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CARBON EMISSIONS, CORPORATE SOCIAL RESPONSIBILITY, AND ENVIRONMENTAL COSTS: EVIDENCE ON ENERGY FIRMS

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Abstract

The increase in greenhouse gas emissions and the discrepancy between reported emissions and actual conditions have made the energy sector a major focus of attention for regulators and investors regarding sustainability issues. This study aims to analyze the effect of carbon emission disclosure, corporate social responsibility (CSR), and environmental costs on firm value, using company size, profitability, and age as control variables. The study used a causal quantitative design with secondary data from 27 energy sector companies listed on the Indonesia Stock Exchange for the 2020–2024 period, analyzed using multiple linear regression. The results show that carbon emission disclosure has a significant negative effect on firm value, while CSR and environmental costs have a significant positive effect. These findings imply that companies need not only to improve environmental transparency but also to develop effective risk mitigation and sustainability management strategies so that non-financial information can be interpreted as a positive signal by investors and support long-term value creation.

Keywords: Carbon Emissions, Corporate Social Responsibility, Environmental Costs, Corporate Value, Energy Sector

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INTRODUCTION

The global energy transition has elevated environmental accountability from a peripheral concern to a central determinant of corporate market valuation. Greenhouse gas concentrations reached record levels in 2024, with global mean temperatures now +1.2°C above pre-industrial baselines and closing in on the critical +1.5°C threshold. Within this context, Indonesia occupies a particularly significant position: as the world's sixth-largest greenhouse gas emitter, the country contributed 2.5% of global emissions in 2024 (Yonatan, 2025), driven primarily by a coal-dependent power grid that supplies 55% of national electricity (APBI-ICMA, 2024) and elevated methane outputs from extractive mining operations (Climate, 2024). These structural conditions place Indonesian energy companies at the epicentre of both carbon production and escalating investor scrutiny.

For capital markets, the environmental performance of energy firms has become a material financial issue rather than a reputational footnote. Investors and regulators increasingly rely on three complementary disclosure mechanisms to assess how firms manage climate-related risk: carbon emission disclosure, which signals the scale and transparency of a firm's greenhouse gas exposure; corporate social responsibility (CSR) reporting, which communicates how firms manage their broader social and environmental obligations; and environmental cost accounting, which demonstrates the concrete financial commitment made toward pollution prevention and remediation. Together, these mechanisms provide capital markets with the non-financial information needed to price long-term sustainability risk into firm valuation (Dhaliwal et al., 2011; Matsumura et al., 2014).

Yet the empirical evidence on how these mechanisms affect firm value remains deeply contested. On carbon disclosure, some studies find that transparency reduces information asymmetry and signals proactive risk management, thereby enhancing investor confidence and market value (Alsaifi et al., 2020; Han et al., 2023). Others report the opposite — that higher disclosure scores are interpreted by markets as evidence of greater environmental liability exposure, triggering a negative valuation response (Matsumura et al., 2014; Perdichizzi et al., 2024). CSR evidence is similarly mixed: while a number of studies link robust sustainability reporting to improved legitimacy, lower cost of equity, and higher Tobin's Q (Awa et al., 2024; Nguyen, 2025), others find that

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large CSR expenditures divert resources from core business activities without generating commensurate market returns (Bhagawan & Mukhopadhyay, 2024; Gupta & Garg, 2022). Regarding environmental costs, proponents argue that preventive environmental spending generates long-run eco-efficiencies and reduces future regulatory liabilities (Ifada & Jaffar, 2023), whereas critics view such outlays as penalties imposed by operational inefficiencies that erode short-term profitability (Egbunike & Okoro, 2018).

These empirical inconsistencies stem, in large part, from a fragmented research design that characterises the existing literature. Prior studies have typically examined carbon disclosure, CSR, or environmental costs in isolation, without accounting for the interaction effects that arise when all three environmental management dimensions operate simultaneously within the same corporate entity (Garzón-Jiménez & Zorio-Grima, 2021; Shi & Wang, 2024). Furthermore, the majority of studies draw on broad, cross-sectoral samples that mask the industry-specific dynamics — regulatory structures, asset characteristics, and emission profiles — that are particularly pronounced in high-carbon industries (Matthews et al., 2024). Critically, no study to date has integrated all three variables within a single regression framework using firm size, profitability, and firm age as controls, applied specifically to Indonesian energy firms.

The 2020–2024 period represents an especially important and under-researched window for examining this question. It encompasses the post-pandemic economic recovery, during which energy commodity booms simultaneously inflated firm profits and amplified environmental scrutiny. It also coincides with escalating domestic ESG pressures following the implementation of OJK Regulation No. 51/POJK.03/2017 on sustainable finance, the expansion of PROPER environmental performance ratings, and growing market sensitivity to Indonesia's carbon tax roadmap. These converging forces make the 2020–2024 period a uniquely informative setting in which to test whether environmental disclosures and expenditures function as genuine value-creating signals or as regulatory compliance burdens perceived negatively by investors.

To address these gaps, this study examines the simultaneous and partial effects of carbon emission disclosure (measured by the 18-item Carbon Emission Disclosure Score, CEDS), CSR (measured by the 84-item GRI Standards 2021 index), and environmental costs (measured as the ratio of environmental

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expenditures to net profit after tax) on firm value (measured by Tobin's Q) for 27 Indonesian energy companies listed on the Indonesia Stock Exchange (IDX) over the 2020–2024 period, yielding 135 pooled observations. Firm size, profitability, and firm age are incorporated as control variables to isolate the independent contribution of each environmental variable and to minimise omitted-variable bias.

This study contributes to the literature in three ways. First, it provides an integrated multi-variable test of three environmental management mechanisms that prior research has examined only in isolation. Second, it isolates a single high-carbon industry — the Indonesian energy sector — to eliminate the cross-sectoral noise that has obscured prior findings. Third, it focuses on the 2020–2024 period, a regulatory and economic inflection point that has received insufficient empirical attention despite its significance for understanding how emerging-market investors price environmental risk.

LITERATURE REVIEW

Stakeholder Theory

Corporate success depends on all parties that affect or are affected by corporate activities, integrating environmental responsibilities into core business strategy (Spasial et al., 2025), Stakeholder Theory (Freeman, 1984). Mitchell et al., further extended this by proposing a classification system based on power, legitimacy and urgency to determine stakeholder salience that helps management to prioritise competing external demands (Mitchell et al., 1997). Harrison and Wicks also stated that firm value contains non-economic assets such as stakeholder trust and organisational legitimacy.

The theory is the basis for the evaluation of CSR, carbon emission disclosure and environmental cost management in the sustainability literature (Awa et al., 2024). The substantive results show that meeting stakeholder expectations protects firms from regulatory and reputational crises. However, prior research often treats stakeholders as a homogenous group. This paper fills that theoretical gap by focusing exclusively on capital providers and regulators in the energy sector, where environmental compliance is a direct determinant of a firm's legal and financial licence to operate.

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Carbon Emissions

The carbon emissions comprise greenhouse gases emitted from the combustion of fossil fuels, notably carbon dioxide and methane (Kiswanto et al., 2023), which are closely linked to global climate change (Bertolini et al., 2025). Mechanistically, the GHG Protocol framework is used to measure the emissions (Song et al., 2012). The framework divides carbon output into direct emissions (Scope 1), indirect emissions caused by purchased energy (Scope 2) and value-chain emissions (Scope 3).

The empirical literature contains an active debate on the effect of carbon disclosures on corporate market value. A supportive stakeholder perspective is that transparent disclosure reduces information asymmetry and signals proactive risk management to green investors. On the contrary, critical reviews of Liesen et al., according to Guenther et al. (2016) and (2015), there is a common methodological problem: carbon disclosures do not align with actual environmental performance (Liesen et al., 2015) Instead, companies often use reporting as a way of impression management or greenwashing (Widarjo et al., 2024). Methodologically, the present study explores this tension in listed Indonesian energy companies to test whether carbon disclosures are genuine signals of risk mitigation or merely symbolic compliance amid intensive energy transitions.

Social Responsibility of the Corporation

Corporate Social Responsibility (CSR) started with Bowen (1953), who defined corporate moral obligations to conform to societal values (Bowen, 1953). Carroll (1979) operationalized this in the form of the CSR Pyramid, prioritizing economic, legal, ethical, and philanthropy responsibilities (Carroll, 1991). Thus, CSR has been transformed into a standard quantitative measure across economic, social and environmental dimensions, for example through modern reporting frameworks such as the GRI Standards (Board, 2021). This operationalisation is in line with the Triple Bottom Line framework (Elkington, 1997) which requires the corporate performance to balance profit, people and the planet under the principles of transparency and accountability (Crowther, 2008).

Empirical evidence on the relationship between CSR and firm value is still highly inconsistent. Several studies suggest that excellent CSR performance enhances corporate legitimacy and maximises financial returns (Awa et al., 2024).

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Yet, other empirical studies indicate that large CSR expenditures are a financial burden that takes away vital resources from core activities. One major limitation of the above studies is that they all rely on cross-sector data, which is more likely to blur sectoral differences. This paper addresses this distortion by singling out the energy sector, allowing for an accurate evaluation of the impact of sustainability reporting targeted at capital intensive firms.

Environmental Costs

Environmental costs represent all financial costs that a company incurs in preventing, managing, mitigating and repairing environmental damage caused by its activities (Ayinla et al., 2024; Vélez Cordero & Torres Negrete, 2024). They are essential indicators to monitor the long-term sustainability of a company's operations (Goenka et al., 2025). Drastyana et al., (2025) categorise these types of expenditures as prevention, detection, internal failure, and external failure costs. Conversely, the IFAC (2005) Environmental Management Accounting framework associates monetary expenditures directly to physical material and emission flows (Reibstein, 2009).

Previous empirical studies have reported mixed financial findings. One argument is that investment in environmental prevention provides long-term eco-efficiencies, minimises future liabilities, and thus protects firm value. By contrast, a body of evidence suggests high environmental costs are a result of operational inefficiencies or the high costs of cleaning up past pollution and penalise short-term profitability. This study adds to the literature by looking into the environmental costs during a period of mandatory regulatory changes to see if the costs are value-destroying penalties or value-creating strategic investments.

Firm Value and Control Variables

Firm value is the market's perception of a firm's current efficiency and future earning potential (Brigham & Houston, 2006). In modern corporate finance literature, Tobin's Q is preferred because it computes the market value of outstanding stock and debt in relation to the replacement cost of total assets (Sukamulja, 2007; Weston & Copeland, 2004), while Price-to-Book Value and Price-to-Earnings Ratio are common metrics. This entire calculation includes both equity and debt markets and therefore, is a reliable measure of the impact of sustainability practices on institutional investors.

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Methodologically, the omission of important firm characteristics can bias empirical results significantly. This study includes three important control variables for obtaining robust econometric isolation. The size of the firm reflects regulatory visibility, as larger energy corporations receive greater public scrutiny and compliance enforcement. Profitability is a measure of a firm's internal capital capacity to absorb the high costs of green transitions without eroding market value. Firm age accounts for organisational maturity, market reputation, and learned curves in the process of navigating change in environmental policy.

Contribution to the Conceptual Framework and Methodological

Currently, the literature is very fragmented, since previous studies have usually analysed either carbon emissions, CSR, or environmental costs individually. This fragmentation creates an empirical blind spot for the ways in which these three distinct dimensions of environmental management are simultaneously interacted within a single corporate entity.

This study presents a unique methodological contribution in that it combines all three independent variables into a single, multi-variable regression model. This framework overcomes the omitted-variable biases that have limited prior research by testing these elements simultaneously with targeted firm-level controls in the context of listed Indonesian energy firms from 2020 to 2024. As a result, such an integrated approach offers a more accurate and holistic evaluation of the impact of environmental management on market value in emerging economies. (**Figure 2**)

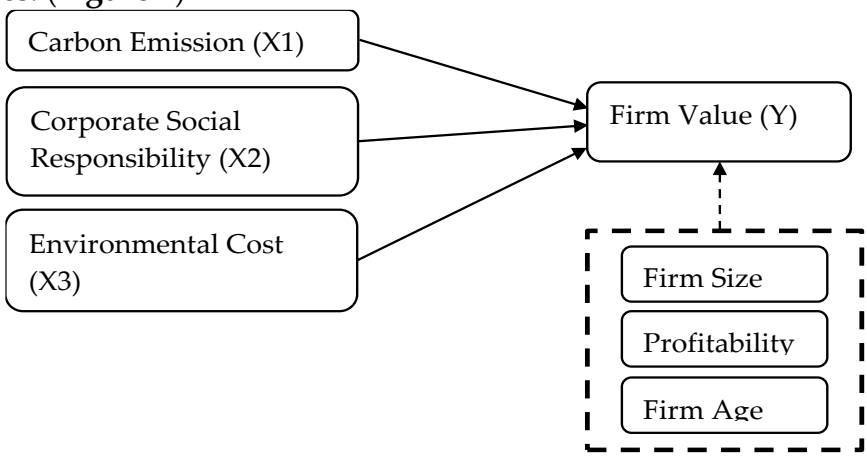

Figure 2.
Conceptual and Research Framework

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RESEARCH METHOD

This research is quantitative and uses explanatory-causal research design to examine the effect of carbon emission disclosure, Corporate Social Responsibility (CSR), and environmental costs on firm value. The sampling technique used is purposive sampling to obtain data on energy sector companies listed on the Indonesia stock exchange (IDX) for the 2020-2024 period. The criteria for inclusion are continuous listing, financial reporting and profitability, so that a pooled data set of 27 companies was obtained with 135 observations.

The independent variables are carbon emission disclosure, proxied by the 18-item Carbon Emission Disclosure Score (CEDS) (Choi et al., 2013); CSR, proxied by the 84-item GRI Standards 2021 index; and environmental costs, proxied by environmental expenditures to net profit after tax ratio. The dependent variable is firm value, measured by Tobin's Q. The model also controls for firm size (natural logarithm of total assets), profitability (Return on Assets), and firm age (years since IPO).

Pooled Ordinary Least Squares (OLS) regression was used to analyse the data. Before testing the hypothesis, descriptive statistics and standard assumption tests (Kolmogorov-Smirnov normality, VIF multicollinearity, Glejser heteroscedasticity, and Durbin-Watson autocorrelation tests) were performed to check for compliance with the Best Linear Unbiased Estimator (BLUE). The empirical model was tested for the power and significance of the explanatory by using the coefficient of determination (R^2 and Adjusted R^2) and the F-test and t-test statistics for simultaneous and partial hypothesis tests.

RESULTS AND DISCUSSION

Secondary Data Used in The Study

The data used in this research are companies that are engaged in the energy sector and are listed on the Indonesia Stock Exchange (IDX) in a row from 2020 to 2024. The data used is secondary data in the form of annual reports and sustainability reports according to the observation period. (**Table 1**)

Table 1.
Energy Companies Listed on IDX in 2020-2024 and Meet the Criteria

No	Code	Company name
1	ADRO	Adaro Energy Indonesia Tbk

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No	Code	Company name
2	AKRA	AKR Corporindo Tbk
3	BIPI	Astrindo Nusantara Infrastructure
4	BSSR	Baramulti Suksessarana Tbk
5	BYAN	Bayan Resources Tbk
6	ELSA	Elnusa Tbk
7	ENRG	Energi Mega Persada Tbk
8	GEMS	Golden Energy Mines Tbk
9	INDY	Indika Energy Tbk
10	ITMA	Reliable Energy Source Tbk
11	ITMG	Indo Tambangraya Megah Tbk
12	MBAP	Mitrabara Adiperdana Tbk
13	MYOH	Samindo Resources Tbk
14	PTBA	Bukit Asam Tbk
15	PTIS	Indo Straits Tbk
16	PTRO	Petrosea Tbk
17	KING	Rukun Raharja Tbk
18	RUIS	Radiant Utama Interinsco Tbk
19	SOCI	Soechi Lines Tbk
20	TOBA	TBS Energi Utama Tbk
21	TPMA	Trans Power Marine Tbk
22	SHIP	Sillo Maritime Perdana Tbk
23	PSSI	IMC Pelita Logistics Tbk
24	DWGL	Dwi Guna Laksana Tbk
25	TCPI	Transcoal Pacific Tbk
26	SGER	Sumber Global Energy Tbk
27	BESS	Batulicin Nusantara Maritim Tbk

Multiple Linear Regression Analysis

Multiple linear regression analysis in this study was used to calculate the magnitude of the influence of the independent variables, namely Carbon Emission Disclosure, Corporate Social Responsibility (CSR), and Environmental Costs, as well as the control variables, namely Firm Size, Profitability, and Firm Age, on Firm Value.

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Based on the results of the multiple linear regression analysis presented in **Table 2**, the following empirical model equation is obtained:

$$Y = 0.579 - 0.019X_1 + 0.479X_2 + 0.011X_3 + 0.020Z_1 - 0.085Z_2 - 0.009Z_3 + \varepsilon$$

The regression constant of 0.579 indicates the baseline level of firm value when all independent and control variables are considered constant. The coefficient for carbon emission disclosure is -0.019, which indicates an inverse relationship where broader disclosure is associated with a decrease in firm value. Conversely, CSR and environmental costs exhibit positive coefficients of 0.479 and 0.011, respectively, which means that an increase in these activities corresponds to higher firm value. Among the control variables, firm size shows a positive coefficient of 0.020, whereas profitability and firm age show negative coefficients of -0.085 and -0.009.

Table 2.
Results of Multiple Linear Regression Analysis

Coefficients [a]						
Model		**Unstandardized Coefficients**		Standardized Coefficients	t	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	.579	.285		2.036	.044
	Carbon Emission	-.019	.002	-.592	-10.004	.000
	CSR	.479	.066	.437	7.269	.000
	Environmental Costs	.011	.002	.310	5.267	.000
	Firm Size	.020	.009	.137	2.288	.024
	Profitability	-.085	.275	-.018	-.310	.757
	Firm Age	-.009	.017	-.029	-.495	.621
a. Dependent Variable: Firm Value						

Source: Processed Data (2026)

To evaluate the overall explanatory power of the model, the coefficient of determination was analyzed. As shown in **Table 3**, the R Square value is 0.563, and the Adjusted R Square is 0.543. This indicates that the combination of carbon emission disclosure, CSR, environmental costs, and the control variables can explain 54.3% of the variation in the firm value of Indonesian energy companies. The remaining 45.7% is influenced by other factors outside the scope of this empirical model.

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Table 3.
Results of the Determination Coefficient Test

Model Summary [b]				
Model	R	**R Square**	**Adjusted R Square**	Standard Error of the Estimate
1	.751 [a]	.563	.543	.10195
a. Predictors: (Constant), Carbon Emissions, CSR, Environmental Costs, Firm Size, Profitability, Firm Age				
b. Dependent Variable: Firm Value				

Source: Processed Data (2026)

Hypothesis Testing

Hypothesis testing was conducted simultaneously and partially to evaluate the empirical relationships among the variables. The F-test was utilized to determine the simultaneous influence of all independent and control variables on the dependent variable. Based on the ANOVA results in **Table 4**, the calculated F-value is 27.531 with a significance level of 0.000. Because the significance value is much smaller than 0.05, it can be concluded that carbon emission disclosure, CSR, environmental costs, firm size, profitability, and firm age simultaneously exert a significant effect on firm value. This confirms that the regression model is appropriate for explaining variations in the firm value of the sampled companies.

Table 4.
1F Test Results

ANOVA [a]						
Model		Sum of Squares	df	Mean Square	**F**	**Sig.**
1	Regression	1.717	6	.286	27.531	.000 [b]
	Residual	1.331	128	.010		
	Total	3.048	134			
a. Dependent Variable: Firm Value						
b. Predictors: (Constant), Carbon Emissions, CSR, Environmental Costs, Firm Size, Profitability, Firm Age.						

Source: Processed Data (2026)

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Furthermore, the t-test was performed to evaluate the partial effect of each individual variable on firm value under the ceteris paribus assumption. The statistical results from **Table 5** provide the basis for testing the three primary hypotheses of this study:

- **Hypothesis 1 (Carbon Emission Disclosure):** The t-test for the carbon emission disclosure variable yields a t-statistic of -10.004 with a significance value of 0.000. Since the significance level is below 0.05, carbon emission disclosure has a significant partial effect on firm value. However, because the direction of the coefficient is negative, **Hypothesis 1, which states that carbon emission disclosure has a positive effect on company value, is rejected**. This finding demonstrates that comprehensive environmental risk reporting by energy companies is perceived negatively by the market, potentially due to concerns over high transition costs and regulatory penalties.
- **Hypothesis 2 (Corporate Social Responsibility):** The CSR variable shows a t-statistic of 7.269 with a significance level of 0.000. Because this significance value is smaller than 0.05, CSR has a positive and significant partial effect on firm value. Therefore, **Hypothesis 2 is accepted**. This indicates that robust sustainability practices effectively build corporate reputation and strengthen investor confidence.
- **Hypothesis 3 (Environmental Costs):** The environmental costs variable demonstrates a t-statistic of 5.267 and a significance level of 0.000. Since the significance is less than 0.05, environmental costs exert a positive and significant partial effect on firm value. Consequently, **Hypothesis 3 is accepted**. This result proves that financial allocations for environmental protection are viewed by investors as a proactive risk mitigation strategy rather than an operational burden.

Table 5.
T-Test Results

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	**T**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	.579	.285		2.036	.044

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	Carbon Emission	-.019	.002	-.592	-10.004	.000
	CSR	.479	.066	.437	7.269	.000
	Environmental Cost	.011	.002	.310	5.267	.000
	Firm Size	.020	.009	.137	2.288	.024
	Profitability	-.085	.275	-.018	-.310	.757
	Firm Age	-.009	.017	-.029	-.495	.621
a. Dependent Variable: Firm Value						

Source: Processed Data (2026)

Regarding the control variables, the t-test reveals that firm size has a positive and significant effect on firm value with a significance level of 0.024. On the other hand, profitability has a significance level of 0.757, and firm age has a significance level of 0.621. Because both values are well above the 0.05 threshold, it can be concluded that profitability and firm age do not have a statistically significant partial effect on the firm value of energy sector companies listed on the IDX during the 2020 to 2024 observation period.

The Transparency Paradox: Why Carbon Emission Disclosures Decrease Energy Sector Firm Value

The regression analysis indicates that carbon emission disclosure has a negative and significant effect on firm value (Tobin's Q), rejecting Hypothesis 1. This confirms a transparency paradox in the Indonesian energy sector during the 2020 through 2024 period, where greater openness regarding greenhouse gas emission volumes correlates with lower capital market valuations.

Theoretically, proprietary costs theory explains this phenomenon, positing that disclosing sensitive, detailed information can generate additional costs that damage a firm's competitive position. In the energy industry, carbon data directly reflects operational dependence on fossil fuels. High emission figures signal strategic vulnerability to increasingly stringent environmental policies.

Furthermore, this decline is tied to investor sentiment regarding Indonesia's upcoming carbon tax policies developed during 2020 through 2024. Market participants calculate disclosed emission volumes as future cost burdens. Higher reported emissions imply larger carbon tax liabilities, which directly reduce projected net cash flows and stock attractiveness.

From a risk management perspective, emission transparency exposes companies to stranded asset risks. Global and domestic investors are highly

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sensitive to energy transition risks, and massive emission disclosures signal large investments in high-carbon infrastructure that may become unusable due to tightening green regulations. Consequently, climate transparency in carbon-sensitive sectors expands the corporate risk profile and triggers a negative market response.

Legitimacy and Reputation Theory: The Dominant Effect of CSR on Escalating Firm Value

In contrast to carbon disclosures, testing for Hypothesis 2 demonstrates that Corporate Social Responsibility (CSR) disclosure has a positive, significant, and dominant effect on firm value, yielding the largest regression coefficient. This indicates that extensive social and environmental reporting is the most effective instrument for energy companies to enhance market appreciation.

This positive effect aligns with legitimacy theory, which posits that companies must operate within societal bounds and norms. The energy sector inherently carries high negative externality risks, including environmental pollution and community land conflicts. Comprehensive CSR reports assure stakeholders that operations respect human and sustainability aspects. This transparency secures a social license to operate, minimizing disruptions or boycotts that could halt mining or energy generation projects.

Using global frameworks like the Global Reporting Initiative (GRI) Standards further builds corporate reputation. Structured CSR disclosures act as high-quality signals that reduce information asymmetry between management and capital markets. Institutional investors adopting responsible investment principles heavily rely on these credible reports to screen portfolios.

Ultimately, a strong CSR-driven reputation creates a competitive advantage, leading to a valuation premium from the capital market. This positive reputation functions as an intangible asset that protects the firm from adverse market sentiment. Thus, CSR disclosure is not an unnecessary expense for energy companies but a strategic investment that drives long-term growth valuation.

Environmental Costs as a Proactive Signal for Future Risk Mitigation

Partial regression analysis shows that actual environmental costs have a positive and significant effect on firm value, supporting Hypothesis 3. This indicates that funds expended by energy companies for environmental

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management are viewed as long-term strategic investments rather than a waste of accounting profits.

This finding reinforces stakeholder theory, which argues that corporate survival depends on support from entities like governments, local communities, and environmental groups. Energy companies in Indonesia face strict regulatory oversight through instruments like PROPER. Tangible environmental expenditures provide concrete proof that management actively fulfills stakeholder expectations rather than making empty green claims.

Additionally, recorded environmental costs signal proactive operational and legal risk mitigation. The energy industry is highly vulnerable to lawsuits from environmental damage or reclamation failures. Allocating adequate environmental costs now minimizes the emergence of much larger legal liabilities, penalties, or shutdown sanctions in the future, which are far more damaging to firm value than routine prevention costs.

Through the lens of signaling theory, consistent environmental spending reduces future uncertainty for market participants, signaling strong risk governance. Investors award a valuation premium to energy companies, demonstrating this financial commitment. The operational certainty gained from harmonious environmental relations is thus successfully converted into higher market value.

Anomalies of Traditional Control Variables: The Dominance of Firm Size over Accounting Profitability

The control variables reveal an interesting anomaly compared to traditional finance literature. Only firm size has a positive and significant effect on Tobin's Q. Conversely, traditional metrics like profitability (ROA) and firm age have no significant influence on market valuation.

The non-significant effect of ROA during 2020 through 2024 is tied to the post-pandemic global commodity boom. Drastic price increases for coal and petroleum caused Indonesian energy firms to record simultaneous, unprecedented net profits. Capital market investors recognized that these high ROA values stemmed from temporary, external market factors rather than sustainable internal efficiency. Consequently, buyers ignored short-term profitability as a primary indicator for long-term firm value.

In contrast, firm size became vital during the regulatory uncertainty of the energy transition. Large-scale companies possess the financial capacity to absorb

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technology investment costs and diversify into renewable energy. Large firms also hold stronger political bargaining power when navigating changing domestic regulations. Investors view extensive asset scale as a bankruptcy buffer, making firm size an effective shield amid industry volatility.

Finally, the insignificance of firm age indicates that historical experience does not guarantee survival during green disruption. The ongoing decarbonization paradigm shift penalizes older energy companies that are locked into legacy systems that are costly to convert. Younger companies often exhibit greater flexibility in adopting eco-friendly business models. Therefore, the market no longer views operational longevity as a quality indicator for Tobin's Q valuations.

CONCLUSION

The study examines the simultaneous and partial effects of carbon emission disclosure, Corporate Social Responsibility (CSR), and environmental costs on the firm value of Indonesian energy companies listed on the Indonesia Stock Exchange (IDX) in the period 2020-2024. The empirical results allow us to draw some main conclusions:

- **Simultaneous Effect**: The simultaneous effect of carbon emission disclosure, CSR, environmental costs, and control variables (firm size, profitability, and firm age) is significant to firm value. These variables explain 54.3 percent of the variation in the firm value of Indonesian energy companies.
- **Carbon Emission Disclosure**: This variable has a significant partial effect but in a negative direction, hence, rejecting Hypothesis 1.
- **Environmental Risks:** The full disclosure of environmental risks of energy companies negatively affects the market, likely because investors are concerned about the extremely high cost of green transition and regulatory penalties.
- **Corporate Social Responsibility:** The positive and significant relationship between CSR practices and firm value results in the acceptance of Hypothesis 2. This suggests that investors appreciate the implementation of strong sustainability practices to enhance the corporate reputation and boost market confidence.

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- **Environmental Costs:** The partial effect of the financial allocation for environmental protection on firm value is positive and significant, supporting the acceptance of Hypothesis 3. What this result indicates is that investors view real spending on environmental mitigation not as an operational burden but rather as a proactive risk reduction strategy.
- **Control Variables:** With regard to the control variables, only firm size has a positive and statistically significant partial effect on firm value. In contrast, profitability and firm age do not have a statistically significant partial effect on the firm value of IDX energy companies in the observation period of 2020-2024.

In conclusion, the market reacts differently to environmental narrative and financial action. Market jitters are caused by the transparency in carbon emissions, but concrete investment in CSR and direct environmental expenditure are rewarded by stakeholders as necessary components of sustainable corporate risk management in emerging markets.

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