovation. Accordingly, Hypothesis 2 in this study is empirically supported.

The Effect of Return on Assets (ROA) on Green Innovation

Profitability, proxied in this study by Return on Assets (ROA), reflects a firm's ability to generate earnings from its asset base and thus serves as a key indicator of operational efficiency. Within the context of sustainable business, strong ROA does more than enhance investor appeal; it also provides an important source of internal financing. From the standpoint of Stakeholder Theory, solid financial performance sends a clear signal of stability and credibility to various stakeholder groups (Jones, 1995). Firms with higher profitability are therefore more likely to gain the confidence of investors—particularly those committed to socially responsible investment—because they are perceived as having sufficient financial capacity to absorb the costs associated with transitioning toward environmentally sustainable practices. This aligns with the regression findings, where the strong coefficient of ROA indicates that financial strength is not just a passive trait but an active enabler of stakeholder-oriented innovation.

From a value creation perspective, prior studies consistently show that higher ROA contributes positively to firm value (Husna & Satria, 2019). Enhanced firm value, in turn, creates stronger incentives for companies to safeguard their reputation through sustained environmental responsibility (Zhang et al., 2020). Superior profitability enables firms to embed sustainability objectives into their core strategies, thereby positioning Green Innovation not as an auxiliary activity but as a long-term mechanism for maintaining competitive advantage.

The empirical findings of this study, which demonstrate a positive effect of ROA on Green Innovation, offer a clear contribution to ongoing debates in the literature. These results challenge the argument put forward by Khan et al. (2021), who suggest that less profitable firms may be more inclined to pursue green innovation as a reputational recovery strategy. Instead, the evidence presented here indicates that meaningful innovation is more likely to emerge from firms with sound financial foundations rather than from reactive or distressed conditions. The findings also contrast with those of Siminica et al. (2019), who report no significant relationship between ROA and sustainability-related activities. In the Indonesian context—particularly during the 2023 observation period marked by the introduction of new green initiatives—profit availability appears to be a primary driver motivating listed firms to adopt environmentally friendly technologies. Taken together, these insights confirm that strong financial performance, when aligned with a sustainability-oriented vision, provides robust empirical support for Hypothesis 3 in this study.

The Effect of Leverage Ratio on Green Innovation

Leverage reflects the extent to which a firm relies on external debt financing to support its operations and growth. From a theoretical perspective, high leverage carries important managerial implications, particularly in relation to creditor pressure. Firms with substantial debt obligations are subject to close monitoring to ensure stable cash flows for interest and principal repayments. Under such conditions, managers are often incentivized to adopt more cautious behavior and to emphasize short-term financial performance in order to minimize the risk of default.

The findings of this study indicate that leverage does not have a statistically significant effect on Green Innovation. This result contributes to the ongoing debate in the literature regarding the relationship between capital structure and sustainability-oriented activities. In contrast to the arguments of Azim Khan (2023) and Nemlioglu and Mallick (2021), who suggest that higher debt levels may encourage firms to innovate more aggressively to improve efficiency, the evidence in this context points to a different mechanism. Rather than acting as a catalyst, debt appears to impose both psychological and financial constraints on managerial decision-making. Green Innovation initiatives—whether related to environmentally friendly technologies or process efficiency—typically require substantial upfront investment and involve considerable uncertainty. For firms already burdened with debt commitments, allocating resources to high-risk innovation projects may be perceived as a threat to financial stability.

This pattern is consistent with the observations of Shi et al. (2022) and Xiang et al. (2022), who argue that while external financing may stimulate innovation in its early stages—such as through targeted loans or subsidies—its long-term effectiveness tends to diminish as financial obligations accumulate. As debt pressure increases, firms are more likely to scale back experimental research and development (R&D) expenditures to preserve capital adequacy and liquidity.

Within the context of Indonesian listed firms in 2023, these findings suggest that Green Innovation is driven primarily by the availability of internal funds, such as retained earnings, rather than by debt-based financing. A capital structure that is overly dependent on leverage may therefore slow down firms' green transformation, as management becomes increasingly risk-averse in response to solvency concerns. Consequently, even when firms acknowledge their environmental responsibilities, financial constraints arising from high leverage can limit their willingness to pursue innovation. Taken together, these results provide empirical support for the conclusion that leverage does not play a decisive role in promoting Green Innovation.

Conclusion

This study was conducted to see the effect of the Green Board Committee, Board Size, ROA, and Leverage Ratio on Green Innovation in Indonesian companies in 2023. Through robustness regression testing, the results show that Green Board Committee, Board Size, and ROA have a significant positive effect on Green Innovation. While the Leverage Ratio has an insignificant positive effect on Green Innovation.

This research has two implications: practical and theoretical implications. In its practical implications, this research helps managers ensure the availability of financial and non-financial resources to implement green innovations. Non-financial resources, such as the Green Board Committee and Board Size, support sustainability strategies, while financing needs to be considered for green innovations to run optimally, including effectiveness testing before implementation. This research also contributes to the literature on financial and non-financial factors that support green innovation. The results support stakeholder and decision-making theories, showing that the integration of both factors improves the quality of decisions related to green innovation and broadens the perspective on the green innovation process.

The references from this research still have many shortcomings. The limited research related to sustainability, especially related to Green Innovation, is one of the limitations. The information provided by companies is limited to annual reports and sustainability reports. There is no specific platform that describes the green practices of companies in Indonesia. This is also the reason for the limitations of the data collection method. For future research, it is necessary to add other components to Green Innovation, such as green technology. In addition to seeing the results of innovation in financial reports and sustainability reports, researchers can also see the company's involvement in reducing environmental impacts, such as GRI components, SDGs, and others.

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