

The influence of ownership structure on carbon emission disclosure: Does women's leadership matter?

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Abstract

Carbon emission is a critical challenge for Indonesia in reconciling economic development with environmental sustainability. Although Presidential Regulation No. 98 of 2021 sets ambitious emission reduction targets, carbon emission disclosure (CED) remains voluntary for most companies. Therefore, this study aimed to examine the influence of ownership structure, specifically foreign, institutional, managerial, and state ownership, on carbon emission disclosure, and also explore the moderating role of women in leadership positions. The analysis was based on panel data from 131 companies in the energy, basic materials, and industrial sectors over the period of 2019 to 2023, leading to a total of 655 company-year observations. The results showed that all types of ownership structure had a significant positive effect on carbon emission disclosure. However, the presence of women in leadership roles significantly weakened the relationship between foreign and managerial ownership and carbon emission disclosure, while it had no significant moderating effect on institutional and state ownership. A robustness test using Presidential Regulation No. 98 of 2021 confirms the model's stability, as key relationships remain unaffected. This reinforced the reliability of the results and deepened the understanding of how ownership structure and gender diversity influence corporate environmental transparency in the context of voluntary carbon emission disclosure.

Keywords: carbon emission disclosure, ownership structure, women's leadership

1. INTRODUCTION

Climate change is becoming a pressing global issue, and it is primarily driven by high levels of carbon emissions. This situation requires urgent attention, particularly from developing countries, such as Indonesia, which must navigate the challenge of pursuing economic growth while maintaining commitments to environmental sustainability. In 2023, global carbon emissions reached 40,417.9 million tons of CO₂e, with Indonesia contributing approximately 861.5 million

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tons (2.1% of the global total). This contribution makes Indonesia the seventh-largest emitter globally and the largest in Southeast Asia [1]. Indonesia's carbon emissions have exhibited a significant upward trend over the past five years. Although emissions temporarily declined in 2020 due to the COVID-19 pandemic, they rebounded in 2021, increased by 27.9% in 2022, and continued to grow by 1.1% in 2023. The manufacturing industry, along with the electricity and gas supply sectors, has been the most substantial contributor, generating far higher emissions than agriculture and transportation [2].

In addressing these challenges, cross-border collaboration is essential for solving environmental issues such as climate change and biodiversity loss. This collaboration necessitates concerted global efforts, including both developed and developing nations [3]. In Indonesia, connecting national climate policy with global initiatives while addressing local priorities remains essential. Regulation No. 98 of 2021 targets a 29–41% emission reduction, but implementation is hindered by limited corporate reporting, as disclosure is still voluntary and inconsistently practiced.

Meeting stakeholder demands for environmental reporting and disclosure provides economic benefits to companies by protecting their reputation and increasing competitive advantage. These practices also support performance monitoring, reveal overlooked environmental risks and opportunities, and ensure compliance with relevant regulations [4]. Therefore, stronger efforts are required to enhance corporate transparency in carbon emission disclosure (CED) [5, 6]. Geng and Lo [3] observed that Western-dominated environmental frameworks overlook Global South realities. Greater inclusivity through insights from countries like Indonesia can enhance equitable transnational governance. Although national policies aid emission reduction, effectiveness depends largely on corporate governance and transparency. This highlights the growing importance of sustainability accounting, which seeks to integrate non-financial environmental data into traditional reporting frameworks. However, the implementation of sustainability accounting in developing nations often faces unique governance challenges.

One internal factor that may influence the extent of carbon emission disclosure is the company's ownership structure, which includes foreign, institutional, managerial, and state shareholders [7, 8]. Ownership structure is important because shareholders often influence decisions related to transparency. Evidence from previous studies suggests that foreign and institutional investors tend to support comprehensive disclosure practices. This is attributed to their long-term investment orientation and greater awareness of environmental risks [9–11]. Institutional investors often prioritize business sustainability and require transparency to protect their reputation and ensure regulatory compliance. However, some studies in Indonesia have found no significant relationship between institutional ownership and carbon disclosure [12].

Managerial ownership has produced mixed results; some studies suggest that it has no significant effect due to potential conflicts of interest that discourage management from revealing information that could harm their image [11, 13]. Other studies argue that managerial ownership encourages support for transparent reporting to protect the company's long-term value [8]. However, contrasting evidence has been reported by Zheng and Shen [14], who found no significant relationship between managerial ownership and disclosure. The role of state ownership also remains a subject of debate. Several studies show that companies with state ownership tend to comply with disclosure rules in support of national sustainability goals [11, 15, 16], while others found no statistically significant effect [7]. These mixed results suggest that the impact of ownership structure depends significantly on the regulatory environment, institutional frameworks, and cultural context.

Leadership is another factor that can influence corporate transparency. The presence of women in leadership roles, such as on the board of directors, audit committee, or executive management, is often associated with a stronger focus on social and environmental responsibility. Although some

studies found no significant effect on carbon emission disclosure [17–20], others show a positive relationship between the proportion of women in leadership and the quality of disclosure [21–24]. There is also evidence that women’s leadership may moderate the relationship between ownership structure and carbon emission disclosure. Some studies suggest that women leaders support more independent and sustainability-oriented decisions that balance corporate responsibility with shareholder interests [25,26]. Therefore, the presence of women may enhance the effectiveness of carbon transparency efforts within companies.

Based on the identified research gaps, this study aims to analyze how ownership structure affects carbon emission disclosure and whether women’s leadership moderates this relationship. Using legitimacy and stakeholder theories, the study explains corporate responses to transparency and accountability pressures. Theoretically, this research offers a significant contribution to the field of sustainability accounting. As sustainability accounting seeks to integrate non-financial environmental data into traditional reporting frameworks, understanding the governance drivers of CED is crucial. By linking specific ownership structures and gender diversity to disclosure quality in a developing economy context, this study enriches the literature on how accounting practices evolve to capture environmental accountability. Practically, the findings provide guidance for policymakers and organizations seeking to establish more transparent, credible, and standardized carbon reports.

2. THEORETICAL FRAMEWORK

2.1. Stakeholder theory

Stakeholder Theory asserts that a company is accountable not only to its shareholders but also to a broader array of parties interested in its operations, including employees, customers, the government, society, and the environment [27]. This theory is commonly used to explain corporate openness regarding sustainability issues, such as carbon emissions. Companies are expected to fulfill stakeholders’ informational needs, as their perceptions and responses can be shaped by the quality and extent of disclosed information [28].

Carbon emission information is generally disclosed through sustainability reports, which signal the company’s commitment to responsible business practices [15,29]. From the Stakeholder Theory perspective, these actions reflect a company’s attempt to increase transparency, improve accountability, and meet specific demands from powerful stakeholder groups [15]. This reduces the information gap between companies and their stakeholders, enhancing trust and long-term business viability [29].

2.2. Legitimacy theory

While Stakeholder Theory focuses on specific relationships, Legitimacy Theory broadens the scope to the "social contract" between the company and society at large. It views "legitimacy" as a license to operate that companies must earn and maintain through socially and environmentally responsible behavior [30]. In the context of carbon emission disclosure, companies aim to present non-financial information transparently to demonstrate alignment with prevailing societal norms and values [31,32]. Disclosure serves as a strategic tool for reinforcing social legitimacy, where environmental transparency signals active responsibility in addressing climate change [33,34].

In practice, disclosing carbon emissions serves as a strategic response to pressure from stakeholders, such as investors, regulators, media, and the general public. External demands motivate

companies to voluntarily disclose environmental performance, reducing the information asymmetry between companies and society [34]. Legitimacy Theory also shows that companies must maintain consistency with societal expectations. Transparent and verifiable disclosures help companies maintain legitimacy, increase stakeholder trust, and reduce reputational and legal risks [32,35].

The integration of these two theories is crucial because relying on a single theoretical lens creates analytical deficiencies. Stakeholder Theory effectively explains "who" the company is reporting to (e.g., investors, regulators) but may not fully capture the broader systemic pressures of societal norms. Conversely, Legitimacy Theory explains "why" disclosure is necessary for survival in a climate-conscious society but may overlook the specific power dynamics exerted by distinct ownership groups. Combined, they offer a robust framework where Stakeholder Theory addresses the micro-level power dynamics, while Legitimacy Theory addresses the macro-level need for social acceptance [34,35].

2.3. Carbon emission disclosure

Carbon emissions refer to the release of greenhouse gases (GHGs) into the atmosphere, which contribute to global warming. Disclosure of these emissions reflects a company's accountability and commitment to sustainability [36]. As part of non-financial reporting, carbon emission disclosure includes quantitative and qualitative information related to environmental performance and plays a crucial role in shaping public perception and corporate value [37].

According to the integrated theoretical framework, carbon disclosure responds to the expectations of multiple stakeholders while simultaneously fulfilling the implicit social contract [38,39]. The theory stresses that companies must foster relationships and build trust with stakeholders beyond financial outcomes. Carbon disclosure facilitates stakeholder engagement and supports market confidence [38]. Legitimacy Theory complements this view by proposing that disclosure allows companies to fulfill the implicit social contract. According to a previous study, transparent carbon reporting communicates consistency with social norms and enhances a company's legitimacy [40]. Companies strengthen identity as environmentally responsible entities through these disclosures [41].

2.4. Ownership structure

Ownership structure refers to the composition of shareholders, which may include foreign, institutional, managerial, or state ownership [7,8]. This structure determines who holds decision-making authority regarding transparency, including carbon emission disclosure. Foreign ownership relates to shares held by non-domestic investors. These investors tend to promote transparency and long-term risk management through environmental disclosure [42,43]. Stakeholder Theory suggests that foreign investors advocate for open communication. Meanwhile, Legitimacy Theory posits that companies with foreign shareholders must maintain a global reputation consistent with sustainability expectations [44,45].

Institutional ownership includes shares owned by large entities, such as banks or pension funds. The investors often focus on sustainability and influence companies to improve carbon disclosure [46,47]. According to Stakeholder Theory, the pressure motivates transparency, while Legitimacy Theory interprets it as a strategy to preserve legitimacy [48,49].

Managerial ownership, where executives hold company shares, may lead to improved environmental accountability due to the vested interests [50,51]. However, conflicts of interest may

also arise. Both theories agree that managerial ownership can influence disclosure, depending on management's commitment to environmental responsibility [11,35].

State ownership refers to companies owned or controlled by the state. These entities are often subject to policy-driven environmental responsibilities and international commitments [52,53]. Based on the Stakeholder Theory perspective, the state acts as a primary stakeholder demanding transparency. This view is supported by Legitimacy Theory, as state-owned enterprises are expected to reflect priorities in environmental disclosures [15,54].

2.5. Women's leadership

Women's leadership in strategic roles contributes significantly to transparency in environmental reporting, including carbon emission disclosure [28,55]. Studies suggest that women are more responsive to environmental and social concerns, leading to stronger commitments to sustainability integration in business practices [48,56].

Stakeholder Theory shows women's leadership as a factor that enhances responsiveness to external expectations, specifically regarding sustainability. Women tend to support greater transparency and encourage carbon disclosure as a sign of social responsibility [57,58]. According to Legitimacy Theory, women leaders promote inclusiveness, which strengthens a company's state-aligned image and increases societal trust. The influence fosters sustainability-driven policies and disclosures [22].

2.6. Ownership structure and carbon emission disclosure

Companies with foreign ownership often face greater pressure to adopt internationally accepted environmental disclosure standards. This is due to expectations from foreign investors who prioritize transparency and global reputation. This view is supported by previous empirical results showing that foreign ownership tends to enhance carbon emission disclosure levels [42,43,59]. However, inconsistent results have been reported in certain contexts. Some studies argue that foreign investors may not significantly influence disclosure in markets where regulatory enforcement is weak or where investors focus solely on short-term financial returns [11]. Despite these variations, the dominant theoretical perspective suggests that foreign shareholders act as agents of global standards.

H1: Foreign ownership has a positive effect on corporate carbon emission disclosure.

Institutional investors, specifically those with long-term investment horizons, are typically more concerned with environmental risks and sustainability performance. The influence of this group often leads to improved corporate disclosure practices. Empirical studies largely support a positive association between institutional ownership and carbon emission disclosure [7,60]. Conversely, other scholars argue that institutional investors may exert excessive control over corporate information, potentially leading to selective disclosure to avoid market volatility [8]. Weighing the demand for risk management against the potential for selective reporting, the prevailing view aligns with the demand for transparency.

H2: Institutional ownership has a positive effect on corporate carbon emission disclosure.

Managerial ownership may influence disclosure practices in multiple directions. Furthermore, managerial equity ownership aligns managerial interests with those of shareholders, promoting

long-term value creation and greater transparency. Some studies suggest that this connection promotes more comprehensive carbon emission reporting [8]. On the other hand, managers may act opportunistically, withholding information that could reflect poorly on performance, thereby reducing disclosure [14]. Studies also point to a non-linear relationship, where disclosure improves only at very low or high levels of managerial ownership [50]. Considering these opposing theoretical arguments and the agency perspective, the hypothesis assumes an alignment of interests.

H3: Managerial ownership has a positive effect on corporate carbon emission disclosure.

State-owned enterprises (SOEs) often operate under stricter regulatory oversight and are expected to correspond with national sustainability goals. These companies tend to disclose environmental information to show compliance and accountability to the public. Previous studies support this notion, showing that state ownership tends to be positively associated with carbon emission disclosure [11,15,16]. However, conflicting evidence suggests that state ownership does not always lead to high-quality disclosure; some SOEs may exhibit weak enforcement or engage in merely symbolic compliance without substantive reporting [7]. Based on Legitimacy Theory and the state's role as a regulator, the expectation remains that state ownership drives disclosure.

H4: State ownership has a positive effect on corporate carbon emission disclosure.

2.7. Ownership structure, women's leadership, and carbon emission disclosure

Women leaders affect corporate strategies and environmental reporting. Foreign ownership drives external accountability, while women's leadership prioritizes internal sustainability and long-term goals. Previous studies suggested that women's leadership can act as a substitute for external monitoring. The presence of women in leadership may render the external pressure from foreign investors less critical, as the company is already intrinsically motivated to disclose [25]. In this context, women's leadership serves as an internal governance mechanism that may weaken the influence of foreign ownership.

H5: Women's leadership weakens the influence of foreign ownership on carbon emission disclosure.

Institutional investors often promote enhanced disclosure, but the influence may be moderated by the presence of women in leadership roles. Women leaders tend to be selective in their responses to external pressure, ensuring that disclosure strategies reflect internal values and corporate capabilities. Consequently, the direct pressure from institutional investors may be balanced by a more thoughtful, values-driven leadership method [26]. Empirical evidence suggests that diverse boards are less reliant on external monitoring to achieve transparency. Thus, the strong direct effect of institutional ownership may be dampened by the presence of female leaders.

H6: Women's leadership weakens the influence of institutional ownership on carbon emission disclosure.

Managerial ownership may present conflicts of interest that discourage transparency, specifically when disclosure could harm managerial reputation or short-term performance. However, women's leadership is associated with a stronger ethical orientation, stakeholder inclusivity, and

commitment to long-term sustainability. This ethical leadership can serve as a counterbalance to managerial discretion, effectively mitigating the opportunistic behaviors associated with managerial ownership [61]. Drawing from these empirical inconsistencies, it is proposed that women’s leadership reduces the information withholding sometimes found in high managerial ownership structures.

H7: Women’s leadership weakens the influence of managerial ownership on carbon emission disclosure.

State ownership often leads to formal compliance with disclosure regulations. However, women’s leadership may motivate companies to go beyond regulatory requirements, fostering proactive and authentic environmental reporting. Previous studies show that gender-diverse leadership tends to reduce dependency on external pressures and promote more internally motivated disclosure [62]. Therefore, even in state-owned enterprises, the presence of women in leadership may reduce reliance on state-driven mandates by embedding sustainability as a core organizational value.

H8: Women’s leadership weakens the influence of state ownership on carbon emission disclosure.

2.8. Conceptual framework

Based on the theoretical analysis and hypothesis development above, the research framework is constructed to illustrate the direct effects of ownership structure on carbon emission disclosure and the moderating role of women’s leadership.

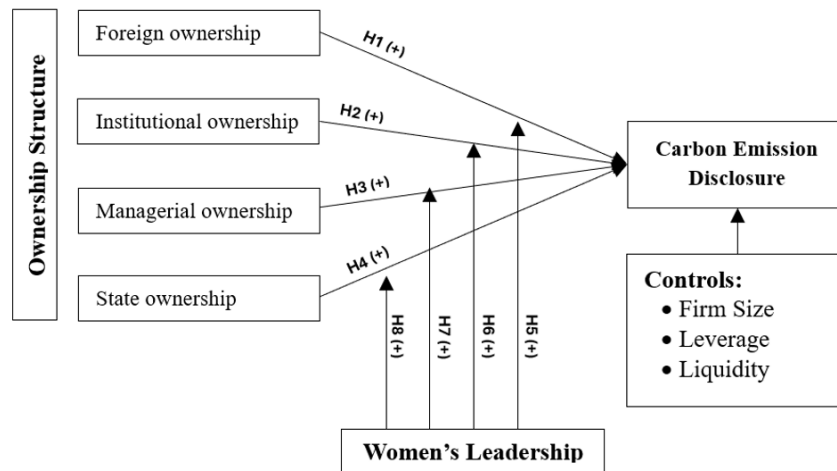


Figure 1: Conceptual framework

As depicted in Figure 1, the framework proposes that Foreign, Institutional, Managerial, and State ownership positively influence Carbon Emission Disclosure. Furthermore, Women’s Leadership is posited to moderate these relationships, specifically weakening the influence of the ownership variables on the disclosure outcome.

3. MATERIALS AND METHODS

3.1. Data and sample

A quantitative method was adopted in this study using secondary data from annual and sustainability reports of companies in the energy, basic materials, and industrial sectors listed on the Indonesia Stock Exchange (IDX) from 2019 to 2023. These sectors were selected because they are classified as high-profile industries with significant environmental footprints, making their carbon disclosure practices critical for analysis. From an initial population of 269 companies, 131 were selected based on specific criteria outlined in Table 1, leading to 655 company-year observations for analysis.

Table 1: *Sampling criteria*

Criteria	Total
Companies in the energy, basic materials, and industrial sectors listed on the Indonesia Stock Exchange (IDX)	269
Companies not consistently listed on the IDX during 2019–2023	(81)
Companies with inaccessible reports	(15)
Companies that did not disclose carbon emission during the study period	(42)
Final number of companies included in the sample	131
Total company-year observations during the study period	655

Source: *Processed Data (2025)*

3.2. Operational definition and measurement of variables

Carbon emission disclosure, the dependent variable, measured how companies report GHG management in operations. Based on the GRI 305 Index, it covered seven indicators: Scope 1, Scope 2, and Scope 3 emissions, intensity, reduction initiatives, ozone-depleting substances, and other significant air emissions. Data from sustainability reports were scored 1 if disclosed and 0 otherwise. The final score was the total disclosed items divided by 7 [6,45,63]. GRI 305 was adopted due to its global credibility, comprehensive structure, and relevance to Indonesian sustainability reporting practices [65,66].

The independent variables included Foreign Ownership (FO), Institutional Ownership (IO), Managerial Ownership (MO), and State Ownership (SO). Foreign Ownership referred to the proportion of shares held by foreign investors relative to total outstanding shares and reflected the influence of international stakeholders [42,43]. Institutional Ownership represented the percentage of shares owned by institutional investors, such as banks or pension funds, which showed monitoring strength [9,23]. Managerial Ownership was the share percentage held by company executives or board members, reflecting managerial consistency with shareholder interests [16,67]. State Ownership was measured by the percentage of shares held by the government, either directly or through state-owned entities, showing state participation in strategic direction [7,8]. Each ownership variable was calculated as a percentage of total outstanding shares.

The moderating variable was Women's Leadership (WD), defined as the proportion of women on the board of directors. In the context of Indonesia's two-tier board system, this variable focuses on the executive decision-makers. It was measured by dividing the number of female board members by the total number of directors. Greater women's representation is associated with higher environmental awareness and disclosure levels [24,68].

The control variables were Company Size (FS), Leverage (LV), and Liquidity (LD). Company Size was measured as the natural logarithm of total assets and reflected the company's scale and

capacity for disclosure [43]. Leverage was the ratio of total liabilities to equity, showing financial risk and external pressure [21]. Liquidity was calculated as the ratio of current assets to current liabilities and reflects short-term financial flexibility [69,70].

3.3. Data analysis method

Data were analyzed using panel data regression with Stata version 17. Descriptive statistics were used to present the data overview. The Chow, Hausman, and LM tests determined the suitable panel model. Hypothesis testing applied moderated regression with five models: Model 1 tested the ownership structure’s direct impact on carbon disclosure, while Models 2 - 5 added interactions between women’s leadership and ownership types to examine moderation.

$$CED = \alpha + \beta_1FO + \beta_2IO + \beta_3SO + \beta_4MO + \beta_5FS + \beta_6LD + \beta_7LV + \varepsilon_1 \tag{1}$$

$$CED = \alpha + \beta_1FO + \beta_2WD + \beta_3(FO \times WD) + \beta_4FS + \beta_5LD + \beta_6LV + \varepsilon_2 \tag{2}$$

$$CED = \alpha + \beta_1IO + \beta_2WD + \beta_3(IO \times WD) + \beta_4FS + \beta_5LD + \beta_6LV + \varepsilon_3 \tag{3}$$

$$CED = \alpha + \beta_1MO + \beta_2WD + \beta_3(MO \times WD) + \beta_4FS + \beta_5LD + \beta_6LV + \varepsilon_4 \tag{4}$$

$$CED = \alpha + \beta_1SO + \beta_2WD + \beta_3(SO \times WD) + \beta_4FS + \beta_5LD + \beta_6LV + \varepsilon_5 \tag{5}$$

Description: *CED* = Carbon Emissions Disclosure; α = Constant; $\beta_1 - \beta_7$ = Regression Coefficient; *FO* = Foreign Ownership; *IO* = Institutional Ownership; *SO* = State Ownership; *MO* = Managerial Ownership; *WD* = Woman’s Leadership; *FS* = Company Size; *LD* = Liquidity; *LV* = Leverage; ε = Error.

4. RESULTS

4.1. Descriptive statistics

Table 2 shows the descriptive statistics for the variables based on 655 company-year observations. The average carbon emission disclosure score was 0.641, showing that, on average, companies disclosed approximately 64.1% of the GRI 305 indicators. The standard deviation of 0.278 suggested moderate variation in disclosure levels across the sample. Foreign Ownership (FO) had a mean of 0.263, Institutional Ownership (IO) 0.431, while Managerial (MO) and State Ownership (SO) averaged 0.063 and 0.040. Women’s Leadership (WD) averaged 0.343, representing 34.3% female board members. Company Size (FS) showed a mean log asset of 28.32 (SD = 2.99), Liquidity (LD) 7.10, and Leverage (LV) 4.78 (SD = 32.62), suggesting outliers in the sample.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
CED	655	0.641026	0.2776944	0	1
FO	655	0.2630198	0.2885654	0	0.998
IO	655	0.4306763	0.3046606	0	0.998
MO	655	0.062684	0.1392444	0	0.739
SO	655	0.0395985	0.1553251	0	0.8
WD	655	0.3427252	0.1720722	0	0.667
FS	655	28.32216	2.997227	12.587	33.73
LD	655	7.101524	13.89086	0.014	208.445
LV	655	4.783524	32.61555	-231.263	786.931

Source: Processed Data Using STATA 17 (2025)

4.2. Regression analysis results

4.2.1 Selection of panel data regression model

The Chow test, Hausman test, and LM test were conducted sequentially to determine the most appropriate panel data regression model. In this case, the Chow test was applied to evaluate whether the Common Effect Model (CEM) or the Fixed Effect Model (FEM) was more appropriate. When the FEM was preferred, the Hausman test was then used to compare the FEM with the Random Effect Model (REM). Finally, the LM test was used to assess whether the REM or CEM provided a better fit for the data.

Table 3: Selection of panel data regression model

Model	Chow Test	Hausman Test	LM Test	Final Chosen Model
Model 1	0.0308	0.8004	0.0396	Random Effects
Model 2	0.0004	0.3288	0.0003	Random Effects
Model 3	0.0001	0.2219	0.0001	Random Effects
Model 4	0.0000	0.0169	0.0000	Fixed Effects
Model 5	0.0010	0.3984	0.0013	Random Effects

Source: Processed Data Using STATA 17 (2025)

Table 3 shows the results of the Chow test, Hausman test, and LM test. The Chow test consistently rejected the CEM for all five models ($\text{Prob} > F < 0.05$), suggesting that panel data models, such as the FEM or REM, were more appropriate. Similarly, the LM test rejected the CEM in all models ($\text{Prob} > \chi^2 < 0.05$), confirming the presence of individual effects. The Hausman test results showed that only Model 4 had a significant p-value ($0.0169 < 0.05$), indicating that FEM was more suitable for this model. Conversely, Models 1, 2, 3, and 5 had non-significant p-values ($\text{Prob} > \chi^2 > 0.05$), suggesting that REM was more appropriate. Based on these findings, Model 4 was analyzed using FEM, while Models 1, 2, 3, and 5 were estimated using REM.

4.3. Regression results

The regression results present several key findings across the five tested models. In Model 1, all independent variables, including Foreign Ownership, Institutional Ownership, Managerial Ownership, and State Ownership, along with the control variables of Firm Size, Liquidity, and Leverage, jointly exert a significant influence on Carbon Emission Disclosure. The Wald chi square value is 805.82 with a probability value less than 0.001. The overall R squared value of 0.5744 indicates that approximately 57.44 percent of the variation in Carbon Emission Disclosure is explained by the independent variables in the model. Individually, Foreign Ownership, Institutional Ownership, Managerial Ownership, and State Ownership all show positive and statistically significant effects on Carbon Emission Disclosure, with probability values below 0.001. Among the control variables, Firm Size is marginally significant with a probability value of 0.046, while Liquidity and Leverage also demonstrate positive and significant relationships with the dependent variable.

Model 2 is also statistically significant, with a Wald chi square value of 745.34 and a probability value below 0.001. The R squared overall is 0.5596. Both Foreign Ownership and Women's Leadership individually exert positive and significant influences on Carbon Emission Disclosure, with probability values of 0.001 and below 0.001, respectively. However, the interaction term between Foreign Ownership and Women's Leadership has a negative coefficient of 0.4708 and is statistically significant, with a probability value of 0.036. This result showed that the presence of women in leadership weakened the positive effect of foreign ownership on carbon emission disclosure. Although both factors independently contributed to higher disclosure levels, the interaction reduced the magnitude of the effect.

Table 4: Regression results

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
FO	0.2118252***	0.2651768***	-	-	-
IO	0.1365981***	-	-0.1554499**	-	-
MO	0.2403075***	-	-	0.5681796***	-
SO	0.3389175***	-	-	-	0.2525152
WD	-	0.270039***	0.1129051	0.3279927***	0.2245206***
FO_WD	-	-0.470805**	-	-	-
IO_WD	-	-	0.2422295	-	-
MO_WD	-	-	-	-0.6270776*	-
SO_WD	-	-	-	-	0.0425169
FS	0.0053175**	0.0086509***	0.0075797***	0.0142006	0.0058370**
LD	0.0116012***	0.0122900***	0.0127547***	0.0113285***	0.0125228***
LV	0.0209377***	0.0210834*	0.0201929***	0.0207415***	0.0201169***
R-square	0.5744	0.5596	0.5505	0.5056	0.5622
Chi/F-Stat	805.82	745.3400	715.3600	62.1300	753.5200
Prob > stat	0.0000	0.0000	0.0000	0.0000	0.0000

***Sig 1%, **Sig 5%, *Sig 10%

Source: Processed Data Using STATA 17 (2025)

Model 3 was statistically significant, with a Wald chi-square value of 715.36 and a probability value below 0.001 (R-squared = 0.5505). Institutional Ownership showed a negative and significant effect on Carbon Emission Disclosure, with a coefficient of 0.1554 and a probability value of 0.022. Women's Leadership and the interaction between Institutional Ownership and Women's Leadership did not show statistically significant results, with probability values of 0.217 and 0.153, respectively. Although the interaction coefficient was positive at 0.2422, suggesting a potential moderating effect, the result was not statistically conclusive.

Model 4 showed statistical significance, with an F statistic of 62.13 and a probability value below 0.001 (R-squared = 0.5056). Managerial Ownership and Women's Leadership both had positive and significant effects on Carbon Emission Disclosure, with probability values of 0.006 and below 0.001, respectively. The interaction term between Managerial Ownership and Women's Leadership had a negative coefficient of 0.6271 and was marginally significant at the 10% level, with a probability value of 0.070. This result suggested that women in leadership roles reduced the positive impact of managerial ownership on disclosure practices.

Model 5 was statistically significant with a Wald chi-square value of 753.52 and a probability value < 0.001 (R-squared = 0.5622). State Ownership did not exhibit a statistically significant relationship with Carbon Emission Disclosure, with a probability value of 0.223. However, Women's Leadership maintained a positive and significant effect, with a coefficient of 0.2245 and a probability value below 0.001. The interaction term between State Ownership and Women's Leadership was not statistically significant, with a coefficient of 0.0425 and a probability value of 0.971. This result suggested that gender diversity did not significantly moderate the relationship between state ownership and carbon emission disclosure.

4.4. Robustness test

Robustness testing was conducted to ensure the consistency of the results under varying conditions. A dummy variable was used to account for the impact of Presidential Regulation No. 98 of 2021, where the value 0 represented the period before the regulation's issuance, and 1 indicated the period after its enactment. The inclusion of this variable enhanced the validity of the results by controlling for external policy shocks that could influence the model's outcome.

The results from all five models showed that the majority of the key independent variables maintained consistent coefficient directions and remained statistically significant across most

Table 5: Robustness test

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
FO	0.2117013***	0.2658378***	-	-	-
IO	0.1365116***	-	-0.1555127**	-	-
MO	0.2403297***	-	-	0.5637056***	-
SO	0.3393004***	-	-	-	0.2517149
WD	-	0.2702622***	0.1127837	0.3277414***	0.2244618***
FO_WD	-	-0.4732647**	-	-	-
IO_WD	-	-	0.2422754	-	-
MO_WD	-	-	-	-0.6264689*	-
SO_WD	-	-	-	-	0.0507700
FS	0.0053239**	0.0086617***	0.0075903***	0.0143106	0.0058483**
LD	0.0115730***	0.0122635***	0.0127260***	0.0112231***	0.0124819***
LV	0.0208965**	0.0210468***	0.0201561***	0.0206609***	0.0200630***
PERPRES	0.0047491	0.0043039	0.0043932	0.0088464	0.0062887
R-square	0.5744	0.5597	0.5505	0.5057	0.5622
Chi/F-Stat	805.1	744.55	714.56	55.66	752.85
Prob > stat	0.0000	0.0000	0.0000	0.0000	0.0000

***Sig 1%, **Sig 5%, *Sig 10%

Source: Processed Data Using STATA 17 (2025)

specifications tested. This consistency suggested that the relationships between the main and the dependent variable were not sensitive to changes in model structure, including the inclusion of an additional control variable in the form of a dummy for Presidential Regulation No. 98 of 2021. The results showed the baseline regression was robust across specifications, confirming internal validity. Consistent coefficient patterns indicated that the results were not driven by model choice but represented genuine relationships in the data. This strengthened confidence in the model's theoretical and policy relevance.

5. DISCUSSION

The empirical results of this study provide robust evidence on how ownership structure and the presence of women in leadership positions influence carbon emission disclosure in publicly listed companies in Indonesia. The positive and significant relationship between foreign ownership and carbon emission disclosure suggests that foreign investors play a significant role in promoting environmental transparency. Companies with substantial foreign shareholding tend to disclose environmental information, driven by pressure from international stakeholders and consistency with global sustainability standards. In accordance with Stakeholder Theory, foreign investors function as powerful stakeholders who influence corporate behavior through expectations of accountability and responsible environmental management. This result was further supported by Legitimacy Theory, showing that companies aim to gain legitimacy in global capital markets by conforming to international norms, including voluntary environmental disclosure. These results reinforce the report of Mardini & Lahyani [59] and Kim et al. [43], who emphasize the strategic role of foreign investors in shaping sustainability reporting in developing economies.

Institutional ownership was found to be positively associated with carbon emission disclosure in the full model (Model 1). Furthermore, institutional investors, such as pension funds and mutual funds, frequently incorporate environmental, social, and governance considerations into their investment analyzes. Investors promote transparency to create long-term value and manage risk. This is consistent with Stakeholder Theory, where institutional shareholders influence governance through engagement, and with Legitimacy Theory, which views them as channels of societal expectations shaping disclosure. However, it is important to note that in Model 3, Institutional Ownership showed a negative effect on disclosure. This discrepancy suggests that the relationship

Table 6: Summary of hypothesis testing results

Hypothesis	Statement	Result	Decision
H1	Foreign ownership has a positive effect on CED.	Positive & Significant	Accepted
H2	Institutional ownership has a positive effect on CED.	Positive & Significant	Accepted
H3	Managerial ownership has a positive effect on corporate carbon emission disclosure	Positive & Significant	Accepted
H4	State ownership has a positive effect on corporate carbon emission disclosure	Positive & Significant	Accepted
H5	Women's leadership weakens the influence of foreign ownership on carbon emission disclosure.	Negative & Significant	Accepted
H6	Women's leadership weakens the influence of institutional ownership on carbon emission disclosure.	Not Significant	Rejected
H7	Women's leadership weakens the influence of managerial ownership on carbon emission disclosure.	Negative & Significant	Accepted
H8	Women's leadership weakens the influence of state ownership on carbon emission disclosure.	Not Significant	Rejected

Source: Processed Data (2025)

is complex when isolated from other ownership variables or when interacting with gender diversity. Institutional investors might prioritize financial stability over voluntary disclosure, or the result may be sensitive to specific model specifications. Despite this variation, the general trend supports the notion that institutional ownership acts as a monitoring mechanism for transparency, consistent with the report of Döring et al. [60] and Bedi & Singh [7] that institutional investors are key drivers of sustainability disclosure across various contexts. Managerial ownership exhibits a positive and statistically significant impact on carbon emission disclosure. Furthermore, managerial equity ownership provides a stronger incentive to safeguard the company's long-term reputation and legitimacy. Manager-shareholders are more directly accountable for strategic outcomes, including the company's environmental reputation. According to Stakeholder Theory, this consistency of interests motivates active engagement with stakeholder demands. Legitimacy Theory suggests that greater managerial ownership increases the tendency of voluntary disclosures aimed at building social acceptance and reducing reputational risk. This result is consistent with the conclusions of Shan et al. [50] and Oyerogba et al. [8], who observe that managerial ownership strengthens both internal commitment to sustainability and external transparency. State ownership was found to positively influence carbon emission disclosure. Companies with government shareholding tend to engage in environmental disclosure due to direct state influence and obligations to serve the public interest. From the Stakeholder Theory perspective, the government acts as a dominant stakeholder with the authority to shape corporate responsibility agendas. Legitimacy Theory further explains that state-owned companies face heightened legitimacy demands, which are addressed through transparent and socially responsible practices, including environmental reporting. These results are consistent with those of Singhania & Bhan [11] and Yustina et al. [16], which emphasize the strategic role of state ownership in promoting accountability and sustainability performance.

Beyond the direct effects of ownership structure, this study examines the moderating role of women in leadership on the relationship between ownership and carbon emission disclosure. The interaction between foreign ownership and women's leadership is found to be negative and statistically significant. This result suggests that the presence of women directors weakens the positive influence of foreign ownership on environmental disclosure. A plausible explanation for this finding is that women leaders promote more careful, substantive reporting instead of merely responding to external pressure. While foreign investors may demand high quantities of disclosure to satisfy global compliance, women leaders may prioritize the quality and internal relevance of the information. Consequently, women leaders may moderate the aggressive push for disclosure from foreign investors, ensuring that reporting reflects genuine sustainability efforts rather than symbolic compliance. This interpretation is consistent with the results of Askarzadeh

et al. [25], who argue that women in leadership may introduce governance dynamics that temper the dominance of external shareholders.

The interaction between institutional ownership and women's leadership is statistically insignificant, showing that women board members do not significantly alter the relationship between institutional investors and carbon emission disclosure. A possible explanation is that institutional investors in Indonesia may not consistently focus on environmental performance in investment decisions. Without strong engagement around environmental, social, and governance themes, the influence of women on the board may be limited. This observation is consistent with the suggestion of Issa et al. [17] and Sulistyowati & Tumirin [19] that gender only diversity may not drive change in disclosure practices unless it is supported by broader institutional mechanisms.

The interaction between managerial ownership and women's leadership is negative and statistically significant, showing that women directors weaken the positive effect of managerial ownership on carbon emission disclosure. This finding highlights the significant role of women as a governance mechanism. While managerial ownership aligns interests, it can also lead to entrenched management that may use disclosure opportunistically. The presence of women on the board appears to act as a check and balance, reducing the dominance of managerial insiders. Women leaders tend to enhance board independence, ensuring that disclosure decisions are driven by broader stakeholder interests rather than solely by managerial preferences. This interpretation is consistent with the results of Baghdadi et al. [61] and Zheng & Shen [14], who showed the role of women in strengthening corporate governance and enhancing board independence.

The interaction between state ownership and women's leadership is statistically insignificant. This result suggests that the presence of women directors does not significantly moderate the relationship between state ownership and carbon emission disclosure. In companies with state ownership, where oversight and accountability mechanisms are already strong due to government participation, the influence of individual board members may be relatively limited. This result is consistent with the report of Issa et al. [17] and Zahra & Astuti [20] that structural and political factors in state-owned enterprises may constrain the impact of gender diversity on strategic decisions such as environmental disclosure.

6. CONCLUSION AND RECOMMENDATIONS

In conclusion, this study provides compelling empirical evidence on the influence of ownership structure and women's leadership on carbon emission disclosure among publicly listed companies in Indonesia. The results show that foreign, institutional, managerial, and state ownership generally exert a positive and significant influence on disclosure practices. These results capture the importance of both external investor pressure and internal governance mechanisms in promoting environmental transparency. The robustness check, which controlled for the implementation of Presidential Regulation No. 98 of 2021, confirmed the stability of these relationships, proving that the findings are not driven by external policy shocks alone.

Women's leadership was found to have a positive direct effect on carbon emission disclosure, suggesting that gender diversity supports greater sustainability transparency. However, the moderating analysis reveals a nuanced dynamic: the presence of women on boards significantly weakens the positive influence of foreign and managerial ownership. This suggests that women leaders may act as a governance filter, prioritizing substantive and carefully considered reporting over aggressive disclosure driven solely by external investor pressure or managerial image-building. Meanwhile, no significant moderating effect was found for institutional or state ownership, indicating that these ownership types may operate under different pressures that are less sensitive to board gender composition in the Indonesian context.

The study offers practical implications for policymakers and corporate boards. For companies, promoting gender diversity is not merely a matter of representation but a strategic mechanism to enhance the quality of environmental governance. For policymakers, the findings highlight the need to standardize carbon reporting requirements to reduce the variability caused by different ownership structures.

This study has limitations, primarily its reliance on quantitative data from annual reports and the use of the GRI 305 index, which may not capture the full depth of climate strategies. Therefore, future research should expand on these findings by exploring the behavioral aspects of leadership. Specifically, future studies are recommended to employ qualitative methods, such as conducting in-depth interviews with board members, to investigate the decision-making processes regarding carbon disclosure. This would provide a deeper understanding of how women leaders negotiate environmental transparency against shareholder demands. Additionally, using more comprehensive disclosure metrics beyond GRI 305 would better capture the quality of corporate environmental accountability.

Declaration of interest: The authors declare no conflicts of interest.

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