



The Influence of Carbon Emission Disclosure, ESG Score, and Investment Opportunity Set on Firm Value of Energy and Manufacturing Companies with Profitability as a Moderating Variable.

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ABSTRACT

This study aims to examine the direct effects of Carbon Emission Disclosure (CED), Environmental, Social, and Governance (ESG) scores, and the Investment Opportunity Set (IOS) on firm value, as well as to investigate the moderating role of Return on Assets (ROA) in the relationships between these variables and firm value. The study focuses on energy and manufacturing companies listed on the Indonesia Stock Exchange (IDX) during the 2021–2024 period. Using a purposive sampling method, 38 companies were selected, resulting in 152 firm-year observations. Data were analyzed using two regression models with StataMP 17. The first model employs panel data regression to examine the direct effects of CED, ESG scores, and IOS on firm value, while the second model employs Moderated Regression Analysis (MRA) to examine the moderating effect of ROA. The results indicate that CED and IOS have positive and significant effects on firm value, whereas ESG scores have a positive but insignificant effect. Furthermore, ROA significantly strengthens the positive relationship between IOS and firm value. However, ROA does not significantly moderate the relationships between CED and ESG scores and firm value. Leverage, measured by the Debt-to-Equity Ratio (DER), is included as a control variable. These findings provide empirical evidence that firms' investment opportunities and carbon emission disclosure play an important role in enhancing firm value, while the effectiveness of ESG performance in influencing market-based firm value may depend on other contextual factors.

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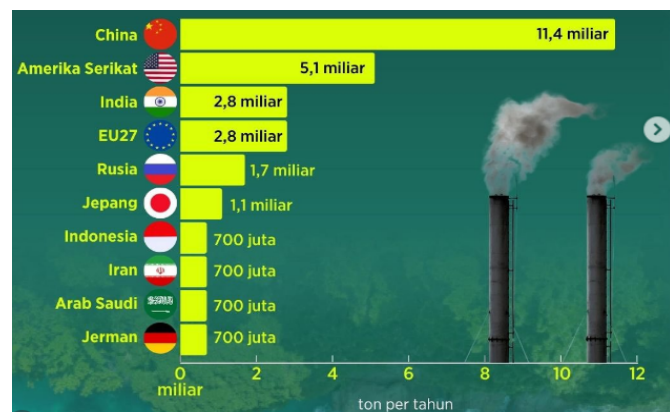
1. INTRODUCTION

Companies around the world are required to increase their company performance because of globalization and technological advances. Company must have a competitive advantage that can maximize short term goals and defend sustainability (long term goals) of their business. The company's short term goal is to utilize all available resources to maximize profits, while the long term goal is to maximize the company's value (Wijayaningsih & Yulianto, 2022). In this condition, Companies are required to remain competitive and motivated to enhance their value as an indicator of successful corporate management in order to attract investors to invest sustainably in the company (Wulanningsih & Agustin, 2020).

Firm value is the point of view investors about how effectively managers have succeeded in managing the resources entrusted to the company (Brigham & Houston, 2010). Mardiana & Wuryani (2019) also argue that firm value is a crucial indicator for shareholders when evaluating a company before making investment decisions, and that it reflects the level of shareholder wealth. For public companies, the stock price in the capital market can reflect the firm's value, and the share price will rise if a large number of investors invest in the company (Heng & Nugroho, 2023). Study from Nizam et al. (2019) and Ozer et al. (2023) argue that company performance can also be assessed from non-financial factors. Firm value can fluctuate not only from financial aspect but also from another factor like Good Corporate Governance (GCG) practices.

Currently, one of the environmental issues facing society is the increase in greenhouse gas emissions. Greenhouse gases are atmospheric gases originating from both natural processes and human (anthropogenic) activities they possess the ability to absorb and emit infrared radiation, thereby causing the greenhouse effect (Daeli, 2024). Rising greenhouse gas emissions have the potential to exacerbate global warming and disrupt climate systems, thereby increasing the risk of widespread and unavoidable impacts.

Figure 1. Ranking of countries producing gas emissions



Source: Global Carbon Project, 2023

Based on reports published by the Global Carbon Project in 2023, Indonesia is ranked among the top ten largest contributors of greenhouse gas emissions in the world. This condition impact to climate change. For example, flash floods had occurred last year in Sumatera, given impact to destruction of public facilities and vital infrastructure, while citizen suffered losses of property and the lives of their family members.

The industrial sectors that produces the highest levels of carbon emissions globally is the energy sector and manufactur companies related to using of natural resources in production

or operational activities such as manufacturing companies (Khairunisa & Pohan, 2022). These sectors play a vital role in creating employment opportunities, increasing industrial value added, and supporting national development (Harahap et al., 2026). However, the energy and manufacturing sectors are also among the industries with the greatest environmental impact compared to other sectors due to their high levels of energy consumption, extensive use of natural resources, and substantial carbon emissions generated from their operational activities.

Base on statement above, we know that the company has a responsibility to stakeholders regarding corporate governance. ESG has become a major concern the commitment demonstrated by the Indonesia Stock Exchange (IDX) toward sustainability practices through the launch of the IDX ESG Leaders Index in 2020. In 2021, 100 listed companies voluntarily and 44 listed companies mandatorily published ESG reports (Qurniyah et al., 2024). ESG represents a framework used by investors to evaluate corporate activities across environmental, social, and governance dimensions, and also serves as an indicator of non-financial performance (Kim & Li, 2021). Investors typically give positive reaction to company because they show a dedication to environmental sustainability, such as by revealing carbon emissions disclosure and funding eco-friendly projects, which eventually raises the company's value (Fatemi et al., 2015).

Another important aspect to be considered in ensuring a company's sustainability and influence firm value in this study is the investment opportunities set. The investment opportunity set is undertaken by companies to generate favorable value for the firm in the future. A higher level of investment opportunities within a corporation is associated with an increase in stock prices and, consequently, firm value (Wihandaru, 2016). Companies with a high level of Investment Opportunity Set (IOS) are associated with their ability to effectively utilize corporate resources or assets to generate profits, which in turn can maximize firm value and enhance shareholders' wealth (Handriani & Irianti, 2015). Investors expect that by obtaining positive information regarding a company's investment opportunity set and subsequently investing in the firm, they will receive higher returns (Wahasusmiah & Arshintia, 2022).

The relationship between carbon emission disclosure, ESG Score, and Investment Opportunity Set on firm value does not always proceed linearly rather, it is influenced by various factors, one of which is profitability. According to Handoko & Santoso (2023) profitability reflects how effectively a company utilizes its resources to generate profits and can be measured using Return on Assets (ROA). Companies with high profitability possess greater financial resources to implement sustainability initiatives, absorb environmental compliance costs, and pursue growth opportunities. And To optimize the relationship between the main variables and minimize the influence of other variables that are not the focus of the study, the researcher includes leverage as a control variable . Leverage is a technique commonly used by investors when they want to estimate the risks involved in a company (Agustiningsih & Septiani, 2022). In this study, leverage measure by using Debt to Equity Ratio (DER).

According to the previous discussion, studies on sustainability and the idea of green finance in investment activity are extremely pertinent and crucial to look at in the present since, as previously mentioned, the state of the Earth is becoming more and more concerning for the survival of its inhabitants. Given their high levels of environmental damage, significant investment requirements, and mounting pressure from investors and regulators to adopt sustainable business practices.

2. Literature Review

Signaling Theory

From signaling theory carbon emissions disclosure and ESG score are non-financial signal a company sends to investors regarding its commitment to environmental management and sustainability. This signal can boost investor confidence, as the company is perceived as better able to anticipate environmental regulatory risks, maintain its reputation, and create long-term value. One more signal that investors can observe is the Investment Opportunity Set (IOS). These investment opportunities provide positive signals regarding the company's future growth prospects. Companies with a high level of Investment Opportunity Set (IOS) are associated with their ability to effectively utilize corporate resources or assets to generate profits, which in turn can maximize firm value and enhance shareholders' wealth (Handriani & Irianti, 2015). Investors expect that by obtaining positive information regarding a company's investment opportunity set and subsequently investing in the firm, they will receive higher returns (Wahasusmiah & Arshinta, 2022).

Firm Value

According to, The firm value is a value of the firm is defined as investors perception of how successfully managers manage the resources entrusted to the company (Brigham & Houston, 2010). To measure firm value, Weston Fred & Copeland (2010) It states that firm value can be calculated using valuation ratios and market ratios. The most thorough indicators of a business's performance are valuation ratios like Price to Book Ratio, Market to Book Ratio, Market to Book Asset Ratio, Market Value of Equity, Enterprise Value, Price Earning Ratio and compare of the Book value and Market Value (Tobin's Q).

Carbon Emission Disclosure

According to Borduas & Donahue (2018), carbon emissions refer to the release of carbon-containing gases, such as carbon dioxide (CO₂) and chlorofluorocarbons (CFCs), into the Earth's atmosphere as a result of carbon-combustion processes. These emissions occur due to activities that produce greenhouse gases, which are the primary causes of Earth's climate change. Through such disclosures from annual report, stakeholders can obtain information about how companies implement sustainable development activities and the environmental protection efforts they undertake (Sudibyo, 2018). By disclosing carbon emissions, companies contribute to the transparency of information needed to understand and address climate change, while also demonstrating efforts to mitigate the negative environmental impacts arising from their operations.

ESG Score

ESG is a framework used to evaluate the extent to which a company conducts business sustainably and responsibly (Arif et al., 2020). ESG is a framework that consist of three main aspect, The first aspect is the Environmental, This refers to climate change, the utilization of natural resources, waste management, and environmental conservation initiatives (Irwansyah & Sebrina, 2024). The second aspect is social, The social aspect or social dimension refers to the social elements of communities and employees affected by the company's business activities. This responsibility includes issues such as respect for human rights, labor conditions, occupational health and safety protection, as well as interactions with surrounding communities and society (Irwansyah & Sebrina, 2024). And then the last aspect is governance relates to a company's performance in implementing transparency, accountability, and responsibility within its business operations (Kristina et al., 2026).

Investment Opportunity Set

Investment opportunity set is a combination company assets and the choice of investment in the future with a positive net present value (Kallapur & Trombley, 1999). The investment

opportunity set is undertaken by companies to generate favorable value for the firm in the future. A higher level of investment opportunities within a corporation is associated with an increase in stock prices and, consequently, firm value (Wihandaru, 2016).

According Kallapur & Trombley, (1999), there are three IOS proxy classifications. The first is IOS-based pricing proxy, This proxy consist of Market to Book Value of Asset (MBVA), Market to Book Value of Equity (MBVE), Earning to price ratio, and using Firm Value to Book Value Property, Plant and Equipment (VPPE). The second is IOS investment proxy, this proxy consir of Capital Expenditure to Book Value of Assets (CAPBVA), Capital Expenditure to Market Value of Assets (CAPMVA), and Investment Assets to Not Sales. The last is IOS-based variants proxy, this proxy using variabilites size to forecast growth invenstment with Variance of Total Return (VARET) and Market Model Beta.

Profitability

Profitability is the ability to generate profits using capital over a certain period (Wijayaningsih & Yulianto, 2022). Profitability can be calculated through various indicators such as Return on Assets (ROA), Return on Equity (ROE), Operating Ratio (OR), Gross Profit Margin (GPM), and Net Profit Margin (NPM). This ratio also provides a measure of a company's management effectiveness. The greater the profits earned, the greater the company's capacity to pay dividends and a higher dividend payout results in greater savings on the cost of capital (Nurhasanah & Kahfi, 2023).

Conceptual Framework

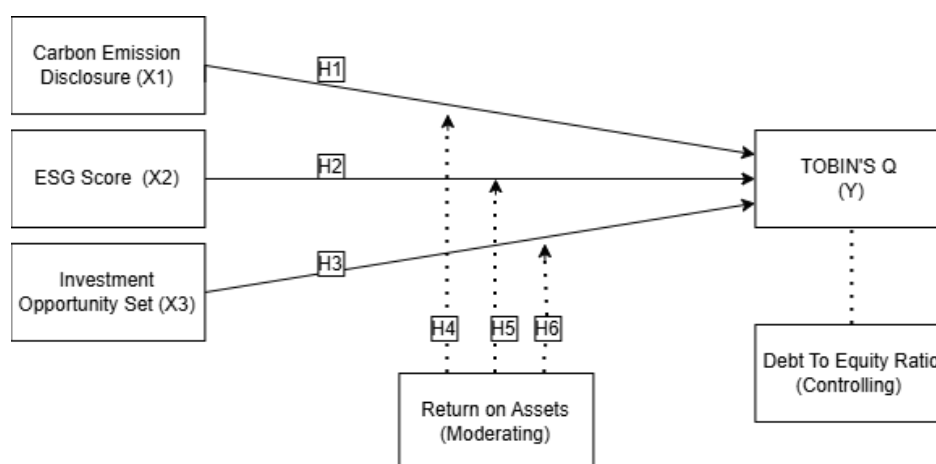


Figure 2. Conceptual framework

Figure 2 illustrates the conceptual framework in which there are three independent variables, namely carbon emission disclosure, ESG Score, and Investment Opportunity Set. Carbon emission disclosure is measured using a content analysis method with disclosure items from (Choi *et al.*, 2013). ESG Score data is collected by refinitiv website and the last is IOS measured by price-based proxy to measure the investment opportunity set, namely the Market to Book Value of Equity (MBVE), which reflects the investment opportunities available to a firm. The dependent variable in this research is firm value, calculated by using Tobin's Q ratio To optimizing relation between independent and dependent variable, in this research using control variable, the variable is ROA. ROA measured by Net Income divided by Total Asset. This research also consist of tone control variables, namely Leverage (DER) measured by Total Liabilities divided by Total Equity.

3. METHOD

In this study, the author using a quantitative research approach. This approach relies on numerical data for statistical analysis. The data used in this research are panel data, which combine cross-sectional data (multiple entities observed at one point in time) and time-series data (a single entity observed over multiple periods). By using secondary data from financial statements, sustainability reports, and supporting business financial information sourced from the Refinitiv Eikon website, this study focuses on The firms in the energy and manufacturing industry that are listed on the Indonesia Stock Exchange (IDX) for the 2021–2024 period. The required data include balance sheets, income statements, company notes to the financial statements, carbon emission disclosure information, and ESG Score disclosure.

The sample consists of energy and manufacturing companies listed on the Indonesia Stock Exchange between 2021 and 2024. A total of 38 companies were selected over a four-year observation period using the purposive sampling method. In this study, Data analysis use two regression models: the first using panel data analysis to assess direct effects on firm value, while the second used Moderating Regression Analysis (MRA) to examine the influence of the moderating variable. StataMP 17 software was used for the analysis

Table 1. Operational and Measurement Variable

Variable	Measurement	Source
Firm Value (Dependent Variable)	Tobin's Q = (MVE + Total Liabilities) / Total Asset Where: MVE = (Outstanding share x year-end stock prices)	(Murwaningsari & Rachmawati, 2023)
Carbon Emission Disclosure (Independent Variable)	The assessment of carbon emission disclosure is conducted by assigning a score of 1 to each item disclosed and a score of 0 to items not disclosed by the company. The maximum possible score is 18 points, while the minimum score is 0. The calculation formula is as follows: CED = $\sum di / M$ CED Where: CED : Pengungkapan Emisi Karbon $\sum di$: Number of disclosed carbon emission items M : Total carbon emission disclosure item refer to (Choi <i>et al.</i> , 2013).	(Choi <i>et al.</i> , 2013)
ESG Score (Independent Variable)	The ESG Score consists of Environmental, Social and Governance scores ranging from 0-100. Rating agencies like MSCI, Sustainalytics, FTSE Russell (LSEG), and Bloomberg assess ESG performance using a combination of company disclosures, public data, and proprietary research. In this study, The researcher using Refinitiv to get ESG Score.	(Setiani <i>et al.</i> , 2024)
Investment Opportunity Set (Independent Variable)	In this study, the researcher using Market to Book Value of Equiry (MBVE). The formula for MBVE can be presented as follows: MBVE= Outstanding share x year-end stock prices / Total Equity	(Firmansyah <i>et al.</i> , 2022)

Leverage (DER)	In this study, Leverage is measured using the Debt to Equity Ratio, with the following formula: DER = Total Debt / Total Equity	(Yuwono & Aurelia, 2021)
Return On Asset (Moderating Variable)	Return on Assets (ROA) is chosen as the measure of The formula for Return on Assets is as follows: ROA = Net profit / Total Asset	(Putri & Machdar, 2024)

4. RESULTS AND DISCUSSIONS

Statistic Analysis

According to (Sugiyono, 2014), Descriptive statistics are used to provide an overview or summary of the information contained in the data collected for a study. In this study, the descriptive statistical analysis presents the number of samples, total observations, mean values for each variable, standard deviations, as well as the minimum and maximum values of each variable

Table 2. Statistical Analysis Result

Variable	Obs	Mean	Std.Dev	Min	Max
CED	148	0,7147	0,1093	0,4444	0,9444
ESG	148	55,2790	18,1364	11,1742	87,4154
IOS	148	0,5406	0,9555	-1,6777	3,8034
DER	148	-0,2577	1,0077	-2,2814	1,6284
ROA	148	0,1025	0,0882	-0,0301	0,5570
TobinsQ	148	1,9254	1,7299	0,5717	10,5701

Based on table above, Tobin's Q represents Firm Value and serves as the dependent variable in this study. The mean value of Tobin's Q is 1,9254, indicating that the average Firm Value across the sampled companies tends to be around this value. The maximum value is 10,5701, while the minimum value is 0,5717. The standard deviation of Tobin's Q is 0.6493063, which is higher than its mean value. This indicates that there is considerable variation in Tobin's Q across the sampled companies, with the observations showing relatively substantial dispersion around the mean.

The mean value of Carbon Emission Disclosure (CED) is 0.7147, indicating that the average level of carbon emission disclosure among the sampled companies tends to be around this value. This also indicates that the level of carbon emission disclosure is relatively high, as the mean value is close to the maximum possible score based on the total number of disclosure items. The maximum value is 0.9444. The standard deviation is 0.1093298, which is lower than the mean value. This indicates that there is variation in CED across the sampled companies, but the dispersion of the observations is relatively low compared with the mean.

The mean ESG Score is 55.2709, indicating that the average ESG Score among the sampled companies is at a moderate level, with observations tending to be around this value. The maximum value is 87.4154, while the minimum value is 11.1742,. The standard deviation is 18.1364, which is lower than the mean value. This indicates that there is variation in ESG Scores across the sampled companies, but the dispersion of the observations is relatively low compared with the mean value.

IOS represents the third independent variable in this study. This variable was previously transformed using the natural logarithm (ln) to ensure that the research data met the requirements of the classical assumption tests. The mean value of IOS is 0.5406, indicating that the average IOS among the sampled companies tends to be around this value. The maximum value is 3.803, while the minimum value is -1.6777, recorded for PT Wijaya Karya Beton Tbk in 2024. The standard deviation is 0.9555, which is higher than the mean value. This indicates that there is considerable variation in IOS across the sampled companies, with the observations showing relatively large dispersion around the mean.

DER represents the control variable in this study. before to the analysis, this variable was also transformed using the natural logarithm (ln). The mean value of DER is -0.2577, indicating that the average transformed DER among the sampled companies tends to be around this value. The maximum value is 1.6284, while the minimum value is -2.2814. The standard deviation is 1.0077, which is higher than the mean value. This indicates that there is considerable variation in DER across the sampled companies, with the observations showing relatively large dispersion around the mean

The mean ROA is 0.10252, indicating that the average profitability level of the sampled companies tends to be around this value. The maximum value is 0.5570, while the minimum value is -0.0301. The standard deviation is 0.0882, which is lower than the mean value. This indicates that there is variation in ROA across the sampled companies, but the dispersion of the observations is relatively low compared with the mean value.

Regression Model

Chow Test

The Chow test is the first test conducted in selecting the appropriate panel data regression model between the Common Effect Model (CEM) and the Fixed Effect Model (FEM). The decision criterion is that if the probability value (Prob > F) is greater than 0.05, the Common Effect Model (CEM) is selected. Conversely, if the probability value (Prob > F) is less than 0.05, the Fixed Effect Model (FEM) is selected.

Table 3. Chow test model 1

F test that all $u_i=0$: F (37, 106) = 14,98	Prob > 0,0000
Fix Effect Model	

Based on the results of the Chow test for Model 1 presented in the table above, the probability value (Prob > F) is 0.0000, which is lower than 0.05. Therefore, the Fixed Effect Model (FEM) is selected as the appropriate panel data regression model based on the Chow test results.

Table 4. Chow test model 2

F test that all $u_i=0$: F(37, 103) = 8,66	Prob > 0,0000
Fix Effect Model	

Base on table above, the probability value (Prob > F) is 0.0000, which is lower than 0.05. Therefore, the Fixed Effect Model (FEM) is selected as the appropriate panel data regression model based on the Chow test results.

Hausman Test

The Hausman test is conducted to select the appropriate panel data regression model between the Random Effects Model (REM) and the Fixed Effects Model (FEM). This test is performed when the Fixed Effects Model (FEM) is selected based on the Chow test. The decision criterion is that if the probability value ($\text{Prob} > \text{Chi}^2$) is more than 0.05, the Random Effects Model (REM) is selected. Conversely, if the probability value ($\text{Prob} > \text{Chi}^2$) is less than 0.05, the Fixed Effects Model (FEM) is selected.

Table 5. Hausman test model 1

$\text{chi}^2(4) = 6,40$	$\text{Prob} > \text{chi}^2 = 0,1714$
Random Effect Model	

Based on the Hausman test results for Model 1 presented in the table above, the probability value ($\text{Prob} > \text{Chi}^2$) is 0,1714, which is more than 0.05. Thus, the Random Effects Model (REM) is selected as the appropriate panel data regression model for Model 1 and this model will test in the LM test.

Table 6. Hausman test model 2

Wald $\text{chi}^2(7) = 10,01$	$\text{Prob} > \text{chi}^2 = 0,1879$
Random Effect Model	

Based on the Hausman test results for Model 1 presented in the table above, the probability value ($\text{Prob} > \text{Chi}^2$) is 0,1879, which is more than 0.05. Thus, the Random Effects Model (REM) is selected as the appropriate panel data regression model for Model 1 and this model will test in the LM test.

Langrage Test

The Lagrange Multiplier (LM) test is conducted to compare the results with the Common Effect Model (CEM). The REM will be chosen if the both value is less than 0.05, whereas the CEM will be chosen if the Both value is more than 0.05.

Table 7. LM test model 1

$\text{Chibar}^2(01) = 98,49$	$\text{Prob} > \text{chi}^2 = 0,000$
Random Effect Model (REM) is selected	

Based on the LM test results Model 1 presented in the table above, the probability value ($\text{Prob} > \text{Chi}^2$) is 0,000, which is less than 0.05. Thus, the Random Effects Model (REM) is selected as the appropriate panel data regression model for Model 1.

Table 8. LM test model 2

$\text{Chibar}^2(01) = 62,01$	$\text{Prob} > \text{chi}^2 = 0,000$
Random Effect Model (REM) is selected	

Based on the LM test results Model 2 presented in the table above, the probability value ($\text{Prob} > \text{Chi}^2$) is 0,000, which is less than 0,05. Thus, the Random Effects Model (REM) is selected as the appropriate panel data regression model for Model 2.

Hypothesis Test (T test)

In this study, there are six hypothesis, hypotheses 1 until hypotheses 3 concern the direct relationship between the independent variables and the dependent variable, while hypotheses 4 until 6 concern the moderating effect of profitability on the relationship between the independent variables and the dependent variable. The hypotheses are as follows:

- H1: Carbon emission disclosure has a positive and significant effect on firm value.
- H2: ESG Score has a positive and significant effect on firm value.
- H3: Investment Opportunity Set has a positive and significant effect on firm value.
- H4: Profitability (ROA) strengthens the effect of Carbon Emission Disclosure on firm value.
- H5: Profitability (ROA) strengthens the effect of ESG Score on firm value

Table 9. T test Model 1

Tobins Q	Coef.	Std. Err.	z	P> z
CED	1,71831	0,77013	2,23	0,026
ESG	0,00082	0,00508	0,16	0,871
IOS	1,42998	0,13095	10,92	0,000
DER	-0,33183	0,10451	-3,17	0,001
Cons	-0,18757	0,62403	-0,30	0,764

Based on the table above, the panel data regression equation for Model 1 in this study is obtained as follows:

$$Y = -0,18757 + 1,71831_{CED} + 0,00082_{ESG} + 1,42998_{IOS} - 0,33183_{DER} + e$$

Based on the regression equation, the constant value (α) is -0,18757. The coefficient for the Carbon Emission Disclosure (CED) variable is 1,71831, indicating a positive relationship. The coefficient for the ESG Score variable is 0,00082 indicating a positive relationship. The coefficient for the Investment Opportunity Set (IOS) variable is 1,42998, indicating a positive relationship. Meanwhile, the coefficient for the Debt to Equity Ratio (DER) variable is -0,33183, indicating a negative relationship.

Based on the table above, the significance value $P>|z|$ for the Carbon Emission Disclosure (CED) variable is 0.026, which is lower than the alpha 0.05. The regression coefficient is 1,71831, indicating a positive relationship. This result demonstrates that Carbon Emission Disclosure has a positive and statistically significant effect on firm value. An increase of one unit in Carbon Emission Disclosure is associated with an increase in firm value of 1,71831, assuming that all other variables remain constant. Therefore, H1, which states that Carbon Emission Disclosure has a positive effect on firm value, is accepted.

From the perspective of Signaling Theory, Carbon Emission Disclosure can serve as a positive signal to the market. When a company voluntarily provides more transparent environmental information, it sends a signal regarding the quality of its environmental risk management and its commitment to sustainability and this can boost investor confidence in the company. This increased confidence reflected in higher stock valuations and ultimately increasing the company's overall value.

Based on the table above, the significance value $P>|z|$ for the ESG Score (ESG) variable is 0.871, which is more than the alpha 0.05. Therefore, the results indicate that the ESG Score does not have a statistically significant effect on firm value. Although the regression coefficient of the ESG Score is positive at 0,00082, this positive relationship but is not

significant. Thus, an increase in the ESG Score cannot be concluded to significantly increase firm value. Therefore, H2, which states that the ESG Score has a positive effect on firm value, is rejected.

The hypothesis testing results of this study reveal an interesting finding that contrasts with much of the existing literature. The rejection of this hypothesis is also consistent with the findings of several previous studies, including Steven & Yanti, (2026). This finding indicates that improvements in a company's ESG performance have not necessarily been directly translated into an increase in firm value by the market. Furthermore, this result suggests that the ESG signals communicated by companies in Indonesia have not yet been fully perceived by the market as sufficiently relevant or strong to influence investors' valuation decisions or generate additional firm value. Therefore, the findings of this study provide further empirical evidence that improvements in ESG performance do not necessarily result in an immediate increase in firm value, particularly within the context of the Indonesian capital market.

Based on the table above, the significance value $P > |z|$ for the Investment Opportunity Set (IOS) variable is 0.000, which is less than the alpha level of 0.05. The regression coefficient is 1,4299, indicating a positive relationship. Previously, the researcher transformed the value of this variable into natural logarithmic form, while the dependent variable (Y) remained in its original form, so the model is called a level-log (semi-log) model.

In a regression model where the independent variable IOS is transformed using the natural logarithm, while the dependent variable remains in its level form, the regression coefficient is interpreted based on the percentage change in the independent variable in relation to the change in the dependent variable in its original unit. Therefore, in a level-log model, the coefficient indicates that a 1 percent increase in the independent variable will change the dependent variable by units, holding other independent variables constant.

So based on the table above, it can be explained that Investment Opportunity Set (IOS) has a positive and statistically significant effect on firm value. Because IOS is in natural logarithm, the coefficient 1.4299 is interpreted by dividing by 100 for a 1% change in IOS. This means that, every 1% increase in IOS will increase Firm Value by 0.014299 units, assuming other independent variables are constant. Therefore, H3, which states that the Investment Opportunity Set has a positive effect on firm value, is accepted.

The results indicate that companies with greater investment and growth opportunities tend to receive higher valuations from the market. This may occur because IOS reflects a company's opportunities to invest in projects that have the potential to generate future economic benefits. According to Signaling Theory, company management needs to provide information that can serve as a signal to investors when assessing the company's future prospects. A high IOS indicates that a company has greater investment opportunities that can be utilized to expand business capacity, develop products, conduct business expansion, and generate new sources of revenue.

When investors receive a signal that a company has strong growth opportunities, they may develop higher expectations regarding the company's ability to generate future profits. These expectations can subsequently increase investor interest in the company. Increased demand for the company's shares may ultimately lead to higher stock prices, which are reflected in an increase in firm value.

Same finding from Zenabia & Falih (2024) in their study of infrastructure sector companies listed on the Indonesia Stock Exchange, found that the Investment Opportunity Set (IOS) has a positive and statistically significant effect on firm value. This finding further strengthens the argument that a company's investment opportunities constitute relevant information for investors in assessing firm value.

Furthermore, the Debt-to-Equity Ratio (DER) as the control variable has a significance value $P > |z|$ of 0.000, which is lower than the alpha level of 0.05. The regression coefficient of DER is -0,33183. The researcher also transformed the value of DER into natural logarithmic form, while the dependent variable (Y) remained in its original form, so the model is called a level-log (semi-log) model. Because of DER is transformed into a natural logarithm, the coefficient is interpreted as meaning that every 1% increase in DER will decrease Firm Value by 0.0033183 units, assuming other independent variables remain constant. Furthermore, a significance value of 0.000, which is less than 0.05, indicates that DER has a negative and statistically significant effect on Firm Value.

Table 10. T test Model 2

Tobins Q	Coef.	Std. Err.	z	$P > z $
CED	2,4996	0,8579	2,91	0,004
ESG	-0,0045	0,0053	-0,86	0,392
IOS	0,8790	0,1316	6,68	0,000
ROA	2, 3765	4,9977	0,48	0,634
CED*ROA	-11,6034	6,3071	-1,84	0,066
ESG*ROA	0,0325	0,0270	1,21	0,228
IOS*ROA	6,2479	0,8686	7,19	0,000
DER	-0,2961	0,0813	-3,64	0,000
Cons	2,0148	0,5059	3,98	0,000

Source: data analysis using StataMP 17, 2026

Based on the table above, the panel data regression equation for Model 2 in this study is obtained as follows:

$$Y \text{ Tobin's } Q = 2,0148 + 2,3765_{ROA} + 2,4996_{CED} - 0,0045_{ESG} + 0,8790_{IOS} - 11,6034_{CED*ROA} + 0,0325_{ESG*ROA} + 6,2479_{IOS*ROA} - 0,2961_{DER} + e$$

Based on the table above, CEDxROA interaction has a coefficient of -11.6034 with a significance value of 0.066 while this value more than 0,05. At a significance level of 5%, these results indicate that ROA does not moderate the effect of CED on firm value. However, the coefficient of the CEDxROA interaction is negative at -1.312578. This indicates that ROA does not strengthen the negative relationship between Carbon Emission Disclosure and firm value. Accordingly, H4 which states that ROA strengthens the positive effect of Carbon Emission Disclosure on firm value, is rejected.

In the first research model, Carbon Emission Disclosure was found to have a positive and statistically significant effect on Firm Value. This finding indicates that information regarding carbon emission management can be perceived as a positive signal by the market. However, the moderation results show that as ROA increases, the incremental effect of Carbon Emission Disclosure on Firm Value becomes smaller. This may occur because a high ROA already provides a direct positive signal regarding the company's financial performance to investors. Consequently, when a company already demonstrates strong financial performance, additional information regarding Carbon Emission Disclosure may provide relatively less incremental information to investors in determining Firm Value

Based on the Model 2 results in the table above, ESGxROA interaction has a coefficient of 0.0325 and the significance value $P > |z|$ for the interaction variable ESGxROA is 0,228, which

is more than the alpha level of 0,05. This result indicates that the ROA does not moderate the effect of CED on firm value. Although the interaction coefficient is positive, it cannot be said that ROA statistically strengthens the relationship between ESG and Tobin's Q. Accordingly, H5 which states that ROA strengthens the positive effect of ESG Score on firm value, is rejected.

These results indicate that ESG information does not necessarily elicit a different market response based on a company's level of profitability. Companies with a high ROA do not automatically make information about Environmental, Social, and Governance performance more relevant in determining Firm Value. Similarly, companies with a lower ROA do not necessarily make ESG information less relevant. This suggests that the relationship between ESG Score and Firm Value may be influenced by factors other than company profitability. The direct effect of ESG Score on Firm Value was also insignificant, further indicating that ESG information is not yet strong enough to be translated by the market into increased Firm Value, for both high- and low-profit companies. Therefore, ROA is not yet capable of significantly changing the relationship between ESG Score and Firm Value.

Furthermore, this study's results align with Laela and Widuri (2025), who found that ESG had no significant effect on Firm Value, and profitability did not act as a moderating variable in this relationship. These results indicate that ESG implementation does not necessarily result in a direct increase in firm value, and the level of company profitability has not been proven to strengthen this relationship. Therefore, this study's results further demonstrate that the influence of ESG on Firm Value is a complex relationship and is not solely determined by a company's ability to generate profits.

Based on the table above, the significance value $P > |z|$ for the interaction variable $IOS \times ROA$ is 0.000. This value is lower than the alpha level of 0.05, indicating that the interaction between the Investment Opportunity Set (IOS) and Return on Assets (ROA) has a statistically significant effect on firm value. The coefficient of the $IOS \times ROA$ interaction is positive at 6,2479. This indicates that ROA strengthens the positive relationship between the Investment Opportunity Set and firm value. In other words, as ROA increases, the positive effect of IOS on firm value tends to become stronger.

Previously, the researcher transformed the value of this variable into natural logarithmic form, while the dependent variable (Y) remained in its original form, so the model is called a level-log (semi-log) model. Because IOS is in natural logarithm, the coefficient 6,2479 is interpreted by dividing by 100 for a 1% change in IOS. This means that every 1% point increase in ROA will increase the influence of $\ln(IOS)$ on Tobin's Q by 0.062479. Therefore, H6, which states that ROA strengthens the positive effect of the Investment Opportunity Set on firm value, is accepted.

Furthermore, the moderation results indicate that the strength of the IOS signal does not operate independently. ROA strengthens the effect of IOS on Firm Value, suggesting that investors consider not only whether a company possesses investment opportunities but also its actual ability to generate profits from the resources it controls. Base on signaling theory, IOS provides information regarding the company's growth potential, whereas ROA provides information regarding the company's ability to generate profits from its available assets. Therefore, the combination of high IOS and high ROA provides investors with a stronger and more comprehensive signal. A high IOS indicates that the company has substantial future growth opportunities, while a high ROA demonstrates that the company has the financial capability to utilize its assets effectively and convert available resources into profits. This combination may increase investor confidence in the company's ability to transform

investment opportunities into actual economic benefits, thereby strengthening the positive effect of IOS on Firm Value.

Similar findings were reported by Zenabia & Falih (2024) in their study of infrastructure sector companies, as well as by Antika et al, (2025) in their study of food and beverage companies. Their studies found that ROA moderates the relationship between IOS and Firm Value by strengthening the positive effect of IOS on Firm Value. The study found that IOS moderated by ROA strengthens the positive relationship with Firm Value. This finding also reinforces the results of H3 in Model 1, which demonstrate that IOS has a positive and statistically significant effect on Firm Value. With ROA acting as a moderating variable, the positive effect of IOS becomes stronger.

For the Debt to Equity Ratio (DER) as a control variable in Model 2, the significance value $P > |t|$ is 0.000. This value is lower than the alpha level of 0.05. The DER coefficient of -0.2961 shows that negative direction. The researcher also transformed the value of DER into natural logarithmic form, while the dependent variable (Y) remained in its original form, so the model is called a level-log (semi-log) model. Because of DER is transformed into a natural logarithm, the coefficient is interpreted as meaning that every 1% increase in DER will decrease Firm Value by 0.002961 units, assuming other independent variables remain constant. Furthermore, a significance value of 0.000, which is less than 0.05, indicates that DER has a negative and statistically significant effect on Firm Value.

The findings of this study are also consistent with Huatauruk et al. (2024) who found that leverage has a negative and statistically significant effect on Firm Value among companies listed on the Indonesia Stock Exchange. Their findings indicate that high leverage can serve as a negative signal because it reflects a higher level of financial risk, which may ultimately reduce investors' interest in the company's shares. Consequently, companies need to maintain their capital structure at an optimal level so that the benefits of debt financing outweigh the financial risks associated with its use.

4. CONCLUSION

The results consist of 6 hypotheses, of which 3 hypotheses are supported and 3 hypotheses are rejected. This study is expected to provide benefits to various stakeholders, particularly academics, companies, investors, and the broader community, by enhancing their understanding of the effects of Carbon Emission Disclosure, ESG Score, investment opportunities, and the role of profitability in strengthening these relationships with Firm Value.

Overall, this study provides one main implication is Firm Value is determined not only by the amount of information disclosed by a company but also by how such information is supported by the company's fundamental condition. The findings reveal different patterns across the variables examined. Carbon Emission Disclosure (CED) has a positive effect on Firm Value, ESG Score does not have a direct significant effect, while Investment Opportunity Set (IOS) has a positive effect on Firm Value. When ROA is incorporated as a moderating variable, ROA weakens the effect of CED but strengthens the effects IOS on Firm Value and can not moderate the effect ESG on Firm Value.

The findings provide implications from the perspective of Signaling Theory. Information disclosed by companies can help investors form expectations regarding corporate quality and future prospects. In the context of IOS, investment opportunities can be perceived as a signal of the company's future growth potential. Antika et al. (2025) explicitly explain that IOS represents a positive signal reflecting a company's growth potential and can increase investor attention and Firm Value.

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