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DO GOVERNANCE MECHANISMS MATTER FOR CARBON PERFORMANCE? EXPLORING BOARD SIZE, SUSTAINABILITY COMMITTEES, AND GENDER DIVERSITY

Octa Marselita[1], Desi Adhariani[2]
Universitas Indonesia[12]
[1]Corresponding author: octamarselita24@gmail.com

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ABSTRAK

Krisis iklim global telah mendorong peningkatan tekanan terhadap perusahaan untuk mengurangi emisi karbon, terutama di negara berkembang. Penelitian ini menguji hubungan tata kelola perusahaan—ukuran dewan direksi, keberadaan komite keberlanjutan, dan keberagaman gender dalam dewan—terhadap intensitas emisi karbon pada perusahaan publik di Indonesia dan Malaysia periode 2016–2023. Penelitian ini menggunakan First-Difference GMM pada 888 observasi tahun-perusahaan. Hasil menunjukkan bahwa ukuran dewan berhubungan negatif signifikan terhadap intensitas emisi, sedangkan komite keberlanjutan dan keberagaman gender tidak ditemukan hubungan yang signifikan. Temuan ini menegaskan pentingnya penguatan fungsi substantif komite keberlanjutan, peningkatan partisipasi gender yang bermakna, serta dukungan regulasi agar tata kelola keberlanjutan berkontribusi nyata terhadap pengurangan emisi.

Kata Kunci: Emisi karbon, tata kelola, ukuran dewan, komite keberlanjutan, keberagaman gender dalam dewan

ABSTRACT

The global climate crisis has intensified pressure on corporations to reduce carbon emissions, particularly in developing countries. This study examines the relationship between corporate governance—board size, the presence of a sustainability committee, and board gender diversity—and carbon emission intensity in publicly listed companies in Indonesia and Malaysia over the period 2016–2023. Using the First-Difference GMM approach on 888 firm-year observations, the findings show that board size is negatively and significantly associated with emission intensity, while no significant relationships are found for sustainability committees and gender diversity. These results highlight the importance of strengthening the substantive function of sustainability committees, enhancing meaningful gender participation, and ensuring regulatory support so that corporate governance can make a tangible contribution to emission reduction.

Keywords: Carbon emissions, corporate governance, board size, sustainability committee, board gender diversity

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1. Introduction

The growing urgency of the global climate crisis has intensified scrutiny of corporate carbon emissions and the factors that drive them. This concern stems from the far-reaching impacts of climate change, which threaten to disrupt global economic activity, endanger human health, and cause irreversible damage to fragile ecological systems (Cahyono et al., 2023). Carbon emissions, or greenhouse gases, have become one of the most pressing environmental challenges and a growing source of pressure for businesses. This shift reflects increasing stakeholder expectations for greater accountability regarding the environmental impacts of corporate operations (Khatib & Al Amosh, 2023). High carbon emission levels can expose companies to regulatory penalties, weaken their competitive position, and damage their public image — all of which may ultimately harm their financial performance (Guo et al., 2024). As corporations account for a substantial share of global greenhouse gas emissions, the role of internal governance mechanisms in shaping corporate carbon performance has become increasingly prominent in both academic research and policy discussions (e.g. Cezanne et al., 2025; Handoyo et al., 2024; Khatib & Al Amosh, 2023; Elsayih et al., 2021; Narsa Goud, 2022; Cordova et al., 2020; Haque, 2017). Corporate governance plays a pivotal role in establishing and steering organizational sustainability mechanisms (Oyewo, 2023). Companies today face growing pressure to address environmental and social challenges, especially those related to climate risks. A wide range of stakeholders—including environmental organizations, civil society, regulators, policymakers, and investors—are increasingly demanding greater transparency and accountability in how corporations manage carbon emissions and respond to climate change (Bedi & Singh, 2024; Muktadir-Al-Mukit & Bhaiyat, 2024; Narsa Goud, 2022; Haque, 2017). These growing concerns have strengthened the call for companies to integrate climate-related issues into their governance structures, both at the management and board levels, by developing strategies aimed at mitigating the negative impacts of carbon emissions (Cahyono et al., 2023). Effective corporate governance helps minimize information asymmetry and align the interests of various stakeholders. Governance mechanisms within organizations play a vital role in supporting sound decision-making, maintaining strategic oversight, and fostering long-term value creation (Cezanne et al., 2025).

Corporate governance, once primarily concerned with accountability and economic value creation, is now increasingly viewed in relation to its environmental implications. Managing carbon emissions introduces a complex set of challenges as well as opportunities for corporate leaders, regulators, investors, stakeholders, and policymakers (Narsa Goud, 2022; Kanashiro & Rivera, 2019). Given the board of directors' central role in policy formulation, corporate governance plays a crucial part in managing environmental and climate-related risks, as well as overseeing the company's involvement in carbon reduction initiatives (Khatib & Al Amosh, 2023). Corporate managers and employees are increasingly expected to design effective organizational structures that not only control emissions and assess risks associated with greenhouse gases (GHGs), but also evaluate carbon management strategies and comprehensively monitor energy efficiency and related costs. (Elsayih et al., 2021). The effectiveness of corporate governance plays a pivotal role in shaping how firms respond to environmental and climate-related risks (Haque, 2017). In

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this context, global regulatory bodies are placing greater emphasis on monitoring corporate governance structures and practices to ensure they align with broader environmental objectives and contribute to long-term sustainability goals (Narsa Goud, 2022; Ioannou & Serafeim, 2017).

A growing body of research has examined the relationship between corporate governance and firms' carbon emissions performance (e.g., Cezanne et al., 2025; Handoyo et al., 2024; Khatib & Al Amosh, 2023; Elsayih et al., 2021; Narsa Goud, 2022; Cordova et al., 2020; Haque, 2017). Recent research increasingly emphasizes the role of contextual factors—such as board structure and committee composition—in shaping the effectiveness of corporate governance mechanisms, representing the current state of advancement in this field. However, empirical evidence from Indonesia and Malaysia remains limited, despite both countries being part of Southeast Asia, a region particularly vulnerable to the impacts of climate change. This study seeks to address this gap by examining whether and how board size, the existence of a sustainability committee, and board gender diversity influence firms' carbon emissions performance. Drawing on legitimacy and stakeholder theories, the study posits that corporate governance mechanisms play a critical role in shaping firms' strategic responses to external pressures related to climate and environmental issues. Overall, this research contributes to the accounting literature by deepening the understanding of how governance structures can support corporate sustainability and climate accountability. First, while previous research has largely concentrated on developed economies, evidence from emerging markets—particularly in Southeast Asia—remains scarce. By focusing on Indonesia and Malaysia, two climate-vulnerable yet underexplored economies, this study expands the geographical scope of governance–carbon research. Second, unlike many existing studies that examine governance mechanisms individually, this research simultaneously explores three key dimensions—board size, the presence of a sustainability committee, and board gender diversity—offering a more integrated understanding of governance effectiveness. Finally, the study provides practical insights for regulators, investors, and corporations in developing adaptive, sustainability-oriented governance structures that align with the growing global emphasis on climate risk reporting and management.

2. Literature Review and Hypothesis Development

Research on the link between corporate governance practices and carbon performance is often grounded in stakeholder theory and legitimacy theory. Legitimacy theory, in particular, highlights that firms seek to gain and maintain social legitimacy as a fundamental requirement for their ongoing operations (Suchman, 1995). In the context of sustainability and environmental reporting, companies are expected to align their behavior and business strategies with societal norms and public expectations regarding environmental management, including carbon emission reduction (Deegan, 2002). In this context, reducing carbon emissions can be seen as a strategic move that signals a firm's commitment to broader societal values, extending beyond purely firm-centered objectives of value creation and performance (Cahyono et al., 2023). Implementing effective governance mechanisms to reduce greenhouse gas emissions not only enhances a firm's legitimacy but also improves its capacity to respond to increasing social pressure on

environmental issues (Cezanne et al., 2025). Legitimacy theory thus offers a strong conceptual basis for understanding carbon emission reduction as a strategic necessity for maintaining social acceptance and ensuring long-term operational continuity. The theory also highlights that, to gain and sustain legitimacy, firms depend heavily on effective governance mechanisms. In other words, governance structures act as the main channels through which companies respond to social and environmental pressures, helping to explain differences in carbon emission performance across firms.

Moreover, stakeholder theory provides a comprehensive framework for understanding how companies can incorporate the interests of diverse stakeholder groups—both internal and external—into their strategic planning processes (Freeman & McVea, 2001). This theory suggests that stakeholders receive different levels of managerial attention depending on their ability to influence the firm, the legitimacy of their claims, and the urgency of the issues they raise (Mitchell et al., 1997). In practice, companies are increasingly pressured by their stakeholders to disclose carbon-related information and the strategies they employ to improve performance (Cordova et al., 2020). As environmental concerns gain prominence, firms have shown a growing tendency to engage in responsible environmental practices (Kılıç & Kuzey, 2019). In this context, corporate governance plays a central role in shaping and directing organizational sustainability mechanisms (Oyewo, 2023). Companies that acknowledge the environment as a critical stakeholder tend to be more inclined to embed sustainability principles within their operational activities and strategic decision-making (Khatib & Al Amosh, 2023). Additionally, governance models that prioritize stakeholder interests encourage companies to adopt innovative strategies to reduce their environmental footprint, lower carbon emissions, and make positive contributions to the ecosystems in which they operate (Khatib & Al Amosh, 2023). Taken together, stakeholder theory underscores that the quality of governance determines the extent to which firms can balance economic objectives with environmental responsibilities.

Together, legitimacy theory and stakeholder theory offer a strong theoretical foundation for understanding the role of governance in corporate carbon performance. Legitimacy theory frames emission reduction as a strategic necessity for maintaining social acceptance and ensuring long-term continuity, while stakeholder theory highlights the ways firms respond to external pressures and integrate sustainability into their governance structures. Importantly, both perspectives converge in emphasizing governance mechanisms as key to explaining differences in corporate carbon performance.

Board size refers to the number of directors serving on a company's board, typically shaped by factors such as firm size, the complexity of business operations, and the ownership structure (Narsa Goud, 2022). Larger boards tend to adopt more cautious and deliberative approaches in making decisions related to carbon emission reduction strategies, which may ultimately enhance the company's environmental performance (Guo et al., 2024). Board size is also widely recognized as a key factor in corporate governance effectiveness, as a larger board can enhance oversight of managerial activities and improve overall governance quality (Houqe & Khan, 2023). Conversely, smaller boards may suffer from limited diversity of expertise, potentially compromising the quality of strategic decision-making (Guest, 2009). Additionally, a heavier workload per individual in smaller boards may undermine the effectiveness of monitoring and control functions performed by

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the board (John & Senbet, 1997). From a stakeholder theory perspective, larger boards can reflect a broader representation of stakeholder interests, fostering more balanced decision-making and strengthening the firm's social capital (Nguyen & Thanh, 2022). Moreover, firms may use larger boards as a signal of their commitment to sustainability and corporate social responsibility, helping to secure and maintain legitimacy in the eyes of the public. Empirical evidence also indicates that companies with larger boards are better positioned to coordinate complex sustainability initiatives and demonstrate their dedication to reducing carbon emissions (Narsa Goud, 2022; Khatib & Al Amosh, 2023) Drawing on these theoretical insights, board size is expected to be positively associated with corporate carbon performance, as reflected in lower carbon emissions. Accordingly, the first hypothesis of this study is formulated as follows:

H_1: Board size is negatively related to corporate carbon emission intensity, indicating that larger boards are associated with better carbon emission performance.

To meet stakeholder expectations and strengthen their legitimacy, as suggested by legitimacy theory, companies have increasingly established environmental sustainability or ESG committees tasked with designing, overseeing, and implementing sustainability initiatives (Lu & Wang, 2021; Oyewo, 2023). According to legitimacy theory, companies with board-level environmental committees are more likely to systematically collect, record, report, and disclose greenhouse gas (GHG) emissions data as a way to gain and maintain legitimacy by highlighting their positive environmental performance (Elsayih et al., 2021; Narsa Goud, 2022). According to Narsa Goud (2022), companies act as accountable entities that must consider and balance the diverse interests of stakeholders. In response to growing stakeholder pressure on climate change, firms are establishing environmental committees to develop sustainable policy frameworks and identify alternatives to fossil fuel use, aiming to reduce carbon emissions (Chakraborty & Dey, 2024). These committees also play a strategic role in guiding management on responses to environmental incidents and in reinforcing the board's commitment to balancing environmental responsibilities with business objectives (Elsayih et al., 2021). A growing body of empirical studies suggests that sustainability committees positively influence environmental performance, including carbon emission reduction (Oyewo, 2023; Nguyen & Thanh, 2022; de Villiers et al., 2011). In other words, having a sustainability committee allows a company to take a more structured approach to designing and implementing emission reduction strategies, improves coordination across different functions, and integrates environmental policies into the core of corporate governance. This not only enhances the company's ability to meet stakeholder expectations but also contributes to better overall carbon performance. Drawing on these theoretical insights and prior empirical evidence, the presence of a sustainability committee is therefore expected to be positively associated with corporate carbon performance, as reflected in lower carbon emissions. Therefore, the second hypothesis of this study is formulated as follows:

H_2: The presence of a sustainability committee is negatively associated with corporate carbon emission intensity, suggesting that firms with such committees exhibit superior carbon emission performance.

Board gender diversity has gained increasing significance in corporate governance, as it is thought to shape strategic decision-making and encourage sustainable business practices. In this regard, stakeholders show a strong preference for gender-diverse boards, believing that such diversity enhances the effectiveness of non-financial performance initiatives (Houqe & Khan, 2023). From a stakeholder perspective, the presence of women on boards helps strengthen corporate-stakeholder relationships, which, in turn, encourages a deeper corporate commitment to social and environmental responsibilities (Hussain et al., 2018; Elsayih et al., 2021). Consistent with this perspective, Guo et al. (2024) contend that boards with greater gender diversity are better positioned to represent a broader range of societal stakeholder interests, thereby enhancing the potential to reconcile economic objectives with corporate social responsibility. Overall, female directors often contribute distinctive strategic perspectives and valuable skills that help advance corporate sustainability efforts, including promoting carbon innovation and management, ensuring compliance with sustainability regulations, and strengthening relationships with stakeholders (Haque, 2017). A growing body of empirical evidence indicates that gender diversity on corporate boards has a positive impact on carbon performance (Cezanne et al., 2025; Oyewo, 2023; Muktadir-Al-Mukit & Bhaiyat, 2024; Elsayih et al., 2021). Drawing on these theoretical insights and prior empirical evidence, gender diversity on boards is expected to be positively linked to corporate carbon performance, reflected in lower carbon emissions. Boards with greater gender diversity tend to approach environmental and carbon-related issues more cautiously, as women are often observed to make careful decisions, show heightened sensitivity to environmental risks, and prioritize long-term sustainability. This perspective not only enhances the quality of short-term decision-making but also supports strategies that improve long-term carbon performance. Therefore, the third hypothesis of this study is formulated as follows:

H_3**:** Board gender diversity is negatively related to corporate carbon emission intensity, implying that greater female representation on boards is linked to improved carbon emission performance.

3. Research Method

This study uses panel data from publicly listed companies in Indonesia and Malaysia covering the period 2016 to 2023. The year 2016 was chosen as the starting point because both countries officially ratified the Paris Agreement that year, signaling their formal commitment to climate change mitigation and carbon emission reduction. Consequently, this period provides a meaningful context for examining the development and implementation of corporate sustainability policies and practices. Table 1 outlines the sample selection process for this study. The initial sample included 2,099 publicly listed companies in Indonesia and Malaysia, based on data from Thomson Reuters Refinitiv Eikon for the 2016–2023 period. After excluding 256 firms from the financial sector and 1,576 firms with incomplete data, the final sample comprises 267 companies, yielding a total of 888 firm-year observations structured as panel data.

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Table 1. Sample Selection

Description	Total
Publicly listed companies in Indonesia and Malaysia covered by Thomson Reuters Refinitiv Eikon for the period 2016–2023	2099 Firms
Excluded: Companies in the financial sector	(256 Firms)
Excluded: Companies with incomplete data	(1576 Firms)
Final sample of companies used for analysis	267 Firm
Total firm-year observations	888 Firm-Year

Source: Author's own work (2025)

The dataset for this study was obtained from the Refinitiv Eikon database, and detailed measurements of all variables are provided in Table 2. The primary dependent variable is carbon emission intensity (CEI), while the key independent variables focus on governance factors, including board size (BS), the presence of a sustainability committee (SC), and board gender diversity (BGD). The model also controls for several additional factors, such as firm size, profitability, leverage, fixed asset intensity, loss status, the COVID-19 period, and renewable energy consumption.

Table 2. Measurement of Variables

Variables	Abbreviations	Measurement	References
Carbon Emission Intensity	CEI	Natural logarithm of total carbon emission scope 1 & 2 divided by total revenue	(Elsayih et al., 2021)
Board Size	BS	The total number of board of directors in the company	(Cezanne et al., 2025; Bedi & Singh, 2024)
Sustainability Committee	SC	1 if the company has a sustainability committee; 0 otherwise	(Cezanne et al., 2025)
Board Gender Diversity	BGD	Proportion of female board members	(Cezanne et al., 2025)
Size	Size	Natural logarithm of total assets	(Cahyono et al., 2023)
Return on Assets	ROA	Total income divided by total assets	(Cezanne et al., 2025)
Leverage	Lev	Total debt divided by total assets	(Cahyono et al., 2023)
Asset Tangibility	PPE	Net PPE divided by total assets	(Narsa Goud, 2022)
Loss	Loss	1 if net income < 0; 0 otherwise	(Cahyono et al., 2023)
Covid	Covid	1 for fiscal years 2020–2021; 0 otherwise	(Khatib & Al Amosh, 2023)

Variables	Abbreviations	Measurement	References
Renewable Energy Capacity	REC	The percentage of renewable energy in a country's total electricity capacity.	(Azizi et al., 2024; Muazu et al., 2023)

Source: Author's own work (2025)

The empirical model employed in this study is specified as follows:

$$CEI_{it} = \beta_0 + \beta_1 CEI_{i,t-1} + \beta_2 BS_{it} + \beta_3 SC_{it} + \beta_4 BGD_{it} + \beta_5 Controls_{it} + e \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

(Description: CEI_{it} denotes the carbon emission intensity of firm *i* in year *t*, while $CEI_{i,t-1}$ is the lagged value of carbon emission intensity. BS_{it} refers to the board size of firm *i* in year *t*. SC_{it} represents the presence of a sustainability committee of firm *i* in year *t*. BGD_{it} denotes the board gender diversity of firm *i* in year *t*. $Controls_{it}$ includes control variables for firm *i* in year *t*. e is the error term)

To address potential issues of endogeneity, heteroskedasticity, and autocorrelation, this study employs the Arellano–Bond dynamic panel data estimator, specifically using the First-Differenced Generalized Method of Moments (FD-GMM). The estimation is carried out in a two-step procedure to enhance efficiency, with lagged values of both the dependent and independent variables serving as internal instruments. The validity of the instruments is assessed using the Sargan test, which examines whether the instruments are correlated with the error term. In addition, the Arellano–Bond AR(2) test is employed to detect any presence of second-order serial correlation in the residuals—an essential condition for ensuring the reliability of lagged instruments in this approach. The significance levels derived from these diagnostic tests serve as key indicators of the robustness and credibility of the dynamic GMM estimation.

4. Results and Discussion

Table 3 presents the distribution of firm-year observations by sector and year over the 2016–2023 period. The number of observations increases notably over time, reflecting the gradual improvement in data availability in recent years. For example, only 35 observations were recorded in 2016, compared to 260 in 2023. This upward trend suggests that many firms in the sample began disclosing relevant information or had accessible data only in the later years of the study period. Regarding sectoral distribution, the Industrials sector accounts for the largest share of the sample with 190 observations, followed by Consumer Staples (138 observations) and Materials (112 observations). In contrast, the Health Care and Information Technology sectors are less represented, with 39 and 54 observations, respectively. This distribution mirrors the structural composition of the corporate landscape in Indonesia and Malaysia, where certain industries are more established, active, or consistent in their reporting practices during the observation period.

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Table 3. Tabulation of Sector and Year

Sector	Year								
	2016	2017	2018	2019	2020	2021	2022	2023	Total
Communication Services	7	8	8	8	9	10	12	15	77
Consumer Discretionary	2	2	1	3	4	9	14	16	51
Consumer Staples	5	6	7	12	14	24	34	36	138
Energy	5	4	6	9	9	14	22	24	93
Health Care	0	1	2	3	3	8	10	12	39
Industrials	5	6	6	8	9	32	55	69	190
Information Technology	0	0	0	0	3	13	19	19	54
Materials	5	6	6	9	10	18	27	31	112
Real Estate	2	3	2	4	8	16	20	26	81
Utilities	4	4	5	5	5	8	10	12	53
Total	35	40	43	61	74	152	223	260	888

Source: Author's own work (2025)

Table 4 presents the descriptive statistics of the variables used in this study. The average carbon emission intensity (CEI) is 4.915, reflecting substantial variation across firms in their emission levels. On average, firms have eight board members, and about 89% have established a sustainability committee (SC). Board gender diversity (BGD) averages 20.95%, suggesting that female representation remains relatively limited. The mean firm size (Size) and profitability (ROA) are 20.915 and 7.4%, respectively. Meanwhile, the average leverage ratio (Lev) is 24.5%, and fixed asset intensity (PPE) accounts for 35.4% of total assets. Most firms in the sample reported losses (87.27%), while approximately one-fourth of the observations (25.45%) correspond to the COVID-19 pandemic period. Finally, the average renewable energy consumption (REC) is 20.857, indicating a modest level of renewable energy utilization among the firms.

Table 4. Descriptive Statistics

Panel A. Continuous and Categorical Variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
CEI	888	4.915	2.019	-1.836	11.613
BS	888	7.962	2.33	1	15
BGD	888	20.952	14.018	0	75
Size	888	20.915	1.59	16.506	24.569
ROA	888	0.074	0.128	-1.675	1.025
Lev	888	0.245	0.175	0	.903
PPE	888	0.354	0.218	0	.899
REC	888	20.857	3.627	14.04	25.7

Panel B. Dummy Variables (Frequency Distribution)

Variable	Obs	Value = 0 (n (%))	Value = 1 (n (%))
SC	888	98 (11.04%)	790 (88.96%)
Loss	888	113 (12.73%)	775 (87.27%)
Covid	888	662 (74.55%)	226 (25.45%)

Notes: CEI: Carbon Emission Intensity; BS: Board Size; SC: Sustainability Committee; BGD: Board Gender Diversity; Size: Firm Size; ROA: Return on Assets; Lev: Leverage; PPE: Asset Tangibility; Loss: Loss Indicator; Covid: COVID-19 Period; REC: Renewable Energy Capacity.
Source: Author's own work (2025)

Table 5 reports the Pearson correlations among the main variables. The results show that carbon emission intensity (CEI) is positively and significantly correlated with board size (BS), firm size, leverage (Lev), and property, plant, and equipment (PPE). This suggests that firms with larger boards, greater scale, higher leverage, and a larger proportion of tangible assets tend to have higher levels of carbon emissions. In contrast, CEI is negatively and significantly correlated with board gender diversity (BGD) and renewable energy consumption (REC), implying that greater female representation on boards and higher renewable energy use are associated with lower emission intensity. Overall, the correlations among the independent variables are moderate, indicating no serious multicollinearity issue

Table 5. Pearson Correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) CEI	1.000									
(2) BS	0.124***	1.000								
(3) SC	0.029	0.200***	1.000							
(4) BGD	-0.098***	0.185***	0.166***	1.000						
(5) Size	0.281***	0.175***	-0.010	-0.173***	1.000					
(6) Lev	0.097***	0.080**	0.045	-0.017	0.358***	1.000				
(7) PPE	0.458***	0.038	0.002	-0.112***	0.209***	0.210***	1.000			
(8) Loss	-0.054	-0.031	-0.005	0.055	0.056*	-0.115***	-0.040	1.000		
(9) Covid	-0.007	-0.025	-0.041	-0.056*	0.044	0.029	0.005	0.038	1.000	
(10) REC	-0.091***	0.459***	0.301***	0.400***	-0.292***	0.015	-0.173***	-0.074*	-0.023	1.000

Notes: CEI: Carbon Emission Intensity; BS: Board Size; SC: Sustainability Committee; BGD: Board Gender Diversity; Size: Firm Size; ROA: Return on Assets; Lev: Leverage; PPE: Asset Tangibility; Loss: Loss Indicator; Covid: COVID-19 Period; REC: Renewable Energy Capacity.
***<0.01, **<0.05, *<0.1
Source: Author's own work (2025)

Before proceeding with the dynamic regression estimation, a multicollinearity test was conducted to ensure that no strong correlations existed among the independent variables that could undermine the stability of the estimates. The initial results revealed that several variables—namely Board Size (BS), Sustainability Committee (SC), Firm Size, Loss, and Renewable Energy Consumption (REC)—exhibited signs of multicollinearity, as indicated by Variance Inflation Factor (VIF) values exceeding the conventional threshold. To address this issue, a centering technique was applied by subtracting the mean from each variable to reduce inter-variable correlations and improve the covariance structure. After centering and re-examining the data, all variables were found to have VIF values within acceptable limits, confirming that the multicollinearity issue had been effectively resolved. Consequently, the model was deemed appropriate for further analysis using the dynamic panel data regression approach.

The adequacy of the model was carefully evaluated, as summarized in Table 6. The Sargan test yielded a chi-square statistic of 18.208 with a p-value of 0.5737, suggesting that the null hypothesis of instrument validity cannot be rejected. This result indicates that the instruments used in the analysis are appropriate and not affected by over-identification problems, thereby minimizing the risk of instrument bias in the estimates. Ensuring instrument validity is particularly important in the FD-GMM framework, as the use of weak or invalid instruments could compromise both the consistency and reliability of the results. In addition, the Arellano–Bond AR (2) test produced a p-value of 0.8271,

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confirming the absence of second-order serial correlation in the error terms and further reinforcing the robustness of the model specification. This finding is important because the presence of higher-order serial correlation would violate the key assumptions of the Arellano–Bond procedure and could lead to biased or inconsistent estimates. In this case, the results confirm that the model specification is appropriately suited to the characteristics of dynamic panel data, thereby strengthening the credibility of the estimated outcomes. Overall, these diagnostic tests indicate that the model meets the core assumptions of the Arellano–Bond approach—namely, instrument validity and the absence of second-order serial correlation. Consequently, the estimates can be considered both statistically robust and theoretically consistent with prior studies that have employed the FD-GMM method to examine the link between corporate governance and sustainability practices (Mansour et al., 2025; Tanthanongsakkun et al., 2023; Voumik et al., 2022). Accordingly, the results in Table 6 are robust and provide a reliable basis for interpretation.

The estimation results in Table 5 show that board size has a coefficient of –0.0316, which is statistically significant at the 5% level. This indicates a negative association between board size and carbon emission intensity. In practical terms, each additional board member is linked to a 0.0316-unit reduction in carbon emission intensity, assuming other factors remain constant. These results lend empirical support to Hypothesis 1 (H1), suggesting that larger boards may be more effective in overseeing and promoting sound environmental management practices, including initiatives aimed at reducing carbon emissions. This result is consistent with prior research (Narsa Goud, 2022), which found that improved carbon performance is associated with firms that have larger board sizes. Granting companies the flexibility to decide the number of board members enables them to include a broader mix of expertise beyond traditional governance functions. This diversity allows for the participation of individuals with strong competencies in environmental, social, and governance (ESG) matters, which can enhance environmental performance by promoting more strategic and forward-looking approaches to climate-related challenges (Cezanne et al., 2025).

Conversely, the analysis of the presence of a sustainability committee yields a coefficient of –0.0411; however, the result is not statistically significant. This indicates that merely having a sustainability committee does not necessarily translate into lower carbon emission intensity, suggesting that the committee's existence alone may not guarantee meaningful environmental outcomes. Accordingly, Hypothesis 2 (H2) does not receive empirical support. In line with the findings of Narsa Goud (2022), This finding challenges the commonly held assumption among stakeholders that establishing an Environmental Committee within a company's governance structure—intended to provide strategic guidance on environmental issues—would naturally enhance organizational legitimacy. A plausible explanation for this unexpected outcome is that, among the companies in the sample, the formation of such committees may function more as a symbolic or image-enhancing measure rather than as evidence of a genuine, substantive commitment to reducing carbon emissions (Elsayih et al., 2018).

Similarly, the variable representing board gender diversity shows a coefficient of 0.00127, but it is not statistically significant. This indicates that the proportion of women serving on corporate boards does not have a meaningful impact on firms' carbon emission

intensity. Consequently, Hypothesis 3 (H3) is not supported by the data. One plausible explanation is the still limited presence of women in board positions within the sampled firms, which may lead to tokenistic representation—where women hold seats on the board but have limited influence on strategic decision-making As noted by Yarram & Adapa (2021), the presence of female board members can lead to social isolation, as they are frequently excluded from male-dominated informal networks. This dynamic may lead to tokenistic participation, where female directors feel compelled to align with decisions dominated by their male counterparts. As a result, they may display more "agentic" behaviors—assertive and conformity-driven—rather than "communal" behaviors that emphasize collaboration and collective judgment (Yarram & Adapa, 2021).

Table 6. Main Analysis

Variables	CEI	Description
CEI_{t-1}	0.334***	
	(0.0467)	
BS	-0.0316**	H1 Supported
	(0.0165)	
SC	-0.0411	H2 Not Supported
	(0.0838)	
BGD	0.00127	H3 Not Supported
	(0.00252)	
Size	-0.306**	
	(0.137)	
ROA	-0.941***	
	(0.128)	
Lev	-0.238	
	(0.396)	
PPE	-0.374	
	(0.400)	
Loss	0.104**	
	(0.0578)	
Covid	0.0716**	
	(0.0320)	
REC	-0.0920***	
	(0.0333)	
Constant	3.530***	
	(0.302)	
Sargan Test: chi2	18.20787	
Sargan Test: Prob > chi2	0.5737	
Arellano–Bond test (AR(2)): p-value	0.8271	
Num. obs	888	
Num. obs. used	381	
Num. of company	149	

Notes: CEI: Carbon Emission Intensity; BS: Board Size; SC: Sustainability Committee; BGD: Board Gender Diversity; Size: Firm Size; ROA: Return on Assets; Lev: Leverage; PPE: Asset Tangibility; Loss: Loss Indicator; Covid: COVID-19 Period; REC: Renewable Energy Capacity.
***<0.01, **<0.05, *<0.1
Source: Author's own work (2025)

2720-9067 (ISSN), 2685-1059 (E-ISSN)
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To provide deeper insights, the sample was divided into subgroups based on country. This approach is justified by the substantial differences in regulatory frameworks governing corporate boards in Indonesia and Malaysia. In Malaysia, for instance, the Malaysian Code on Corporate Governance (MCCG) 2021 mandates that at least half of a company's board members be independent directors, and for large corporations, the majority must be independent. This stronger emphasis on board independence reflects Malaysia's more mature governance environment and may help explain variations in board effectiveness across the two countries. This requirement is further strengthened by the Bursa Malaysia Listing Requirements, which stipulate that companies must have at least two independent directors or one-third of the board—whichever is greater. In contrast, Indonesia adopts a different governance structure that emphasizes the role of independent commissioners rather than independent directors. According to the OJK Regulation No. 33/POJK.04/2014, publicly listed firms are required to appoint independent commissioners comprising at least 30% of the total board of commissioners. These institutional differences suggest that the strength and effectiveness of board oversight mechanisms may vary across the two countries, thereby warranting additional country-level testing. Table 7 presents the regression results for the country-specific sub-samples—Indonesia and Malaysia. The findings reveal notable contrasts between the two contexts. In Indonesia, board size shows no significant influence on carbon emissions. In contrast, in Malaysia, larger boards appear to strengthen sustainability oversight, leading to lower emission levels. Likewise, sustainability committees play a meaningful role in reducing emissions among Malaysian firms, whereas their impact in Indonesia remains limited, suggesting that such governance mechanisms may still be in the early stages of effective implementation. These results reflect varying degrees of integration and effectiveness in how sustainability governance mechanisms operate across countries. Notably, board gender diversity shows no significant impact on carbon performance in either context. Together, these findings highlight cross-country differences in governance responses to sustainability challenges—where Malaysia appears to have more adaptive and responsive mechanisms, while Indonesia may need to further strengthen the roles of boards and sustainability committees to enhance their influence on carbon emission management.

Table 7. Sub-Sample Country

Variables	Indonesia	Malaysia
	CEI	CEI
CEI_{t-1}	0.417***	0.183**
	(0.0333)	(0.0827)
BS	-0.00856	-0.0258*
	(0.0202)	(0.0146)
SC	-0.00338	-0.491***
	(0.0667)	(0.110)
BGD	0.000341	0.000963
	(0.00288)	(0.00241)
Size	0.197	-0.511***
	(0.177)	(0.118)

Variables	Indonesia	Malaysia
	CEI	CEI
ROA	-0.626*	-0.777***
	(0.426)	(0.107)
Lev	2.100***	-0.333*
	(0.267)	(0.241)
PPE	-0.222	-0.493
	(0.665)	(0.432)
Loss	0.225***	0.0385
	(0.0764)	(0.0624)
Covid	0.0693***	0.0785**
	(0.0183)	(0.0398)
REC	-0.0116	-0.154***
	(0.0276)	(0.0598)
Constant	1.973***	4.232***
	(0.625)	(0.518)
Sargan Test: chi2	19.3444	16.43279
Sargan Test: Prob > chi2	0.4996	0.6894
Arellano–Bond test (AR(2)): p-value	0.3485	0.5397
Num. obs	217	672
Num. obs. used	105	276
Num. company	36	113

Notes: CEI: Carbon Emission Intensity; BS: Board Size; SC: Sustainability Committee; BGD: Board Gender Diversity; Size: Firm Size; ROA: Return on Assets; Lev: Leverage; PPE: Asset Tangibility; Loss: Loss Indicator; Covid: COVID-19 Period; REC: Renewable Energy Capacity.
***<0.01, **<0.05, *<0.1
Source: Author's own work (2025)

5. Conclusion, Implications, and Limitations

Climate change and carbon emissions have emerged as some of the most urgent global challenges of our time, drawing growing attention to the importance of corporate environmental responsibility. Companies today face increasing pressure from regulators, investors, and other stakeholders to minimize their environmental footprint, particularly by reducing carbon emissions. Within this context, corporate governance plays a pivotal role, serving as a key mechanism that shapes how firms design and implement their environmental strategies and overall sustainability performance. This study examines how corporate governance structures—specifically board size, the presence of a sustainability committee, and board gender diversity—affect carbon emission intensity. Using data from publicly listed firms in Indonesia and Malaysia, it provides empirical evidence from two emerging economies where sustainability regulations are still developing. The results show that board size has a significant negative relationship with carbon emission intensity, supporting the view that larger boards enhance sustainability oversight. However, neither the presence of a sustainability committee nor board gender diversity demonstrates a significant overall effect. Further subgroup analysis by country reveals notable contextual differences in these relationships. In Malaysia, both board size and the presence of a

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sustainability committee play a significant role in reducing carbon emissions. In contrast, these governance mechanisms have yet to show comparable effectiveness in Indonesia.

This study offers several theoretical, practical, and policy implications. From a theoretical standpoint, the findings extend the existing corporate governance and sustainability literature by demonstrating that board size can contribute to lowering carbon emission intensity in emerging economies, whereas sustainability committees and board gender diversity do not exhibit consistent effects across contexts. The findings indicate that the monitoring and advisory functions embedded within board structures play a central role in shaping environmental performance, while symbolic governance mechanisms may have limited real impact. From a practical perspective, companies should focus on strengthening the substantive roles of sustainability committees beyond their mere formal existence, ensuring that these committees actively participate in environmental oversight. Additionally, efforts to enhance board gender diversity should be supported by inclusive organizational practices that move beyond tokenism, allowing female directors to meaningfully contribute to strategic environmental decision-making. From a policy standpoint, the findings highlight the critical role of regulatory and institutional support in aligning governance mechanisms with sustainability goals. For emerging economies such as Indonesia and Malaysia, policymakers are encouraged to design regulations that go beyond merely mandating governance structures. Instead, they should emphasize the functional effectiveness of these mechanisms to minimize symbolic compliance and encourage genuine progress in corporate carbon performance.

This study has several limitations. First, its measure of climate performance is confined to greenhouse gas (GHG) emission intensity, which may not fully capture the breadth of companies' environmental strategies. Second, the sample focuses solely on publicly listed firms in two countries, which may limit the generalizability of the findings to other contexts. Future research is encouraged to incorporate more comprehensive sustainability indicators, adopt mixed-method approaches to gain deeper qualitative insights into governance dynamics, and extend the analysis across different countries and firm sizes. By doing so, subsequent studies can provide a stronger foundation for developing evidence-based and context-sensitive sustainability policies.

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