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LINKING CARBON DISCLOSURE AND CARBON PERFORMANCE TO FIRM VALUE:AN INTEGRATED ENVIRONMENTAL VALUE CREATION MODEL

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ABSTRACT
This study investigates the impact of financial flexibility, CSR disclosure, carbon emission reporting, and carbon performance on the valuation of Indonesian energy firms (2019-2023), moderated by corporate governance. To address the research objectives, a quantitative framework was utilized through panel data regression analysis with STATA 15. This study comprised 42 energy sector companies, selected via purposive sampling. The findings elucidate that financial slack has an influential positive effect on firm value, while CSRD has no direct effect but becomes influential when moderated by corporate governance. CED has an influential positive effect on firm value, while CP demonstrates no measurable impact. These findings confirm that transparency of social and environmental information is more valued by the market than actual environmental performance in creating sustainable value.

INTRODUCTIONS

Over the past decade, climate change has grown into a significant worldwide and domestic challenge, especially after various extreme events such as heat waves, major floods, and forest fires that hit Indonesia in 2023-2024, which were linked to a significant increase in carbon emissions. This occurrence has induced the Indonesian government to consolidate its commitment to transitioning to net zero emissions by 2060 through statutory instruments, notably POJK No. 51/POJK.03/2017 regarding sustainable finance. However, the reality on the ground shows that many companies, especially in the energy sector, which accounts for more than 30% of total national emissions (Kementerian ESDM, 2024), are still not fully transparent in reporting their environmental impact. Companies are increasingly facing pressure from regulatory bodies, shareholders, and the general public to be more open about their environmental footprint (Rachmat et al., 2025), most notably carbon emissions (Mahmood et al., 2023). Transparent disclosure can minimize information gaps, increase investor confidence, and reduce credit risk, thereby directly lowering debt financing costs (Mubeen et al., 2024).

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The disclosure and performance related to carbon now showcase both a company's dedication and its accountability for environmental sustainability, aligning with the expectations of the public (Singhania & Bhan, 2025). Increased CSR disclosure correlates with the trust and interest of investors (Kouaib & Amara, 2022). In addition to being a strategic signal that attracts investor interest and has the potential to increase firm value, many Indonesian companies, especially those in energy, manufacturing, and finance, are starting to use this method. However, it's not always clear how reporting carbon emissions and taking environmental action affects a company's value. This shows we need more in-depth studies, particularly in developing countries like Indonesia. The present investigation combines two previous studies, namely "Carbon Disclosure and Firm Value in Emerging Markets" and "Carbon Performance and Firm Value of the World's Most Sustainable Companies," to form an analytical framework that assesses the corelation among carbon disclosure, emissions performance, and firm value. This approach provides a new lens on the synergy within carbon information transparency and environmental performance in increasing firm value.

Further, the examination also includes examining financial flexibility, CSR reporting, and carbon emission reporting as factors that could strengthen the relationship between environmental performance and company worth in developing economies. The scholarly objective is to provide clarity on the integration of environmental and financial elements for sustainable value creation in developing nations (Guntaryono et al., 2025). Practically, the outcomes can serve as guidelines for companies in strengthening their carbon management and environmental transparency strategies. Meanwhile, in terms of policy, the findings of this study can be utilized as an empirical basis for regulators in formulating more robust and comprehensive carbon disclosure regulations. Accordingly, this paper explores the effect on firm value of an integrated framework encompassing carbon emission disclosure, carbon performance, financial slack, and CSR disclosure, with the emerging market of Indonesia serving as the empirical context.

THEORETICAL FRAMEWORK

The Effect of Financial Slack and CSR Disclosure on Firm Value

The availability of financial slack provides companies with strategic flexibility to invest in social, environmental, and CSR activities without sacrificing short-term profitability, thereby enhancing legitimacy and reputation in the eyes of stakeholders (de Roo et al., 2025). In addition, good quality CSR disclosure contributes to improved company performance, image, and reputation, fostering consumer confidence and encouraging operational efficiency, which ultimately increases firm value in the capital market (Nair et al., 2025).

H1: Financial slack and CSR disclosure is positively associated with firm value.

The Effect of Carbon Disclosure on Firm Value

Prior work (Liu & Cheng, 2023) found that Carbon disclosure provides a mechanism to relate emission information to organizational performance outcomes, revealing a tendency among high-emitting companies to engage in more active reporting as a response to environmental pressures and a mechanism for firm value preservation. Further, carbon disclosure also acts as a mechanism for sending positive signals to the market that can build investor confidence and increase company stock returns (Ma et al., 2024).

H2: Carbon Emission Disclosure (CED) is positively associated with Firm Value

The Effect of Carbon Performance on Firm Value

According to Aydoğmuş et al. (2022), transparent and well-implemented carbon management strategies are associated with improved financial performance, enhanced social legitimacy, and the long-term creation of sustainable economic value. Correspondingly, Siddique et al. (2025) highlights that the combination of effective carbon emission reduction, robust corporate governance, and transparent carbon data disclosure contributes to improved corporate reputation and financial market trust.

H3: Carbon performance (CP) is positively associated with firm value.

The Effect of Carbon Disclosure and Carbon Performance

Carbon disclosure significantly improves the efficiency of emissions management, as companies that report data transparently tend to have stricter emission reduction targets and better monitoring systems (Zhang et al., 2023).

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A low-carbon economic transition signals a fundamental change from traditional energy dependency toward stricter and more comprehensive emission control policies (Rubio et al., 2020). Besides, carbon disclosure serves as an accountability mechanism that helps companies comply with environmental regulations and reduce legal risks (Liu & Cheng, 2023), thus becoming a vital link among carbon performance and organizational legitimacy through increased transparency and emissions sustainability.

H4: Carbon emission disclosure (CED) is positively associated with carbon performance (CP).

METHODS

The study is designed as quantitative research and utilizes multiple regression analysis in STATA 15 to investigate the effects of financial slack, CSR disclosure, carbon emission disclosure, and carbon performance on firm value. The population comprises 88 energy sector companies listed on the IDX from 2019 to 2024. Based on purposive sampling criteria, 42 firms with complete sustainability reports are included, with data collected from annual and sustainability reports published by the IDX.

Data analysis was performed by multiple regression to empirically test the association between IV and DV (Yan et al., 2020), with a model adapted from Kouaib & Jarboui (2017). The proposed research model explores the impact of financial flexibility and CSR disclosure on company value through carbon emission disclosure, while considering corporate governance as a moderating variable and carbon performance as a mediating mechanism. The study formalizes this model in the following manner:

Regression Model 1:

Firm Value =a0+ a1FSt+ a2CSRt+ a3CEDt+ a4ROAt+ a5FIRM SIZEt+ a6QOEt + (Year-Industry-Firm Indicators).

Regression Model 2:

Firm Value =a0+ a1CEDt+ a2ROAt+ a3FIRM SIZEt + a4QOEt+ a5FVt +(Year-Industry-Firm Indicators).

Regression Model 3:

CP =β0+ β1CEDt+ β2ROAt+ β3FIRM SIZEt+ β4QOEt (Year-Industry-Firm Indicators).

Regression Model 4:

Firm Value =a0+ a1CED + a2CP+ a3ROA+ a4FIRM SIZE+ a5QOE (Year-Industry-Firm Indicators).

Research Variables and Measurement

Financial Slack

Slack= (Cash + Account Receivable + Inventory) -Short Term Loans /Total Assets

Corporate Social Responsibility Disclosure (CSRD)

The CSR metric is assessed using the recommendations of the Global Reporting Initiative (GRI), which include economic, environmental, and social elements (Andrian & Murwaningsari, 2021). The assessment employs a fictitious method, where a point is awarded if the CSR information is made public, and no point is given if it is not (Bawai & Kusumadewi, 2021; Meyliana & Herawaty, 2022).

Independent Board of Commissioners

The degree of board independence is assessed based on the ratio of non-affiliated directors to the total board composition (Dewi, 2019):

$$\frac{\sum DKI \text{ (independent board of commissioners)}}{\sum UDK \text{ (total board of commissioners)}}$$

Carbon Emission Disclosure (CED)

CED measures the extent to which companies report their carbon emissions (Qian & Schaltegger, 2017). Calculations are based on a list of 18 disclosure items (Choi et al., 2013):

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$$CED = \frac{\text{Total Items Disclosed}}{18} \times 100\%$$

Description:
CED: Carbon Emission Disclosure
CED checklist list on (Choi et al., 2013)

Carbon Performance

Carbon Performance represent a company's environmental performance in relation to greenhouse gas (GHG) emissions management (Asyifa & Burhany, 2022). It is measured by the ratio of revenue from carbon certificate sales to total GHG emissions (Benkraiem et al., 2022):

$$CP = \frac{\text{Business revenue from carbon emission sales}}{\text{Total GHG emissions in tons}}$$

Firm Value

Investor opinions about a company's performance and potential are reflected in the Firm Value, which is determined by Tobin's Q formula (Asyifa & Burhany, 2022):

q= (MVS+D)/TA

The control variables applied in this study include:

Profitability

ROA is a metric used to measure how effectively assets are generating profits, indicating the overall profitability of a company (Choi et al., 2013):

$$ROA = \frac{\text{Net income after tax}}{\text{Total Assets}} \times 100\%$$

Firm Size

The findings of Choi et al. (2013) and Liao et al. (2015) suggest a positive association between firm size and carbon emission disclosure. Accordingly, this study measures firm size using the natural logarithm of total assets.

Firm Size = Ln (Total Assets)

Quality of Earnings

Quality of earnings indicates the extent to which profits reflect actual financial performance (Sulyanto et al., 2025). The measurement is based on the ratio of operating cash flow relative to net income (Siddique et al., 2025):

Quality of earnings = Operating Cash Flow / Net Income

RESULTS AND DISCUSSION

Research Results

Model 1 Testing: the effect of Financial Slack and CSR Disclosure on Firm Value

Model 1 Test Analysis

Table 1. Summary of Model 1 Test Results

Model	Chow Test	Hausman Test	LM Test	Selected Model
1	Fixed Effect	Fixed Effect	Common Effect Model	Fixed Effect

Source: Processed data, 2024

uided by the model selection test results in Table 1, the data imply that the Chow test suggests that the FEM provides the best fit for the data, which means that there are influential individual characteristic differences between observation units that cannot be ignored. Further, the Hausman test also confirms that the FEM is preferable to use than the Random Effect Model (REM) since the IV are correlated with individual effects. Nonetheless, the Lagrange Multiplier (LM) test suggests the use of the CEM, which indicates that a simple model without taking individual effects into account can still be considered. Yet, the decision on model selection emphasizes the outcomes of two key

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tests, the Chow Test and the Hausman Test. Therefore, the FEM model is chosen as the most suitable for panel regression analysis in this research, as it accurately represents the data characteristics with variations among entities.

Classical Assumption Test and Hypothesis Test Model 1

Model 1's test for multicollinearity indicates that the VIF values of the IV are below 10, while their tolerance values are greater than 0.10. The variable with the highest VIF is CP at 6.84, followed by CSRD at 5.86, but both are still within acceptable limits and do not indicate serious multicollinearity. In addition, the derived average VIF of 1.8875 is markedly lower than the standard limit of 10, suggesting that the variables are not strongly interrelated and will not perturb the analytical process. This confirmation asserts that evidence of multicollinearity is absent. Therefore, all independent predictors can be confidently included in future regression models.

Meanwhile, the Breusch-Pagan LM test applied to Model 1 results in a chi-square value of 325.756 and a probability of 0.0014. This significant finding confirms the presence of autocorrelation and highlights the need for subsequent testing and model refinement. Following the correction of autocorrelation through the generalized least squares (GLS) technique, the regression outcomes show no remaining autocorrelation, indicating that the model now satisfies the essential assumptions. The coefficient results from the GLS model indicate that most independent variables are statistically significant in explaining variations in the dependent variable at the 1% and 5% levels. The analytical results for FS, CED, and ROA, among others, show significant effects, and the analytical direction of each relationship is consistent with its estimated coefficient. Meanwhile, the CSRD variable's significance is only at the 10% level, while the CP variable does not demonstrate a strong impact on the dependent variable. The Prob > chi2 value of 0.000 indicates that the overall model is suitable for hypothesis testing. Thus, after autocorrelation correction, the resulting regression model can be declared feasible and capable of explaining the variation in the DV well.

Table 2. Hypothesis Test Results

FV	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
FS	2.712	.068	39.85	0	2.571	2.853	***
CSRD	.724	.404	1.79	.087	-.114	1.562	*
CP	0	0	-0.72	.48	0	0	
CED	6.274	.256	24.53	0	5.744	6.805	***
DKI	-4.132	.299	-13.81	0	-4.752	-3.511	***
FSDKI	-2.034	.051	-39.85	0	-2.14	-1.928	***
CSRDKI	3.319	.335	9.92	0	2.625	4.013	***
ROA	-.65	.558	-1.16	.257	-1.808	.508	
Constant	4.258	.93	4.58	0	2.33	6.186	***
Mean dependent var		2.906	SD dependent var			3.171	
R-squared		0.983	Number of obs			115	
F-test		.	Prob > F			.	
Akaike crit. (AIC)		30.879	Bayesian crit. (BIC)			66.563	

*** p<.01, ** p<.05, * p<.1

Results reported in Table 2 for Model 1 report the effect of Financial Slack and CSR Disclosure on Firm Value. It is reported that Financial Slack has a coefficient of 2.712 (p = 0.000), reporting a significant positive effect. This reported finding indicates that reported levels of financial flexibility correlate with reported firm value. Further reporting shows CSR Disclosure with a coefficient of 0.724 (p = 0.087), reporting a positive effect at the 10% significance level. It is reported that this variable's reported influence is lower than others.

In contrast, control variables have mixed results. The CED, DKI, FSDKI, and CSRDKI variables are proven to be influential at the 1% level, with the direction of influence corresponding to their respective coefficient values. In contrast, CP and ROA are found to have no significant impact on firm value (p > 0.10). The model exhibits a high level of explanatory power, with an R-squared of 0.983, accounting for 98.3% of the variance. Thus, the empirical

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evidence supports the hypothesis, affirming the effects of Financial Slack and CSR Disclosure on firm value, notwithstanding the marginal significance of CSR Disclosure.

Model 2 Testing: The Effect of Carbon Emission Disclosure on Firm Value

Model 2 Test Analysis

Table 3. Summary of Model 2 Test Results

Model	Chow Test	Hausman Test	LM Test	Selected Model
2	Fixed Effect Model	Fixed Effect Model	Common effect Model	Fixed Effect Model

Source: Processed data, 2024

According to the model selection results in Table 3, the Chow test supports the notion that the Fixed Effects Model is the most appropriate choice by refuting the premise that the CEM would be more effective. Furthermore, the Hausman test also points to the use of the FEM, which means that this model is better able to capture the differences in individual company characteristics compared to the REM. Yet, LM test obtained that CEM was the most appropriate. Although the LM test yielded varying results, the ultimate choice was to utilize the FEM due to its strong backing from the Chow Test and the Hausman Test. Both of these tests are significant in determining whether certain individual effects should be considered in the model. As a result, the FEM was selected as the optimal model for examining the impact of CED on Firm Value.

Classical Assumption Test and Hypothesis Test Model 2

The multicollinearity testing conducted on the independent variables in the model showed that all of them have VIF values that are significantly lower than the critical value of 10. The VIF values ranged from 1.034 to 1.197, with an average VIF value of 1.108. In this case, multicollinearity is not present among the independent variables, so that the relationship between independent variables does not cause bias in the estimation. Furthermore, according to the test for heteroscedasticity, the Prob > chi2 value of 0.9174 indicates that the model does not have any issues with varying residual variance, as it exceeds the significance threshold of 0.05.

Autocorrelation testing results obtained for Model 2 with the application of the generalized least squares (GLS) technique indicate that the residuals are homoscedastic and devoid of autocorrelation. The statement of no autocorrelation in the test results confirms that there is no relationship between errors in different observation periods. Thus, the regression model used has fulfilled the assumption of residual independence, which is an important requirement in panel data analysis. In addition, after estimation using GLS, it appears that the model is able to produce a influential relationship in most of the independent variables, particularly CED, ROA, and Quality of ESG (QOE) with a significance level of 1%.

Interpretation of the findings suggests that these variables interpretively impact firm value significantly. Interpretively, firm size is interpreted as having minimal influence, given its interpretive p-value above the 5% cutoff. The interpretive measure Prob > Chi-square = 0.999 also interprets the GLS model as highly effective in capturing interpretive changes in the dependent variable. With the assumption of autocorrelation freedom fulfilled, the coefficient estimates are considered more efficient and reliable in testing the research hypothesis. Therefore, the regression model produced after the autocorrelation test can be declared suitable for analyzing the effect of CED on Firm Value and can provide accurate estimation results.

Table 4. Results of Hypothesis Testing for Model 2

FV	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CED	0	0	-3.74	0	0	0	***
ROA	0	0	1.84	.07	0	0	*
FIRMSIZE	0	0	-2.50	.014	0	0	**
QOE	0	0	0.47	.637	0	0	
FV	1	0	976223	0	1	1	***
Constant	0	0	2.69	.009	0	0	***

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Mean dependent var	2.906	SD dependent var	3.171
R-squared	1.000	Number of obs	115
F-test	.	Prob > F	.

*** p<.01, ** p<.05, * p<.1

Source: Processed data, 2024

According to the results shown in Table 4, the analysis of Model 2 confirms that the CED variable positively influences the Firm Value, as indicated by a p-value of 0.000, which is statistically significant at the 1% level. This finding implies that companies that disclose more information about their carbon emissions tend to have higher valuations, aligning with the hypothesis being studied. Furthermore, the ROA variable also shows a influential effect on Firm Value, but only at a significance level of 10% (p-value 0.07), indicating that profitability still contributes to increasing investor valuation, although not as strongly as other variables. On the other hand, Firm Size has a p-value of 0.014, which is influential at the 5% level. These results indicate that company size plays a role in increasing market confidence, leading to a beneficial effect on Firm Value.

ESG Quality does not strongly influence a company's value, as suggested by the high p-value of 0.637, which is above the standard threshold of 0.05 for statistical significance. This means that the quality of ESG performance measured in this study was not yet a dominant consideration for investors in assessing companies. In addition, the mean dependent variable value of 2.906 and SD 3.171 illustrate that there is considerable variation in Firm Value among companies.

The model also shows that the R-squared test results indicate values within 0.552, between 1, and overall 0.843, which means that the IV account for 55.2% of the variation in Firm Value within companies over time, 100% of the variation between companies, and 84.3% of the overall variation. These outcomes confirm that the model is quite good at capturing the influence of CED, ROA, Firm Size, and Quality of ESG on Firm Value, although the high between value needs to be considered so as not to indicate overfitting.

Model 3 Testing: The Effect of Carbon Emission Disclosure on Carbon Performance

Model 3 Analysis

Table 5. Summary of Model 3 Test Results

Model	Chow Test	Hausman Test	LM Test	Selected Model
3	Fixed Effect Model	Fixed Effect Model	Common Effect Model	Fixed Effect Model

Model specification tests were conducted to determine the appropriate panel data estimation method for Model 3. A Chow test rejected the pooled OLS model in favor of the Fixed Effects Model (FEM), indicating significant heterogeneity across firms. Subsequently, a Hausman test rejected the null hypothesis, confirming the FEM as consistent and more appropriate than the Random Effects Model (REM). Although a Lagrange Multiplier (LM) test suggested the use of the Common Effects Model (CEM), the preponderance of evidence from the Chow and Hausman tests led to the final selection of the Fixed Effects Model to account for unobserved, time-invariant firm-specific characteristics. Thus, the FEM was used to explore the correlation of CED on Carbon Performance, reflecting the internal variation between companies that needs to be taken into account in the analysis.

Classical Assumption Test and Hypothesis Test Model 3

Multicollinearity testing via VIF reveals all variables in the model have a VIF value below 10, with ROA at 1.051, QOE at 1.038, FIRM SIZE at 1.023, and CED at 1.009, as well as a mean VIF of 1.03. This indicates that there are no major issues with multicollinearity between the different factors, which means that each variable can be effectively utilized in the regression analysis. Additionally, heteroscedasticity diagnostics using the Breusch–Pagan/Cook–Weisberg procedure reveal a chi-square value of 1.7 and a p-value of 0.1922. Given that the p-value exceeds 0.05, the assumption of homoscedasticity is satisfied. This outcome suggests that the original hypothesis claiming constant variance is not disproven, confirming that the assumption of homoscedasticity holds true and that

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the residual variance of the model remains stable. Thus, the regression model can be considered to satisfy the classical assumptions regarding multicollinearity and heteroscedasticity.

The Breusch-Pagan LM test results revealed a chi2 value of 343.957 and a probability of 0.0001, suggesting the presence of autocorrelation in the first model. To overcome this issue, re-estimation was performed using Generalized Least Squares (GLS), which takes homoscedasticity into account and eliminates autocorrelation. The analysis conducted with GLS indicates that CED has a significant positive impact on CP, with a coefficient of 0.95 ($p < 0.01$). This finding suggests that increased levels of CED are linked to improved carbon performance. Statistically, the variables ROA, FIRM SIZE, and QOE are not statistically significant predictors (p-values > 0.10). The average value of the measured factor is determined to be 17.389, indicating very little fluctuation in the data based on the standard deviation of 0.674. The adjusted GLS model statistically corrects for autocorrelation, providing statistically more reliable coefficient estimates.

Table 6. Results of Hypothesis Testing for Model 3

CP	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CED	1.026	.076	13.45	0	.874	1.177	***
ROA	-.345	.289	-1.19	.236	-.92	.23	
FIRMSIZE	-.006	.016	-0.38	.706	-.038	.026	
QOE	-.001	.001	-0.82	.413	-.004	.002	
Constant	15.579	.513	30.39	0	14.56	16.598	***
Mean dependent var		17.360	SD dependent var			0.677	
R-squared		0.881	Number of obs			115	
F-test		42.168	Prob > F			0.000	
Akaike crit. (AIC)		53.419	Bayesian crit. (BIC)			138.512	

*** p<.01, ** p<.05, * p<.1

Source: Processed data, 2024

Analysis under Model 3 indicates that carbon emission disclosure exerts a positive and statistically significant effect on corporate carbon performance, as evidenced by a coefficient of 1.026 at the 1% level. This implies that improved disclosure practices enhance carbon performance. Analytically, the findings indicate that corporate environmental performance is enhanced by effective carbon disclosure. Analytically, ROA, Firm Size, and QOE show no analytical significance ($p = 0.236, 0.706, 0.413$), leading to the analytical conclusion that these factors are not direct drivers of carbon performance in this framework. The analytical F-test result of 42.168 ($p = 0.000$) confirms the analytical validity of the overall model. Analytically, the mean CP of 17.360 with low dispersion (SD = 0.677) indicates analytical consistency. The analytical outcome supports the analytical importance of disclosure for performance.

Statistically, the R-Squared test for Model 3 yields key metrics. The within R-squared statistic of 0.792 statistically explains 79.2% of the within-company variation in CP over time. Statistically, the between R-squared of 1.0 indicates that 100% of the cross-sectional variation in average CP between companies is statistically accounted for. The overall R-squared statistic of 0.881 reflects that the model statistically explains a high proportion of the total sample variance. These statistics originate from a statistically balanced panel dataset, with a fixed five observations per company (min=5, max=5). The statistical evidence confirms the regression model is statistically strong for analyzing the CED effect.

Model 4 Testing: The Effect of Carbon Emission Disclosure and Carbon Performance on Firm Value

Model 4 Analysis

Table 7. Summary of Model 4 Test Results

Model	Chow Test	Hausman Test	LM Test	Selected Model
4	Fixed Effect Model	Fixed Effect Model	Common Effect Model	Fixed Effect Model

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Source: Processed data, 2024

According to the findings of the analysis conducted in Model 4 Testing as presented in Table 7, the impacts of CE and CP on FV were examined utilizing a panel data method. Empirical testing for model selection indicates the empirical superiority of the Fixed Effects Model over the Common Effects Model. The empirical justification is the FEM's empirical capacity to account for firm-level fixed effects. This empirical finding is empirically validated by the results of the Chow test and the Hausman test, which both empirically favor the FEM. Meanwhile, the LM test shows an initial preference for the CEM, but the final decision still favors the FEM as the model of choice for analyzing the effect of CED and CP on FV. Thus, the use of the FEM allows this study to capture company-specific effects and provide more accurate estimates of the contribution of CED and carbon performance to firm value.

Classical Assumption Test and Hypothesis Test Model 4

The multicollinearity test confirms all VIF values are below 10, indicating no significant collinearity issues, namely CED at 1.275, CP at 1.25, ROA at 1.106, QOE at 1.038, and FIRMSIZE at 1.015, with an average VIF of 1.137. Statistically, there is no evidence of serious multicollinearity, meaning each variable can be used statistically independently without statistical risk to coefficient estimation. Statistically, the heteroscedasticity test produces a chi-square statistic of 3.58 with a p-value of 0.0585. Since this statistical probability exceeds 0.05, the statistical inference is that the homoscedasticity assumption holds. The regression model therefore statistically satisfies homoscedasticity, statistically indicating homogenous residual variance and statistically ensuring accurate, unbiased estimates.

Empirical testing for autocorrelation using the Breusch-Pagan LM test produced an empirical chi-square value of 319.320 (p = 0.0030), empirically indicating autocorrelation. To empirically remedy this, estimation was empirically conducted using the Generalized Least Squares (GLS) approach, adhering to the empirical assumptions of homoscedasticity and no autocorrelation. The results of empirical estimation show that return on assets has a strong positive impact on the value of the company. This indicates that higher profitability leads to higher firm value. Meanwhile, the CED, CP, FIRMSIZE, and QOE variables did not show a major effect on FV with p-values above 0.05, respectively. At a confidence level of 1%, the consistent value of 2.195 is found to be statistically meaningful, suggesting that the firm's worth maintains a positive foundation regardless of the values of other variables. Overall, this GLS model is effective in handling autocorrelation and provides more accurate estimates of the influence of independent variables on firm value.

Table 8. Results of Hypothesis Testing for Model 4

FV	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CED	2.935	.673	4.36	0	1.596	4.274	***
CP	.18	.113	1.59	.115	-.045	.405	
ROA	-.713	1.087	-0.66	.514	-2.876	1.45	
FIRMSIZE	-.175	.076	-2.30	.024	-.327	-.023	**
QOE	.006	.011	0.50	.62	-.017	.028	
Constant	.197	2.802	0.07	.944	-5.376	5.77	
Mean dependent var		2.906	SD dependent var			3.171	
R-squared		0.849	Number of obs			115	
F-test		22.837	Prob > F			0.000	
Akaike crit. (AIC)		437.756	Bayesian crit. (BIC)			525.594	

*** p<.01, ** p<.05, * p<.1

Source: Processed data, 2024

Interpretation of Model 4's test results in Table 8 suggests that CED interpretively enhances Firm Value. With an interpretive coefficient of 2.935 and a p-value of 0.000, the findings are interpreted to mean that market valuation improves with more extensive carbon emission disclosure. Meanwhile, Carbon Performance (CP) shows a favorable but uninfluential effect (coefficient 0.18; p-value 0.115), indicating that a company's carbon performance has not been

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statistically proven to impact its value. The impact of ROA and QOE on FV is not statistically significant, but FIRMSIZE has a noteworthy negative effect (coefficient -0.175; p-value 0.024) suggesting that larger companies may have slightly lower firm value in this particular model. The significant F-test result (Prob > F = 0.000) confirms that the model as a whole is suitable for analyzing the effect of CED and CP on firm value. Thus, Model 4 emphasizes the importance of carbon emissions disclosure as a significant factor in increasing firm value, while carbon performance and several other control variables have not had a significant effect.

Evaluation of Model 4's R-squared components leads to a highly positive assessment. The within R-squared of 0.567 is evaluated as demonstrating a substantial capacity to explain intra-firm dynamics. The between R-squared of 1.000 receives a perfect evaluative score for explaining cross-sectional differences. The overall R-squared of 0.849 is evaluated as indicating the model captures most evaluable variation in the sample. This evaluation confirms the model's evaluated suitability for examining the evaluated effects of CED and Carbon Performance on firm value.

Discussion

Model 1: The Effect of Financial Slack and CSR Disclosure on Firm Value

The results of Model 1 analysis show that Financial Slack (FS) has a favorable and influentialeffect on Firm Value (FV). The discovery suggests that organizations with greater financial adaptability are able to fund strategic ventures like technological advancements or eco-friendly undertakings, leading to a rise in overall company worth. This outcome aligns with the concept that financial adaptability enables companies to be more nimble and competitive when dealing with changes in the market (Malini, 2021).

However, there is a positive impact on the fair value attributable to Corporate Social Responsibility Disclosure (CSRD), even though it has not reached statistical significance yet. This indicates that although companies that actively disclose their CSR activities tend to be encouraged to innovate, the effect on company value is not yet strong enough to reach significance. However, examining the correlation between CSR reporting and the existence of an Independent Board of Commissioners (DKI), there is a noticeable increase in impact. This discovery validates the idea that thorough oversight from an independent board can enhance the beneficial effects of CSR disclosure on company worth, showcasing the significance of corporate governance in optimizing the advantages of CSR for investors (Fauziah et al., 2020).

Model 2: The Effect of Carbon Emission Disclosure on Firm Value

The results of Model 2 test found that CED has a favorable and influential on Firm Value (FV). This discovery validates the significance of companies being open about their environmental and social practices, as it can build trust among stakeholders and enhance the company's standing with investors, particularly on an international scale (Primanandari et al., 2021). Investors see sharing information about carbon emissions as a way to reduce reputational risk and comply with regulations, ultimately leading to a more favorable view of a company's worth.

Conversely, Firm Size shows a significant negative effect on FV, indicating that large company size does not always guarantee an increase in value if operational efficiency and emissions management are not yet optimal. This underscores the importance of effective internal management in supporting company value growth. Meanwhile, the Profitability variable, measured through ROA and Quality of Earnings (QOE), does not show a significant effect on FV, indicating that traditional financial performance factors are not always the main determinants of company value if they are not accompanied by adequate sustainability and transparency practices.

Model 3: The Effect of Carbon Emission Disclosure on Carbon Performance

The empirical results from Model 3 reveal that carbon emission disclosure positively influences carbon performance, implying that increased transparency in carbon reporting encourages firms to adopt tangible actions aimed at controlling and reducing emissions, leading to better environmental outcomes. The outcomes align with the concepts of legitimacy theory and signaling theory, suggesting that sharing information is not just about meeting external expectations but also about enhancing accountability within the organization and driving advancements in

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environmental practices. Carbon emissions disclosure in this context plays a dual role as a response to social and regulatory pressures and as an internal strategy to improve efficiency and environmentally friendly practices.

Meanwhile, it was found that ROA, company size, and QOE do not have a statistically meaningful impact on carbon performance. This finding suggests that financial performance and organizational magnitude are not central drivers of carbon performance disparities within the framework of this study. These findings indicate that environmental disclosure aspects play a more critical role in influencing CP than financial characteristics or company size, even though these variables are often assumed to influence environmental performance in some management and accounting literature.

Model 4: The Effect of Carbon Emission Disclosure and Carbon Performance on Firm Value

Model 4 assesses the direct impact of carbon emission disclosure and carbon performance on firm value. The results demonstrate that carbon emission disclosure exerts a significant positive effect on firm value, while carbon performance has a positive yet statistically insignificant influence, which is consistent with earlier empirical evidence (Maghfiroh et al., 2023) which states that companies with better PROPER ratings tend to gain higher levels of investor confidence as they are considered capable of managing environmental risks and operating sustainably.

Companies with good environmental performance can increase their value if this performance is communicated through transparent reporting (Daromes, 2020). This shows that investors' perceptions of a company's value are more influenced by the openness and credibility of environmental information disclosure than by actual reductions in carbon emissions. The findings validate that the impact of disclosure is stronger than the impact of performance in developing markets like Indonesia, where investor awareness of sustainability issues is still heavily influenced by the extent to which environmental information is disclosed clearly and credibly.

CONCLUSION

Model 1-4 results indicate that financial slack contributes to higher firm value, as financial flexibility allows firms to pursue strategic initiatives, manage uncertainty, and capitalize on growth prospects, thereby strengthening economic and social value creation. Corporate Social Responsibility Disclosure (CSRD) does not have a significant direct effect, but becomes relevant when supported by good corporate governance, demonstrating the importance of integrating social transparency and internal control mechanisms. Meanwhile, empirical evidence shows that carbon emission disclosure significantly affects firm value and carbon performance, supporting the view that transparency in environmental information is essential for building investor confidence. Conversely, carbon performance does not significantly influence firm value, implying that the market values disclosure more highly than actual sustainability achievements.

As a result, companies need to improve the transparency of their sustainability reports, integrate CSR and carbon management into their business strategies, and strengthen the role of independent boards of commissioners. For governments and regulators such as the OJK and IDX, strengthening carbon emissions disclosure regulations, providing incentives for active reporting, and developing national carbon reporting standards in accordance with the TCFD are important steps. Further research is recommended to expand the sector and study period and add variables such as the strength of environmental policies or green innovation to gain a a richer perspective of the interaction between sustainability and firm value.

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