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Leveraging Sustainability: How Firm Size Shapes the Value-Creating Effects of Carbon Emission Disclosure and Environmental Performance on Firm Value

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ABSTRACT: As the severity of global warming escalates, investors increasingly favor firms demonstrating strong environmental responsibility, underscoring the growing importance of sustainability in capital market decisions. This study examines the effect of carbon emission disclosure and environmental performance on firm value, considering firm size as an interaction factor within IDX-listed energy firms during the 2019–2024 period. This study utilizes longitudinal secondary datasets sourced from audited financial disclosures and corporate sustainability reports. The sample consists of 11 energy companies selected through purposive sampling. Carbon emission disclosure is measured using the GRI 305 index. Environmental performance is proxied by PROPER ratings. Firm value is calculated by price-to-book value (PBV), and the natural logarithm of total assets represents firm size. Data were analyzed using panel data regression and Moderated Regression Analysis (MRA). The results indicate that carbon emission disclosure does not significantly affect firm value. Environmental performance, however, shows a negative influence on corporate valuation. Furthermore, firm size does not moderate the relationship between carbon emission disclosure and firm value, but it significantly moderates the relationship between environmental performance and firm value. These findings indicate that environmental performance is generally perceived by the market as a cost-intensive activity, exerting a negative effect on firm value, particularly for smaller firms. However, the positive interaction between environmental performance and firm size suggests that larger firms can leverage their scale to translate environmental efforts into relatively greater value creation, highlighting the importance of aligning sustainability strategies with firm size for long-term value.

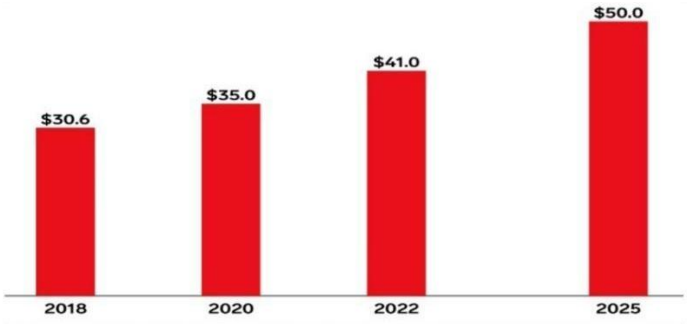
Keywords : Firm Value, Carbon Emission Disclosure, Environmental Performance, Firm Size, Energy Sector.

INTRODUCTION

Firm value is part of a fundamental indicator used to measure the extent of the firm's management performance, which can create prosperity for shareholders, expand access to funding, and maintain

the company's image in public perception and with investors. Companies tend to continue to strive to stay ahead of the competition by implementing various strategies in line with their core goal, which is to maximize their value (Hasanah & Paramita, 2025). Firm value represents more than the financial strength reported in the balance sheet; it also embodies market expectations regarding growth prospects, operational efficiency, and management's capability to handle dynamic business risks (Brigham & Houston, 2021). In the past decade, according to a Reuters 2024 report, investors have a fiduciary duty to analyze and act on climate risks, since they go beyond social and environmental concerns and are increasingly considered relevant to corporate stability and valuation of companies. This condition is represented in the Sustainable Development Goals (SDGs). The 13th point is action on climate change. Global warming occurs due to an increase in atmospheric greenhouse gases, specifically carbon dioxide (CO_2), which causes changes in the Earth's temperature.

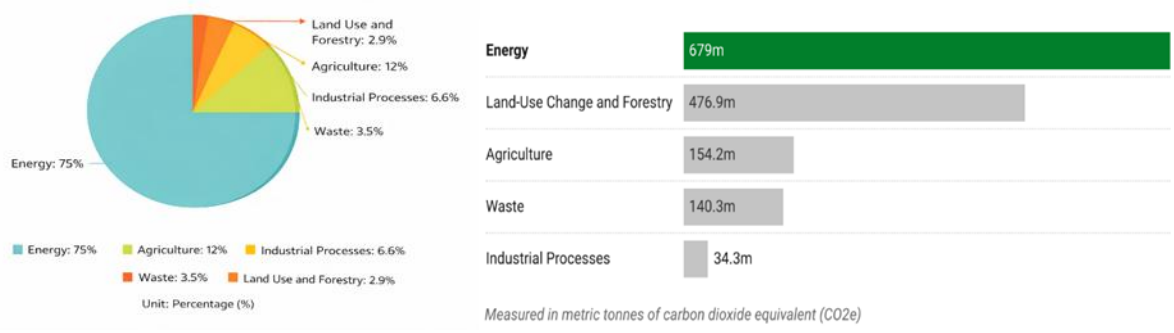
Figure 1. Growth of Environmental, Social, and Governance (ESG) Assets Managed Worldwide



Source: Bloomberg, 2022

Globally, the shift in investor preferences is reflected in the continued increase in Environmental, Social, and Governance (ESG)-based assets. This phenomenon reflects a shift in global investors' preferences toward sustainability-focused investments, driven by increasing regulations, stakeholder pressure, and market demand for corporations that are capable of handling social and environmental problems.

Figure 2. Proportion of Global Greenhouse Gas Emissions by Sector and Greenhouse Gas Emissions by Sector in Indonesia

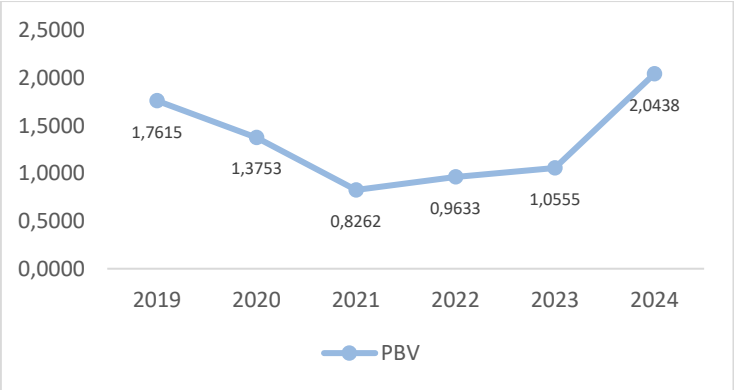


Source: databoks.katadata.co.id, 2020, and Climate Watch, 2021

This increase in investor interest occurs in line with regulatory and social pressures on firms that are considered to have a substantial effect on the environment. Among all industrial sectors, the energy sector is the primary focus because it is the main source of emissions of greenhouse gas (GHG) globally and nationally. Dependence on fossil fuels, low penetration of renewable energy, and rising energy demand make this sector the most significant contributor to total emissions. Given the large share of emissions they generate, companies in the energy sector face greater regulatory pressure to reduce carbon emissions and implement clean energy transition policies. This pushes corporations to be more open about their carbon-emission reporting through disclosure and to enhance their environmental performance to meet the sustainability demands of regulatory bodies, investors, and the general public.

Given the dominant contribution of the energy sector to greenhouse gas emissions in Indonesia, a more sector-specific analysis becomes particularly relevant. While prior ESG-related studies in Indonesia have offered valuable insights, most of them examine mixed industrial sectors and apply heterogeneous measurement approaches, resulting in limited evidence for carbon-intensive industries. Addressing this gap, the present study focuses on energy-sector firms, which face unique regulatory pressures such as the 2022 coal export ban and clean energy transition mandates alongside high fossil fuel dependence; this setting provides a distinct context for testing ESG impacts unlike prior multi-sector analyses. The study covers the 2019–2024 period, chosen to capture full sustainability disclosure implementation starting 2019, post-pandemic recovery, and sector-specific regulatory shifts. Carbon emission disclosure is measured using the GRI 305 standard, environmental performance is proxied by the government-based PROPER rating, and firm size is examined as a moderating variable through an interaction-term approach.

Figure 3. Average Firm value (PBV) Chart in Energy Sector Companies 2019-2024



Source: www.idx.co.id data reprocessed, 2025

Figure 3 shows that, during the 2019-2024 period, the overall energy sector PBV declined from 2019 until reaching its lowest point in 2021. However, the trend reversed with a sharp increase in 2024, when the PBV jumped by approximately 93.64% relative to the previous year. During the period of decline, there were several years, specifically 2021 and 2022, during which the PBV was below 1, indicating undervaluation; the market valuation of the stock was below its recorded book value.

2021 is still affected by the post-pandemic recovery, when industrial and business electricity consumption and fuel sales have not returned to normal levels, which coincided with lower investor expectations regarding the performance of energy companies. The Ministry of Energy and Mineral Resources reported that electricity usage from the industrial and business sectors is still below pre-pandemic levels, while fuel sales have also not returned to normal due to the slow recovery of mobility. This condition coincided with weaker investor expectations, which may have been associated with lower market valuations in the energy sector. Meanwhile, undervaluation in 2022 coincided with the implementation of the coal export ban and heightened regulatory uncertainty, which may have contributed to more cautious market perceptions regarding future cash flows and policy stability. Although global coal prices rose in mid-2022, markets remain cautious amid high uncertainty over energy policy and the risk of government intervention, so the energy sector's valuation has not fully recovered. Given the observational nature of the data, these interpretations should be understood as associations rather than causal effects.

The increase in CED is an integral part of corporate sustainability reporting that is increasingly attracting the attention of investors and stakeholders. Based on signal theory, disclosing information about environmental aspects, such as CED, sends a favorable indication to the market, reflecting the firm's dedication to sustainable, transparent business practices. This signal may shape investors' perceptions of the firm's long-term outlook, and are often associated with stock price movements. Some previous investigation carried out by (Hardiyansah et al., 2021), (Budiman et al., 2024), and (Putri & Paramita, 2025) conclude that the carbon emissions disclosure affects the firm's value. However, these results are inconsistent with those of (Asyifa & Burhany, 2022) and (Kurnia et al., 2021), who found that this CED has no direct effect on firm value.

Firms exhibiting strong environmental performance tend to attract investors, as they see the potential for greater sustainability and corporate accountability toward society, consistent with stakeholder-oriented perspectives that maintain that the firm needs to offer benefits to all parties involved. The better the company performs in environmental terms, the greater the market's confidence in its performance and prospects (Ani, 2021). Studies conducted by (Daromes et al., 2020) demonstrates that ecological outcomes substantially shape corporate valuation and research carried out by (Paramita & Ali, 2023) Also asserts that PROPER was used as a proxy for green investment, exerts a positive impact on the firm value, which supports the argument that companies committed to sustainability can increase their attractiveness among investors. However, these findings contradict those of (Widagdo et al., 2023) and (Sitorus, 2024), who determined that environmental performance doesn't significantly influence the firm value.

Furthermore, besides carbon emissions disclosure and environmental performance, several other factors can strengthen or weaken the company's value, namely, firm size. Firm size can be reflected in various measures; one indicator is the size of its total assets (Anto, 2021). Theoretically, the bigger the corporation, the more public spotlight it receives. A large company's size generally have greater access to secure financing, which management can employ to boost the firm's value (Aspari & Ramli, 2024). This condition encourages large-scale companies to disclose information regarding their carbon emissions and environmental performance as an effort to maintain social legitimacy, thereby positively affecting market perception and ultimately increasing the firm value

(Wahyuningrum et al., 2025). Consistent with research by (Ericho & Amin, 2024) firm size is found to strengthen the association between the performance of the environment and the disclosure of carbon emissions and firm value, and (Sitorus, 2024) further reveals that firm size significantly moderates this association.

Despite the growing emphasis on sustainability and ESG-oriented investment, the firm value of energy sector companies, as measured by Price to Book Value (PBV), experienced a pronounced decline and remained in an undervalued condition during the 2021–2022 period. This downward trend reflects weakened market confidence amid post-pandemic uncertainty, regulatory intervention in the energy market, and rising compliance costs related to carbon reduction and environmental standards. Limited transparency in carbon emission disclosure and uneven environmental performance may have intensified investors' perceptions of long-term risk, resulting in discounted market valuations. Moreover, prior empirical studies provide inconsistent evidence regarding the influence of carbon emission disclosure and environmental performance on firm value, particularly with respect to the moderating role of firm size. These unresolved inconsistencies highlight a critical research gap and underscore the necessity of further investigation to clarify how sustainability-related practices affect firm value in Indonesia's energy sector, which faces significant transition and regulatory pressures.

Signalling Theory

Signal theory posits that parties holding more information (such as management or companies) will provide signals by disclosing certain information to reduce information asymmetry and influence outsiders' perceptions, such as investors or creditors (Kim et al., 2021; Spence, 1973; Yahaya, 2025).

Legitimacy Theory

Legitimacy theory explains that organizations seek to guarantee that their actions are deemed in line with the values and social norms that apply to the broader community, so that reporting, including environmental disclosures, is used as a means to acquire, maintain, or restore legitimacy from stakeholders (Fuadah et al., 2018; Suchman, 1995; Yahaya, 2025). However, if businesses fail to meet these expectations, the public's trust will suffer, which will have an impact on the business's performance (Triana & Simatupang, 2025).

Stakeholder Theory

Stakeholder theory affirms that the company has a responsibility to manage relationships with various parties that may be influenced or influenced by its activities, such as shareholders, employees, customers, communities, and regulators, in order to create shared value and increase

transparency to support long-term sustainability (Freeman & McVea, 1984; Fuadah et al., 2018; Yahaya, 2025).

Firm Value

A firm value is a market view of the corporation's capability to create value and sustain profitability, reflected in its performance and prospects (Brigham & Houston, 2021; Mulyana & Saputra, 2018; Satria & Widyawati, 2023). A firm's value is measured by its stock price, which reflects investors' assessment of its asset management capabilities. The increase in firm value indicates enhanced welfare of shareholders, along with strengthened investor trust in corporate outcomes and future potential (Safitri & Paramita, 2025). In this study, price-to-book value (PBV) was employed to measure firm value by comparing a company's market valuation per share with its corresponding book value (Brigham & Houston, 2021).

Interpretively, a PBV > 1 indicates a positive market appreciation of the business's potential; PBV = 1 reflects a market valuation commensurate with the book value; while a PBV < 1 indicates an undervalued condition reflecting the market's negative perceived outlook of the firm. Thus, a higher PBV reflects growing investor confidence in the firm's capacity to generate future value. The PBV formula is:

$$PBV = \frac{Market\ Price\ per\ Share}{Book\ Value\ per\ Share}$$

Carbon Emission Disclosure

Emissions transparency constitutes a form of sustainability-oriented reporting practice regarding carbon emissions produced, either voluntary or mandatory, which functions as a form of environmental responsibility, an instrument for evaluating emission levels and their reduction targets, as well as a means of corporate accountability to stakeholders in the context of sustainability (Daromes et al., 2020; Hardiyansah & Agustini, 2021; Simamora et al., 2022). In this study, carbon emissions disclosure was measured following guidance established by the Global Reporting Initiative framework, an internationally recognised reporting standard that evaluates the company's economic, social, and environmental impact and promotes transparent and sustainable business practices (Gutama & Sisdianto, 2024). The standard used is GRI-305 because it is the primary indicator of carbon emission disclosure, is applicable across all industrial sectors, and can be applied to all industrial sectors (Budiman et al., 2024). With the following formula:

Table 1. List Item GRI 305

No.	GRI 305	Scope
1	305-1	Direct GHG emissions (Scope 1)
2	305-2	Indirect GHG energy emissions (Scope 2)
3	305-3	Other indirect GHG emissions (Scope 3)
4	305-4	GHG emission intensity
5	305-5	Reduction of GHG emissions
6	305-6	Ozone-depleting substances (ODS) emissions
7	305-7	Nitrogen Oxides (NOX), sulfur oxides (SOX), and other significant air emissions

Source: (Budiman et al., 2024)

Therefore, the formula for disclosing carbon emissions applied in this research is prepared based on this approach.

$$CED = \left(\frac{\Sigma di}{M}\right) x\ 100\%$$

Description:
Σdi = The total number of scores of 1 acquired by the company
M = The maximum number of indicators that can be reported

Environmental Performance

Environmental performance refers to an evaluation of a firm's ecological conduct realising good and sustainable environmental conditions, which is reflected in the company's tangible efforts in managing its operational effects on the environment, including pollution control, waste management, energy efficiency, and regulatory compliance (Hardiyansah & Agustini, 2021; Ramdani & Nugraha, 2024; Utomo et al., 2020). In this research, the firm's environmental performance was evaluated using the Enterprise PROPER scheme, a governmental environmental evaluation initiative instrument implemented by the Environment and Forestry Ministry to assess compliance levels and encourage companies to pursue environmental innovations beyond compliance (KLHK, 2019). PROPER classifies the company's environmental performance into five colour classifications, consisting of black, red, blue, green, and gold, each of which represents the level of environmental management, ranging from innovation excellence to violations of applicable regulations.

Table 2. PROPER Rating

Color	Peringkat
Gold	5
Green	4
Blue	3
Red	2
Black	1

Source: KLHK, 2024

Firm Size

Firm size is the size or scale of the company that describes the capacity, experience, and risk in managing resources and projects, proxied through total assets, and can influence strategies, practices, and market stakeholder assessments regarding corporate outcomes and worth (Ericho & Amin, 2024; Puspitaningtyas & Ratnawati, 2024; Sitorus, 2024). In research, Firm size is operationalized through the logarithmic transformation of total assets firm size to handle large asset values without altering the proportion of intrinsic value, resulting in more consistent and standardised data (Zafira, 2021). The measurement formula is:

$$Size = Ln\ Total\ Assets$$

The Effect of Carbon Emission Disclosure on Firm Value

From the stakeholder perspective, disclosing carbon emissions is a form of corporate accountability for environmental impacts that can increase market credibility and confidence by reducing information asymmetry (Husnaini et al., 2023). Good disclosure is perceived as a serious environmental risk management effort, thereby triggering investor interest, increasing demand for shares, and driving up stock prices. Assuming the book value is relatively stable in the short term, an increase in stock price will influence the price-to-book value, which serves as a stand-in for (Ginanjar et al., 2023). Therefore, increased reporting of greenhouse gas output is correlated with higher firm value, as proxied by PBV.
H1: Carbon emission disclosure has a positive effect on firm value.

The Effect of Environmental Performance on Firm Value

According to signalling theory, firms with superior environmental performance, as indicated by green or gold PROPER ratings, send positive signals about the effectiveness of environmental management, regulatory compliance, and operational sustainability that are difficult for competitors to imitate (Sutrisno et al., 2024). This signal increases investor confidence, lowers risk perception, and triggers a rise in stock prices, which ultimately increases the firm's value through an increase in PBV (Husnaini et al., 2023). Therefore, optimal environmental performance is predicted to increase the firm value.

H2: Environmental performance has a positive effect on firm value.

The Effect of Carbon Emission Disclosure on Firm Value Moderated by Firm Size

In the context of signalling theory, firm size is essential to reinforcing the effect of emissions transparency on corporate valuation, as large corporations typically have higher financial resources, technology, and managerial capacity to generate, manage, and communicate environmental information in detail and credibly. When large companies make carbon emission disclosures, the market considers them not just symbolic but a strong signal of sustainability commitment supported by real operational capabilities. This condition strengthens investor confidence and improves perceptions of long-term prospects, leading to higher share prices and, ultimately, an increase in the price-to-book value. Therefore, the larger the firm, the more the effect of emissions transparency intensifies in moderating firm value.
H3: Firm size moderates the effect of carbon emission disclosure on firm value.

The Effect of Environmental Performance on Firm Value Moderated by Firm Size

Company size also moderates the relationship between environmental performance and company value. From the perspective of signal theory, firm size serves as an indicator of a company's growth potential, thereby attracting investors (Utami & Paramita, 2024). Large companies face higher public expectations and have a greater ability to invest in superior environmental practices, such as environmentally friendly technologies, energy efficiency, and certified waste management systems. The market perceives good environmental performance in large companies as a more credible signal than small companies, because large companies are considered able to maintain environmental quality consistently and measurably. This increases investor confidence, reduces risk perceptions, and encourages market appreciation, as reflected in the increase in PBV. Therefore, firm size strengthens the effect of environmental performance on firm value, indicating that sustainability outcomes are perceived as more credible signals when disclosed by larger firms.
H4: Firm size moderates the effect between environmental performance on firm value.

METHOD

Research Type

This study employs a quantitative research approach with a causal-explanatory design. The objective is to empirically examine the effect of carbon emission disclosure and environmental performance on firm value, as well as to assess the moderating role of firm size. The analysis is conducted using panel data, which combines cross-sectional data across firms and time-series data over multiple years, enabling a more robust evaluation of both inter-firm differences and temporal dynamics.

Population and Sample/Informants

The population of this study consists of all energy sector companies listed on the Indonesia Stock Exchange (IDX). A purposive sampling technique is applied to select firms that meet specific criteria, including consistent listing status and the availability of complete annual and sustainability reports during the observation period. Based on these criteria, the final sample comprises 11 energy sector companies with complete financial and non-financial data for the 2019–2024 period, forming a balanced panel dataset suitable for econometric analysis.

Research Location

The research is conducted in Indonesia, focusing on publicly listed energy sector firms operating under the regulatory and institutional environment of the Indonesia Stock Exchange.

Instrumentation or Tools

This study utilizes a structured data extraction framework to collect quantitative data from secondary sources. Firm value is measured using the Price-to-Book Value (PBV) ratio derived from financial statements. Carbon emission disclosure is measured using a disclosure index based on the Global Reporting Initiative (GRI) 305 standard, constructed through a binary scoring approach in which each disclosure item is assigned a value of 1 if disclosed and 0 otherwise. A detailed description of the disclosure items and index construction is provided in the variable definition section. Environmental performance is measured using the PROPER rating issued by the Ministry of Environment and Forestry. The ordinal PROPER ratings are transformed into numerical interval values using the Method of Successive Interval (MSI) to allow for parametric analysis. Firm size is measured as the natural logarithm of total assets. Statistical analysis is conducted using econometric software.

Data Collection Procedures

Quantitative data were collected through systematic documentation of secondary sources. Annual reports and sustainability reports are obtained from official company websites and the IDX database.

Data Analysis

Data analysis begins with descriptive statistics to summarize the characteristics and distribution of the variables. Panel data regression analysis is then employed to test the proposed hypotheses. Three alternative models are estimated, namely the Common Effect Model, Fixed Effect Model, and Random Effect Model. The most appropriate model is selected using the Chow test, Hausman

test, and Lagrange Multiplier test. To examine the moderating effect of firm size, Moderated Regression Analysis (MRA) is conducted by incorporating interaction terms between firm size and the independent variables. Classical assumption tests, including tests for multicollinearity and heteroskedasticity are performed to ensure the validity and reliability of the regression results.

RESULT AND DISCUSSION

Statistical Descriptive Analysis

This study uses environmental performance and carbon emissions disclosure as explanatory variables for corporate valuation, incorporating organizational scale as an interaction variable. Before starting the analysis, a descriptive statistical analysis was carried out by the researchers, as presented in the following table:

Table 3. Descriptive Statistical Analysis Results

Variabel	N	Min	Max	Average	Std. Dev
Firm Value	66	0.3555	8.2602	1.3376	1.4415
Carbon Emission Disclosure	66	0.1429	1.0000	0.7641	0.2670
Environmental Performance	66	3.0000	5.5260	4.2938	0.9152
Firm Size	66	29.6406	32.7578	31.3047	0.8324

Source: Data processing results with Eviews 13, 2025

Prior to conducting the hypothesis test, the distributions of each variable were analyzed using descriptive statistics. The mean value of the carbon emission disclosure index is 0.7641, with a standard deviation of 0.2670, indicating a moderate and relatively homogeneous level of disclosure across firms. Meanwhile, the average environmental performance score is 4.2938 on a scale of 1 to 5, indicating that most companies implement appreciable environmental practices. The average PBV for companies is 1.3376, suggesting that companies often trade at prices above their book value. In this study, firm size is measured using the natural logarithm of total assets, which exhibits an average of 31.3047, along with a dispersion level of 0.8324, suggesting the presence of relatively large firms within the energy sector sample.

Panel Data Regression Model Selection Test

Chow Test

Table 4. Chow Test Results

Effect Test	Statistic	d.f.	Prob.
Cross-section F	1.315521	(10,53)	0.2466
Cross-section Chi-square	14.632975	10	0.1460

Source: Data processing results with Eviews 13, 2025

Referring to the previous table, the Chi-square probability value is 0.1460, which exceeds the conventional 0.05 level of significance. Accordingly, the null hypothesis (H0) cannot be rejected, leading to the rejection of the alternative hypothesis (Ha). As a result, the most suitable estimating model is the Common Effect Model (CEM).

LM Test

Table 5. Lagrange Multiplier Test Results

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	0.188284	0.000753	0.189037
	(0.6643)	(0.9781)	(0.6637)

Source: Data processing results with Eviews 13, 2025

Considering the above table, the Breusch–Pagan cross-section test yields a p-value of 0.6643, surpassing conventional significance thresholds. Accordingly, the null hypothesis (H0) is not rejected, whereas the alternative hypothesis (Ha) is rejected. As a result, the model Common Effect Model (CEM) is used.

Classic Assumption Test

Following Basuki (2021), diagnostic tests for multicollinearity and heteroscedasticity are conducted in panel data regression. To address detected heteroscedasticity, robustness of the results was confirmed using White cross-section robust standard errors. The robust estimation produced coefficients consistent in sign and significance with the main model, indicating that the findings are reliable and not sensitive to heteroscedasticity.

Multicollinearity Test

Table 6. Multicollinearity Test Results

	X1_CED	X2_EP
X1_CED	1.000000	0.199872
X2_EP	0.199872	1.000000

Source: Data processing results with Eviews 13, 2025

Referring to the above table, the estimated association measure linking CED and EP falls below multicollinearity limits. Therefore, these results suggest that multicollinearity is not a concern for the independent variables and thus meeting the multicollinearity assumption.

Heteroscedasticity Test

Table 7. Heteroscedasticity Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.375188	0.092301	4.064823	0.0002
X1_CED	0.015753	0.091688	0.171813	0.8643
X2_EP	-0.191087	0.147135	-1.298714	0.1998

Source: Data processing results with Eviews 13, 2025

Referring to the table above, the probability values for the X1 (CED) and X2 (EP) variables are greater than the significance of 0.05. Respectively show no indication of variance inconsistency, and that it pass the heteroscedasticity test.

Panel Data Regression

Table 8. Panel Data Regression Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.815766	0.855039	4.462683	0.0000
X1_CED	-0.061508	0.576900	-0.106618	0.9154
X2_EP	-0.566445	0.188751	-3.001016	0.0039

Source: Data processing results with Eviews 13, 2025

As shown in the table, the following is the regression equation of the panel data obtained:

$$FV = 3.815766 - 0.061508CED - 0.566445EP + eit$$

The computed regression equation indicates that an increase of one unit in CED index leads to a reduction of 0.061508 units in FV, assuming the other variables remain constant. Likewise, a one unit increase in environmental performance EP, measured by the PROPER rating, is associated with a decrease of 0.566445 units in firm value.

Hypothesis Test

Partial Test (T Test)

Table 9. Partial Test Results (T Test)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.815766	0.855039	4.462683	0.0000
X1_CED	-0.061508	0.576900	-0.106618	0.9154
X2_EP	-0.566445	0.188751	-3.001016	0.0039

Source: Data processing results with Eviews 13, 2025

As shown in the table, the t-test results assessing the effect of predictor variables on the outcome variable are reported below:

1. The Effect of Carbon Emission Disclosure on Firm Value

The empirical results indicate that Carbon Emission Disclosure (X1) has a p-value of 0.9154, which is above the 0.05 significance threshold. This finding suggests that the null hypothesis (H0) cannot be rejected, while the alternative hypothesis (Ha) is rejected. Therefore, carbon emission disclosure is not statistically proven to influence firm value.

2. The Effect of Environmental Performance on Firm Value

Environmental Performance (X2) shows a p-value of 0.0039, which is below the 0.05 significance level. This result indicates that the null hypothesis (H0) is rejected, while the alternative hypothesis (Ha) is accepted. Accordingly, environmental performance has a statistically significant effect on firm value.

Simultaneous Test (F Test)

Table 10. Simultaneous Test Results (F Test)

F-statistic	4.762958
Prob(F-statistic)	0.011849

Source: Data processing results with Eviews 13, 2025

Considering Table 10, the F-test results indicate the value of the prob. As 0.011849 < 0.05, statistical testing supports acceptance of the alternative proposition that environmental performance (X2) and carbon emission disclosure (X1), when considered jointly, have a statistically significant effect on firm value. However, this joint significance is primarily driven by environmental performance, as carbon emission disclosure does not exhibit a statistically significant effect when evaluated individually.

Coefficient Determination Test

Table 11. Determination Coefficient Test Results

R-squared	0.210693
Adjusted R-squared	0.144917

Source: Data processing results with Eviews 13, 2025

According to the table, the adjusted R-squared value is 0.144917 is obtained from the regression model that includes environmental performance, carbon emission disclosure, firm size, and their interaction terms. This result indicates that approximately 14.49% of the variation in firm value is explained by environmental performance and carbon emission disclosure, with firm size acting as a moderating variable. In contrast, the remaining 85.51% was associated with other factors that were not considered within the scope of this study. This indicates that the model does not aim to fully explain firm value, but rather to examine specific associations between sustainability-related variables and firm value, which is consistent with empirical research in finance where firm value is influenced by numerous observed and unobserved factors.

Moderated Regression Analysis (MRA) Test

Table 12. Test Results Moderated Regression Analysis (MRA)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-65.64372	35.55509	-1.846254	0.0698
X1	-12.88207	20.30328	-0.634482	0.5282
X2	15.87098	8.087341	1.962447	0.0544
Z	2.255207	1.147432	1.965439	0.0540
X1_Z	0.399936	0.655599	0.610031	0.5441
X2_Z	0.530305	0.258122	2.054471	0.0443

Source: Data processing results with Eviews 13, 2025

As shown in the table, the estimated moderation regression equation is presented below:

$$FV = -65.64372 - 12.88207CED + 15.87098EP + 2.255207FS + 0.399936CED*FS + 0.530305EP*FS + \varepsilon it$$

The interaction term X1*Z (CED*firm size) has an estimated coefficient of 0.399936, accompanied by a non-significant probability, indicating no evidence that firm size moderates the relationship between carbon emission disclosure and firm value. In contrast, the interaction term X2*Z (environmental performance*firm size) exhibits a coefficient of 0.530305 with a p-value of 0.0443, which is below the 0.05 significance threshold, indicating that organizational scale amplifies the link between environmental performance and firm value.

The Effect of Carbon Emission Disclosure on Firm Value

The finding of the t-test indicated that there was no discernible effect of carbon emission disclosure on corporate worth. These findings do not support the first hypothesis, which proposed a positive relationship between the disclosure of carbon emissions and firm value within the observed sample of energy companies.

This result implies that the role of carbon emission disclosure as a value-relevant signal, as suggested by stakeholder theory, may not be fully reflected in investors' valuation decisions in this context. The indifference of firm value to carbon emission disclosure can be explained by empirical conditions in Indonesia, where carbon emission disclosure practices in energy companies are still normative and compliance-oriented, leading to relatively homogeneous disclosure pattern between companies. Under such conditions, carbon emission disclosure may provide limited incremental informational value to investors, thereby reducing its effectiveness in differentiating firms and influencing market valuations.

These results are in line with the conclusions of earlier studies by (Sitorus, 2024), (Daromes et al., 2020), (Rachmawati, 2021), and (Asyifa & Burhany, 2022), which discovered that the firm value is unaffected by carbon emission disclosure. However, this finding contradicts previous studies undertaken by (Hardiyansah et al., 2021), (KURNIA et al., 2020), and (Hardiyansah & Agustini, 2021), through which found that CED affected firm value.

The Effect of Environmental Performance on Firm Value

The t-test results reveal that environmental performance exerts a statistically substantial decline in corporate valuation. This indicates that improvements in environmental performance are associated with lower firm value within the observed sample of energy companies during the observation period.

This outcome may reflect the specific characteristics of the energy industry, which is highly capital-intensive and subject to substantial regulatory and operational risks. Improvements in environmental performance often require substantial upfront investments, higher operating costs, and long-term capital expenditures, while their financial benefits may not be immediately observable. As a result, investors may interpret strong environmental performance not only as a sustainability signal but also as an indication of increased short-term cost pressure and potential profitability trade-offs. Moreover, within the energy industry, environmental initiatives are frequently perceived as regulatory compliance requirements rather than strategic differentiators. This perception may weaken the signaling power of environmental performance in shaping market valuation. Consequently, in the short run, the intended positive signaling of environmental performance disclosures is not fully capitalized into firm value during the observation period.

These results confirm several previous studies, including those by (Ericho & Amin, 2024), which found that environmental performance negatively affects firm value. However, it contradicts the findings of (Sitorus, 2024) and (Noor & Ginting, 2022), who discovered that the firm value is unaffected by environmental performance.

The Effect of Carbon Emission Disclosure on Firm Value Moderated by Firm Size

The MRA findings demonstrate that organizational scale fails to alter the association between carbon reporting practices and firm value. These findings indicate that no moderating effect of firm size is observed within the association linking carbon emission disclosure to corporate worth; consequently, the third hypothesis, which posits that firm size moderates the impact of CED on firm value, is rejected.

In the context of carbon emissions disclosure, these results indicate that the market consistently assesses it regardless of company size within the observed sample. In other words, the signals provided by carbon emission disclosure to investors and stakeholders are considered equally relevant to large and small energy companies in influencing firm value. One possible explanation is that carbon emission issues have become a broadly recognized and regulated concern across firms, leading disclosure practices to be evaluated in a relatively uniform manner, regardless of company scale. Under such conditions, firm size may not strengthen or weaken the value relevance of carbon emission disclosure in influencing market valuation.

The Effect of Environmental Performance on Firm Value Moderated by Firm Size

The MRA test results demonstrate that firm size moderates the association linking environmental performance to firm value. These findings indicate that the relationship between environmental performance and firm value varies according to firm size, with the direction of moderation strengthened in the sense that firm size mitigates the adverse effect of environmental performance on firm value. Thus, the hypothesis that firm size has a moderating influence on the relationship between environmental performance and firm value is accepted, given the statistically significant interaction term.

This result is consistent with prior research by (Ericho & Amin, 2024), which shows that firm size enhances the effect of environmental performance and firm value by mitigating its negative valuation impact. Larger firms that consistently prioritize ecological responsibility are more likely to generate enhanced returns for investors, especially when their operations grow.

From a theoretical perspective, these findings support signaling theory, which proposes that larger firms possess greater resource capacity, higher public visibility, and stronger institutional pressure to demonstrate sustainability commitments consistently and credibly. In large-scale firms, strong environmental performance is less likely to be interpreted purely as a cost burden and is instead perceived by the market as a more credible signal of managerial quality and long-term sustainability. This enhanced signal credibility leads to lower risk perceptions and relatively more favorable market responses, as reflected in firm value. Accordingly, firm size strengthens the signaling mechanism of environmental performance by attenuating its negative valuation effect, rather than reversing its direction, when supported by a larger operational scale.

CONCLUSION

This research analyzes how emission transparency and ecological outcomes influence corporate valuation while considering organizational scale as an interaction factor, based on longitudinal data from publicly traded energy firms in Indonesia during the 2019–2024 period. According to empirical findings, disclosure of carbon emissions does not exert a statistically significant influence on firm value. These findings may suggest that the practice of carbon emission disclosure within Indonesia's energy sector remains normative and relatively homogeneous, and thus has not provided a strong informational signal for investors in the company valuation process.

On the other hand, environmental performance has been shown to have a statistically significant negative association with firm value. These findings may reflect the characteristics of capital-intensive and high-risk industries such as the energy sector, where improvements in environmental performance often require substantial investments and higher operating costs. These conditions encourage the market to view environmental performance not only as a signal of long-term sustainability, but also as a potential pressure on short-term financial performance, thus having an impact on the decrease in the firm's value within the observed period.

The moderation analysis suggests that firm size does not significantly moderate the association between carbon emission disclosure and corporate worth, indicating that the market reaction to carbon disclosure is relatively uniform across firm sizes. Despite this, firm size is found to significantly moderate the relationship between environmental performance and firm value, such that larger firm size attenuates the negative effect of environmental performance on firm value. This suggests that environmental performance generates greater value relevance by reducing its adverse valuation effect when implemented by larger firms. Large companies generally possess stronger resource capacity, higher public visibility, and greater credibility in implementing environmental initiatives, causing the market to perceive their environmental performance as a more reliable signal of long-term sustainability and managerial capability.

In summary, this study contributes data-driven findings that advance the environmental, social, and governance (ESG) literature by demonstrating that sustainability-related practices in developing countries, particularly within high-emission industries, are not uniformly valued by the market. The findings highlight the importance of firm-specific characteristics, including firm size, in the assessment of economic implications of environmental performance and disclosure. Furthermore, this research provides practical insights for corporate management, investors, and policymakers in designing sustainability strategies that are not only environmentally responsible but also economically meaningful.

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