



Sustainability Assurance, Carbon Emission Disclosure, and Green Investment: Their Effects on Market Reactions with Financial Performance as a Moderator (Empirical Study of Energy Sector Companies Listed on the Indonesia Stock Exchange for the 2021-2023 Period)

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ABSTRACT

This research investigates whether product strategy, price, and branding contribute to shaping the product life cycle of Central Batik products at the Heritage Rest Area KM 260B Banjaratma. The research approach used is a quantitative method with a purposive random sampling technique, where the sample consists of 70 respondents who are consumers who have visited the Central Batik Rest Area Heritage KM 260B Banjaratma. Data were obtained using Likert-scale questionnaires and analyzed through multiple linear regression to evaluate both separate and joint variable effects. The results demonstrate that Product Strategy, Price, and Branding collectively and positively influence the Product Life Cycle, supported by a significance value of 0.000 (< 0.05). This evidence highlights that aligning product strategy and pricing while fostering customer satisfaction can reinforce the positioning and competitive advantage of Central Batik at the Heritage Rest Area KM 260B Banjaratm.

INTRODUCTION

The Indonesian capital market has shown a consistent growth trend in recent years. Based on Figure 1.1, which contains data from the Indonesia Central Securities Depository (KSEI), the number of capital market investors increased significantly from 10.31 million in 2022 to 15.77 million in March 2025.

This growth has occurred not only in stock instruments but also in mutual funds and government securities, reflecting an increase in financial literacy and investors' interest in various investment instruments. The rising number of investors indicates that the Indonesian capital market is becoming increasingly active and participative in responding to information published by companies. Accordingly, market sensitivity to corporate information is also rising, making market reactions an important indicator in evaluating responses to corporate strategies and performance (KSEI, 2025).

The significant growth in investors also suggests that market reactions are becoming more oriented toward high expectations regarding corporate performance, governance, and transparency (Bondar et al., 2023). Investors are now not only paying attention to financial reports but are also beginning to consider non-financial information, particularly related to corporate social and environmental responsibility (Rusmiani & Rahayu, 2023). In line with this, Utami (2024) notes that investors' interest in ESG aspects has sharply increased, encouraging companies to disclose sustainability information more transparently. This indicates that a company's success in attracting investors is measured not only by profitability but also by the extent to which the company demonstrates its commitment to sustainability.

However, despite the growing need for sustainability information, investor confidence in such information remains low. A PwC (2023) report states that only 10% of investors are truly confident in the reliability of sustainability information provided by companies, while 57% feel that verification of such information is inadequate. This condition highlights a gap between investors' demand for ESG information and the quality of disclosures available, leading to doubts about the credibility of the information (Rosana et al., 2025). Such uncertainty can weaken market reactions to sustainability information, as investors tend to doubt the validity of data that is not supported by adequate verification processes.

One way to reduce information asymmetry is through Sustainability Assurance, which involves third-party independent verification that enhances the credibility of sustainability reports. Sustainability Assurance provides greater confidence to investors regarding a company's long-term commitment to environmental, social, and governance aspects (Pratama, 2024). Moreover, Sustainability Assurance also serves as a quality signal, as verified sustainability information allows investors to assess higher credibility and tends to lead to more profitable investment decisions (Dilla et al., 2023). Investors perceive that companies with reports that have undergone an assurance process strive to reduce information asymmetry, resulting in a more positive market reaction to such reports.

According to earlier studies, businesses still provide different information about how the market responds. Ernst et al. (2025) discovered that because investors believe information that has been independently verified, Sustainability Assurance has a beneficial impact on market reactions. On the other hand, Asyari and Hernawati (2023) claimed that market reactions are not much impacted by carbon emission disclosure, which is probably because investors pay little attention to environmental information. While Putri and Halimatusyadiah (2024) discovered that Green Investment has not yet caused a substantial market reaction, Putri and Paramita (2025) shown that Green Investment has a beneficial influence since it is viewed as a company's long-term plan.

This study is a development of the research conducted by Asyari and Hernawati (2023), which examined the effect of Carbon Emission Disclosure on market reactions with media exposure as a moderating variable. Their study focused on manufacturing companies listed on the Indonesia Stock Exchange, particularly in the food and beverage, cement, and tobacco industry sub-sectors. The development in this research adds two independent variables, namely Sustainability Assurance and Green Investment, to broaden the scope of sustainability information studied. Additionally, the moderating variable used in this study is financial performance, chosen because profitability remains a primary consideration in investment decisions. Another difference is that this study focuses on companies in the energy sector.

Based on the research gap and previous research findings as described in the background of this study, the phenomenon of the influence of Sustainability Assurance, Carbon Emission Disclosure, and Green Investment on market reactions with financial performance as a moderating variable is important to investigate further.

LITERATURE REVIEW

Signaling Theory

Signaling theory explains that when there is information asymmetry, the party with more complete information sends signals to the other party (Spence, 1973). This theory was originally developed in the context of the labor market, where job applicants provide signals such as education to differentiate themselves from competitors (Spence, 1973). Signaling theory helps explain how asymmetric information can be addressed through credible communication (Connelly et al., 2011). Its application has since expanded to various fields, including capital markets and investment decision-making. In the context of capital markets,

Signals such as financial statements, sustainability reports, or governance practices are used to reduce uncertainty and influence investor perceptions (Kristin, 2024; Connelly et al., 2011).

Stakeholder Theory

Stakeholder theory emphasizes that companies should consider the interests of all parties affected by their activities, not just shareholders (Freeman, 1984). In this context, market reactions can be seen as a form of response from one of the key stakeholders, namely investors, to the information disclosed by the company. Sustainability information, such as environmental, social, and governance (ESG) practices, often serves as an important indicator for investors to assess a company's credibility and long-term prospects (Pandey et al., 2024). When a company is perceived to meet stakeholder expectations through transparency and social responsibility, the market will respond positively, for example, through increases in stock prices or trading volumes (Widiatami et al., 2024). Good ESG information can strengthen the relationship between the company and its investors.

Market Reaction

Market reaction refers to the collective response of investors to information published by a company, reflected in changes in stock prices or trading volumes. According to Jogyanto (2008), as cited by Hutami and Ardiyanto (2015), market reaction can be measured through abnormal returns that occur after a material event. New information deemed relevant by investors will cause stock prices to change as the market adjusts its expectations regarding the company's value. Fama (1970) explains that in an efficient market, stock prices quickly reflect all available information. Market reaction serves as an important indicator of how investors receive and assess certain information; both financial and non-financial information can trigger market reactions depending on the perceived value it carries. Market reaction functions as a direct reflection of investors' perceptions and decisions.

Sustainability Assurance

Sustainability Assurance is an independent assurance process over the non-financial information included in a company's sustainability report. Simnett et al. (2009) state that the main objective of assurance is to enhance the credibility of reports by providing confidence that the information has been tested against certain criteria. Kolk and Perego (2010) explain that assurance serves as an external governance mechanism used by companies to strengthen the legitimacy of their ESG disclosures in the eyes of stakeholders. Junior et al. (2014) also add that assurance can increase investor confidence in sustainability reports. Generally, this assurance is conducted by an independent third party and uses standards such as ISAE 3000 or AA1000AS to ensure the quality of the reported information.

Carbon Emission Disclosure

Carbon emission disclosure describes a company's information regarding the amount of emissions produced and the mitigation measures implemented. It reflects the company's responsibility for the environmental impact of its business activities. According to Choi et al. (2013), carbon emission disclosure demonstrates a company's commitment to managing environmental impacts and

sustainability strategies. Liao et al. (2015) state that this disclosure aims to enhance corporate transparency and accountability for its contribution to climate change. Carbon emission disclosure is part of Corporate Social Responsibility (CSR) and is usually carried out voluntarily in the company's annual report (Jannah & Muid, 2014, as cited in Ngatimin et al., 2023). This disclosure enables investors to assess the company's readiness to comply with climate regulations.

Green Investment

Green Investment is a form of investment allocated to support projects that have a positive impact on the environment, such as renewable energy, energy efficiency, resource conservation, and other environmentally friendly technologies. According to Flammer (2023), Green Investment refers to a company's investment in initiatives aimed at enhancing environmental sustainability and reducing negative impacts on ecosystems. Meanwhile, Michelon et al. (2015) define Green Investment as a company's financial commitment to activities or assets related to responsible environmental management. This definition emphasizes that Green Investment is not merely part of a CSR strategy but is a component of the company's strategic policy to create long-term value oriented toward sustainability.

RESEARCH METHOD

The type of research used in this study is quantitative research with an associative approach. Karimuddin (2022) states that quantitative research is a scientific investigation that systematically examines parts and phenomena as well as the causal relationships between them. Quantitative research is defined as a systematic investigation of phenomena by collecting data that can be measured using statistical, mathematical, or computational techniques. The associative approach aims to examine the relationship between two or more variables and seeks to identify cause-and-effect relationships among the relevant variables (Karimuddin, 2022). The data analysis technique used is moderation regression analysis, which serves to test whether the financial performance variable can strengthen or weaken the influence of the independent variables, namely Sustainability Assurance, Carbon Emission Disclosure, and Green Investment, on market reaction.

RESULTS AND DISCUSSION

Descriptive Statistical Analysis

With regard to the variables Market Reaction (MR), Sustainability Assurance (SA), Carbon Emission Disclosure (CED), Green Investment (GI), and Financial Performance (FP), descriptive statistical analysis seeks to give a summary of the features of the data in this study. The mean, median, maximum, and minimum values are among the statistics displayed. as well as the standard deviation of each variable. The results of the statistical data processing are presented in Table 4.3 below:

Tabel 4.3 Descriptive Statistics

Description	Y_RP	X1_SA	X2_CED	X3_GI	Z_KK
Mean	0.450171	0.188406	0.765298	0.004705	3.005523
Median	0.490356	0.000000	0.833333	0.000793	2.808655
Maximum	0.846951	1.000000	0.944444	0.098023	6.994109
Minimum	0.044054	0.000000	0.277778	1.11E-06	1.080899
Std. Dev.	0.194378	0.392460	0.163186	0.012163	1.004638
Observations	138	138	138	138	138

Source: Processed EViews output, 2025

Based on the table above, the following explanations can be provided:

1. **Market Reaction (MR)** has a mean value of 0.4502, indicating that, on average, the market reaction to sustainability disclosures is at 45%. The median of 0.4904 shows that half of the data lies above and below this value relatively evenly. The standard deviation of 0.1944 indicates a moderate level of data dispersion. The maximum value of 0.8470 was recorded by PT Bumi Resources Tbk (BUMI) in 2021, reflecting the highest market response to sustainability information. Meanwhile, the minimum value of 0.0441 was recorded by PT Itama Ranoraya Tbk (ITMA) in 2022, indicating the lowest market reaction.
2. **Sustainability Assurance (SA)** has a mean of 0.1884, suggesting that only about 19% of the total observations conducted assurance on sustainability reports. The median of 0.0000 reinforces that most companies did not carry out assurance. The standard deviation of 0.3925 indicates variation in assurance practices among companies. The maximum value of 1.0000 was achieved by 10 companies, including PT ABM Investama Tbk (ABMM), PT Darma Henwa Tbk (DEWA), PT Delta Dunia Makmur Tbk (DOID), PT Energi Mega Persada Tbk (ENRG), PT Alfa Energi Investama Tbk (FIRE), PT Golden Energy Mines Tbk (GEMS), PT Indika Energy Tbk (INDY), PT Indo Tambangraya Megah Tbk (ITMG), PT Bukit Asam Tbk (PTBA), and PT Petrosea Tbk (PTRO). The remaining companies recorded the minimum value of 0.0000 as they did not perform assurance during the observation period.
3. **Carbon Emission Disclosure (CED)** shows a relatively high mean of 0.7653 and a median of 0.8333, indicating that, in general, companies have performed carbon disclosure quite well. The standard deviation of 0.1632 reflects a moderate variation in carbon disclosure practices. The maximum value of 0.9444 was achieved by seven companies: PT Bumi Resources Tbk (BUMI), PT Darma Henwa Tbk (DEWA), PT Elnusa Tbk (ELSA), PT Alfa Energi Investama Tbk (FIRE), PT Golden Energy Mines Tbk (GEMS), PT Bukit Asam Tbk (PTBA), and PT Petrosea Tbk (PTRO). Meanwhile, the minimum value of 0.2778 was consistently recorded by two entities, PT Ultima Nusa Investama Tbk (UNIQ) and PT Wintermar Offshore Marine Tbk (WINS), during the period from 2021 to 2023.
4. **Green Investment (GI)** has a very low mean of 0.0047, with a median of 0.0008, indicating that the allocation of green investments by energy companies remains very low. The standard deviation of 0.0122 reflects the limited spread of green investment values among companies. The maximum value of 0.0980 was recorded by PT Bukit Asam Tbk (PTBA) in 2023, reflecting

a relatively high commitment to developing green investments. The minimum value of 0,000001 This was found in 23 companies, one of which was PT Adaro Minerals Indonesia Tbk (ADMR).

5. Financial Performance (FC) showed an average value of 3.0055 and a median of 2.8087, indicating a generally good level of company profitability. The standard deviation of 1.0046 indicates significant differences in financial performance between companies. The maximum value of 6.9941 was achieved by PT Bumi Resources Tbk (BUMI) in 2021. Meanwhile, the minimum value of 1.0809 was recorded by PT Itama Ranoraya Tbk (ITMA) in 2023.

Panel Data Regression Model Estimation Results

Common Effect Model Results

The Common Effect Model (CEM) assumes that there are no differences in characteristics between companies or time periods in the panel data. The estimation results of this model are shown in Table 4.4 below:

Table 4.4 Common Effect Model (CEM) Results

Variable	Coefficien t	Std. Error	t-Statistic	Prob.
C	0.275083	0.079659	3.453280	0.0007
X1_SA	0.112757	0.046585	2.420443	0.0168
X2_CED	0.223981	0.106225	2.108552	0.0368
X3_GI	-3.733726	1.430802	-2.609534	0.0101
Root MSE	0.182685	R-squared		0.110249
Mean dependent var	0.450171	Adjusted R-squared		0.090329
S.D. dependent var	0.194378	S.E. of regression		0.185391
Akaike info criterion	-0.504141	Sum squared resid		4.605564
Schwarz criterion	-0.419293	Log likelihood		38.78570
Hannan-Quinn criter.	-0.469660	F-statistic		5.534640
Durbin-Watson stat	0.298778	Prob(F-statistic)		0.001300

0.000001 was found in 23 companies, one of which is PT Adaro Minerals Indonesia Tbk (ADMR).

1. **Financial Performance (FP)** shows a mean value of 3.0055 and a median of 2.8087, indicating that the overall profitability level of the companies is fairly good. The standard deviation of 1.0046 suggests a considerable difference in financial performance among companies. The maximum value of 6.9941 was recorded by PT Bumi Resources Tbk (BUMI) in 2021, while the minimum value of 1.0809 was recorded by PT Itama Ranoraya Tbk (ITMA) in 2023.

Panel Data Regression Model Estimation Results

Common Effect Model Results

The Common Effect Model (CEM) assumes that there are no differences in characteristics between companies or across time periods in the panel data. The estimation results of this model are presented in Table 4.4 below:

The F-statistic of 5.534640 with a probability of 0.001300 indicates that the model is simultaneously significant, and the Durbin-Watson value of 0.298778 indicates the possibility of autocorrelation in the model.

Fixed Effect Model Results

The Fixed Effect Model (FEM) is used to control for differences in fixed characteristics between companies in the panel data. The estimation results of this model are shown in Table 4.5 below:

Table 4.5 Fixed Effect Model (FEM) Results

Variable	Coefficient		t-Statistic	Prob.
	t	Std. Error		
C	0.725513	0.169935	4.269351	0.0000
X1_SA	0.134553	0.066471	2.024224	0.0459
X2_CED	-0.399653	0.224129	-1.783138	0.0780
X3_GI	1.096838	1.173056	0.935026	0.3523
Effects Specification				
Cross-section fixed (dummy variables)				
Root MSE	0.060543	R-squared		0.902279
Mean dependent var	0.450171	Adjusted R-squared		0.849575
S.D. dependent var	0.194378	S.E. of regression		0.075389
Akaike info criterion	-2.060791	Sum squared resid		0.505827
Schwarz criterion	-1.021404	Log likelihood		191.1946
Hannan-Quinn criter.	-1.638410	F-statistic		17.11991
Durbin-Watson stat	2.111817	Prob(F-statistic)		0.000000

Source: Processed EViews output, 2025

The estimation results using the Fixed Effect Model (FEM) show that the Sustainability Assurance variable has a coefficient of 0.134553 with a probability of 0.0459, while the Carbon Emission Disclosure variable has a coefficient of -0.399653 with a probability of 0.0780, and Green Investment has a coefficient of 1.096838 with a probability of 0.3523. The R-squared value of 0.849575 indicates that this model is able to explain explaining 84.95% of the variation in Market Reaction. The F-statistic value of 17.11991 with a probability of 0.000000 indicates that the model is simultaneously significant, and the Durbin-Watson value of 2.111817 suggests that there is no autocorrelation in the model.

Random Effect Model Results

The Random Effect Model (REM) assumes that individual differences between companies are random effects that are not correlated with the independent variables. The estimation results of this model are presented in Table 4.6 below:

Table 4.6 Results of the Random Effect Model (REM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.448612	0.105849	4.238219	0.0000
X1_SA	0.108900	0.049957	2.179876	0.0310
X2_CED	-0.025835	0.137478	-0.187922	0.8512
X3_GI	0.172725	1.064755	0.162220	0.8714
Effects Specification				
			S.D.	Rho
Cross-section random			0.170913	0.8371
Idiosyncratic random			0.075389	0.1629
Weighted Statistics				
Root MSE	0.076058	R-squared		0.035539
Mean dependent var	0.111097	Adjusted R-squared		0.013946
S.D. dependent var	0.077728	S.E. of regression		0.077184
Sum squared resid	0.798297	F-statistic		1.645895
Durbin-Watson stat	1.381354	Prob(F-statistic)		0.181809
Unweighted Statistics				
		Mean dependent var		
R-squared	0.032947			0.450171
Sum squared resid	5.005699	Durbin-Watson stat		0.220295

Source: EViews output processed, 2025

According to the Random Effect Model estimation results, the Sustainability Assurance variable has a coefficient of 0.108900 with Green Investment has a coefficient of 0.172725 with a probability of 0.8714, the Carbon Emission Disclosure variable has a coefficient of -0.025835 with a probability of 0.8512, and the Sustainability Assurance variable has a coefficient of 0.108900 with a probability of 0.0310. This model can only account for 1.39% of the variation in Market Reaction, according to the R-squared value of 0.013946. The model is not concurrently significant, as indicated by the F-statistic value of 1.645895 with a probability of 0.181809. The model may contain autocorrelation, as shown by the Durbin-Watson value of 1.381354.

Panel Data Regression Model Selection Results

Chow Test Results

The Chow test is conducted to determine whether the Common Effect Model (CEM) or the Fixed Effect Model (FEM) is more appropriate in panel data regression analysis. The results of this test are presented in Table 4.7 below:

Table 4.7 Chow Test Results

Effects Test	Statistic	d.f.	Prob.
Cross-section F	16.029906	(45,89)	0.0000
Cross-section Chi-square	304.817805	45	0.0000

Source: EViews output processed, 2025

The F-statistic value is 16.029906 with a probability of 0.0000 and the Chi-square value is 304.817805 with a probability of 0.0000 based on the test results displayed in Table 4.7. The Fixed Effect Model is more suitable than the Common Effect Model when both tests' probability values are less than 0.05. These findings show that the link between the independent factors and market reaction is influenced by notable variations in company characteristics. As a result, the Fixed Effect Model is chosen for additional testing during the Hausman test phase.

Hausman Test Results

The Hausman test is conducted to determine the best model between the Fixed Effect Model and the Random Effect Model by examining whether there is a correlation between individual effects and the independent variables. The results of this test are presented in Table 4.8 below:

Table 4.8 Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	9.459847	3	0.0238

Source: Processed EViews output, 2025

Based on the test results shown in Table 4.8, the chi-square value is 9.459847 with 3 degrees of freedom and a probability value of 0,0238.

Since the probability value is smaller than the significance level of 0.05, the null hypothesis is rejected, and the Fixed Effect model is considered more appropriate than the Random Effect model. Therefore, the model chosen for further analysis in this study is the Fixed Effect Model.

Conclusion of Panel Data Regression Model Test

After a series of tests on the panel data regression model, namely the Chow test, Hausman test, and Lagrange Multiplier test, the most appropriate model to be used in this study can be determined. The Chow test is conducted to compare the Common Effect Model (CEM) with the Fixed Effect Model (FEM), while the Hausman test is used to choose between the Fixed Effect Model and the Random Effect Model (REM). The Lagrange Multiplier test is used to compare the Common Effect Model with the Random Effect Model. The results of these three tests are summarized in Table 4.9 below:

Table 4.9 Summary of Panel Data Regression Model Testing

No	Method	Testing	Results
1	Chow – test	Common vs Fixed	Fixed Effect Model
2	Hausman - test	Fixed vs Random	Fixed Effect Model

Source: Data processed by the researcher, 2025

DISCUSSION OF RESEARCH RESULTS

The Effect of Sustainability Assurance on Market Reaction

The test results indicate that the variable Sustainability Assurance has a significant effect on market reaction for energy sector companies listed on the Indonesia Stock Exchange (IDX), with a significance value of 0.0459 (< 0.05). This finding suggests that the presence of assurance in sustainability reports can enhance investor confidence, thereby encouraging a positive market response. From the perspective of **Signaling Theory** (Spence, 1973), companies can reduce information asymmetry by providing credible information to investors. Sustainability assurance serves as a tangible form of a company's commitment and accountability toward sustainable practices. Moreover, assurance also reflects the company's dedication to disclosing sustainability reports that are valid and free from managerial bias.

These findings are also consistent with Stakeholder Theory (Freeman, 1984), which emphasizes the importance of meeting stakeholder expectations regarding transparency and accountability in non-financial information. This result is supported by previous studies, such as Ernst et al. (2025), which showed that sustainability reports receiving assurance generate stronger market reactions. Pandey et al. (2024) also concluded that assurance enhances management credibility regarding sustainability risks. In addition, Klibi et al. (2024) found that investors respond more positively to companies that present independently verified information. The presence of

Sustainability Assurance has been proven to provide significant added value to capital market perception, particularly in the context of energy sector companies. Based on 138 observations in this study, only 26 observations indicated that energy sector companies conducted assurance on their sustainability reports. The average Sustainability Assurance value was recorded at 0.188406, indicating that assurance practices are not yet common among energy sector companies in Indonesia. This situation shows that the presence of assurance is still relatively rare, yet it serves as a differentiating factor that sends a strong signal to investors. Companies that choose to implement assurance are perceived as more progressive and responsible. Therefore, although the number of companies applying assurance is not yet dominant, its presence is still able to trigger a positive market reaction by enhancing investor confidence in the quality of sustainability information disclosed. Based on these results, the first hypothesis (H1) is accepted, as Sustainability Assurance is proven to have a significant effect on market reactions in the tested model.

Effect of Carbon Emission Disclosure on Market Reaction

Based on regression test results, it was found that Carbon Emission Disclosure does not have a significant effect on market reactions in energy sector companies listed on the IDX, with a probability value of 0.0780 (> 0.05). This indicates that the level of carbon emission disclosure has not been able to influence investor perception in the capital market. This finding contradicts the initial expectations of the study and the Signaling Theory framework (Spence, 1973), which posits that sustainability information, such as carbon emissions, can function as a positive signal to the market. Signal failure occurs when the disclosure is superficial, symbolic, or inconsistent across years. This shows that shallow disclosure is insufficient to positively shape market perception.

From the Stakeholder Theory perspective (Freeman, 1984), carbon emission disclosure should serve as a form of corporate accountability to stakeholders regarding environmental impacts. However, if the information provided is not in-depth, the market response remains limited. Asyari and Arieftiara (2022) stated that carbon emission disclosure does not always provide a positive impact on market reaction, especially when the disclosure is symbolic and has not yet become part of a comprehensive sustainability strategy. Ramadhani et al. (2024) showed that carbon emission disclosure has not been able to generate a significant market response. Both findings emphasize the importance of quality, consistency, and integration in disclosure for sustainability information to influence market perception.

Based on descriptive statistics, the average Carbon Emission Disclosure value for energy sector companies in this research sample is 0.765298, with a minimum value of 0.277778. Although the average disclosure is relatively high, but the minimum value indicates that some companies provide only limited disclosure. This variation suggests that the quality and consistency of disclosure are still uneven, reducing the effectiveness of the signals perceived by investors. Therefore, carbon emission disclosures that are superficial or irrelevant tend to receive little market attention and are not strong enough to trigger a significant investor reaction. Carbon emission disclosure remains largely a formal compliance activity and has not yet become economically valuable information in the eyes of market participants.

Based on these results, the second hypothesis (H2) is rejected because Carbon Emission Disclosure does not show a significant effect on market reactions in the tested model.

Effect of Green Investment on Market Reaction

The test results indicate that the Green Investment variable does not have a significant effect on market reactions in energy sector companies listed on the IDX, with a probability value of 0.3523 (> 0.05). This means that the company's allocation of funds for green projects is not yet strong enough to generate a positive response from investors in the capital market. This finding contradicts the prediction of Signaling Theory (Spence, 1973), which states that Green Investment can provide a positive signal regarding the company's long-term commitment to sustainability. However, if the signal is not accompanied by concrete evidence, such as significant fund allocation or transparent reporting,

the market may respond neutrally. This indicates that the effectiveness of the signal depends on the quality of information provided.

From the perspective of Stakeholder Theory (Freeman, 1984), green investment should serve as a form of corporate responsibility toward the environment and society. However, if information related to Green Investment is not presented in detail or standardized, investors will find it difficult to assess its effectiveness. This aligns with the findings of Ainy et al. (2024) and Putri & Halimatusyadiah (2024), who stated that the Indonesian capital market has not shown a significant reaction to Green Investment information, partly due to low transparency and inconsistency of disclosure. Investors tend to require quantitative and high-quality information to link it to potential future risks and opportunities, as well as to evaluate the extent to which green investment can provide tangible added value.

This is supported by descriptive statistics, which show that the average Green Investment value for energy sector companies in the study is 0.004705, with a minimum value of 0.000001 out of a total of 138 observations. This value reflects that the company's fund allocation for green investment is still very small compared to the total assets held. The low proportion indicates that Green Investment has not yet become a primary focus in the asset management strategy of energy sector companies. This explains why the signals generated are not strong enough to significantly influence market perception. When the contribution of green investment to the asset structure is minimal, investors tend to overlook it as an indicator of sustainability commitment.

Based on these results, the third hypothesis (H3) is rejected because Green Investment does not show a significant effect on market reaction in the tested model.

The Effect of Sustainability Assurance on Market Reaction with Financial Performance as a Moderating Variable

The test results indicate that the interaction variable between Sustainability Assurance and Financial Performance does not have a significant effect on market reaction for energy sector companies listed on the IDX, with a probability value of 0.8271 (> 0.05). This means that although Sustainability Assurance directly impacts market reaction, this effect does not become stronger or weaker with good financial performance. These findings are not in line with the assumptions of Signaling Theory (Spence, 1973), which states that a signal will be more effective when supported by solid financial conditions. In this case, the presence of assurance alone serves as a positive signal for investors, regardless of the company's financial strength.

These findings are also not consistent with the assumptions of Stakeholder Theory, which suggests that stakeholders will trust sustainability information more if it is accompanied by strong financial performance. Studies by Duhita et al. (2022) and Lestari and Ardini (2021) show that financial performance does not affect market reaction, indicating that financial performance is not always a consideration for investors in responding to sustainability information, and a company's financial strength does not necessarily enhance the effect of other

information, including assurance. These results support the findings of this study that the presence of assurance alone is sufficient to provide a signal to the market, without needing reinforcement from financial performance. In other words, investors can respond directly to the sustainability signal conveyed through assurance without considering additional financial indicators.

Based on descriptive statistics, the average financial performance score of 3.005523 indicates that most energy sector companies in the sample have a fairly good level of profitability. The minimum value of 1.080899 and maximum of 6.994109 reflect a fairly wide variation in financial performance between companies. However, this variation does not strengthen the effect of Sustainability Assurance on market reaction. This indicates that investors do not always associate financial strength with the credibility of sustainability signals, so the practice of assurance is still considered valuable without the support of financial performance indicators.

Based on these results, the fourth hypothesis (H4) is rejected because financial performance does not moderate the effect of Sustainability Assurance on market reaction in the tested model.

The Effect of Carbon Emission Disclosure on Market Reaction with Financial Performance as a Moderating Variable

The test results indicate that the interaction between Carbon Emission Disclosure and Financial Performance does not have a significant effect on market reaction for energy sector companies listed on the IDX, with a value of The probability value is 0.0771 (>0.05). This means that, although companies disclose carbon emissions and have strong financial performance, the combination of the two is not sufficient to trigger a significant market reaction. This finding does not support the assumptions of Signaling Theory (Spence, 1973), which states that signals are more effective when supported by internal indicators such as financial strength. In this case, investors apparently do not yet consider carbon emission disclosures, even when combined with financial performance, as a credible signal for investment decision-making.

From the perspective of Stakeholder Theory (Freeman, 1984), energy sector companies have a significant responsibility to address public expectations regarding environmental issues, including carbon emission management. However, if the information provided is not detailed or presented consistently, then even if a company demonstrates strong financial performance, the signal is still not strong enough to attract market attention. This is reinforced by the findings of Asyari and Hernawati (2023), who showed that carbon emission disclosures do not have a significant impact on investor reactions. Furthermore, Lestari and Ardini (2021) also stated that financial performance does not always moderate the relationship between sustainability information and market reactions, particularly in the context of emission reporting.

Based on descriptive statistics, the average Carbon Emission Disclosure score of 0.765298 and the average Financial Performance score of 3.005523 indicate that most energy sector companies in the sample have disclosed carbon emissions with fairly high intensity and have relatively good profitability. However, the minimum Carbon Emission Disclosure score of only 0.277778 shows that some companies disclose carbon emissions very limitedly. The

inconsistency and variation in these disclosures, even when accompanied by strong financial performance, are not sufficient to create a strong signal that can significantly influence investor reactions. This indicates that the quality of disclosure is an important factor in shaping market perception.

Based on these results, the fifth hypothesis (H5) is rejected because Financial Performance does not moderate the effect of Carbon Emission Disclosure on market reactions in the tested model.

The Effect of Green Investment on Market Reactions with Financial Performance as a Moderating Variable

Based on the moderation test results, it was found that the interaction between Green Investment and Financial Performance does not have a significant effect on market reactions for energy sector companies listed on the IDX, with a probability value of 0.5961 (>0.05). This indicates that the presence of high financial performance is not sufficient to strengthen the relationship between Green Investment and market reactions. Within the framework of Signaling Theory (Spence, 1973), green investment signals should be more trusted if carried out by companies with strong financial performance. However, these results indicate that the market has not yet responded meaningfully to this combination.

1. which indicates that sustainability signals in the form of green investment have not yet become a primary reference for investors in assessing a company's prospects.
2. From the perspective of Stakeholder Theory (Freeman, 1984), the combination of green investment practices and solid financial performance should strengthen investors' perceptions of a company's responsibility and sustainability. However, if the information provided is still symbolic, unmeasured, or lacks consistent reporting standards, the market will have difficulty assessing the strategic value of this combination. This finding is consistent with Ainy et al. (2024), who stated that investors do not fully respond to Green Investment information if it is not supported by robust reporting. In addition, Duhita et al. (2022) also showed that financial performance does not always strengthen the effect of green practices on market perception, especially if these practices are not widely understood or considered economically immaterial.
3. Based on descriptive statistics, the average Green Investment value in this study is only 0.004705, and the average Financial Performance is 3.005523. The very small Green Investment value compared to the total assets of energy sector companies indicates that the allocation of funds for green projects is still very limited. This low proportion may reduce the signaling power of Green Investment practices themselves, even if the company has fairly strong financial performance. Therefore, the combination of green investment and high profitability is not yet sufficient to trigger a significant market reaction.

4. Based on these results, the sixth hypothesis (H6) is rejected because Financial Performance does not moderate the effect of Green Investment on market reaction in this study's model.
5. Financial Performance does not moderate the relationship between Carbon Emission Disclosure and Market Reaction. The interaction between Carbon Emission Disclosure and Financial Performance does not show a significant effect, indicating that carbon emission disclosures are not perceived as more valuable by the market, even when the company has strong financial performance.
6. Financial Performance does not moderate the relationship between Green Investment and Market Reaction. Investors have not yet responded meaningfully to green investment practices, even when implemented by companies with strong financial performance.

Limitations

This study has several limitations that may affect the results and the generalizability of the findings. These limitations include:

1. Based on the results of this study, Carbon Emission Disclosure (CED) does not have a significant effect on Market Reaction. This finding indicates that carbon emission information has not yet become a primary consideration for investors in Indonesia when assessing company performance. One possible reason is that corporate disclosures of emissions are still descriptive rather than quantitative, making comparisons between companies difficult. The researchers also faced challenges in measuring the CED index due to variations in report formats and content depth, which introduces a risk of subjective bias in the assessment.
2. Based on the results of this study, Green Investment (GI) does not have a significant effect on Market Reaction. This is likely because investors have not yet considered green investment information as a primary factor in investment decision-making. Furthermore, green investment practices in Indonesia are still relatively limited, poorly documented, and lack standardized reporting. The researchers faced limitations in optimally measuring the Green Investment variable, as most companies have not disclosed green investment information explicitly or in a standardized manner in annual reports or sustainability reports. This limitation may affect the accuracy of measuring the GI variable and impact the regression estimation results.
3. The analysis results indicate that Financial Performance does not moderate the relationship between Sustainability Assurance, Carbon Emission Disclosure, or Green Investment and Market Reaction. This suggests that a company's financial condition does not strengthen or weaken investors' perceptions of the sustainability information provided. Theoretically, financial performance should enhance the credibility of sustainability signals; however, in this context, such a relationship has not been significantly established. The researchers also faced limitations in capturing the dynamic interactions between these variables due to the

constraints of secondary data, which are aggregated and do not directly reflect investors' perceptions.

4. The data obtained come from companies' annual reports and sustainability reports, which vary in terms of format, presentation structure, and completeness of information. This inconsistency may introduce potential bias in data interpretation.
5. The quantitative approach used limits the scope for exploring qualitative factors, such as investors' perceptions or other contextual factors, which may play a role in shaping market reactions to sustainability practices.

Therefore, the findings of this study should be interpreted with caution and serve as a basis for further research that can expand the temporal scope, methodological approaches, and industry sectors studied.

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