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Foreign Board Composition and Sustainability Committee's Impact on Carbon Emission Disclosure in Indonesian Listed Firms

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ABSTRACT

Purpose: The study examines how foreign board members and a sustainability committee affect carbon emission disclosure (CED) in Indonesian firms. The study posits that firms with governance structures comprising foreign directors and foreign commissioners, supported by a sustainability committee, are more likely to enhance their commitment to transparent CED information to the public.

Methods/Study design/Approach: The study employs unbalanced panel data from 2,893 firm-year observations of non-financial companies listed on the Indonesia Stock Exchange (IDX) over the 2014-2023 period. The hypotheses are tested using fixed-effects regression and moderation analysis. The data were obtained from official IDX publications and corporate websites.

Result/Findings: The findings indicate that the presence of foreign directors actually lowers the CED because they focus more on creating economic value than on voluntary disclosure, thereby making the monitoring of sustainability practices less effective. However, this negative effect can be transformed into a more positive one if the company has a sustainability committee, which acts as a governance mechanism to provide information, coordination, and monitoring, in line with agency theory, thereby helping foreign directors understand sustainability issues and mitigating their shortcomings in the Indonesian context.

Novelty/Originality/Value: Specific research examining the relationship between foreign directors, foreign commissioners, and sustainability committees on CED in Indonesia is still limited.

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INTRODUCTION

Climate change risk is a global issue; therefore, ensuring the quality of disclosure information reported by each corporate entity is essential (Stanny & Ely, 2008). Limited disclosure of emission-related information can hinder investors and other stakeholders in making informed decisions, understanding the impact of corporate activities on climate change, and assessing the initiatives undertaken by firms to mitigate climate-related risks. For regulators, such limited disclosure also poses challenges in tracking carbon emissions at the national level (Alrazi et al., 2016). In other words, disclosing carbon emission information to investors can be viewed as an initial step toward addressing climate change issues and reducing a company's carbon footprint (Ben-Amar et al., 2017).

Sustainability disclosure provides significant opportunities for companies to leverage strategic sustainability initiatives to achieve competitive advantage and improved firm value (Ioannou & Serafeim, 2019). Firms are expected to disclose carbon emissions as a means of public communication, fulfilling

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stakeholder interests, and obtaining legitimacy in relation to environmental management (Blanco et al., 2017). CED also influences investment decision-making criteria, including investor behavior (Ahmad et al., 2020). Companies that voluntarily disclose information on carbon emissions may enhance their firm value (Lee et al., 2021). Increased transparency through disclosure will reduce information asymmetry and lead to more consistent assessments among market participants (Christensen et al., 2022). Therefore, firms must strengthen their commitment to addressing climate change issues and implementing measures to control emissions resulting from increased business activities.

Companies with stronger governance structures tend to provide more comprehensive CED, as such structures increase accountability for implementing sustainable practices (Choi et al., 2013; Miller & Serafeim, 2014). Board governance, including members' backgrounds and professional networks, plays a crucial role in improving the quality of climate disclosure (Nathalia & Setiawan, 2022). Specifically, board nationality diversity has been shown to positively influence the likelihood of CED (Kılıç & Kuzey, 2018). This diversity provides a broader range of perspectives, insights, and knowledge, thereby enhancing the company's decision-making capacity (Estélyi & Nisar, 2016). The presence of foreign board members, who bring diverse skills and networks, can enhance corporate effectiveness and efficiency (Mardini & Lahyani, 2022). Therefore, the relationship between board nationality diversity and the level of corporate disclosure, particularly regarding CED, remains an important area for further investigation (Beji et al., 2020).

Nationality differences among board members also influence corporate policy decisions, and this diversity can improve corporate social performance (Harjoto et al., 2019). Empirical evidence shows a positive impact of board nationality diversity on CSR performance (Beji et al., 2020), CSR disclosure (Garanina & Aray, 2021), and carbon information disclosure (Kılıç & Kuzey, 2018). However, specific research on the relationship between foreign directors and commissioners and CED in Indonesia is still limited. Previous studies, using different proxies, found that foreign board diversity positively impacts CED (Syabilla et al., 2021), and companies with a more diverse composition of foreign commissioners and directors exhibit higher levels of CED (Jannah & Narsa, 2021). For example, Syabilla et al. (2021) used foreign directors, Jannah & Narsa (2021) used foreign directors and commissioners, and Ummah & Setiawan (2021) used foreign commissioners. These studies concluded that the national diversity of directors and commissioners has a positive effect on CED. Several studies outside Indonesia also show similar results, for example, Kılıç & Kuzey (2018) in Turkey, Lahyani (2022), and Mardini & Lahyani (2022) in France. They concluded that the presence of a foreign board can balance stakeholder and shareholder demands regarding CED information.

This study also uses a sustainability committee as a moderating variable suspected of increasing CED. This study uses the term sustainability committee as part of the corporate governance structure, which is assumed to strengthen the role of directors, commissioners, and ownership structure in CED. The existence of a sustainability committee serves as a monitoring mechanism, so that every decision made by management regarding environmental aspects can be effectively monitored (Upadhyay et al., 2014). Biswas et al. (2018) and Dixon-Fowler et al. (2017) state that a sustainability committee can contribute to a company's environmental practices, while Peters et al. (2018) emphasize that its formation is an effective way to monitor environmental issues. It can be concluded that the oversight function of a sustainability committee can also align the interests of stakeholders and the company.

Existing studies on CED in Indonesia have predominantly relied on the disclosure index developed by Choi et al. (2013) as the primary measurement instrument. Although this index has been widely adopted, its dominance indicates a limited diversification of measurement approaches within the Indonesian research context. In contrast, international CED literature has increasingly employed alternative and more nuanced disclosure indices, such as those proposed by Liu et al. (2017), He et al. (2019), and Park et al. (2023), reflecting the dynamic evolution of climate-related disclosure practices. Furthermore, Indonesia has established a distinct regulatory framework through POJK No. 51/2017 (Otoritas Jasa Keuangan, 2017), which mandates sustainability reporting and explicitly addresses emission-related disclosures. However, prior empirical studies in Indonesia have largely failed to integrate these domestic regulatory requirements into the construction of CED indices. This condition reveals a clear research gap, namely the misalignment between commonly used CED measurement practices and the simultaneous development of international disclosure frameworks and national regulations. To address this gap, the novelty of this study lies in developing a comprehensive and context-specific CED index that synthesizes the indices of Choi et al. (2013), Liu et al. (2017), He et al. (2019), and Park et al. (2023), while aligning them with GRI, TCFD, and POJK No. 51/2017. This integrated index offers a more relevant and institutionally grounded measure of CED in Indonesia.

With respect to sustainability governance, this study employs a comprehensive and hierarchical measurement of the sustainability committee by capturing all forms of sustainability responsibility within firms, including sustainability teams or units; sustainability, environmental, or ESG divisions, departments, or committees; and the appointment of a sustainability director or Chief Sustainability Officer (CSO). The sustainability committee variable is measured using an ordinal score ranging from 0 to 3, reflecting increasing

levels of organizational commitment to sustainability governance. In contrast, prior studies have predominantly relied on a binary dummy measure (0–1), which assumes homogeneity across firms and overlooks differences in governance sophistication. This measurement approach reveals a clear research gap, as it fails to capture the heterogeneity and strategic depth of sustainability governance structures. Accordingly, the novelty of this study lies in introducing a more nuanced, graded measure of the sustainability committee, which better reflects variations in firms' institutionalization of sustainability and provides a more accurate representation of sustainability governance quality.

This study's research objectives are theoretically grounded in agency theory, stakeholder theory, and resource dependence theory, which together provide a comprehensive explanation of how corporate governance mechanisms influence CED. From an agency theory perspective, CED serves as a transparency and monitoring mechanism that reduces information asymmetry between managers and shareholders (Jensen & Meckling, 1976). The presence of foreign directors and foreign commissioners is expected to enhance board monitoring effectiveness due to their greater independence, international experience, and exposure to stricter disclosure environments, thereby encouraging more extensive environmental disclosure. In parallel, stakeholder theory argues that firms respond to the expectations and pressures of multiple stakeholder groups, such as regulators, investors, and civil society, by increasing the scope and quality of sustainability-related disclosures to maintain legitimacy and stakeholder support (Freeman, 1984). Within this framework, the establishment of a sustainability committee reflects a firm's proactive response to stakeholder demands through formal governance structures dedicated to environmental oversight. Furthermore, resource dependence theory emphasizes the role of board members and governance mechanisms as providers of critical resources, including expertise, external networks, and institutional legitimacy (Pfeffer & Salancik, 1978). Foreign board members and specialized sustainability committees can supply firms with environmental knowledge and access to global best practices, thereby facilitating more comprehensive and credible CED.

This study aims to advance the literature on corporate environmental disclosure by examining how board internationalization, in the form of foreign directors and foreign commissioners, and sustainability governance mechanisms, particularly sustainability committees, influence CED. Drawing on agency theory, stakeholder theory, and resource dependence theory, the study investigates whether the presence of foreign board members enhances firms' incentives and capabilities to disclose carbon emission information, and whether sustainability committees function as effective governance mechanisms to institutionalize and strengthen CED practices. In this context, foreign board members and specialized sustainability committees provide firms with environmental expertise, access to global best practices, and institutional legitimacy, thereby facilitating more comprehensive, credible, and transparent CED.

From an agency theory perspective, CED represents a governance mechanism that reduces information asymmetry and constrains managerial opportunism in environmental reporting (Jensen & Meckling, 1976). The presence of foreign directors and foreign commissioners is expected to strengthen board monitoring due to their greater independence, international exposure, and familiarity with stricter disclosure regimes. Prior studies suggest that foreign board members are less embedded in domestic networks and controlling interests, enabling them to exercise more effective oversight and demand higher transparency from management (Masulis et al., 2012). Moreover, their experience with advanced environmental regulations and sustainability reporting standards increases sensitivity to climate-related risks and disclosure expectations (Oxelheim & Randøy, 2003; Giannetti et al., 2015). Consequently, foreign directors and commissioners are more likely to pressure management to enhance the scope and credibility of CED as a means of protecting shareholder interests and reducing agency costs.

Building on the agency-based argument that foreign board members enhance monitoring quality. Prior empirical studies provide consistent evidence that foreign directors and foreign commissioners strengthen firms' environmental and CED practices. Through their international exposure and familiarity with global environmental challenges, foreign board members contribute valuable insights that support more transparent carbon reporting. The appointment of foreign directors also serves as a reputational signal, reflecting firms' alignment with internationally recognized governance and sustainability standards (Muttakin et al., 2015). Empirical findings indicate that foreign board representation is positively associated with environmental performance (Beji et al., 2020) and more extensive CED (Jannah & Narsa, 2021). Moreover, foreign directors facilitate a better balance between shareholder and stakeholder interests, thereby enhancing the credibility of carbon-related information disclosed to the market (Lahyani, 2022). Evidence further suggests that firms with foreign board members exhibit superior carbon performance and higher-quality CED, contributing to reduced information asymmetry (Mardini & Lahyani, 2022).

Despite these expected benefits, the influence of foreign directors on CED may not always be positive, particularly in emerging markets with a two-tier governance system such as Indonesia. From an agency perspective, foreign directors may face information asymmetry, limited familiarity with domestic

environmental regulations, and geographical, cultural, and language barriers that reduce their ability to oversee sustainability-related decisions effectively (Katmon et al., 2017; Rashid & Barokah, 2024). Moreover, foreign directors may prioritize short-term financial performance and shareholder value creation over voluntary environmental disclosure, especially when sustainability practices are still evolving within the institutional context (Anazonwu et al., 2018). Previous studies have therefore suggested that the effectiveness of foreign directors depends on the institutional environment, governance structure, and the extent to which they are integrated into corporate decision-making (Katmon et al., 2017; Rashid & Barokah, 2024). These competing theoretical arguments indicate that the relationship between foreign directors and carbon emission disclosure may be either positive or negative depending on organizational and institutional conditions. Although competing theoretical arguments exist, this study expects a positive association because foreign directors are expected to contribute international expertise, enhance governance quality, and strengthen firms' environmental transparency. Accordingly, this study proposes that the presence of foreign directors and foreign commissioners is positively associated with firms' CED.

H₁: Foreign directors have a positive effect on CED

H₂: Foreign commissioners have a positive effect on CED

This study analyzes the role of sustainability committees as a governance component suspected of improving corporate CED practices. These committees serve as an oversight mechanism to oversee environmental managerial decisions, thereby aligning shareholder interests with the behavior of directors and managers. From a stakeholder and agency theory perspective, the establishment of a sustainability committee constitutes a formal governance mechanism that enhances firms' responsiveness to stakeholder pressures while strengthening internal monitoring of environmental issues. Stakeholder theory posits that increasing demands from regulators, investors, and society encourage firms to institutionalize sustainability oversight to maintain legitimacy (Freeman, 1984). At the same time, agency theory suggests that sustainability committees improve board oversight over environmental risks and disclosure practices, thereby reducing managerial discretion and information asymmetry in carbon reporting (Jensen & Meckling, 1976). By dedicating specialized expertise and organizational resources to sustainability matters, such committees facilitate more systematic monitoring and disclosure of carbon emissions. Empirical evidence supports this view, showing that firms with sustainability or environmental committees exhibit higher-quality environmental reporting and more extensive CED (Liao et al., 2015; Ben-Amar & McIlkenny, 2014; Muttakin et al., 2015). The presence of sustainability committees also positively contributes to corporate environmental practices (Biswas et al., 2018; Dixon-Fowler et al., 2017) and is an efficient means of monitoring corporate environmental issues (Peters et al., 2018).

Empirical studies further demonstrate that sustainability expertise at the board and executive levels is operationalized through formal governance structures, such as environmental or CSR committees and the appointment of a Chief Sustainability Officer (CSO) (Velte & Stawinoga, 2020; Budianto et al., 2025). Prior evidence suggests that these mechanisms enhance the quality and credibility of sustainability-related disclosures by ensuring that environmental information is systematically monitored and strategically communicated to external stakeholders (Yunus et al., 2016). Firms with more developed sustainability governance structures, including larger boards and established sustainability committees, tend to exhibit higher-quality sustainability reporting (Latif et al., 2023). Recent empirical findings also indicate that the presence of a CSO with specialized sustainability expertise is positively associated with improved environmental and biodiversity disclosure (Velte, 2023), while sustainability and environmental committees have been shown to enhance CED in various institutional settings (Kılıç & Kuzey, 2018; Hollindale et al., 2017; Jannah & Narsa, 2021). The prevailing empirical evidence supports the view that formal sustainability governance structures contribute to more extensive and transparent carbon-related disclosure. Accordingly, this study proposes that the presence and strength of sustainability committees are positively associated with firms' CED.

H₃: The sustainability committee has a positive effect on CED

The moderating effect of the sustainability committee is conceptualized as an interaction mechanism that conditions the relationship between foreign board representation and CED. From an agency theory perspective, while the presence of foreign directors and foreign commissioners enhances monitoring incentives and demands for transparency, these effects are expected to be stronger when firms possess a sustainability committee that provides structured oversight and technical support for environmental reporting (Jensen & Meckling, 1976). In empirical terms, this implies that the positive influence of foreign directors and foreign commissioners on CED is amplified through their interaction with the sustainability committee, as the committee facilitates the translation of board-level monitoring into operational disclosure practices. Furthermore, from a stakeholder theory perspective, sustainability committees institutionalize stakeholder expectations for environmental transparency, enabling foreign board members, who are more attuned to

global stakeholder pressures, to exert greater influence on CED when such committees are in place (Freeman, 1984).

Corporate governance structures play a pivotal role in enhancing CED and providing positive signals regarding a firm's sustainability performance (Kurnia et al., 2020). Companies are expected to consistently disclose carbon-related information in their annual reports to assist boards of directors and regulatory bodies in managing carbon emissions (Akhanolu et al., 2023). From the perspective of agency theory, Lueg et al. (2019) suggest that high-quality sustainability disclosure helps reduce information asymmetry, build investor and stakeholder trust, and lower the firm's cost of capital. As noted by Liao et al. (2015), environmental committees play a moderating role by balancing the firm's financial interests and mediating potential conflicts between stakeholders and the company. Within the agency theory framework, committees are established to facilitate the board in monitoring managerial behavior and aligning the interests of investors, stakeholders, and managers (Daily et al. 2003; Nicholson & Kiel, 2007). The sustainability committee serves as a monitoring mechanism to assist both management and the board in addressing environmental issues (Upadhyay et al., 2014; Peters et al., 2018).

Complementing this view, resource dependence theory suggests that sustainability committees provide specialized environmental expertise and internal informational resources that interact with the international knowledge and networks of foreign directors and commissioners, amplifying their impact on disclosure outcomes (Pfeffer & Salancik, 1978). Given the limited empirical evidence in the Indonesian context, this study argues that sustainability committees serve as a moderating governance mechanism that strengthens the positive influence of foreign directors and foreign commissioners on CED. Accordingly, the following hypotheses are proposed.

H₄: The sustainability committee strengthens the positive influence of foreign directors on CED

H₅: The sustainability committee strengthens the positive influence of foreign commissioners on CED

Thus, this study posits a positive relationship between foreign directors, foreign commissioners, sustainability committee and the level of CED, as illustrated in Figure 1.

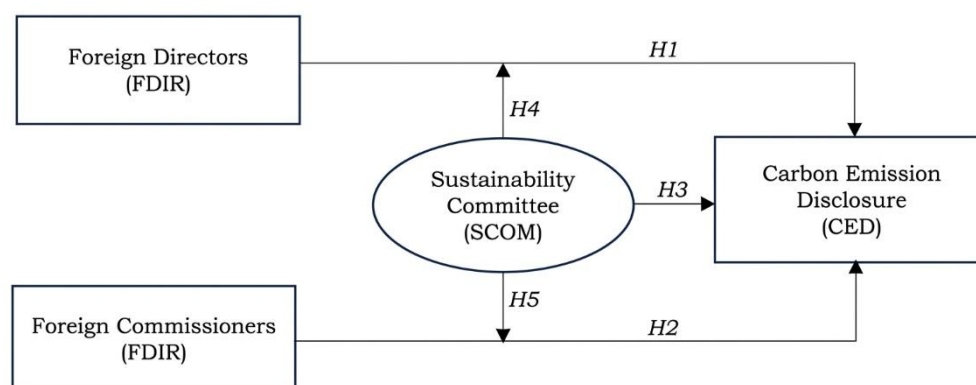


Figure 1. Conceptual framework
Source: Compiled by author (2025)

METHOD

This study employs panel data derived from non-financial public companies listed on the Indonesia Stock Exchange (IDX) over the period 2014-2023. We manually collected and compiled data on carbon emission disclosure, the proportion of foreign directors, foreign commissioners, and the existence of sustainability committees through content analysis of annual reports and sustainability reports. To enhance the validity of data collection, a purposive sampling technique was employed to ensure that the final sample met all criteria necessary for hypothesis testing (Sekaran & Bougie, 2017). Table 1 presents the process of sample selection in this study. The total population consists of 6,550 firm-year observations. After excluding incomplete data, the final sample comprises 2,893 firm-year observations.

Table 1. Research sample selection criteria

Description	Amount
Non-financial companies listed on the IDX (2014-2023)	6,550
Missing data: annual report & sustainability report	(1,563)
Missing data: no carbon emissions disclosure reporting found	(2,094)
Total observations (10 years)	2,893

Source: The processed data (2025)

Table 2. Definitions and Operationalization of Variables

Variables	Measurement	Reference
Carbon Emission Disclosure (CED)	$CED = \frac{\text{Total score of disclosure}}{\text{Maximum score of disclosure}}$	Choi et al. (2013), Liu et al. (2017), He et al. (2019), Park et al. (2023), GRI 305 & 302 (Global Reporting Initiative (2016), POJK 51/2017 (Otoritas Jasa Keuangan, 2017)
Foreign Directors (FDIR)	$FDIR = \frac{\text{Number of foreign directors}}{\text{Total directors on the BOD}}$	Kılıç & Kuzey (2018), Garanina & Aray (2019), Jannah & Narsa (2021), Mardini & Lahyani (2022)
Foreign Commissioners (FCOM)	$FCOM = \frac{\text{Number of foreign commissioners}}{\text{Total commissioners on the BOC}}$	Jannah & Narsa (2021), Ummah & Setiawan (2021)
Sustainability Committee (SCOM)	0 (does not have a sustainability officer or sustainability responsibility); 1 (has at least a sustainability team or unit); 2 (has a sustainability committee, division, or department); 3 (has a dedicated sustainability director or chief sustainability officer or CSO)	Hollindale et al. (2017), Jannah & Narsa (2021), Fitriasari (2023), Chairina & Tjahjadi (2023), Budianto et al. (2025)
Institutional Ownership (IOWN)	Percentage of institutional ownership	Croci et al. (2012), Jaggi et al. (2017), Akbaş & Canikli (2019), Shen et al. (2020)
Foreign Ownership (FOWN)	Percentage of foreign ownership	Estélyi & Nisar (2016), McGuinness et al. (2017), Tingbani et al. (2020), Fan et al. (2023), Bedi & Singh (2024), Al-Mari & Mardini (2024)
Firms Size (SIZE)	Natural logarithm of total assets of the firm	Shen et al. (2020), Nathalia & Setiawan (2022), Datt et al. (2022), Toukabri (2024)
Firms Audit (AUD)	A dummy variable coded 1 if the company has been audited by either of the big 4 accounting firms (Deloitte, PwC, EY, KPMG) and 0 if otherwise	Tingbani et al. (2020), Bedi & Singh (2024), Dharma et al. (2024), Rahmawati et al. (2024)
Profitability 1 (ROA)	Percentage of net income to total assets	Mardini & Lahyani (2022), Al-Mari & Mardini (2024), Rahmawati et al. (2024), Cahyono et al. (2024)
Profitability 2 (ROE)	Percentage of net income to total equity	Al-Mari & Mardini (2024), Fan et al. (2023), Bedi & Singh (2024), Rahmawati et al. (2024)
Leverage 1 (DAR)	Percentage of total debt to total assets	Al-Mari & Mardini (2024), (Fan et al., 2023), (Bedi & Singh, 2024), Rahmawati et al. (2024)
Leverage 2 (DER)	Percentage of total debt to total equity	Abdullah et al. (2020), Jannah & Narsa (2021), Meiryani et al. (2023); Wahyuningrum et al. (2024), Dharma et al. (2024), Rahmawati et al. (2024)
Environmental Performance (PROPER)	The PROPER rating obtained by the company, with the following details: 5 = golden rating (very good), 4 = green rating (very good), 3 = blue rating (good), 2 = red rating (bad), 1 = black rating (very bad), and 0 = non-participation	Yunus et al. (2016), Bravi et al. (2020), Ummah & Setiawan (2021)
Environmental Certificate (ISO-14001)	A dummy variable coded 1 if the company holds an ISO:14001 certificate and 0 if otherwise	Chairina & Tjahjadi (2023), Budianto et al. (2025)
Sustainability Report Assurance (ASSURE)	A dummy variable coded 1 if the SR has been assessed by an external assurance institution, and 0 otherwise.	

Source: The processed data (2025)

This study uses fixed-effect (FEM) and moderated regression analysis to test the hypothesis. The FEM estimator was selected not only because the Hausman specification test indicated its superiority over the random-effects model (REM) but also because it controls for unobserved time-invariant firm characteristics that may be correlated with board composition and CED, thereby mitigating omitted variable bias. The dependent variable (CED) comprises 21 indicators, each scored on a binary scale (0 or 1). A score of 1 is assigned if a company discloses the relevant information; otherwise, a score of 0 is assigned. The complete list of CED indicators used in this study is presented in Table A1. The independent variables include the proportion of foreign directors (FDIR) and foreign commissioners (FCOM) on the board. The moderating variable, the sustainability committee (SCOM), is measured on an ordinal scale of 0–3 reflecting the maturity of a company's sustainability governance: scores of 0 (no structure), 1 (team/unit present), 2 (formal committee/department present), and 3 (head of sustainability/CSO present). Control variables include institutional (IOWN) and foreign (FOWN) ownership, firm size (SIZE), profitability (ROA, ROE), leverage (DAR, DER), big four auditor (AUDIT), environmental performance (PROPER), environmental certification (ISO-14001), and external assurance (ASSURE). More detailed explanations regarding the definitions and operationalization of variables are presented in Table 2. The regression model is shown by

Equation 1, 2, and 3. Furthermore, robustness tests are conducted to ensure the reliability of the main findings.

Equation 1. Relationship between FDIR, FCOM, and CED:

$$CED = \alpha + \beta_1 FDIR + \beta_2 FCOM + \beta_3 IOWN + \beta_4 FOWN + \beta_5 SIZE + \beta_6 AUDIT + \beta_7 ROA + \beta_8 ROE + \beta_9 DAR + \beta_{10} DER + \beta_{11} PROPER + \beta_{12} ISO + \beta_{13} ASSURE + \varepsilon \dots\dots\dots 1$$

Equation 2. Relationship between FDIR, FCOM, SCOM, and CED:

$$CED = \alpha + \beta_1 FDIR + \beta_2 FCOM + \beta_3 SCOM + \beta_4 IOWN + \beta_5 FOWN + \beta_6 SIZE + \beta_7 AUDIT + \beta_8 ROA + \beta_9 ROE + \beta_{10} DAR + \beta_{11} DER + \beta_{12} PROPER + \beta_{13} ISO + \beta_{14} ASSURE + \varepsilon \dots\dots\dots 2$$

Equation 3. Relationship between FDIR, FCOM, Moderating Effects, and CED:

$$CED = \alpha + \beta_1 FDIR + \beta_2 FCOM + \beta_3 SCOM + \beta_4 SCOM \times FDIR + \beta_5 SCOM \times FCOM + \beta_6 IOWN + \beta_7 FOWN + \beta_8 SIZE + \beta_9 AUDIT + \beta_{10} ROA + \beta_{11} ROE + \beta_{12} DAR + \beta_{13} DER + \beta_{14} PROPER + \beta_{15} ISO + \beta_{16} ASSURE + \varepsilon \dots\dots\dots 3$$

RESULTS AND DISCUSSIONS

Table 3 and Table 4 shows the results of descriptive statistics. The average CED value is 0.322, indicating that companies disclose 32.2% of the total indicators, on average. The average proportion of FDIR and FCOM is 0.110 and 0.107, respectively, indicating a relatively low level of foreign representation. The average SCOM is 0.365, indicating that most companies do not yet have a dedicated sustainability structure. Panel B highlights that only a small proportion of companies have a formal structure: 103 companies (4%) have a CSO, 272 companies (9%) have a SCOM, and 202 companies (7%) have a sustainability team.

Table 3. Summary statistics (N = 2,893)

Variable	Mean	Median	Minimum	Maximum	Std.Dev
CED	0.322	0.238	0.048	1.000	0.249
FDIR	0.110	0.000	0.000	1.000	0.202
FCOM	0.107	0.000	0.000	1.000	0.199
SCOM	0.365	0.000	0.000	3.000	0.796
IOWN	0.703	0.797	0.000	0.998	0.279
FOWN	0.230	0.106	0.000	0.982	0.280
SIZE	19.222	19.292	8.329	24.089	1.881
AUDIT	0.350	0.000	0.000	1.000	0.477
ROA	0.015	0.030	-5.592	4.693	0.314
ROE	0.019	0.044	-5.422	3.939	0.382
DAR	0.366	0.341	0.000	0.988	0.209
DER	0.681	0.492	-5.741	5.980	0.869
PROPER	0.957	0.000	0.000	5.000	1.574
ISO	0.480	0.000	0.000	1.000	0.499
ASSURE	0.057	0.000	0.000	1.000	0.231

Source: The processed data (2025)

The Pearson correlation test was conducted to ensure the absence of high or perfect multicollinearity among the independent variables in the regression models (Gujarati & Porter, 2009). By examining the Pearson correlation coefficients in Table A2, all independent variables exhibit correlation values below 0.75 (<0.75). This finding indicates that no substantial correlation exists among the independent variables, suggesting that multicollinearity is not a major concern in this study. Therefore, the hypothesis testing using panel data regression analysis can be appropriately performed with the independent variables specified in the proposed regression models. Furthermore, Table A2 presents the Variance Inflation Factor (VIF) values for each independent variable. All VIF values are below 10 (<10), reinforcing that there is no significant evidence of multicollinearity within the regression model. These results confirm that the data meet the necessary statistical assumptions for reliable estimation and interpretation of regression outcomes.

Selecting the most appropriate regression model is crucial to obtaining valid and reliable empirical results. In panel data regression analysis, there are three alternative models: the Common Effects Model (CEM), the Fixed Effects Model (FEM), and the Random Effects Model (REM). Determining the most suitable model requires several diagnostic tests, namely the Chow test, the Hausman test, and the Lagrange Multiplier test (Ghoshali & Ratmono, 2017). Table 5 summarizes the results of the Chow and Hausman tests.

Table 4. Summary statistics for dummy variables (N = 2,893)

Variable	Score	Sample	Percent
SCOM	3 = has a chief sustainability officer (CSO)	103	0.04
	2 = has a sustainability committee/department	272	0.09
	1 = has a sustainability team/unit	202	0.07
	0 = does not have	2316	0.80
PROPER	5 = golden (very satisfying)	69	0.02
	4 = green (very good)	205	0.07
	3 = blue (good)	535	0.19
	2 = red (bad)	0	0.00
	1 = black (very bad)	0	0.00
	0 = non-rating	2084	0.72
AUDIT	1 = using one of the Big-4 auditors	1012	0.35
	0 = otherwise	1881	0.65
ISO	1 = if the company has an ISO:14001	1390	0.48
	0 = otherwise	1503	0.52
ASSURE	1 = using external assurance on SR	165	0.06
	0 = otherwise	2728	0.94

Source: The processed data (2025)

The Chow test results show a p-value below 0.05 ($p < 0.05$), indicating that the null hypothesis is rejected and the alternative hypothesis is accepted. Therefore, the FEM is preferred over the CEM. Furthermore, the Hausman test yields a significant p-value of less than 0.05 ($p < 0.05$), suggesting that the null hypothesis should also be rejected and the alternative hypothesis accepted.

The FEM was chosen not only because it is supported by the Hausman specification test, but also because it is theoretically appropriate for this study. The relationship between board composition and CED is likely influenced by unobserved firm-specific characteristics. These time-invariant characteristics are expected to be correlated with the explanatory variables, particularly the composition of foreign board members and the existence of a SCOM. By controlling for this unobserved heterogeneity, the fixed effects estimator provides more consistent and unbiased estimates of the relationships examined in this study.

Table 5. Selection of regression model

No	Chow test	Hausman test	P-value	Results
1. Cross-section F Probability	3.1925 (0.0000)		< 0.05	FEM
2. Cross-section random Probability		150.2877 (0.0000)	< 0.05	FEM

Source: The processed data (2025)

Table 6 presents the main regression results (FEM) for all models. Models 1, 2, and 3 examine the individual effects of FDIR, FCOM, and SCOM. Model 4 serves as the baseline specification, including the main effects of FDIR, FCOM, the SCOM, and control variables. Models 5 expand on this baseline specification by introducing interaction terms (SCOM×FDIR and SCOM×FCOM) to examine whether the SCOM moderates the relationship between foreign board composition and CED. Comparing these models allows for the evaluation of the additional contribution of interaction effects beyond the direct effects of the explanatory variables.

Foreign Directors (FDIR), Foreign Commissioners (FCOM) and CED

The analysis results reveal differing influences between FDIR and FCOM on CED. Models 1, 4 and 5 show that FDIR has a negative effect on CED, where a higher proportion of FDIR is associated with lower CED. This finding contrasts with numerous previous studies, such as Kılıç & Kuzey (2018), Jannah & Narsa (2021), Mardini & Lahyani (2022), Octavio & Setiawan (2024), and Wahyuningrum et al. (2024) which consistently reported a positive relationship between foreign board membership and enhanced CED. Conversely, the results of Model 2, 4, and 5 indicate that FCOM has a positive and highly significant effect on CED. This suggests that within Indonesia's two-tier governance system, the oversight role of FCOM is more effective in promoting sustainability disclosure than the operational role of FDIR. A potential explanation is that FDIR may focus on short-term profitability, whereas FCOM emphasizes broader governance and long-term sustainability oversight. Thus, the positive finding for FCOM aligns with existing literature, positioning FCOM as a crucial oversight mechanism to align corporate actions with the interests of both shareholders and stakeholders. This results aligns with prior studies by Kılıç & Kuzey (2018); Jannah & Narsa (2021); Lahyani (2022); Mardini & Lahyani (2022); Octavio & Setiawan (2024); and Wahyuningrum et al. (2024).

Table 6. Regression results

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
FDIR	-0.036 (-0.716)			-0.069 (1.511)	-0.113** (-2.302)
FCOM		0.121** (2.402)		0.103** (2.259)	0.148*** 3.101
SCOM			0.174*** (24.929)	0.174*** (24.898)	0.176*** (20.171)
SCOM*FDIR					0.072** (2.445)
SCOM*FCOM					-0.084*** (-3.056)
IOWN	0.045 (1.205)	0.050 (1.331)	0.034 (1.038)	0.034 (1.028)	0.034** (1.025)
FOWN	-0.025 (-0.622)	-0.046 (-1.137)	-0.070** (-1.977)	-0.075** (-2.071)	-0.071* (-1.937)
SIZE	0.122*** (9.629)	0.122*** (9.612)	0.083*** (7.337)	0.084*** (7.406)	0.082*** (7.213)
AUDIT	0.012 (0.413)	0.006 (0.223)	0.009 (0.372)	0.007 (0.288)	0.008 (0.306)
ROA	-0.006 (-0.310)	-0.005 (-0.279)	0.003 (0.175)	0.003 (0.162)	0.003 (0.151)
ROE	-0.013 (-1.201)	-0.013 (-1.141)	-0.007 (-0.733)	-0.007 (-0.754)	-0.008 (-0.821)
DAR	0.021 (0.446)	0.022 (0.474)	0.015 (0.351)	0.014 (0.343)	0.012 (0.297)
DER	-0.008 (-0.958)	-0.008 (-1.003)	-0.005 (-0.711)	-0.005 (-0.696)	-0.006 (-0.814)
PROPER	0.028*** (5.791)	0.028*** (5.821)	0.015*** (3.586)	0.016*** (3.619)	0.016*** (3.800)
ISO	0.092*** (4.929)	0.091*** (4.844)	0.087*** (5.227)	0.085*** (5.138)	0.085*** (5.135)
ASSURE	0.322*** (14.525)	0.319*** (14.429)	0.139*** (6.646)	0.139*** (6.625)	0.139*** (6.685)
Adjusted-R ²	0.501	0.502	0.609	0.609	0.612
F-Statistic	5.467	5.488	7.936	7.936	7.964
N	2,893	2,893	2,893	2,893	2,893

Source: The processed data (2025)

Sig.level ***0.01, **0.05, *0.1

The findings reveal an asymmetric effect of board internationalization on CED. While FDIR are negatively associated with CED, FCOM show a positive relationship with CED, indicating that the influence of foreign board members depends on their governance roles and level of independence. From an agency theory perspective, FDIR (who are directly involved in managerial and operational decision-making) may prioritize efficiency, cost control, and short-term financial performance, thereby adopting more cautious disclosure strategies to mitigate potential regulatory scrutiny and reputational risks (Liao et al., 2015). Their dual role as both monitors and decision-makers may limit their effectiveness in reducing information asymmetry related to environmental disclosure. In contrast, FCOM primarily function as independent monitors of management, which strengthens their ability to demand higher transparency and accountability in sustainability reporting, consistent with agency theory predictions (Daily et al. 2003; Nicholson & Kiel, 2007). From a resource dependence theory perspective, although both FDIR and FCOM possess international experience and access to global networks, FCOM are better positioned to mobilize these resources to enhance organizational legitimacy and align firms with international environmental norms and stakeholder expectations (Alshirah et al., 2019). Consequently, their presence facilitates more extensive and credible CED, particularly in emerging market contexts where external legitimacy and governance quality are critical (Liao et al., 2015; Kurnia et al., 2020). Overall, these findings suggest that board internationalization does not uniformly enhance environmental transparency; instead, its effectiveness in promoting CED is contingent upon the institutional role and governance function of foreign board members.

Sustainability Committees (SCOM) and CED

The analysis of Models 3, 4, and 5 consistently shows that the presence of a SCOM has a positive effect on CED. This indicates that companies with an SCOM disclose more comprehensive carbon information. This finding aligns with agency theory, which posits that specialized committees enhance

oversight and align stakeholder interests. The SCOM acts as a governance mechanism that strengthens board supervision of environmental practices, supports management in addressing ecological issues, and promotes responsible conduct. These results are supported by extensive prior research. Studies by Raimo et al. (2022), Velte (2023), and Fu et al. (2020) confirm that dedicated sustainability officers or committees improve disclosure quality and corporate social performance. Furthermore, research from Kılıç & Kuzey (2018), Jannah & Narsa (2021), and more recent work by Bedi & Singh (2024), Toukabri (2025), and Budianto et al. (2025) consistently demonstrates a positive link between sustainability governance structures and enhanced CED. In conclusion, the SCOM is a crucial mechanism for improving CED. It reduces information asymmetry, enhances accountability, aligns incentives, and mitigates risk, thereby harmonizing the interests of management, shareholders, and stakeholders in meeting environmental responsibilities.

This finding supports stakeholder theory, which posits that firms are accountable to a broad range of stakeholders whose demands for environmental transparency have intensified amid growing concerns over climate change (Freeman, 1984; Mitchell et al., 1997). The presence of a SCOM institutionalizes stakeholder interests within the corporate governance framework by ensuring that environmental and carbon-related issues receive systematic attention at the board level (Liao et al., 2015). SCOM enhance firms' responsiveness to stakeholder pressures by overseeing environmental performance and sustainability reporting processes, thereby improving the consistency and credibility of CED (Kılıç & Kuzey, 2018; Peters et al., 2018). This governance mechanism reduces symbolic or selective disclosure and promotes more comprehensive carbon-related information, which is crucial for maintaining organizational legitimacy and stakeholder trust (Deegan, 2002; Suchman, 1995). Empirical evidence from prior studies consistently shows that firms with sustainability or environmental committees (SCOM) exhibit higher quality environmental and CED (Hollindale et al., 2017; Jannah & Narsa, 2021; Latif et al., 2023).

In the Indonesian context, where environmental disclosure practices remain largely voluntary, the SCOM serves as a critical internal governance mechanism that strengthens firms' engagement with stakeholder expectations, thereby reinforcing the positive association between sustainability governance and CED.

The Role of SCOM as a Moderating Variable of FDIR and FCOM on CED

The analysis reveals a nuanced moderating role of the SCOM. Contrary to the proposed hypothesis, H_1 is not supported, as FDIR exhibit a significant negative direct effect on CED. However, the interaction term between SCOM and FDIR is positive and statistically significant. Rather than strengthening an already positive relationship, the findings suggest that SCOM functions as a complementary governance mechanism that enables FDIR to contribute more effectively to environmental transparency. This result is consistent with the competing theoretical arguments presented in the literature review, which acknowledge that although FDIR may provide valuable international expertise and global sustainability perspectives, their effectiveness may be constrained by institutional, regulatory, and cultural barriers within Indonesia's two-tier governance system. The presence of a dedicated SCOM appears to alleviate these constraints by providing structured coordination and sustainability oversight, thereby allowing FDIR to better translate their expertise into improved CED practices.

From the perspective of resource dependence theory, FDIR contribute international experience, environmental expertise, and access to global sustainability practices that constitute valuable organizational resources (Hillman et al., 2000). Nevertheless, these resources generate governance benefits only when they are effectively integrated into organizational decision-making. The SCOM facilitates this integration by institutionalizing sustainability responsibilities and coordinating disclosure processes. Similarly, agency theory suggests that the SCOM strengthens internal monitoring, reduces information asymmetry, and aligns managerial actions with the environmental expectations of investors and other stakeholders (Daily et al., 2003; Liao et al., 2015). Accordingly, the positive interaction indicates that stronger sustainability governance progressively attenuates the negative effect of FDIR. However, the marginal effect becomes positive only in firms with relatively mature sustainability governance structures ($SCOM \geq 2$), which represent a smaller proportion of the sample. Therefore, the findings should be interpreted as evidence that stronger sustainability governance can offset the governance limitations of FDIR rather than implying that all firms benefit equally. This finding is consistent with previous studies emphasizing the complementary role of board expertise and dedicated sustainability governance mechanisms in improving environmental transparency (Kılıç & Kuzey, 2018; Velte & Stawinoga, 2020).

Conversely, the interaction between SCOM and FCOM in Model 5 shows a significant negative effect on CED. This finding suggests that SCOM does not strengthen the positive influence of FCOM but rather reduces its incremental contribution to CED. A plausible explanation is the presence of governance overlap, whereby the sustainability oversight responsibilities performed by SCOM partially overlap with the supervisory responsibilities of FCOM within Indonesia's two-tier governance system. As firms establish more formal sustainability governance mechanisms, FCOM continue to play an important monitoring role; however, their additional contribution to sustainability disclosure becomes less pronounced because

sustainability oversight is increasingly coordinated through the dedicated committee. Thus, the negative interaction should be interpreted as a diminishing marginal governance effect, rather than a complete substitution of the monitoring role of FCOM. This finding indicates that SCOM complements the operational role of FDIR while simultaneously reducing the incremental governance benefits provided by FCOM. The effectiveness of FCOM is conditional upon the maturity of the firm's sustainability governance structure. FCOM play a stronger monitoring role when sustainability governance is relatively limited. However, once firms establish more formal sustainability governance mechanisms, their incremental contribution gradually diminishes.

Within the agency theory framework, FCOM primarily perform supervisory and control-oriented functions aimed at enhancing accountability and mitigating agency conflicts. The establishment of a SCOM does not replace these responsibilities but may create functional overlap in sustainability oversight, thereby reducing the marginal influence of FCOM on CED. As sustainability governance becomes increasingly institutionalized through a specialized committee, additional monitoring by foreign commissioners generates relatively smaller incremental benefits, leading to an attenuated interaction effect. This interpretation is consistent with the positive main effect of FCOM and the negative interaction coefficient. From a resource dependence perspective, FCOM continue to provide valuable international expertise, external networks, and legitimacy; however, when sustainability-related responsibilities are increasingly coordinated through SCOM, these resources may not be fully translated into additional disclosure practices. Since FCOM are not directly involved in day-to-day operational and strategic implementation, their incremental influence on disclosure decisions becomes more limited once specialized sustainability governance mechanisms are established (Peters et al., 2018). Accordingly, the negative moderating effect reflects a diminishing marginal governance contribution resulting from overlapping governance functions, rather than a complete displacement of the role of FCOM.

Robustness Test

To assess the robustness of the statistical inferences, the regression models were re-estimated using alternative robust covariance estimators available in EViews. The results remained qualitatively unchanged across various covariance specifications, indicating that the findings are robust to potential heteroscedasticity and panel dependence. Therefore, the reported conclusions are not sensitive to the choice of covariance estimation method.

Alternative Measurement of the Dependent Variable (CED)

As a robustness check, the measurement of the dependent variable CED was modified. While the primary analysis used a self-developed index comprising 21 indicators, this additional test adopts the 18 item disclosure index developed by Choi et al. (2013). The Choi index was selected because it has been widely applied in prior studies within the Indonesian context, making it a relevant benchmark for comparison. Both measurement models were then compared to assess the sensitivity and consistency of the regression results. Table A3 presents the comparison between the main model (Model 1) and the alternative Choi model (Model 2).

Based on the coefficients, probabilities, and *t*-statistics, the results for FDIR, FCOM, SCOM, and their interaction terms (SCOM×FDIR and SCOM×FCOM) in Choi model remain consistent with those of the main model. This consistency reinforces two key findings. First, the positive effect of FDIR on CED is contingent upon the moderating role of SCOM, suggesting that sustainability committees enhance the ability of foreign directors to promote transparency in emission disclosure. Second, although FCOM, serving as an independent supervisory mechanism within Indonesia's *two-tier governance system*, has a positive influence on CED, its effect turns negative when interacting with SCOM. This second finding reinforces the interpretation that the presence of SCOM may be perceived as duplicating monitoring functions, leading foreign commissioners to reduce their proactive engagement in CED, assuming that sustainability-related issues are already addressed by SCOM.

Dividing the Sample into High-Emission and Low-Emission Industries

This test was conducted to analyze the determinants of CED by comparing firms in high-emission and low-emission industries. Unlike the primary analysis, which examined the full sample as a whole, this additional test divides the sample into two groups based on emission intensity. The objective is to assess whether the significance and direction of the results differ once industry-specific characteristics are taken into account. Table A4 presents a comparative summary of regression results from three models: Model 1 (full sample), Model 2 (high-emission sample), and Model 3 (low-emission sample).

In the high-emission sample, several notable shifts in variable effects were observed. First, the negative effect of FDIR becomes more pronounced (coeff: -0.149), suggesting that foreign directors tend to

impede emission transparency in sectors facing strong environmental scrutiny. Second, the positive effect of FCOM increases substantially (coeff: 0.324), implying that FCOM are more responsive and proactive in addressing stakeholder demands for environmental accountability. Third, the positive and significant effect of FCOM is concentrated in high-emission industries, where environmental legitimacy pressures are substantially greater. Firms operating in carbon-intensive sectors face stronger scrutiny from regulators, investors, and other stakeholders regarding climate-related disclosure. Consequently, FCOM are more actively engaged in promoting transparency to maintain organizational legitimacy. By contrast, firms in low-emission industries (Model 3) experience relatively weaker environmental disclosure pressures, reducing the monitoring incentives of FCOM. This finding suggests that governance mechanisms become more influential when stakeholder expectations regarding environmental accountability are stronger. This finding is consistent with agency theory, which suggests that stronger monitoring mechanisms become more valuable when agency conflicts and environmental risks are greater, and with resource dependence theory, which argues that the value of directors' external resources depends on the strategic needs and institutional pressures faced by firms.

Robustness Tests: Subsample Analysis Excluding Firms without SCOM

To examine whether the highly unbalanced distribution of the SCOM variable influences the main findings, an additional robustness test was conducted by excluding firms without any sustainability governance mechanism (SCOM = 0). This subsample consists of 577 firm-year observations from the original 2,893 observations, including only firms with a sustainability team, sustainability committee, or chief sustainability officer. Table A5 reports the estimation results. Overall, the robustness test provides evidence that the main findings remain qualitatively consistent with those obtained from the full sample. The direction of the estimated coefficients is unchanged across all variables, indicating that the relationships identified in the main analysis are not driven solely by the large proportion of firms without sustainability governance mechanisms.

Specifically, FDIR continue to exhibit a negative coefficient, while FCOM and the SCOM maintain positive coefficients. Likewise, the interaction between SCOM and FDIR remains positive, whereas the interaction between SCOM and FCOM remains negative, consistent with the full-sample estimates. Although several coefficients lose statistical significance in the subsample analysis, this is likely attributable to the substantial reduction in sample size from 2,893 to 577 firm-year observations, which decreases statistical power rather than indicating a change in the underlying relationships. Overall, these findings suggest that the conclusions of this study are robust to alternative sample specifications. Therefore, the significant effects reported in the main analysis cannot be attributed merely to the highly skewed distribution of the SCOM variable but instead reflect stable relationships among firms that have implemented formal sustainability governance mechanisms.

CONCLUSION

This study provides empirical evidence that the influence of board internationalization on CED is contingent upon the governance role of foreign board members and the maturity of firms' sustainability governance mechanisms. The findings demonstrate that FDIR and FCOM do not contribute uniformly to environmental transparency within Indonesia's two-tier governance system. Contrary to the initial hypothesis, FDIR exhibit a significant negative effect on CED, suggesting that the expected governance benefits of FDIR may not be fully realized in the Indonesian institutional context. This finding supports the competing theoretical arguments proposed in this study, indicating that institutional, regulatory, and governance constraints may limit FDIR ability to translate their international expertise into enhanced environmental disclosure. In contrast, FCOM positively influence CED, consistent with agency theory, which emphasizes the monitoring role of commissioners in reducing information asymmetry and strengthening corporate accountability. Furthermore, the SCOM exerts a significant positive effect on CED, highlighting its importance as a dedicated governance mechanism that institutionalizes sustainability oversight and enhances environmental transparency.

The moderating analysis further reveals that the role of the SCOM differs across board functions. The positive interaction between SCOM and FDIR indicates that stronger sustainability governance progressively mitigates the negative influence of FDIR. However, this governance benefit is primarily evident among firms with relatively mature sustainability governance structures, where the SCOM assumes a more formal role in coordinating environmental oversight. Conversely, although FCOM continue to exert a positive direct influence on CED, their incremental governance contribution gradually diminishes as sustainability governance becomes more institutionalized. Rather than indicating a complete substitution of the monitoring role of FCOM, the negative interaction suggests a diminishing marginal governance effect arising from overlapping sustainability oversight responsibilities between FCOM and the SCOM. These findings demonstrate that the effectiveness of foreign board members depends not only on their international

experience but also on how sustainability governance mechanisms are structured and integrated within the firm's governance system.

The findings extend the literature on corporate governance and sustainability by demonstrating that sustainability governance serves as an important contextual condition shaping the effectiveness of board internationalization. From an agency theory perspective, the SCOM strengthens monitoring effectiveness and reduces information asymmetry, particularly by enabling FDIR to contribute more effectively to environmental transparency. From a resource dependence perspective, the governance value of foreign board members depends on the firm's ability to institutionalize their international expertise through dedicated sustainability governance mechanisms. Overall, this study contributes to the growing literature by showing that the relationship between board internationalization and CED is conditional rather than universal, emphasizing the importance of governance alignment in improving corporate environmental transparency.

This study has several limitations that provide opportunities for future research. First, the SCOM variable is measured using an ordinal scale (0–3), with approximately 80% of the observations concentrated in the baseline category (SCOM = 0). Although additional robustness analyses indicate that the main findings remain qualitatively consistent, future studies may adopt alternative measurements, such as separate dummy variables or continuous governance indices, to better capture the maturity and effectiveness of sustainability governance.

Second, although this study employs fixed-effects estimation and several robustness analyses to improve the reliability of the findings, potential endogeneity related to board composition cannot be completely eliminated. Future research may employ more advanced identification strategies, such as dynamic panel estimation, instrumental variables, or generalized method of moments (GMM), to further address potential reverse causality and omitted-variable bias.

Third, CED is measured using publicly reported corporate information. Consequently, the measure reflects firms' disclosure practices rather than their actual environmental performance and may therefore be subject to reporting bias or symbolic disclosure. Future research could combine disclosure-based measures with verified carbon emission databases or external ESG assessments to provide a more comprehensive evaluation of environmental performance.

Finally, this study does not distinguish foreign board members according to their country of origin or institutional background. Since board members from different countries may possess different governance traditions, regulatory experiences, and environmental values, future studies should classify FDIR and FCOM using institutional characteristics, such as the World Bank income classification, Environmental Performance Index (EPI), or legal origin, to provide deeper insights into how international board diversity influences sustainability governance and CED.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Budianto: Conceptualization, Methodology, Software, Project administration, Writing – original draft. **Doddy Setiawan:** Conceptualization, Methodology, Writing – review. **Wahyu Widarjo:** Theoretical and conceptual framework, Writing – review & editing. **Taufiq Arifin:** Validation, Software, Supervision.

DECLARATION OF COMPETING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY

Data will be made available on request.

AI USAGE STATEMENT

During the preparation of this work, the authors used ChatGPT (OpenAI) and Grammarly to improve the language and clarity of the manuscript. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the publication's content.

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Appendix 1

Table A1. Carbon emission disclosure indicators

ID	Disclosure Items	Score
<i>CC</i>	<i>Risks, Opportunities, and Actions Related to Climate Change</i>	
CC1	Climate change-related risks with potential impacts on business	1
CC2	Climate change-related opportunities with potential impacts on business	1
CC3	Actions initiated or planned to address climate change risks and opportunities	1
<i>ACC</i>	<i>Climate Change Governance and Accountability</i>	
ACC1	Indication that the board/executive body holds responsibility for climate-related actions	1
<i>TS</i>	<i>Carbon Emission Reduction Targets and Strategies</i>	
TS1	Formulation of emission reduction plans/targets for the next period	1
TS2	Implementation of long-term/short-term emission reduction strategies	1
<i>GHG</i>	<i>Greenhouse Gas Emissions Accounting</i>	
GHG1	Approach/methodology used to calculate GHG emissions	1
GHG2	Total GHG emissions reported	1
GHG3	Disclosure of Scope 1 emissions	1
GHG4	Disclosure of Scope 2 emissions	1
GHG5	Disclosure of Scope 3 emissions	1
GHG6	Total GHG emission intensity/concentration	1
GHG7	Reduction in GHG intensity/emissions from the previous period	1
GHG8	Disclosure of ozone-depleting substances (ODS) emissions – e.g. CFCs, N ₂ O	1
GHG9	Disclosure of other significant air emissions (e.g. NO _x , SO _x , CO, HCl, NH ₃)	1
<i>EC</i>	<i>Energy Consumption Accounting</i>	
EC1	Total energy consumption	1
EC2	Energy use intensity	1
EC3	Energy consumption disclosure by type	1
EC4	Reduction in energy consumption (energy efficiency)	1
EC5	Efforts to reduce energy consumption	1
EC6	Efforts to utilize renewable energy sources	1
Total Score		21

Source: Budianto et al. (2025)

Appendix 2

Table A2. Correlation results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	VIF
CED	1															
FDIR	0.096**	1														1.696
FCOM	0.092**	0.587**	1													1.796
SCOM	0.522**	0.114**	0.080**	1												1.238
IOWN	0.088**	0.028	0.041*	0.071**	1											1.076
FOWN	0.123**	0.497**	0.549**	0.097**	0.109**	1										1.658
SIZE	0.414**	0.137**	0.137**	0.327**	0.215**	0.244**	1									1.674
AUDIT	0.289**	0.297**	0.314**	0.194**	0.177**	0.367**	0.459**	1								1.535
ROA	0.096**	0.047*	0.038*	0.046*	0.028	0.065**	0.188**	0.110**	1							1.211
ROE	0.062**	0.044*	0.027	0.039*	0.037*	0.059**	0.098**	0.093**	0.299**	1						1.129
DAR	0.014	0.132**	0.040*	0.044*	0.040*	0.115**	0.107**	0.015	-.191**	-.174**	1					1.656
DER	0.023	0.074**	0.016	0.024	0.040*	0.118**	0.080**	0.038*	0.045*	-.069**	0.563	1				1.535
PROPER	0.406**	0.203**	0.152**	0.307**	0.020	0.205**	0.414**	0.392**	0.108**	0.102**	0.038*	0.007	1			1.528
ISO-14001	0.341**	0.156**	0.132**	0.207**	0.032	0.162**	0.407**	0.296**	0.093**	0.067**	0.105**	0.068**	0.448**	1		1.373
ASSURE	0.426**	0.034	0.019	0.327**	0.031	0.074**	0.285**	0.142**	0.035	0.038*	0.033	0.048**	0.276**	0.202**	1	1.198

Source: The processed data (2025)

** correlation is significant at the 0.01

* correlation is significant at the 0.05

Appendix 3

Table A3. Robustness checks for alternative measurements of CED

Variables	Model 1 - CED	Model 2 - CHOI
FDIR	-0.113**(-2.302)	-0.125**(-2.308)
FCOM	0.148*** (3.101)	0.149*** (2.897)
SCOM	0.176*** (20.171)	0.162*** (17.708)
M1_SCOM*FDIR	0.072** (2.445)	0.051* (1.653)
M2_SCOM*FCOM	-0.084*** (-3.056)	-0.068** (-2.394)
IOWN	0.034** (1.025)	0.043 (1.209)
FOWN	-0.071* (-1.937)	-0.083** (-2.302)
SIZE	0.082*** (7.213)	0.105*** (7.729)
AUDIT	0.008 (0.306)	-0.035 (-1.311)
ROA	0.003 (0.151)	0.006 (0.368)
ROE	-0.008 (-0.821)	-0.009 (-0.953)
DAR	0.012 (0.297)	-0.021 (-0.467)
DER	-0.006 (-0.814)	-0.006 (-0.819)
PROPER	0.016*** (3.800)	0.011** (2.417)
ISO	0.085*** (5.135)	0.095*** (5.565)
ASSURE	0.139*** (6.685)	0.126*** (6.054)
R ²	0.699	0.720
Adjusted R ²	0.612	0.632
F-Statistic	7.964	8.197
Prob(F-Stat)	0.000	0.000
N	2,893	2,703

Source: The processed data (2025)

Sig.level ***0.01, **0.05, *0.1

Appendix 4

Table A4. Robustness checks for high-emission and low-emission industries samples

Variables	Model 1 CED	Model 2 <i>High-Emission</i>	Model 3 <i>Low-Emission</i>
FDIR	-0.113**(-2.302)	-0.149**(-2.208)	-0.043(-0.583)
FCOM	0.148*** (3.101)	0.324*** (4.392)	-0.027(-0.463)
SCOM	0.176*** (20.171)	0.176*** (15.761)	0.176*** (11.286)
M1_SCOM*FDIR	0.072** (2.445)	0.074** (2.036)	0.070 (1.151)
M2_SCOM*FCOM	-0.084*** (-3.056)	-0.109*** (-3.238)	-0.068 (-1.107)
IOWN	0.034** (1.025)	0.051 (0.997)	0.017 (0.414)
FOWN	-0.071* (-1.937)	-0.092* (-1.802)	-0.039 (-0.768)
SIZE	0.082*** (7.213)	0.109*** (6.031)	0.059*** (4.369)
AUDIT	0.008 (0.306)	-0.044 (-1.206)	0.081** (2.406)
ROA	0.003 (0.151)	0.032 (0.988)	-0.011 (-0.616)
ROE	-0.008 (-0.821)	-0.010 (-0.647)	-0.006 (-0.491)
DAR	0.012 (0.297)	-0.069 (-1.148)	0.148** (2.480)
DER	-0.006 (-0.814)	-0.003 (-0.335)	-0.013 (-1.211)
PROPER	0.016*** (3.800)	0.018*** (3.321)	0.012 (1.588)
ISO	0.085*** (5.135)	0.058** (2.187)	0.105*** (5.374)
ASSURE	0.139*** (6.685)	0.147*** (5.560)	0.099*** (2.616)
R ²	0.699	0.699	0.653
Adjusted R ²	0.612	0.521	0.532
F-Statistic	7.964	8.894	5.423
Prob(F-Stat)	0.000	0.000	0.000
N	2,893	1,519	1,374

Source: The processed data (2025)

Sig.level ***0.01, **0.05, *0.1

Appendix 5

Table A5. Robustness checks with subsample (excluding SCOM=0)

Variables	Model 1 (full sample)	Model 2 (577 sample)
FDIR	-0.113**(-2.302)	-0.182(-1.586)
FCOM	0.148*** (3.101)	0.221*(1.679)
SCOM	0.176*** (20.171)	0.045*** (3.067)
M1_SCOM*FDIR	0.072** (2.445)	0.088(1.469)
M2_SCOM*FCOM	-0.084***(-3.056)	-0.094(-1.497)
IOWN	0.034** (1.025)	0.084*** (2.794)
FOWN	-0.071*(-1.937)	-0.034(-1.115)
SIZE	0.082*** (7.213)	0.033*** (5.492)
AUDIT	0.008(0.306)	0.034*(1.871)
ROA	0.003(0.151)	0.142*(1.901)
ROE	-0.008(-0.821)	-0.500*(-1.787)
DAR	0.012(0.297)	-0.054(-0.902)
DER	-0.006(-0.814)	0.006(0.4500)
PROPER	0.016*** (3.800)	0.014*** (2.778)
ISO	0.085*** (5.135)	0.058*** (2.993)
ASSURE	0.139*** (6.685)	0.180*** (8.319)
R2	0.699	0.423
Adjusted R2	0.612	0.407
F-Statistic	7.964	9.645
Prob(F-Stat)	0.000	0.000
N	2,893	577

Source: The processed data (2026)

Sig.level ***0.01, **0.05, *0.1