



Carbon emission disclosure, financial performance, and firm value: The moderating role of environmental performance

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Abstract

The purpose of this study is to investigate, evaluate and provide empirical evidence regarding the role of environmental performance in moderating the effect of carbon emission disclosure and financial performance on firm value in basic materials sector companies listed on Indonesia Stock Exchange during the 2021–2024 period. This research is based on the inconsistency of previous findings regarding the effect of carbon emissions disclosure and financial performance on firm value, as well as the unclear role of environmental performance as a moderating variable in explaining the effect between carbon emissions disclosure and financial performance. This study employs a quantitative approach, using secondary data obtained from bloomberg terminal, companies' annual and sustainability reports, and the official website of the Ministry of Environment and Forestry (KLHK). The analytical method employed is Moderated Regression Analysis (MRA) to test the research hypotheses. The independent variables in this study are carbon emission disclosure and financial performance, the dependent variable is firm value, and environmental performance serves as the moderating variable. The study's findings demonstrate that carbon emission disclosure and financial performance have a significant positive and direct influence on firm value. However, environmental performance is not able to moderate the effect of carbon emissions disclosure on firm value. In contrast, environmental performance is proven to moderate the effect of financial performance on firm value. Thus, carbon emission disclosure and financial performance are play more important as a sign of environmental responsibility and as a way for investors to evaluate a company's sustainability and prospects.

Keywords: Carbon emission disclosure, financial performance, environmental performance, firm value

Introduction

Firm value maximization is one of the main goals of every business entity in order to achieve financial stability as high as possible at the current risk level, satisfy stakeholders, and ensure operational efficiency in the future. Firm value is a crucial indicator that shows investors' perceptions of the effectiveness of the company's operations as well as the level of profitability that the company can achieve (Hardiyansah & Agustini, 2021) ^[21]. In the capital market, share prices are determined by the mechanisms of supply and demand, and are affected by investor perceptions of the company's performance and future prospects (Agus, 2010) ^[1]. The use of share prices as a representation of share value is based on the assumption that the market price reflects investors' assessments of the company's fundamentals and risk. Share prices will increase significantly if investors view the company's fundamentals and prospects positively. In recent years, investors' perspectives in evaluating business entities have undergone a paradigm shift from a single bottom-line to a triple bottom-line approach that integrates profit, people, and planet. Companies can no longer focus exclusively on the accumulation of financial profit while disregarding the negative externalities of their operational activities (Noor *et al.*, 2022) ^[27]. Growing public demands and global awareness now compel market participants to evaluate a company's environmental commitment prior to allocating capital (Geiszler *et al.*, 2018) ^[18]. Companies that proactively respond to sustainability issues have been shown to build a more solid reputation in order to maintain business continuity (Riski & Prasetyono, 2023). Nevertheless, current conditions reveal

that numerous industrial activities continue to cause significant environmental pollution and ecological damage. This situation serves as clear evidence that corporate awareness of the importance of maintaining environmental balance still requires substantial improvement.

One of the crucial instruments employed by companies to demonstrate their commitment to environmental sustainability is the disclosure of carbon emissions generated during a given period. This disclosure represents a comprehensive form of reporting encompassing estimates of greenhouse gas emission volumes produced, the utilization of renewable energy, and strategies for mitigating the impacts of climate change (Ennis *et al.*, 2012) ^[15]. Through the transparent presentation of data in sustainability reports, companies signal to the market that management is handling climate-related risks in a structured manner (Noor *et al.*, 2022) ^[27]. Conversely, the neglect of such information transparency risks eroding investor confidence, which may trigger a decline in share demand on the stock exchange (Ghelli & Schröder, 2013) ^[19].

The urgency of disclosing carbon emission information is particularly critical for companies operating in the basic materials sector. This sector is categorized as a high-profile industry due to the nature of its operations, which involve the direct extraction of natural resources, are energy-intensive, and generate emissions in substantial volumes. Based on data from the Ministry of Environment and Forestry (KLHK) for the 2021–2024 ^[7, 21] period, extractive and basic materials manufacturing activities have contributed significantly to the accumulation of greenhouse gas emissions in Indonesia. These empirical facts place the

basic materials sector under considerably stricter regulatory pressure and public scrutiny compared to other sectors.

On the other hand, financial success continues to play a crucial role in a company's existence inside the capital market, going beyond non-financial factors like emission disclosure. Financial performance reflects the actual financial health condition and the effectiveness of management in utilizing all assets to generate profit over a given period. This financial information is formally summarized in financial statements, which serve as a form of management accountability to capital providers (Rahardjo, 2002) ^[30]. Reliable financial statements with high informational content are essential for investors to accurately assess share value and measure investment risk.

The existence of sustainability disclosure practices in Indonesia is driven by concrete legal compliance, rather than merely a response to global business trends. At the international level, the global community reached an agreement through The Paris Agreement (2016) ^[36] to curb the rate of global warming, which was subsequently ratified through Law Number 16 of 2016. This juridical commitment was translated into technical capital market regulations through the Financial Services Authority Regulation (POJK) Number 51/POJK.03/2017 concerning the implementation of sustainable finance. For the basic materials sector, this obligation became fully effective during the 2021–2024 ^[7, 21] period, thereby ensuring the availability of environmental data that has been standardized by the government.

Despite the strong theoretical urgency of both variables, a number of prior studies examining the effect of carbon emission disclosure on firm value continue to yield inconsistent results. Research conducted by Hardiyansah & Agustini (2021) and Fitriana *et al.* (2024) ^[17, 21] found that carbon emission transparency has a significant positive effect on firm value. In contrast, Asyifa & Burhany (2022) ^[3] identified a negative effect, while Rachmawati (2021) ^[29] concluded that carbon emission disclosure has no effect whatsoever. Similar inconsistencies were also found regarding the effect of financial performance (ROA), wherein some studies reported positive results Azzahra & Lekok (2023) ^[5], whereas others identified a negative effect (Lisnawati & Koswara, 2024) ^[24].

The uncertainty of these empirical results creates room for the involvement of environmental performance as a moderating variable in explaining the relationships among variables. Several prior researchers have attempted to examine the role of environmental performance; however, their findings continue to yield mixed results. Hardiyansah & Agustini (2021) ^[21] demonstrated that environmental performance is capable of moderating and strengthening the effect of carbon emission disclosure on firm value. However, Damas *et al.* (2021) and Mariani & Suryani (2018) ^[11, 18] concluded that environmental performance does not possess significant moderating capability. These diverging findings underscore the need for further analysis to re-evaluate the role of environmental impact management capacity.

Theoretically, the relationship between carbon emission disclosure, environmental performance, and firm value can be explained through the Legitimacy Theory. Dowling & Pfeffer (1975) ^[13] argued that corporate operations depend on a 'social contract' that requires business activities to align with societal norms. Companies strive to obtain public legitimacy by routinely publishing financial and non-

financial information through annual reports or sustainability reports. Carbon emission disclosure is analyzed as a tactical mechanism to reduce reputational risk, wherein optimal environmental performance is required as evidence validating ecological commitment (Berthelot & Rober, 2011) ^[8]. Investors who prioritize sustainability aspects will express their appreciation for this legitimacy through an increase in share prices.

The relationship between financial performance and firm value under the moderating influence of environmental performance is bridged by Signaling Theory. Spence (1973) ^[33] explained that signals conveyed by management to external parties reflect the internal quality and prospects of the organization. When a company reports a high Return on Assets (ROA) ratio, the market interprets this as a positive signal (good news) regarding the entity's capacity to convert assets into profit (Brigham & Houston, 2012) ^[9]. However, for such a signal to be deemed credible and free from information asymmetry bias, an objective third-party assessment indicator is required. The PROPER rating acts as a signal enhancer that validates that financial profit has been achieved without exploiting the preservation of nature (Deegan & Unerman, 2011) ^[12].

Both information disclosure mechanisms operate within the framework of the Efficient Market Hypothesis. Fama (1970) ^[16] asserted that in an efficient capital market, the prices of financial instruments that are formed already reflect all available relevant information. The most relevant form of market efficiency in this context is the semi-strong form, in which share prices respond swiftly to non-financial public announcements (Hartono, 2022) ^[22]. This theory reinforces the strategic position of information disclosure, as the capital market will rapidly evaluate the reliability of emission disclosures and PROPER ratings. Companies that consistently present favorable information tend to build long-term investor confidence, which in turn contributes to the strengthening of market capitalization value.

Based on the research gaps identified from inconsistent prior to empirical findings and a comprehensive theoretical foundation, this study possesses genuine academic urgency. This study aims to analyze the effect of carbon emission disclosure and financial performance on firm value, with environmental performance as a moderating variable in basic materials sector companies listed on the Indonesia Stock Exchange (IDX) during the 2021–2024 ^[7] period. The novelty of this study lies in the integrative examination of environmental performance as a dual moderating variable to address the inconsistencies found in prior research. Furthermore, the carbon emission disclosure proxy is measured using a more comprehensive approach by adopting 18 indicator items from Bae Choi *et al.* (2013) ^[6].

Theoretical Framework and Hypothesis Formulation

This section explains the theoretical foundations relevant to and employed as the basis of the study, encompassing Legitimacy Theory, Signaling Theory, and the Efficient Market Hypothesis Theory. Furthermore, this section also elaborates on the conceptual framework delineating the relationships among the research variables, as well as the development of research hypotheses.

Legitimacy Theory

Legitimacy Theory was first introduced by Dowling & Pfeffer (1975) ^[13], focusing on the existence of a reciprocal relationship between companies and the surrounding

community. Legitimacy Theory is grounded in the concept of a 'social contract,' which posits that every business entity, including companies operating alongside society, maintains a contractual relationship with its social environment. Adherence to such social expectations may enhance a company's legitimacy, which in turn has the potential to drive an increase in firm value.

Carbon emission disclosure represents a corporate strategy to obtain legitimacy from stakeholders while simultaneously mitigating various operational, reputational, and legal risks arising from the impacts of greenhouse gases (Berthelot & Rober, 2011) ^[8]. To ensure that such commitment is not perceived as mere rhetoric, companies require tangible environmental performance as validating evidence of their actions. Thus, through the integration of emission disclosure and concrete environmental performance, companies are able to meet social expectations and respond to public pressure in order to obtain as well as maintain such legitimacy.

Signaling Theory

Signaling Theory posits that signals transmitted by company management constitute information regarding the quality, capability, and condition of the company that is conveyed to external parties. Signaling Theory refers to the behavior of company management in providing guidance to investors concerning future prospects and management's ability to realize their expectations (Brigham & Houston, 2012) ^[9]. The motivation of companies to disclose information stems from the existence of information asymmetry between internal and external parties of the company.

Financial performance proxied by the Return on Assets (ROA) ratio reflects a company's ability to generate profit from its total assets, wherein a high ROA value is received by investors as a positive signal (good news) regarding the company's healthy and prospective condition. For such a signal to be deemed credible and to avoid creating information asymmetry in the capital market, companies require environmental performance as a signal enhancer to validate the accuracy of the financial information disclosed. Through the integration of reliable environmental and financial information disclosure, companies are able to attain a positive reputation and stakeholder confidence, which ultimately triggers an increase in share demand and elevates overall firm value.

Efficient Market Hypothesis Theory

The Efficient Market Hypothesis is a theory first introduced by Fama (1970) ^[16], which posits that share prices in the capital market already reflect all available relevant information. The arrival of new information, whether in the form of financial or non-financial reports, promptly triggers price adjustments in the capital market. This affirms a cause-and-effect relationship, wherein high-quality information drives efficient share price movements, while delays or inaccuracies in signals conversely create valuation distortions (Hartono, 2022) ^[22].

The Efficient Market Hypothesis theory reinforces the argument that information is a strategic element capable of influencing investor perceptions and ultimately shaping share prices in the capital market. Companies will be more motivated to manage information strategically and responsibly when they recognize that publicly disclosed information will directly impact the rise or decline of share

prices. Furthermore, companies that consistently present favorable information (good news) tend to build long-term investor confidence, which in turn may enhance overall firm value.

Theoretical Framework

The relationship between the independent and dependent variables is shown in the framework that follows.

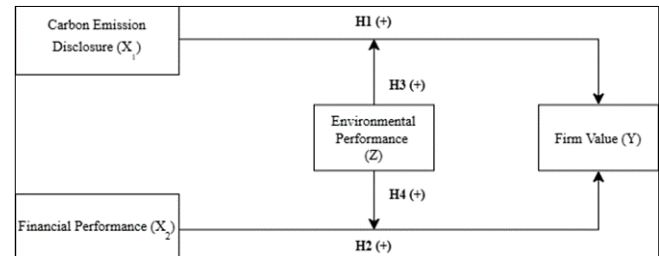


Fig 1: Theoretical Framework

Hypothesis Formulation

The Effect of Carbon Emissions Disclosure on Firm Value

Companies that openly disclose carbon emissions generated from their operational activities are generally perceived as having a commitment to sustainability, as this demonstrates concrete efforts to reduce emissions and support low-carbon projects initiated by the government. This consequently has a positive impact on firm value, in line with the growing attention of investors toward global environmental issues in the future (Luo & Tang, 2016) ^[25].

According to Hardiyansah & Agustini (2021) ^[21], carbon emission disclosure has a positive impact on firm value, wherein such disclosure is regarded as a crucial instrument for maintaining stakeholder confidence. Fitriana *et al.* (2024) ^[17] also explains that carbon emission disclosure positively influences firm value. Companies that disclose their carbon emissions are considered sustainable entities that support low-carbon programs initiated by the government.

Based on the legitimacy theory, carbon emission disclosure undertaken by companies represents an effort to obtain recognition and support from stakeholders in order to sustain long-term operational activities. Companies maintain a social contract with the community and the environment in which they operate; therefore, they must preserve their legitimacy through carbon emission disclosure as a form of environmental accountability.

H1: Carbon emission disclosure has a positive impact on firm value.

The Effect of Financial Performance on Firm Value

Financial performance represents an overview of the ability and achievements of a company in managing its assets, liabilities, equity, revenues, and profit over a given period. Financial performance is measured using the Return on Assets (ROA) ratio, which is a financial ratio that measures a company's level of profitability derived from the comparison between net profit and total assets.

According to Mariani & Suryani (2018), financial performance has a significant positive effect on firm value. A company's ability to generate profit serves as a positive signal responded to by the market, as it reflects the

efficiency of asset management, which ultimately drives an increase in share demand and firm value.

Based on signaling theory, financial performance data serves as a strategic signal from management to stakeholders regarding asset efficiency and growth prospects. This informational transmission effectively minimizes information asymmetry between internal and external corporate parties. Consequently, market investors can evaluate the company's intrinsic value with greater accuracy and objectivity.

H2: Financial Performance has a positive effect on firm value.

The Role of Environmental Performance in Moderating the Effect of Carbon Emission Disclosure on Firm Value

Carbon emission disclosure alone is insufficient to convince investors if it is not supported by sound environmental performance. Therefore, a company's environmental performance assessed through PROPER serves as an objective assurance that environmental commitments have been genuinely fulfilled. It is the synergy between transparent reporting and a formal green track record that ultimately validates corporate commitment, thereby fostering full investor confidence and enhancing firm value. According to Auliya & Margasari (2018) ^[4], environmental performance assessed through PROPER ratings has a significant impact on the enhancement of firm value. Carbon disclosure represents a strategic instrument influencing capital market perceptions rather than a mere administrative obligation. Within this framework, environmental performance quality serves as a crucial moderating variable. This factor effectively strengthens the impact of environmental disclosure on firm value in the eyes of stakeholders (Toly, 2019) ^[37].

Based on signaling theory, environmental performance serves as a signal enhancer that moderates carbon disclosure's impact on firm value. High environmental performance renders these disclosure signals far more credible to the capital market. Consequently, companies secure a strong reputation, ensuring every corporate signal receives a significantly greater response from stakeholders.

H3: Environmental performance moderates the effect of carbon emissions disclosure on firm value.

The Role of Environmental Performance in Moderating the Effect of Financial Performance on Firm Value

Corporate performance in the context of sustainable development goals is no longer assessed solely on the basis of financial performance, but also encompasses environmental performance. Modern investors tend to consider sustainability aspects alongside profitability, wherein environmental performance proxied by PROPER can function as a signal enhancer. Thus, the interaction variable is expected to be capable of influencing market responses toward firm value.

According to Wardhana (2017) ^[38], in the era of modern business, corporate orientation is no longer exclusively focused on profit generation. Financial achievement accompanied by a superior environmental performance reputation has been shown to enhance competitiveness as well as firm value in a sustainable manner.

Based on Signaling Theory, the combined signal of ROA and PROPER enables the market to rapidly integrate financial and environmental information into valuation

(Tandelilin, 2017) ^[14]. The integration of sound profitability and concrete environmental commitment has been shown to trigger an increase in share prices. Consequently, this positive response is directly reflected through an enhancement of firm value.

H4: Environmental performance moderates the effect of financial performance on firm value.

Research Methodology

This section provides an overview of the research population and sample, the operationalization of the study variables, and the research model employed.

Population and Sample

Population refers to the entire set of objects or subjects possessing certain predetermined characteristics and qualities to be examined, thereby enabling researchers to draw relevant and accurate conclusions (Sugiyono, 2019) ^[34]. The population employed in this study encompasses all basic materials sector companies listed on the Indonesia Stock Exchange (IDX) during the 2021–2024 ^[7] period.

The sample in this study was selected using a purposive sampling method, whereby samples are selected based on specific criteria in accordance with the research objectives. The research sample consisted of basic materials sector companies that met the following criteria:

1. Basic materials sector companies listed on the Indonesia Stock Exchange (IDX) during the 2021–2024 ^[7] period.
2. Basic materials sector companies registered as participants in the PROPER program during the 2021–2024 ^[7] period.
3. Basic materials sector companies that consistently published annual reports and sustainability reports for four consecutive years on the IDX during the 2021–2024 ^[7] period.

Model and Research Variables

This study uses three types of variables, namely dependent variable, independent variables, and moderating variable. The dependent variable in this research is firm value, while the independent variables are carbon emission disclosure and financial performance. In addition, environmental performance is used as a moderating variable to analyze whether environmental performance is able to moderate the effect of carbon emission disclosure and financial performance on firm value. These variables are used to examine the effect of carbon emission disclosure and financial performance on firm value, both directly and indirectly through profitability, in basic materials sector companies listed on the Indonesia Stock Exchange (IDX) during the 2021–2024 ^[7] period.

Firm Value

The dependent variable in this study is firm value. Firm value reflects investors' assessment or perception of a company's ability to manage its business, particularly in attracting and managing investments in the capital market (Laksani *et al.*, 2020). According to Agus (2010) ^[1, 23], firm value can be reflected through share prices formed by the mechanisms of supply and demand on the stock exchange, and is influenced by investors' assessments of the company's performance and future prospects. In this study, firm value is measured using Tobin's Q. Tobin's Q is used as it

compares the market value of a firm's securities to its total asset replacement cost, reflecting both financial performance and investor sentiment. The use of Tobin's Q ratio as a proxy for firm value in this study refers to previous studies, including Baffour Gyau *et al.* (2024) and Rahmanita (2020) ^[7, 31]. The formula for calculating Tobin's Q is as follows:

$$\text{Tobin's Q} = (\text{Market Capital} + \text{Total Liabilities} + \text{Preferred Equity} + \text{Minority Interest}) / (\text{Total Assets})$$

A higher Tobin's Q ratio indicates that the company is valued more positively by the market because investors perceive the company as possessing superior growth prospects and intangible asset value. Conversely, a lower Tobin's Q ratio indicates that the market valuation of the company is relatively low compared to the replacement cost of its physical assets.

Carbon Emissions Disclosure

Carbon emission disclosure is an independent variable in this study. Carbon emission disclosure is a form of environmental disclosure that reflects information related to carbon emission intensity, energy consumption, emission reduction targets and strategies, as well as potential risks and opportunities arising from climate change. In this study, carbon emission disclosure is measured using a carbon emission disclosure index based on disclosure items adapted from Bae Choi *et al.* (2013) ^[6].

$$\text{CEDit} = \frac{\sum \text{CED}_{it}}{\text{CED}_{\text{Max}}}$$

The process of calculating the carbon emission disclosure index is carried out by assigning a score to each item disclosed by the company. Each disclosed item is assigned a value of 1, such that the maximum score attainable is 18 points, while the minimum score is 0. Subsequently, the total score obtained by the company is divided by the total number of disclosure items, which is 18. A higher index value indicates that the company has a higher level of transparency in disclosing carbon emission information.

Financial Performance

Financial performance is an independent variable in this study. Financial performance represents an overview of the ability and achievements of a company in managing its assets, liabilities, equity, revenues, and profit over a given period. In this study, financial performance is measured using the Return on Assets (ROA) ratio, as it is capable of indicating the extent to which a company can utilize its assets to generate profit.

$$\text{Return On Assets} = \frac{\text{Net Income After Tax}}{\text{Total Assets}}$$

The higher the ROA, the more effectively management deploys its assets to generate returns, while a lower ROA suggests suboptimal asset utilization.

Environmental Performance

Environmental performance is the moderating variable in this study. Environmental performance represents the ability and achievement of a company in controlling the impacts arising from its operational activities on environmental

conditions. Environmental performance in this study is proxied using the PROPER rating, assessed by calculating an ordinal scale ranging from 1 to 5 for each color rating. The PROPER rating system consists of five color categories, as follows:

Table 1: PROPER Ranking

Ranking	Description	Score
Gold	Excellent	5
Green	Very Good	4
Blue	Good	3
Red	Poor	2
Black	Very Poor	1

A higher PROPER score indicates that the company is more effective in managing its environmental impacts and achieving ecological compliance, while a lower PROPER score indicates lower efficiency and commitment in corporate environmental management.

Analysis Method

The data analysis process in this study was conducted using a quantitative approach with panel data regression analysis. This method was selected to examine the extent to which carbon emission disclosure and financial performance influence firm value, with environmental performance serving as a moderating variable. The independent variables in this study were carbon emission disclosure and financial performance, while the dependent variable was firm value and the moderating variable was environmental performance.

Data processing was performed using E-Views software version 14 to obtain the necessary statistical analysis results. The analysis methods employed in this study included descriptive statistical analysis, regression model selection tests, classical assumption tests, moderated regression analysis, and hypotheses testing. The research model in this study can be formulated in the following regression equations:

$$Y = \alpha + \beta_1.X_1 + \beta_2.X_2 + \beta_3(X_1*Z) + \beta_4(X_2*Z) + e$$

Explanation:

Y = Firm Value

α = Constant

β = Regression coefficient for each independent variable

X₁ = Carbon Emissions Disclosure

X₂ = Financial Performance

Z = Environmental Performance

e = Error

This equation is employed to investigate the effects of carbon emission disclosure, financial performance, and environmental performance on firm value. Moderated Regression Analysis (MRA) test is further employed to evaluate the moderating role of environmental performance in the relationship between carbon emission disclosure, financial performance, and firm value.

Hypotheses Test

Hypothesis testing is conducted as a subsequent stage after the regression model has been declared valid and satisfies all predetermined statistical requirements. Hypothesis testing aims to verify the validity of assumptions formulated

at the initial stage of the study, while simultaneously measuring the extent to which the independent variables influence the dependent variable both partially and simultaneously. The types of tests employed in this study include the Coefficient of Determination Test (R^2), the Simultaneous Significance Test (F-Statistic), and the Partial Test (t-Statistic).

Research Results and Discussion Description of Research Objects

This study employs quantitative secondary data in the form of annual reports and sustainability reports obtained from the official website of the companies and also Bloomberg Terminal. Additional data were collected through various relevant supporting scientific publications. The research population encompasses all basic materials sector companies listed on the Indonesia Stock Exchange during the 2021–2024 ^[7] period. The final sample was determined using the purposive sampling method based on specific predetermined criteria. The sample selection stages in this study are outlined as follows:

Table 2: Research Sample

No.	Sample Criteria	Number
1.	Basic materials sector companies listed on the IDX during the 2021–2024 ^[7] period.	113
2.	Basic materials sector companies registered as PROPER participants during the 2021–2024 ^[7] period.	(51)
3.	Basic materials sector companies that consistently published annual reports and sustainability reports for four consecutive years on the IDX during the 2021–2024 ^[7] period.	(33)
Number of companies eligible for the study		29
Number of research samples (29 companies x 4 years)		116
Number of data outliers (3 companies x 4 years)		(12)
Number of samples examined (26 companies x 4 years)		104

Descriptive Statistics

Table 3: Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
TBSQ	104	0,000600	1,580800	0,313192	0,262788
CED	104	0,330000	0,830000	0,620000	0,080472
ROA	104	-0,148300	0,199400	0,039451	0,063977
EP	104	2,000000	5,000000	3,192308	0,558725
Valid N (listwise)	104				

Source: Output E-Views 14, 2026

Based on the descriptive statistics table, the firm value variable proxied by Tobin's Q has a minimum value of 0.000600. This value indicates the presence of companies with market valuations below their asset book value. The maximum value of Tobin's Q in this study is 1.580800, which reflects a very high market appreciation for certain companies. The average value of this variable is 0.313192, confirming that the majority of the sample has a market value below its net asset value. Meanwhile, the standard deviation of 0.262788, which is smaller than the mean, indicates that the distribution of Tobin's Q data is homogeneous, or does not exhibit extreme variability. The carbon emission disclosure variable, proxied by CED, recorded a minimum value of 0.330000 and a maximum

value of 0.830000, indicating that the sample's transparency level ranges between 33% and 83% of the total indicators. The mean value of 0.620000 demonstrates that basic materials sector issuers have generally fulfilled 62% of the expected carbon emission reporting standards. Meanwhile, the standard deviation of 0.080472, which is smaller than the mean, confirms that the distribution of CED data is homogeneous among the observed entities. For the financial performance variable proxied by ROA, the minimum value was recorded at -0.148300 and the maximum at 0.199400, reflecting a performance range from the largest profit deficit to the highest efficiency in asset utilization. The mean ROA value of 0.039451 indicates that the general profitability of the sample companies is at an asset return rate of 3.9%. Lastly, the standard deviation of 0.063977 suggests that the variation in profitability achievement among companies within this sector tends to be normal and stable.

The environmental performance (EP) variable, proxied by PROPER, recorded a minimum value of 2.000000 and a maximum value of 5.000000. The minimum value indicates that there are sample companies positioned at the "Red" rating, while the maximum value reflects the achievement of the "Gold" rating, representing absolute excellence in environmental management. The mean value of 3.192308 confirms that the majority of issuers are generally positioned at the 'Blue' rating, signifying compliance with environmental regulations. Meanwhile, the standard deviation of 0.558725, which is smaller than the mean, indicates that the distribution of EP data tends to be homogeneous among the sample entities.

Regression Model Selection Tests

Chow Test

The Chow test is conducted to compare the Common Effect Model (CEM) and the Fixed Effect Model (FEM) in order to determine which model is most appropriate for estimating the research data. The decision-making criterion in this test is if the probability value of the Cross-section Chi-square is less than 0.05, the selected model is FEM. Conversely, if the probability value exceeds 0.05, the selected model is CEM. The results of the Chow test are presented in Table 4:

Table 4: Results of Chow Test

Model Selection Test	Probability (Cross-section Chi Square)	Selected Model
Chow Test	0,0000	Fixed Effect Model

Source: Output E-Views 14, 2026

Based on the test results presented in Table 4, the probability value for the Cross-section Chi-square is 0.0000. Since this probability value is well below the 0.05 significance threshold ($0.0000 < 0.05$), therefore H_0 is rejected and H_1 is accepted. This indicates that the Fixed Effect Model (FEM) provides a more appropriate estimation for the panel data analysis.

Hausman Test

The Hausman test is employed to select between the Fixed Effect Model (FEM) and the Random Effect Model (REM) based on the Cross-section random probability value. If the probability value exceeds 0.05, REM is selected as the preferred model. Conversely, if the probability value falls below 0.05, FEM is determined as the most appropriate model. The complete test results are presented in Table 5:

Table 5: Results of Hausman Test

Model Selection Test	Probability (Cross-section random)	Selected Model
Hausman Test	0,0000	Fixed Effect Model

Source: Output E-Views 14, 2026

Based on Table 5, the Cross-section random probability value obtained is 0.0000, which falls below the 0.05 significance threshold. Consequently, H_0 , which states that the model follows REM, is rejected, while H_1 , which states that the model follows FEM, is accepted. This indicates that the Fixed Effect Model (FEM) provides a more appropriate estimation.

Lagrange Multiplier Test

The Lagrange Multiplier (LM) test is employed to select between the Common Effect Model (CEM) and the Random Effect Model (REM) based on the Breusch-Pagan significance value. If the probability value falls below 0.05, REM is selected as the preferred model; conversely, if it exceeds 0.05, CEM is deemed more appropriate. The test results are presented in Table 6:

Table 6: Results of Lagrange Multiplier Test

Model Selection Test	Probability (Cross-section Breusch-Pagan)	Selected Model
Lagrange Multiplier Test	0,0000	Random Effect Model

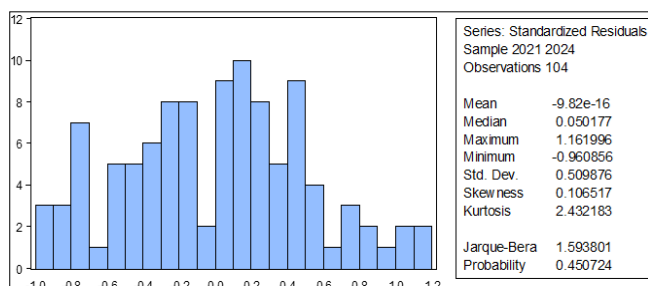
Source: Output E-Views 14, 2026

Based on the test results that presented in Table 6, the Breusch-Pagan probability value is recorded at 0.0000. Since this value falls below the 0.05 significance level ($0.0000 < 0.05$), REM is theoretically superior to CEM. However, given that both the Chow test and Hausman test consistently selected the Fixed Effect Model, FEM is maintained as the most appropriate model for estimation in this study

Classical Assumption Tests

Normality Test

The normality test results presented in Image 2. The Jarque-Bera test produces a value of 1.593801 with a probability value of 0.450724, which exceeds the 0.05 significance level. This indicates that the residual data are normally distributed, confirming that the regression model satisfies the normality assumption and is suitable for subsequent analysis.



Source: Output E-Views 14, 2026

Fig 2: Results of the Jarque-Bera Test

Multicollinearity Test

The multicollinearity test in this study employs the correlation matrix test. Based on the results of the correlation matrix test presented in Table 7, the correlation values among the independent variables range between -0.066277 until 0.181384. This regression model does not exhibit multicollinearity issues, as all correlation coefficients fall well below the threshold of 0.80. Therefore, all variables can be combined for the estimation of the research model.

Table 7: Results of Correlation Matrix Test

	CED	ROA	EP
CED	1.000000	0,014611	0,181384
ROA	0,014611	1.000000	-0,066277
EP	0,181384	-0,066277	1.000000

Source: Output E-Views 14, 2026

Heteroscedasticity Test

The heteroscedasticity test in this study employs the Glejser test. Based on the results presented in Table 8, the probability value for the carbon emission disclosure (CED) variable is 0.5362, while the financial performance (ROA) variable shows a probability value of 0.7120. Furthermore, the interaction variable between carbon emissions and environmental performance (CEDXEP) shows a probability value of 0.6415, and the interaction between financial performance and environmental performance (ROAXEP) stands at 0.8063. Because all variables exhibit probability values well above the 0.05 significance level, the model satisfies the homoscedasticity assumption, confirming its validity for subsequent regression analysis.

Table 8: Results of Glejser Test

Variable	Prob. Value
CED	0,5362
ROA	0,7120
CEDXEP	0,6415
ROAXEP	0,8063

Source: Output E-Views 14, 2026

Autocorrelation Test

The autocorrelation test in this study was conducted using the Durbin-Watson test, where a model is free from autocorrelation if it satisfies the condition $dU < DW < 4 - dU$. Based on the results in Table 9, the Durbin-Watson statistic (DW) is 1.886738. Comparing this with the Durbin-Watson table at a 5% significance level for 104 observations ($n = 104$) and 5 independent variables ($k = 5$) yields a dU value of 1.7823. Because the calculated DW falls within the required range ($1.7823 < 1.886738 < 2.2177$), the regression model is free from autocorrelation and satisfies the classical assumption for subsequent hypothesis testing.

Table 9: Results of Durbin-Watson Test

Durbin-Watson Test	
Durbin-Watson stat	1,886738

Source: Output E-Views 14, 2026

Moderated Regression Analysis

Moderated Regression Analysis (MRA) is a specific type of multiple linear regression that includes an interaction term representing the multiplication of two or more independent variables (Sumiyati, 2017) [35]. MRA is used to determine

whether the moderating variable strengthens or weakens the relationship between the independent and dependent variables (Ghozali, 2018) ^[20]. In this study, the MRA model tests the effects of carbon emission disclosure and financial performance on firm value, with environmental performance acting as the moderating variable. The MRA outputs are presented in Table 10:

Table 10: Results of Moderated Regression Analysis Test

Variable	Coefficient	Std. Error	t-statistics	Prob.
C	-3,026670	0,875881	-3,455574	0,0009
CED	5,193561	1,422443	3,651155	0,0005
ROA	5,081470	1,475491	3,443918	0,0010
EP	-0,247107	0,261842	-0,943726	0,3484
CEDXEP	0,293605	0,437301	0,671403	0,5041
ROAXEP	-1,511887	0,464888	-3,267214	0,0017

Source: Output E-Views 14, 2026

Based on the estimation results in Table 7, utilizing the selected Fixed Effect Model (FEM), the regression equation is formulated as follows:

$$Y = -3.0266699941 + 5.19356141822 * CED + 5.08147010746 * ROA - 0.247107498737 * EP + 0.293605136831 * CEDXEP - 1.51188708449 * ROAXEP$$

Hypotheses Testing

Coefficient of Determination Test

The coefficient of determination (R^2) test measures the capability of a regression model to explain the overall influence of the independent, moderating, and interaction variables on the dependent variable (Ghozali, 2018) ^[20]. In this study, the test relies on the Adjusted R-squared value, which ranges from 0 to 1. A value close to 0 indicates that the model has a very weak ability to explain the variation in the dependent variable, whereas a value close to 1 demonstrates that almost all variations in the dependent variable can be explained by the predictors. The results of the coefficient of determination test are presented in Table 11:

Table 11: Results of the Coefficient of Determination Test (R^2)

Effects Specification	Results
R-squared	0,932252
Adjusted R-squared	0,904411

Source: Output E-Views 14, 2026

Based on Table 11, the Adjusted R-squared value is 0.904411. This indicates that the independent variables (CED and ROA), the moderating variable (EP), and their interaction terms (CEDXEP and ROAXEP) collectively explain 90.44% of the variation in the dependent variable, firm value (Tobin's Q). The remaining 9.56% is explained by other variables outside the scope of this research model.

F-test

The F-statistic test is fundamentally conducted to determine whether all independent, moderating, and interaction variables included in the research model exert a simultaneous influence on the dependent variable (Ghozali, 2018) ^[20]. In this study, the F-test evaluates whether carbon emission disclosure and financial performance, with environmental performance acting as a moderating variable,

simultaneously affect firm value. The results of the simultaneous F-statistic test are presented in Table 12:

Table 12: Simultaneous Significance Test (F-Statistic Test)

Effects Specification	Results
F-statistic	33,48428
Prob(F-statistic)	0,000000

Source: Output E-Views 14, 2026

Based on Table 12, the F-statistic value is 33.48428 with a probability value (Prob F-statistic) of 0.0000. Because the significance level is well below the 0.05 threshold, it can be concluded that carbon emission disclosure, financial performance, environmental performance, and their interaction terms simultaneously exert a significant influence on firm value.

t-test

The t-test examines the partial effect of each independent variable on the dependent variable.

Table 13: Partial Significance Test (t-test)

Variable	t-statistic	Prob.
CED	3,651155	0,0005
ROA	3,443918	0,0010
CEDXEP	0,671403	0,5041
ROAXEP	-3,267214	0,0017

Source: Output E-Views 14, 2026

The test results presented in Table 13 reveal the following findings:

1. Carbon Emission Disclosure (CED) has a significance value of 0.0005 ($0.0005 < 0.05$), a t-value of 3.651155, and a coefficient value of 5.193561. This indicates that carbon emission disclosure has a significant positive effect on firm value, meaning that higher levels of carbon emission disclosure are associated with higher firm value.
2. Financial Performance (ROA) has a significance value of 0.0010 ($0.0010 < 0.05$), a t-value of 3.443918, and a coefficient value of 5.081470. The positive coefficient indicates that an increase in profitability is associated with an increase in firm value. Therefore, financial performance has a significant positive effect on firm value.
3. The interaction variable between carbon emission disclosure and environmental performance (CEDXEP) has a significance value of 0.5041 ($0.5041 > 0.05$), a t-value of 0.6714, and a coefficient value of 0.293605. Since the significance value exceeds the 0.05 threshold, it can be concluded that environmental performance is unable to significantly moderate the effect of carbon emission disclosure on firm value.
4. The interaction variable between financial performance and environmental performance (ROAXEP) has a significance value of 0.0017 ($0.0017 < 0.05$), a t-value of -3.267214, and a coefficient value of -1.511887. The significance value falling below the 0.05 threshold confirms that environmental performance is able to significantly moderate the effect of financial performance on firm value on a partial basis, with the negative coefficient indicating a weakening direction of the relationship.

Interpretation of Results

The Effect of Carbon Emission Disclosure on Firm Value

The first hypothesis, which states that carbon emission disclosure has a significant positive effect on firm value in the basic materials sector during the 2021–2024^[7, 21] period, is accepted. Carbon emission disclosure presented in sustainability and/or annual reports receives positive responses from the public, thereby enhancing corporate image. Clear information regarding carbon footprint provides external parties with greater certainty in recognizing the long-term benefits of corporate sustainability. Thus, carbon emission disclosure is a significant factor that positively contributes to firm value in the Indonesian basic materials sector during the 2021–2024^[7, 21] period.

This finding is consistent with Legitimacy Theory, which posits that companies continuously strive to obtain societal legitimacy by aligning their activities with prevailing social norms and values (Dowling & Pfeffer, 1975)^[13]. This result is further supported by Hardiyansah & Agustini (2021)^[21] who found that carbon emission disclosure has a significant positive impact on firm value, as such disclosure is regarded as a crucial instrument for maintaining stakeholder confidence. Consequently, investors are more willing to invest in such companies, driving share demand upward and ultimately leading to an increase in firm value.

The Effect of Financial Performance on Firm Value

Based on the test results, financial performance has a significant positive effect on firm value, thus the second hypothesis is accepted. An increase in ROA provides a strong indication of the high rate of return to be received by investors, thereby attracting them to purchase shares and generating higher returns for shareholders. The resulting increase in share prices and market prices subsequently influences firm value.

This finding is consistent with Signaling Theory, which highlights the role of high-quality information in reducing information asymmetry between management and investors. According to Bruns Jr (1968)^[10], information acts as a signal that shapes investors' cognitive reasoning by communicating a company's financial condition, prospects, and management accountability. In this context, high profitability serves as a positive signal reflecting financial stability and long-term sustainability, which in turn stimulates investor interest and enhances firm value as measured by Tobin's Q.

This is further supported by Mariani & Suryani (2018), who found that financial performance positively and significantly affects firm value, as a company's ability to generate profit signals efficient asset management, ultimately driving share demand and firm value upward. Therefore, financial performance proxied by ROA has a significant positive effect on firm value.

The Role of Environmental Performance in Moderating the Effect of Carbon Emissions Disclosure on Firm Value

Based on the test results, environmental performance is unable to moderate the relationship between carbon emission disclosure and firm value, indicating that the third hypothesis is rejected. This suggests that whether a company achieves a high or low PROPER rating does not

moderate the effect of carbon emission disclosure on market appreciation of firm value. The findings of this study indicate that environmental performance does not play a significant role in strengthening the relationship between carbon emission disclosure and firm value. This implies that investors tend to regard carbon emission disclosure as standalone information that is sufficiently robust to convey a company's environmental responsibility, without necessarily relying on environmental performance assessments reflected in PROPER ratings.

Signaling Theory suggests that environmental performance acts as a signal enhancer of carbon emission disclosure, thereby moderating its effect on firm value proxied by Tobin's Q, this study's results do not support such a moderating role. This finding is consistent with Damas *et al.* (2021) and Anggraeni (2015)^[2, 11], who concluded that environmental performance does not possess the ability to moderate the relationship between carbon emission disclosure and firm value. This may be attributed to the fact that PROPER ratings do not comprehensively reflect environmental performance, and therefore fail to strengthen the positive relationship between carbon emission disclosure and firm value (Anggraeni, 2015)^[2].

The Role of Environmental Performance in Moderating the Effect of Financial Performance on Firm Value

The test of the fourth hypothesis demonstrates that environmental performance significantly moderates the relationship between financial performance and firm value. The recorded regression coefficient of -1.51887 indicates that environmental performance significantly weakens the positive relationship between financial performance and firm value in the basic materials sector during the 2021–2024^[7, 21] period. Thus, despite achieving strong financial performance, superior environmental performance does not strengthen but rather diminishes market responses in the form of firm value appreciation.

This finding suggests that environmental performance weakens the positive impact of financial performance on firm value. Despite generating substantial profit, companies that actively pursue high PROPER ratings are perceived by the market as incurring additional operational costs, which offsets the positive effect of profitability. From a Signaling Theory perspective, the significant investment required for superior environmental performance is interpreted by market participants as a short-term financial burden rather than a value-enhancing factor.

This is consistent with Mariani & Suryani (2018), who found that environmental performance does not strengthen the relationship between financial performance and firm value, as high PROPER rating costs are often viewed as a burden by investors. Therefore, environmental performance weakens rather than strengthens the relationship between financial performance and firm value in the basic materials sector.

Conclusion and Limitations

Conclusion

This study examined the moderating role of environmental performance on the effect of carbon emission disclosure and financial performance on firm value in basic materials sector companies listed on the Indonesia Stock Exchange during the 2021–2024^[7] period. The following conclusions are drawn:

1. Carbon emission disclosure has a positive and significant effect on firm value. This indicates that companies with higher levels of carbon emission transparency tend to receive more positive responses from the market, reflecting their commitment to environmental sustainability.
2. Financial performance has a positive and significant effect on firm value. This shows that companies with higher profitability levels are perceived by investors as operationally efficient with promising future prospects, thereby driving an increase in firm value.
3. Environmental performance does not significantly moderate the relationship between carbon emission disclosure and firm value. This indicates that a company's PROPER rating does not alter investors' assessment of the positive impact of carbon emission disclosure on firm value.
4. Environmental performance significantly moderates the relationship between financial performance and firm value in a weakening direction. This suggests that substantial investment required to achieve superior environmental performance is perceived by the market as an additional cost burden, thereby reducing the positive impact of profitability on firm value in the basic materials sector.

Limitations

This study has several limitations that should be considered in future research in order to obtain more comprehensive results, including the following:

1. Many basic materials sector companies in Indonesia have not yet published separate sustainability reports, particularly during the 2021 and 2022 ^[3] observation years.
2. Many basic materials sector companies have not fully disclosed all 18 carbon emission disclosure assessment indicator items in either their annual reports or sustainability reports.
3. Many basic materials sector companies have not registered for or consistently participated in the PROPER program throughout the 2021–2024 ^[7] period.

Suggestions

This study has several recommendations that may serve as references for future research, including the following:

1. Basic materials sector companies, particularly those listed on the IDX, should consistently publish sustainability reports on an annual basis, given that such reports have become a recognized sustainability reporting standard both nationally and internationally in assessing corporate non-financial responsibility.
2. Basic materials sector companies, particularly those listed on the IDX, should disclose all carbon emission assessment indicator items in a complete, clear, and detailed manner to prevent information asymmetry between management and stakeholders.
3. Basic materials sector companies, particularly those listed on the IDX, should improve their compliance with applicable environmental regulations in Indonesia by actively and consistently participating in the PROPER program.
4. Future research is recommended to expand or adopt alternative measurement proxies beyond the 18 assessment indicator items adapted from Choi *et al.*

(2013) ^[6], in order to provide a more current and comprehensive picture of carbon emission information transparency and its impact on firm value.

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