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Carbon Emission Disclosure and Firm Value: The Moderating Role of Corporate Governance

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Abstract

The purpose of this study is to analyze the effect of carbon emission disclosure on firm value and the interaction of foreign ownership and foreign board diversity as moderation variables. This study is a causal associative study with a quantitative approach, researchers used 77 samples from several company sectors included in the carbon intensive industry listed on the Indonesia Stock Exchange (IDX) from 2021 to 2023 using moderated regression analysis. The results of the analysis show that carbon emission disclosure has a significant positive effect on firm value. foreign board diversity moderates negatively and foreign ownership does not moderate the relationship between carbon emission disclosure and firm value. The result practically can be a consideration for companies in carrying out carbon disclosure as well as input for investors in making investment decisions. The implication of this study is that it can be a consideration for the authorities in preparing regulations related to carbon emission disclosure, especially in Indonesia which is still voluntary.

Keywords:
Carbon Emission Disclosure, Firm Value, Foreign Ownership, Foreign Board Diversity

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1. Introduction

The growth of firm value is the long-term goal that businesses prioritize. A company's wealth is reflected in its firm value, which can be seen through its securities (Ifada et al., 2021). It serves as a primary goal for stakeholders, including investors, creditors, and managers. The significance of firm value prompts investors and creditors to adopt increasingly selective approaches when investing in or extending credit to companies. Fundamentally, every company aims to maximise profit, which, in the context of intensifying global competition, drives efforts to enhance competitiveness across various aspects, particularly in increasing stock prices (Mumpuni and Indrastuti, 2021).

Data from the IDX during the trading period from 2 to 5 January 2024 indicate a positive trend. The highest weekly increase was observed in the average daily stock transaction frequency, which rose by 29.83% to 1,154,208 transactions, compared to 888,989 transactions in the previous week. An increase was also recorded in the Composite Stock Price Index (IHSG), which grew by 1.07%, reaching 7,350.62 from 7,272.80 at the previous week's close. The IHSG achieved its all-time high during the closing of trading on Thursday (4 January), at the level of 7,359.76 (IDX, 2024).

The Industrial Revolution has resulted in increased carbon concentrations in the atmosphere, leading to global warming and climate change (Irwhantoko and Basuki, 2016). In many nations worldwide, the topic of global warming is currently being explored extensively. The threat posed by global warming has prompted various stakeholders to take significant action, including business entities, which are now expected to communicate their contributions to global warming due to the carbon emissions they produce (Choi et. al., 2013). Carbon emissions are believed to be the primary factor contributing to global warming and environmental change (Muhammad and Aryani, 2021).

In 2021, the global total of Greenhouse Gas (GHG) emissions was recorded at 34,175.3 million tons of CO2 equivalent, with a carbon increase of 1,753.7 MtCO2eq over the 10-year period from 2012 to 2021. In Indonesia, GHG emissions also increased over the last decade. In 2021, Indonesia's total GHG emissions were recorded at 568.3 million tons of CO2 equivalent, marking an increase of 98.2 million tons of CO2 equivalent from 2012 (IEA, 2023). Given the impact of climate change on business sustainability, carbon emission disclosure has become an emerging issue in many countries, including Indonesia (Hermawan et al., 2018). In Indonesia, carbon emission disclosure is still voluntary (Irwhantoko and Basuki, 2016), which can be tolerated due to its novelty, resulting in only a few companies engaging in such disclosures (Anggita et al., 2022).

Concerns about environmental circumstances, especially the adverse effects of global warming, are the driving force behind this research. Numerous investigations have been carried out to examine the connection between firm value and carbon emission disclosure. As investors view the disclosure of carbon information as bad news, prior research suggests that there is a negative correlation between carbon emission disclosure and firm value. They believe that the costs involved do not justify the potential benefits (Matsumura et. al., 2014; Muhammad and Aryani, 2021). Other researchers have found that carbon emission disclosure does not have a significant relationship with firm value, which may be due to the use of dummy variables that fail to explain the motives behind carbon emission disclosure (Sudibyo, 2018). On the other hand, some studies have shown a different result, where carbon emission disclosure positively affects firm value. By disclosing carbon information, which reflects a company's responsibility to the environment, a positive public image is formed. Furthermore, this disclosure is also believed to enhance competitive advantage (Hardiyansah and Agustini, 2021; Kurnia et al., 2021; Noor and Ginting, 2022; Rahmianingsih and Malau, 2022). Thus, another motivation for this study is the inconsistency in prior research. To address this, the researchers introduce the Corporate Governance variables of foreign ownership and foreign board diversity as moderating variables.

Companies in the carbon Intensive Industry sector that are listed on the IDX between 2021 and

2023 are the subject of this study. This study aims to investigate and evaluate the following questions: (1) Does carbon emission disclosure affect firm value in carbon intensive industries? (2) Can foreign ownership moderate the relationship between carbon emission disclosure and firm value in carbon intensive industries? (3) Can foreign board diversity moderate the relationship between carbon emission disclosure and firm value in carbon intensive industries? Additionally, this study attempts to close the gap left by earlier research in Indonesia, which has frequently concentrated on certain industries. This study focuses on companies in the carbon intensive industry, which includes several sectors in Indonesia, such as consumer non-cyclicals, industrial, basic materials, real estate management & development, transportation & logistics, infrastructure, and energy.

2. Literature review

2.1Agency theory

Agency theory was first proposed by Jensen and Meckling in 1976. The core principle of agency theory is the existence of a relationship or contract between the principal, which is the shareholder, and the agent, which is the manager or corporate executive. A decline in firm value can be attributed to agency conflicts, and good corporate governance can reduce such conflicts (Sindy and Butar-Butar, 2023). Agency conflicts arise when managers have an obligation to maximize shareholder welfare, but at the same time, managers have their own interests in maximizing their welfare through bonuses promised by shareholders. The alignment of interests between these parties often leads to agency problems or conflicts. Management, entrusted with the responsibility of running the company, typically has more comprehensive information, unlike shareholders, who have limited access to information. This information imbalance can trigger conflicts between the parties. The differing interests lead both sides to seek ways to gain advantages for themselves (Nainggolan and Karunia, 2022).

A decline in firm value can be caused by agency conflicts, and good corporate governance can mitigate these conflicts (Sindy and Butar-Butar, 2023). Theoretically, this suggests that good governance practices lead to a reduction in agency costs. Therefore, it is important for companies to implement good governance principles (Arora and Sharma, 2016).

Environmental disclosures, particularly carbon emission disclosure, are one mechanism to minimise information asymmetry between principals and agents. External pressures arising from operational activities that produce carbon emissions, which adversely affect the climate, ultimately pose significant risks, such as declining firm value. The inclusion of foreign entities within a company's ownership and board structure is expected to provide more stringent oversight of corporate and environmental performance, thereby mitigating the potential reduction in firm value.

2.2 Legitimacy theory

First presented by Dowling and Pfeffer in 1975 (Jannah and Narsa, 2021), legitimacy theory describes how an organization engages with society at large and is related to the idea of the social contract. There is a connection between legitimacy and shifting societal norms. Because society has always aimed for a future in which every person has the right to a good life, access to freedom, justice, equality, a pollution-free environment, and other elements deemed necessary for human existence (Islam, 2017). Changes in societal expectations mean that what was once considered acceptable may now be viewed as unacceptable. This shift in expectations creates what is known as the legitimacy gap, referring to the disparity between what society expects organizations to do and how they should behave and act (Choi et. al., 2013). Thus, organizations must pay attention to these

changes in societal expectations to prevent threats to their survival (Islam, 2017).

Companies can engage in the necessary disclosures to meet these expectations and gain legitimacy from the public. In relation to declining firm value and the climate phenomena resulting from corporate activities, the appropriate disclosure, namely carbon emission disclosure, is required. According to Hardiyansah and Agustini (2021), companies that disclose carbon emissions exhibit good environmental performance, which results in the public granting legitimacy, thereby enhancing the company's image and attracting investors.

Firms that attain public legitimacy gain various benefits, including enhanced reputation and a positive image, which distinguish them from competitors and foster increased trust and loyalty among investors and customers. Furthermore, legitimacy aids companies in managing and mitigating negative issues while improving their ability to address criticism and safeguard their reputation. This creates a stronger foundation for long-term growth and sustainability.

2.3 Stakeholder theory

The theory regarding the relationship between a company and various stakeholders or interested parties, such as shareholders, employees, suppliers, government, and the general public, is known as stakeholder theory. This theory was initially developed by R. Edward Freeman in 1984 through his book Strategic Management: A Stakeholder Approach. The history of stakeholder theory begins with the idea that companies are not only responsible to shareholders but also to various other stakeholders who have an interest in the company. This theory has since evolved and become an integral part of strategic management, business ethics, and corporate social responsibility (Freeman et. al., 2021).

In its operations, a company impacts not only itself but also its stakeholders, including the broader community. The phenomena of global warming and climate change resulting from corporate operations negatively affect the environment, making it an important issue for discussion. Society, either directly or indirectly, may encourage companies to disclose environmental information, such as carbon emission disclosure. According to Oktarina (2018), the main objective of stakeholder theory is to help managers understand stakeholders and assist them in improving firm value by mitigating the negative impacts of corporate activities and minimizing harm to stakeholders.

Companies that understand the needs of stakeholders, particularly the community, have the potential to reduce the risk of conflicts and disruptions to their operations. The ability to comprehend and respond to community needs provides a competitive advantage, enabling companies to differentiate themselves from competitors and establish favourable conditions for sustainable growth and long-term success.

2.4 Signaling theory

Signaling theory explains an event where internal parties of an entity, possessing private information, whether positive or negative, must decide whether to communicate this information to external parties. This theory involves two parties: the internal company as the signaler and the external audience as the receiver. The theory focuses on the deliberate communication of positive signals to the public to convey the entity's positive actions with the aim of receiving a favorable response from the audience or receiver (Connelly et. al., 2011).

According to signaling theory, pressure on companies from various parties, including stakeholders, can be alleviated through carbon emission disclosures. This signals that the company is aware of the environmental crisis and is taking steps to mitigate the associated risks. Such actions can protect the company's reputation and image to a certain extent (Lu et al., 2021). The carbon

emission disclosure carbon emission disclosures made by companies, driven by global warming resulting from corporate operations, represent a form of non-financial disclosure. When this information is shared with the public, it is intended to serve as a positive signal indicating that the company is aware of, capable of managing, and responsible for the environmental risks it creates, thus safeguarding its image.

Carbon emission disclosures are expected to serve as positive signals, particularly to external stakeholders, as these disclosures demonstrate a company's commitment to reducing emissions generated through its operational activities. Such positive signals are anticipated to reflect the quality of management, attract investor interest, and ultimately contribute to an increase in firm value.

2.5 Hypothesis development

2.5.1 The influence of carbon emission disclosure on firm value

The increasing prominence of environmental issues has placed pressure on companies to provide information regarding their operational activities and their impact on the environment (Muhammad and Aryani, 2021). One of the contributions businesses can make to address environmental concerns, specifically on the issue of global warming, is by disclosing their carbon emissions (Akhiroh and Kiswanto, 2016).

Research conducted by Blesia et al. (2023) and Azhari and Hasibuan (2023) discovered a significant positive correlation between Indonesian firm value and disclosure of carbon emissions. Companies are under increased pressure from multiple sources to reveal the environmental effects of their operations. Similar findings were reported by Kurnia et al. (2021), although their study spanned two countries, Indonesia and Australia. In contrast to Australia, where carbon emission disclosure had no effect on business value, Indonesia showed a strong positive correlation between carbon disclosure and firm value. The substantial costs associated with carbon emission disclosure result in increased spending and cash outflows, which may impede the growth of the firm's value.

Other research conducted by Hardiyansah and Agustini (2021), Rahmianingsih and Malau (2022), Noor and Ginting (2022), Yuliandhari et al. (2023) states that carbon emission disclosure has a positive effect on firm value. The motivation for companies to disclose carbon emissions is to gain legitimacy from the public. Companies must pay attention to environmental factors that support sustainability, so that they can have a positive impact on society or the business itself. Disclosing carbon emissions data allows the public and investors to assess a company's level of concern and factor it into their investment decisions.

Research indicates that carbon emission disclosure positively correlates with firm value in Indonesia, despite the high costs involved. The market's positive response to carbon emission disclosure can enhance corporate sustainability and attract environmentally conscious investors, ultimately increasing firm value. Based on the theoretical framework above, the following hypothesis is formulated:

H_1: Carbon emission disclosure has a positive influence on firm value.

2.5.2 The moderating effect of foreign ownership

Jensen and Meckling (1976) propose that foreign ownership constitutes a corporate governance mechanism that can aid in controlling agency problems. The presence of foreign investors is seen as an effective supervisory mechanism for each decision made by management. The contractual relationship that exists between the principle and the agent is the foundation of agency theory; in this case, foreign ownership serves as the principal and gives the managers of the business (agents) the power to establish an advantageous employment contract. The objective is for agents to manage

resources prudently, thereby generating expected profits and mitigating risks in accordance with mutual agreements. Stakeholder theory further explains how corporate managers can more effectively manage relationships between stakeholders within a company. Enhancing firm value by minimizing stakeholder losses is a broad goal underscored by stakeholder theory (Oktarina, 2018).

There is a favorable correlation between foreign ownership and firm value, according to research by Sari and Budiasih (2018). More transparency in financial information is demanded by foreign investors than by domestic ones. Foreign investors are expected to perform greater control on business operations. By mitigating the negative impacts of C carbon emission disclosure, foreign investors tend to value this type of transparency more than local investors (Muhammad and Aryani, 2021). Based on these observations, the researcher formulates the following hypothesis:

H_2: Foreign ownership positively moderates the relationship between carbon emission disclosure and firm value.

2.5.3 The moderating effect of foreign board diversity

Aksan and Gantyowati (2020) found no significant relationship between foreign board diversity and firm value, which is likely due to the low number of foreign board members, making it difficult to establish a robust link between these variables. Conversely, Khairani and Harahap (2017) found a positive association between foreign board diversity and firm value. Theoretically, a board member with an international background and accustomed to global culture is likely to contribute to environmental issues by implementing high standards in environmental management practices (Khalid et. al., 2022). A study by Narsa and Jannah (2021) concluded that foreign diversity positively impacts carbon emission disclosure. In relation to such disclosures, foreign diversity on boards introduces new perspectives in motivating and reporting current information related to carbon emission disclosure, which stem from experiences in leading previous companies and subsequently applying these practices in the present organization.

Boards with diverse national backgrounds possess broader information and knowledge, which is anticipated to contribute positively to addressing environmental issues through sound environmental management practices. In terms of carbon disclosure, this serves as a method for companies to attain legitimacy from the public, particularly among those affected by the company's operational activities. Effective environmental management by the company is also expected to receive a positive response from stakeholders, including the public and investors, ultimately enhancing firm value. Based on this background, the researcher formulates the third hypothesis as follows:

H_3: Foreign board diversity positively moderates the relationship between carbon emission disclosure and firm value.

3. Research methodology

3.1 Data

The secondary data that was used in this investigation was unbalanced data. From 2021 to 2023, all publicly traded companies classified as carbon intensive industries that were listed on the IDX represent the study's population. The researcher chooses particular segments of the population that are thought to be representative or highly informative about the issue or subject being studied using the purposive sampling technique (Rasyid, 2022). In other words, this sampling method involves selecting samples based on specific criteria. The sampling criteria for this study are as follows: (1) The public company is a carbon-intensive industry listed on the IDX from 2021 to 2023, as such industries tend to produce higher carbon emissions (He et al., 2013). (2) The company discloses carbon emissions in its annual or sustainability reports during the observation period. (3) The variables under study are fully available in the company's annual or sustainability reports or on the

company website from 2021 to 2023.

3.2 Research variables and measurements

3.2.1 Dependent variable

Firm value

The dependent variable in this study is firm value, which may be measured using methods such as Price to Book Value (PBV), Market Capitalization (MCAP), and Tobin's Q (Anggraeni, 2018; Muhammad and Aryani, 2021; Anggita et al., 2022).

For this study, Tobin's Q is used to measure firm value. Rather than employing the basic formula for Tobin's Q, the study uses the formula applied by Muslichah (2020), as the basic calculation requires detailed data, including the Replacement Value of Assets, which is challenging to obtain. Other studies, such as those by Lumapow and Tumiwa (2017) and Oktarina (2018), have also employed this approach to Tobin's Q. The formula to calculate Tobin's Q is as follows:

$$TQ = \frac{(MVE + D)}{BVA}$$

TQ = Tobin's Q value
MVE = Market Value of Equity (Current Price x Total Shares)
D = Total Debt
BVA = Book Value of Assets

3.2.2 Independent variable

Carbon emission disclosure

The independent variable in this study is Carbon Emission Disclosure (CED), measured using an index developed by Choi et al. (2013). This index is derived from factors identified in the information request sheets of the Carbon Disclosure Project (CDP), organized into five categories: climate change (risks and opportunities), GHG emissions, energy consumption, GHG reduction and its costs, and carbon emissions accountability. These five categories are further detailed into 18 items. Several other studies have adopted this index to measure CED, including research by Widyastuti et al. (2023), Sari and Budiasih (2022), Anggita et al. (2022), Jannah and Narsa (2021), and Ng et al. (2022). The maximum score each company can obtain is 18 if all disclosure categories are reported.

3.2.3 Moderator variable

Foreign ownership

The Foreign Ownership (FO) variable represents the presence of foreign ownership within a company. FO is measured by dividing the total shares owned by foreign investors by the total shares outstanding over a given period (Justina and Simamora, 2017). The formula is as follows:

FO = Total shares held by foreign investor/ Total outstanding shares

Foreign board diversity

The Foreign Board Diversity (FBD) variable reflects the diversity of foreign members on the board of commissioners. FBD is measured by dividing the number of foreign commissioners by the total number of commissioners (Innayah *et al.*, 2021). The formula is as follows:

FBD = Number of foreign commissioners/ Total number of commissioners

3.2.4 Control variables

Firm Size: The firm's total assets, converted using the natural logarithm (ln), can be used to

calculate Firm Size (FS) (Kholmi et al., 2020).

Profitability: Profitability (PRO) is measured using the Return on Assets (ROA), which is the company's profit divided by total assets. The profitability value reflects the company's performance, where high profitability indicates strong performance (Rini et al., 2021). Profitability is calculated using the following formula (Fahmi, 2020):

$$PRO = \frac{Net\ Income}{Total\ Assets}$$

Leverage: Leverage is also used as a control variable in this study. High leverage indicates that a company heavily relies on third-party financing for its operational activities. Leverage (LEV) is measured by comparing total debt to total assets (Yusuf, 2020). The formula is as follows (Fahmi, 2020):

$$LEV = \frac{Total\ Debt}{Total\ Assets}$$

3.3 Empirical model

The analysis method used in this study is Moderated Regression Analysis (MRA). This method is applied to analyze the effect of CED on firm value, as well as the interaction effects of foreign board diversity and foreign ownership. The equations are as follows:

$$FV = \alpha + \beta 1CED + \beta 2FS + \beta 3PRO + \beta 4LEV + e \quad (1)$$

$$FV = \alpha + \beta 1CED + \beta 2FBD + \beta 3FO + \beta 4FS + \beta 5PRO + \beta 6LEV + e \quad (2)$$

$$FV = \alpha + \beta 1CED + \beta 2FBD + \beta 3FO + \beta 4CED * FBD + \beta 5CED * FO + \beta 6FS + \beta 7PRO + \beta 8LEV + e \quad (3)$$

Where:

FV = Firm Value
CED = Carbon Emission Disclosure
FBD = Foreign Board Diversity
FO = Foreign Ownership
FS = Firm Size
PRO = Profitability
LEV = Leverage
α = Constant
β = Regression Coefficient
e = Error

4. Results

Secondary data was used in this investigation. Companies in the carbon intensive industry sector that were listed between 2021 and 2023 on the IDX represent the research population. Several samples were chosen based on the predetermined classification criteria, as shown in the Table 1:

Table 1. Sample

Description	Total
Number of companies listed on the IDX in 2023 (Classified as Carbon Intensive Industry)	580
The company does not disclose carbon emissions by category	(503)
Number of sample companies	77
Number of observations (Unbalanced)	189

4.1 Descriptive statistics

The firm value variable in this study is measured using Tobin's Q (Monica et al., 2021). As shown in Table 2, the average firm value is 1.45. Given the comparison between the maximum, minimum, and average values, where the mean is closer to the minimum, it can be inferred that Indonesian companies have effectively managed their assets and possess good investment prospects. A Tobin's Q value greater than 1 indicates that the company has successfully achieved its objective of maximizing firm value, considering Tobin's Q as a ratio accounting for stock value, debt, and assets (Ramadhan et. al., 2023).

Table 2. Descriptive Test Results

	FV	CED	FBD	FO	FS	PRO	LEV
Mean	1,450	0.298	0.375	0.407	29,515	0.063	0.482
Median	1,117	0.278	0.333	0.342	29,442	0.046	0.430
Maximum	10,570	0.667	1,000	0.998	33,731	0.593	2,312
Minimum	0.183	0.056	0.143	0.000	25,313	-0.454	0.033
Std. Dev.	1,206	0.164	0.182	0.308	1,676	0.115	0.345
Observations	189	189	189	189	189	189	189

The carbon emission disclosure variable in this study is measured using the carbon measurement index developed by Choi et al. (2013). Table 2 indicates that the average carbon emission disclosure is 0.30. The maximum disclosure value of 0.67 suggests that, of the 18 categories of carbon disclosure, only 12 (or 67%) are disclosed, while the minimum value is 0.05 (or 5%), meaning the company disclosed only one category. Considering the average value's proximity to the minimum, it can be concluded that most companies show relatively low attention to carbon emission disclosure.

The foreign board diversity variable is measured as the ratio of foreign commissioners to total commissioners (Suranta et al., 2020). As seen in Table 2, the average foreign board diversity is 0.37. The maximum value of 1.00 indicates that 100% of the board of commissioners is composed of foreign members, while the minimum value of 0.14 signifies that foreign commissioners constitute only 14% of the total board.

The foreign ownership variable is measured by the ratio of foreign investors' total shares to total outstanding shares (Justina and Simamora, 2017). As displayed in Table 2, the average foreign ownership is 0.41. The maximum value of 0.99 suggests that 99% of the outstanding shares are owned by foreign investors, whereas the minimum value of 0.000 indicates that only 0.0027% of outstanding shares are held by foreign investors.

4.2Classical assumtion test

4.2.1 Multicolinearity test

Table 3. Multicolinearity Test

		CED	FBD	FO	FS	PRO	LEV
Carbon Emission Disclosure	CED	1.000	-0.125	0.027	0.330	0.108	-0.096
Foreign Board Diversity	FBD	-0.125	1.000	0.452	-0.199	-0.120	-0.092
Foreign Ownership	FO	0.027	0.452	1.000	0.091	-0.072	0.101
Firm Size	FS	0.330	-0.199	0.091	1.000	0.073	0.134
Provitability	PRO	0.108	-0.120	-0.072	0.073	1.000	-0.314
Leverage	LEV	-0.096	-0.092	0.101	0.134	-0.314	1.000

As indicated in Table 3, the multicolinearity test results show that the regression model is free

from multicollinearity potential, as all correlation coefficient values between independent variables are below 0.85, thereby failing to reject the null hypothesis (H_0) and confirming the absence of multicolinearity issues.

4.2.2 Heteroscedasticity test

Table 4. Heteroscedasticity Test

		Probability
Carbon Emission Disclosure	CED	0.753
Foreign Board Diversity	FBD	0.420
Foreign Ownership	FO	0.173
Firm Size	FS	0.396
Leverage	LEV	0.746
Profitability	PRO	0.145

As presented in Table 4, the results of the heteroscedasticity test reveal that each variable has a value greater than 0.05, indicating that the regression model is free from heteroscedasticity. This suggests that the research data is sufficiently homogeneous and reliable.

4.3 Regression analysis result

Model selection analysis, including the Chow Test, Hausman Test, and Lagrange Multiplier Test, was carried out in order to do the panel data regression analysis and give a summary of the study data. The most suitable model was found to be the Fixed Effect Model. The following are the outcomes of the panel data regression using the Fixed Effect Model:

Table 5. Panel regression result data (Fixed Effect Model)

Variabel	Symbol	Coefficient	T	Prob.
C			4.965	(0.000)
Carbon Emission Disclosure	CED	2.279	2.042	(0.044)
Firm Size (Control Variable)	FS	-1.257	-4.844	(0.000)
Leverage (Control Variable)	LEV	0.743	1.468	(0.145)
Profitability (Control Variable)	PRO	1.892	2.058	(0.042)
Foreign Board Diversity	FBD	2.433	2.101	(0.038)
Foreign Ownership	FO	-0.587	-0.681	(0.497)
Foreign Board Diversity*CED		-9.469	-3.752	(0.000)
Foreign Ownership*CED		1.921	1.431	(0.156)
R-squared		Adjusted R-squared	F-statistic	Prob (F-statistic)
0.924		0.863	15.133	0.000

4.4 Hypothesis test results

Based on the results of the regression test presented in Table 5, the probability value (F-Statistic) is 0.0000, which is lower than the significance level of 0.05. This finding indicates that the independent variables collectively have a significant effect on the dependent variable. Table 5 shows that the R-squared (R^2) value is 0.9244, or 92.44%, suggesting a positive relationship between the independent variable that is carbon emission disclosure, and firm value as dependent variable. Furthermore, the Adjusted R-squared (Adj. R^2) value from the same test in Table 5 is 0.8633, or 86.33%. This percentage indicates that carbon emission disclosure as an independent variable accounts for 86.33% of the variance in firm value, with the remaining 13.67% explained by

other variables not included in this study.

From the tests presented in Table 5, the t-value for the carbon emission disclosure variable is positive at 2.0415, with a probability of 0.0437, which is lower than the significance level of 0.05 (0.0437 < 0.05). The first hypothesis (H_1), which claims that carbon emission disclosure has a positive impact on firm value, is supported by this finding, which results in the conclusion that the variable has a positive and significant effect on firm value.

This outcome aligns with Signaling Theory, which posits that companies must meet public expectations; any gap between public expectations and company behavior creates a Legitimacy Gap. To reduce this gap, companies can disclose information to meet expectations and gain public legitimacy. Stakeholder Theory further asserts that companies should operate not solely for profit but to benefit all stakeholders. By disclosing carbon emissions, a company can reduce the risk of conflicts with the public that may disrupt operations and cause financial losses. Additionally, Signaling Theory suggests that positive signals to the public may yield positive feedback or responses. This study's findings indicate that carbon emission disclosure serves as a positive signal for companies, as demonstrated by the increase in firm value. Empirical evidence from this study demonstrates that carbon emission disclosure plays a significant role in enhancing firm value. Not only does it provide competitive advantages, but it also helps companies gain legitimacy from both the public and investors.

Subsequent testing reveals an interaction between foreign ownership and the relationship between carbon emission disclosure and firm value. The t-value is 1.4308, with a probability of 0.1555, which is greater than the significance level of 0.05 (0.1555 > 0.05). This study rejects the second hypothesis (H_2), which claims that foreign ownership would strengthen the association between carbon emission disclosure and firm value. Instead, it shows that foreign ownership does not strengthen this relationship. This result runs counter to the theory this study developed. There is no empirical evidence that the relationship between carbon emission disclosure and firm value is significantly impacted by foreign ownership. Regardless of the percentage of foreign ownership, it does not use carbon emission disclosure to increase firm value.

Additionally, the investigation also shows that the association between carbon emission disclosure and firm value with the interaction of foreign board diversity. With a probability of 0.0003 and a t-value of -3.7523, the coefficient is -9.4692, below the significance level of 0.05 (0.0003 < 0.05). As a result, the third hypothesis (H_3), according to which the relationship between carbon emission disclosure and firm value is strengthened by foreign board diversity, is disproved. The study's hypothesis is refuted by this outcome. According to the test results, the association between firm value and carbon emission disclosure is weakened by foreign board diversity. A company's foreign board diversity percentage does not use carbon emission disclosure to increase firm value.

One possible reason why foreign board diversity and foreign ownership can not positively moderate relationship between carbon emission disclosure and firm value is that the average number of foreign committee members in this survey is still low at 37.5%. On the other hand, the lack of experience and understanding of new work environment conditions can also have a negative impact. The weakening of the firm's value may be caused by emerging agency conflicts. Carbon emissions information is expensive, and this information creates conflicts of interest and concerns among investors that the costs incurred are not commensurate with the revenues companies can earn.

5. Conclusion

This study analyzes diversity on the foreign board and foreign ownership as moderating factors to examine the impact of carbon emission disclosure on firm value. The market reacts favorably to carbon information and views it as a sign of company sustainability, as seen by the substantial beneficial impact of carbon emission disclosure on firm value. Therefore, companies that are transparent and responsible in disclosing carbon emissions tend to receive support from both the public and the market, as reflected in an increase in firm value. This is especially relevant given the increase in atmospheric carbon concentrations, which contribute to global warming and climate change due to corporate operational activities. The association between carbon emission disclosure and firm value is not strengthened by foreign ownership as a moderating variable. The impact of carbon emission disclosure on firm value is not influenced by the percentage of foreign ownership. Similarly, foreign board diversity diminishes rather than strengthens the link between firm value and carbon emission disclosure. Carbon emission disclosure in Indonesia remains voluntary, which means foreign ownership and foreign board diversity do not place sufficient emphasis on carbon disclosure. Moreover, providing carbon emission disclosure incurs significant costs, resulting in a potential conflict of interest, as the costs involved may not be offset by returns for the company.

The findings from this study provide insights for policymakers involved in developing regulations on carbon emission disclosure. In addition, Indonesia has implemented a carbon exchange transaction policy in line with the Financial Service Authority (OJK) policy number 14 of 2023 on carbon trading through carbon exchange. By regulating carbon emission disclosure, the government could more effectively monitor companies, particularly concerning carbon-related activities, and supervise companies that produce excessive carbon emissions. The results of this study can be practically used as consideration for companies when disclosing their carbon emissions, especially since disclosing carbon emissions has a significant positive impact on firm value. Although disclosing carbon emissions incurs costs, it is believed to have a positive impact on firm value. Finally, this study can provide input to investors in making investment decisions, by considering that companies that disclose carbon emission disclosure can increase firm value.

The main limitation of this study is the limited data due to the voluntary nature of carbon emission disclosure. Researchers may also face subjectivity issues when evaluating each indicator, as no regulation currently mandates how carbon emission disclosure should be presented. Based on this study's data limitations, future research could benefit from the establishment of regulations in Indonesia governing carbon emission disclosure, given its urgency in addressing climate change issues. Few companies currently disclose carbon emissions. Future studies are encouraged to adopt additional carbon emission disclosure indicators that are more relevant to the Indonesian context, or to explore other indicators that may be more suitable for the region.

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