Government Ownership and Market Valuation of Greenhouse Gas Emissions in State-Owned Enterprises: Empirical Evidence from Indonesia

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ABSTRACT

Climate change has broadened corporate valuation beyond financial performance to include environmental consequences. This study examines the association between greenhouse gas (GHG) emissions and firm value in Indonesian state-owned enterprises (SOEs) and assesses whether direct government ownership moderates that association. The sample comprises 14 listed SOEs observed from 2015 to 2024, producing 140 firm-year observations. Panel regressions were estimated using random effects with White cross-sectional robust standard errors. Firm value is proxied by Tobin's Q, while the explanatory variables comprise Scope 1, Scope 2, Scope 3, and emission intensity under GRI 305. Scope 1, Scope 2, and Scope 3 emissions are not statistically associated with firm value. Emission intensity has a negative coefficient that is marginally significant at the 10% level (β = -3.15E-05; p = 0.0745). The interaction between emission intensity and government ownership is positive and also marginally significant at the 10% level (β = 7.07E-07; p = 0.0787), whereas the remaining interaction terms are insignificant. The evidence therefore provides only tentative support for an intensity-based market response and for a moderating role of government ownership. These findings should be interpreted cautiously because the sample is limited, explanatory power is modest, and the study does not establish causality.

Keywords: greenhouse gas emissions, firm value, state-owned enterprises, government ownership, emission intensity

INTRODUCTION

Climate change has become one of the most pressing global challenges of the contemporary era. Rising global temperatures, the growing frequency of extreme weather events, and intensifying international pressure to reduce greenhouse gas emissions have made it clear that climate change can no longer be viewed solely as an environmental concern. It has also become an economic, business, and corporate governance issue. Reports from the Intergovernmental Panel on Climate Change emphasize that human activities, particularly greenhouse gas emissions generated by industrial and economic processes, are among the main drivers of global warming (Intergovernmental Panel on Climate Change, 2021). In the same vein, the Paris Agreement highlights the importance of emission reduction and stronger transparency in climate-related reporting (United Nations Framework Convention on Climate Change, 2015)

In the corporate context, the growing emphasis on sustainability has reshaped stakeholder expectations. Firms are no longer assessed only on their ability to deliver strong financial performance, but also on how they manage the environmental consequences of their operations. As a result, disclosure of greenhouse gas emissions is gaining greater attention in corporate reporting. Information on emissions not only reflects a company's level of compliance with regulations but also signals operational efficiency, environmental risk exposure, and readiness to transition to a low-carbon economy (Deegan, 2002), (Spence, 1973), (Suchman, 1995).

Previous research shows that information about carbon emissions and management policies can influence investor perceptions and corporate values, although results have been inconsistent. A number of studies have

found that high emissions tend to lower a company's value because they are perceived as indicators of high environmental risks, potential compliance costs, and reputational pressure (Cooper et al., 2018), (Matsumura et al., 2014), (Matthews et al., 2024). In contrast, other studies show that environmental disclosure transparency and sustainability performance can be positively valued by the market because they are seen as reflecting a company's accountability, reputation, and long-term orientation (Gabrielle & Toly, 2019), (Griffin et al., 2017), (Wu et al., 2022). In the Indonesian context, empirical results also show mixed patterns. Some studies have found a positive influence of carbon emission disclosure and environmental performance on corporate value, while other studies show a weak, insignificant, or even negative influence, particularly in carbon-intensive sectors (Kurnia et al., 2020, 2021), (Noor & Ginting, 2022), (Rachmawati, 2021), (Sari & Budiasih, 2022), (Susilawati et al., 2025).

In Indonesia, sustainability commitments have also been strengthened through policies that encourage companies to report their environmental impacts more transparently. One of the important regulations in this context is the Financial Services Authority Regulation No. 51/POJK.03/2017, which requires public companies, including state-owned enterprises, to prepare sustainability reports regularly (Otoritas Jasa Keuangan, 2017). In practice, companies generally refer to the Global Reporting Initiative standard, particularly GRI 305, as a guideline for measuring and disclosing greenhouse gas emissions from direct and indirect sources (Global Reporting Initiative, 2016). For SOEs, these obligations mean more because they not only carry out commercial functions but also fulfill a broader public mandate and social responsibility.

SOEs have different institutional characteristics compared to private companies. Beyond pursuing efficiency and profitability, SOEs operate under a stronger public accountability framework. From the perspective of agency theory, ownership structures influence the supervisory mechanisms, managerial incentives, and quality of corporate decision-making (Jensen & Meckling, 1976). From a stakeholder theory perspective, companies with higher public accountability tend to face greater pressure to respond to social and environmental demands more openly (Freeman & McVea, 2005). In this context, government ownership can affect how market participants interpret emissions information. On the one hand, state ownership can be perceived as stronger supervision. On the other hand, investors may view government ownership only as a structural characteristic that adds no new signal.

Although relevant, empirical evidence on how the market assesses greenhouse gas emissions from Indonesian SOEs remains limited. Most previous research has focused on public companies in general without explicitly distinguishing between state-owned and non-state companies. In addition, studies that specifically include the percentage of government ownership as a moderator in the relationship between greenhouse gas emissions and corporate value remain relatively limited (Arniati et al., 2025), (Nilasakti et al., 2024), (Suhartini, Putri, et al., 2024), (Wijaya & Handoko, 2025). In fact, SOEs have distinctive characteristics because they face greater pressure to maintain legitimacy, stronger political oversight, and higher public expectations than private companies.

Based on this description, this research provides three main contributions. First, this study examines the relevance of market assessments to greenhouse gas emissions separately for Scope 1, Scope 2, Scope 3, and emission intensity, rather than relying on aggregate measures such as ESG. Second, this study examines whether government ownership moderates the relationship between emissions and corporate value in SOEs with dual commercial and public mandates. Third, this study presents empirical evidence from developing countries, particularly Indonesia, which has distinctive dynamics in sustainability regulation and state ownership concentration. Thus, this research is expected to expand understanding of how environmental information translates into market valuation in the context of SOEs.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

This research uses an integrated theoretical framework. Agency theory posits that emissions, especially those arising directly from operational activities, reflect managerial quality, operational efficiency, and the company's ability to control environmental risks. Within this framework, environmental indicators under management's control are more readily translated into market signals because of the company's internal decisions. Signaling theory complements this explanation by treating emissions information as a signal a

company sends to investors about risk, efficiency, and long-term prospects. Meanwhile, legitimacy theory and stakeholder theory explain that emissions issues matter more for companies operating in high-public-accountability settings, such as SOEs, because they must maintain social legitimacy and respond to stakeholder demands. Thus, agency theory explains the economic substance of emissions; signaling theory explains how the market reads emissions; legitimacy theory explains why socio-political pressures on emissions matter; and stakeholder theory explains why various parties, including investors, regulators, and the public, weigh emissions information.

Direct greenhouse gas emissions (Scope 1) and corporate value

Scope 1 emissions are direct emissions from sources the company owns or controls, making them the emissions most closely tied to core operational activities. From an agency theory perspective, Scope 1 most strongly reflects management quality because it arises from operational decisions within the company's internal control. When direct emissions are high, investors may interpret this as production inefficiency, heavy reliance on high-emission technologies, or weak corporate readiness to meet transition policies for a low-carbon economy.

From a signaling-theory perspective, Scope 1 is also the most market-readable environmental indicator because it is directly related to the company's operations. Compared with broader sustainability indicators, direct emissions provide clearer signals about a company's exposure to regulatory risks, technology adjustment costs, and reputational pressures. Studies show that actual emissions can lower a company's value when the market views them as a material economic risk. Matsumura et al. (2014) point out the existence of a company's value, the consequences of carbon emissions, and their disclosure, while Matthews et al. (2024) affirm that actual GHG emissions are relevant to market assessments. Based on this argument, the higher a company's direct emissions, the more likely the market is to assign a lower rating; thus, hypothesis 1 is formulated as follows.

H1: Direct greenhouse gas emissions (Scope 1) have a negative effect on the value of the company.

Indirect greenhouse gas emissions from energy consumption (Scope 2) and corporate value

Scope 2 emissions reflect indirect emissions from the energy the company purchases and consumes. Although the company does not generate Scope 2 emissions directly through its internal processes, they remain relevant because they reflect the company's energy consumption structure and efficiency. Within the framework of agency theory, managers can still be held accountable for these emissions, particularly for decisions on energy efficiency, energy source selection, and long-term operational policies, although their direct control is lower than for Scope 1.

From a signaling theory perspective, Scope 2 information can signal to investors how a company is managing its energy dependency amid the pressures of the energy transition. Companies with high Scope 2 emissions are perceived as relying more on high-emission energy systems and may face higher energy costs and greater adaptation pressures in the future. However, because external factors such as the national energy mix also affect Scope 2, market responses to this indicator are unlikely to be as strong as those for Scope 1. However, in theory, Scope 2 remains relevant to market valuations because it reflects a company's energy-efficiency dimension. Hypothesis 2 is as follows.

H2: Indirect greenhouse gas emissions from energy consumption (Scope 2) affect the value of the company.

Other indirect greenhouse gas emissions (Scope 3) and corporate value

Scope 3 emissions include other indirect emissions across the value chain, including supplier activities, distribution, product use, and other upstream and downstream processes. Compared with Scopes 1 and 2, Scope 3 is the broadest and most complex indicator. On the one hand, these emissions can reflect the size of the company's overall economic carbon footprint. On the other hand, management can control these emissions less directly because they involve many actors outside the organization's boundaries.

From a stakeholder theory perspective, Scope 3 is increasingly important because it shows that a company's environmental responsibility extends beyond its operations to include relationships with suppliers, consumers, and the broader business network. However, from a signaling theory perspective, a Scope 3 signal may be less valuable because investors need more complex interpretation to link it to the company's economic consequences. However, if the market views value chain emissions as a proxy for reputation and broader transition risk, then Scope 3 still has the potential to affect a company's value. Hypothesis 3 is as follows.

H3: Other indirect greenhouse gas emissions (Scope 3) affect the value of the company**.**

Emission intensity and corporate value

Unlike absolute measures, emission intensity indicates emissions relative to the scale of a company's economic activity, such as revenue. Therefore, this indicator reflects environmental efficiency more than just the amount of emissions. Within agency theory, emission intensity can be seen as a function of the quality of managerial decisions in managing the relationships among production, income, and environmental impact. Companies with high emission intensity produce more emissions per unit of economic activity, so they can be perceived as less efficient.

From a signaling theory perspective, emissions intensity can signal a company's sustainability efficiency more sharply than an absolute measure, especially when investors consider a company's ability to create value with a lower environmental footprint. Matthews et al. (2024) assert that the market can distinguish between the scale of emissions and emissions-related indicators depending on the economy's materiality. Therefore, emission intensity can theoretically affect a company's value; hypothesis 4 is as follows.

H4: Greenhouse gas emission intensity affects company value.

The role of government ownership moderation

Government ownership is thought to moderate the relationship between emissions and corporate value because the state's presence as a major shareholder can affect how investors interpret environmental information. From a legitimacy theory perspective, companies with high government ownership face greater social and political pressure to demonstrate environmental accountability. In the context of SOEs, high emissions can be seen not only as an economic efficiency issue but also as a potential failure to meet public expectations and sustainable development mandates.

In contrast, stakeholder theory emphasizes that state-owned companies have a wider, more complex stakeholder base. As a result, emissions information is more likely to attract market attention when the company is state-controlled. Recent literature shows that government ownership is associated with climate-related corporate reporting, and ownership structures affect the quality of such reporting. Nguyen et al. (2025) show that government ownership has different implications for voluntary carbon disclosure. However, it is unclear whether the role also extends to how markets assess actual emissions. Accordingly, government ownership is positioned as a variable that can strengthen or weaken emissions' influence on corporate value.

H5a: Government ownership moderates the impact between direct greenhouse gas emissions (Scope 1) and corporate value.

H5b: Government ownership moderates the impact between indirect greenhouse gas emissions from energy consumption (Scope 2) and corporate value.

H5c: Government ownership moderates the impact between other indirect greenhouse gas emissions (Scope 3) and corporate value.

H5d: Government ownership moderates the impact between greenhouse gas emission intensity and corporate value.

Figure 1 illustrates the framework, showing the direct influence of greenhouse gas emissions on corporate value and the moderating role of government ownership.

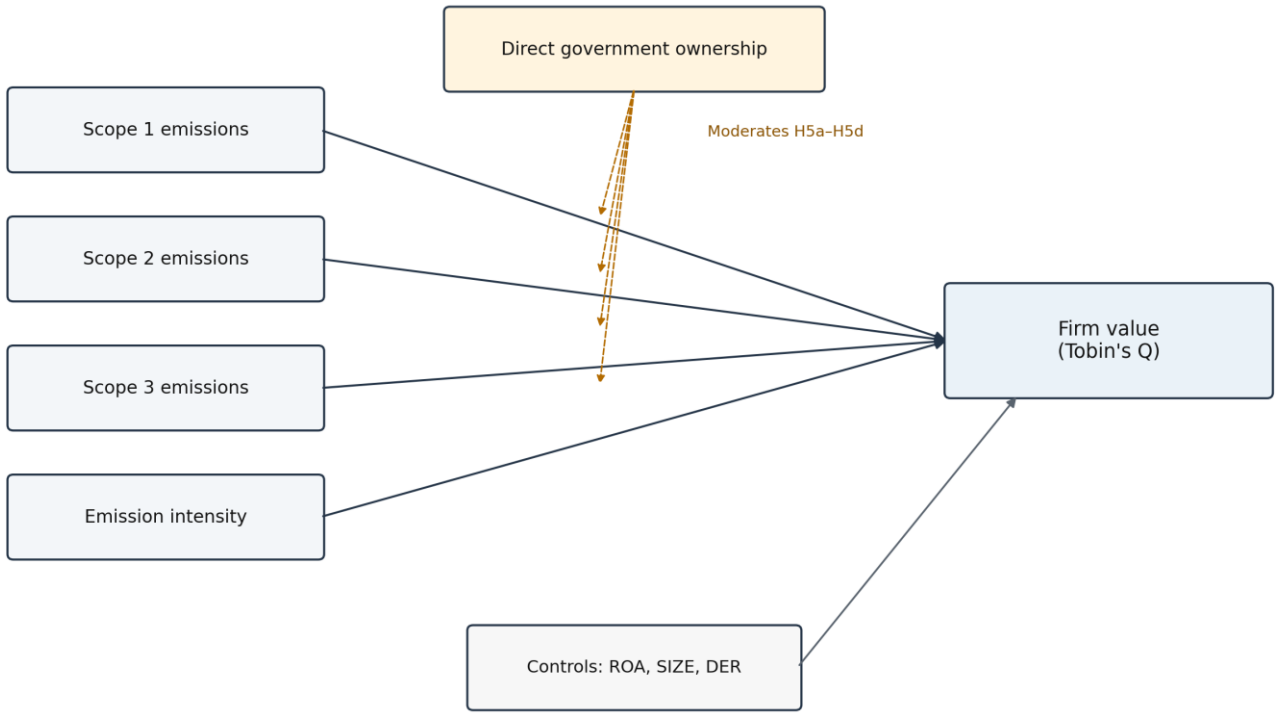

Figure 1. Conceptual Model

RESEARCH METHODS

This study uses a quantitative design based on secondary panel data obtained from the annual and sustainability reports of SOEs listed on the Indonesia Stock Exchange for 2015–2024. GHG emissions were collected primarily from sustainability reports prepared with reference to GRI 305, whereas financial information, direct government ownership, and control variables were obtained from annual reports (Global Reporting Initiative, 2016).

The population comprised SOEs listed on the Indonesia Stock Exchange during the observation period. Purposive sampling required firms to remain listed during 2015-2024, publish the relevant annual and sustainability reports, disclose GHG information under GRI 305, and provide the financial information needed to construct the variables. Fourteen firms met the working criteria, resulting in a balanced panel of 140 firm-year observations. The sample spans several industries; therefore, the estimated coefficients represent average associations across heterogeneous SOEs rather than sector-specific effects.

Firm value is measured using an approximate Tobin's Q ratio: the market value of equity plus the book value of total liabilities, divided by the book value of total assets. Market value of equity is calculated as the year-end closing share price multiplied by outstanding shares. A value above one indicates that the market values the firm above the recorded value of its assets. This market-based measure is widely used in studies linking environmental performance to corporate valuation (Liu et al., 2023; Suhartini et al., 2024).

The explanatory variables are direct emissions (Scope 1; GRI 305-1), indirect emissions from purchased energy (Scope 2; GRI 305-2), other indirect value-chain emissions (Scope 3; GRI 305-3), and emission intensity (GRI 305-4). Absolute emissions are expressed in metric tons of carbon-dioxide equivalent (tCO_2e). Emission intensity is defined as the selected total GHG-emissions numerator divided by revenue; the revenue denominator must be expressed in a consistent monetary unit across firms and years. Direct government ownership is measured as the percentage of outstanding shares held directly by the Republic of Indonesia. Accordingly, a value of 0% can occur after a firm becomes controlled indirectly through a state-owned holding

company; it does not necessarily imply the absence of ultimate state control. We include ROA, firm size (the natural logarithm of total assets), and DER as control variables.

We use panel regression to evaluate the association between GHG emissions and firm value. Each emissions indicator is estimated in a separate model to reduce collinearity among overlapping emissions measures. The model includes government ownership and an interaction term between each emissions measure and government ownership, together with ROA, firm size, and leverage as controls. The moderating model is specified as follows:

$$\text{Tobin's } Q_{it} = \alpha + \beta 1 X_{it} + \beta 2 Z_{it} + \beta 3 (X_{it} \times Z_{it}) + \beta 4 ROA_{it} + \beta 5 SIZE_{it} + \beta 6 DER_{it} + \varepsilon_{it} \quad (1)$$

In Equation (1), i denotes the firm and t denotes the year. Tobin's Q represents firm value, X represents one GHG indicator, Z represents direct government ownership, X × Z is the interaction term, and ε is the disturbance term. The coefficient on X represents the emissions slope when Z equals zero; the interaction coefficient indicates how that slope changes as direct government ownership increases. This conditional interpretation is important because the main coefficient on X is not an average effect when the moderator is uncentered.

Model selection was based on the Chow and Hausman tests. The Chow test rejected the pooled model, whereas the Hausman test did not reject the random-effects specification. The random-effects models were therefore estimated with White cross-section robust standard errors to reduce sensitivity to heteroskedasticity and within-firm error dependence. Statistical significance is reported at the 1%, 5%, and 10% levels. Results at 10% are described as marginal or tentative rather than conclusive. The analysis was conducted in EViews. Because random effects require unobserved firm-specific effects to be uncorrelated with the regressors, the results are interpreted as conditional associations rather than causal effects.

RESEARCH RESULTS

Tobin's Q averages 1.626 and ranges from 0.541 to 15.192, indicating substantial variation in market valuation. The emissions variables are highly dispersed: the means are 1,623,798 tCO_2e for Scope 1, 199,153.9 tCO_2e for Scope 2, and 825,836.9 tCO_2e for Scope 3, while their maxima are many times larger than their medians. Emission intensity shows a similarly asymmetric distribution. These patterns indicate substantial right-skewness and possible influential observations; therefore, interpret the level-form estimates cautiously and check them against transformed specifications. Direct government ownership averages 55.52%.

The Chow test produces a probability of 0.0000, rejecting the pooled model in favor of a specification that recognizes firm effects. The Hausman test yields p = 0.1646, so we do not reject the null hypothesis that the random-effects estimator is consistent. Random effects are therefore used as the primary specification. This decision is statistical, not proof that firm-specific effects are unrelated to all regressors; fixed effects and alternative specifications remain necessary robustness checks.

Table 1. Panel Model Selection Tests

Test	Statistic	Probability
Chow test (Cross-section F)	12.9589	0
Hausman test (Chi-square)	10.4484	0.1646
Selected model: Random effects		

Note: The Chow test compares pooled and fixed-effects specifications. The Hausman test compares fixed and random effects. Failure to reject the Hausman null supports random effects under its assumptions but does not eliminate possible endogeneity or reverse causality.

Table 2 shows no statistically significant association between Scope 1 (β = 3.56E-07; p = 0.7168), Scope 2 (β = -4.17E-06; p = 0.2092), or Scope 3 emissions (β = 5.03E-08; p = 0.4401) and Tobin's Q. Emission intensity has a negative coefficient and is marginally significant at the 10% level (β = -3.15E-05; p = 0.0745). Thus, the

results do not support H1, H2, or H3, and they only tentatively support H4. The results do not support a claim that Scope 1 has a negative and significant effect.

Table 2. Random-Effects Estimates of GHG Emissions, Government Ownership, and Firm Value

Variables	Model 1.1	Model 1.2	Model 1.3	Model 1.4
	Tobin's Q	Tobin's Q	Tobin's Q	Tobin's Q
GHG emissions **Scope 1** (X)	3.56E-07			
	(0.7168)			
GHG emission **Scope 2** (X)		-4.17E-06		
		(0.2092)		
GHG emission **Scope 3** (X)			5.03E-08	
			(0.4401)	
GHG emission **Intensity** (X)				-3.15E-05
				(0.0745)*
Government ownership (Z)	-0.013913	-0.014224	-0.013298	-0.013512
	(0.2055)	(0.2002)	(0.2163)	(0.2092)
X x Z	-7.57E-09	7.81E-08	-5.64E-10	7.07E-07
	(0.697)	(0.2262)	(0.5666)	(0.0787)*
ROA	3.651024	3.746327	3.752856	3.734703
	(0.2786)	(0.2853)	(0.2827)	(0.2840)
SIZE	-0.477884	-0.45439	-0.469494	-0.484626
	(0.2030)	(0.2139)	(0.2013)	(0.1986)
DER	-0.077058	-0.0812	-0.078847	-0.076906
	(0.178)	(0.1683)	(0.1775)	(0.1788)
Constant	18.09501	17.32968	17.72612	(18.21029)
	(0.1736)	(0.1819)	(0.1734)	(0.1714)
Observations	140	140	140	140
Number of firms	14	14	14	14
R-squared	0.153721	0.144463	0.14301	0.14543
Adjusted R-squared	0.115544	0.105868	0.104349	0.106878
ProbF-statistic	0.000972	0.001791	0.001969	0.001681

Note: The dependent variable is Tobin's Q. Models 1.1–1.4, derived from equation (1), estimate Scope 1, Scope 2, Scope 3, and emission intensity separately. Entries are coefficients; p-values are reported in parentheses. We use white cross-sectional robust standard errors. * $p < 0.10$. We interpret results at $p < 0.10$ as marginal evidence.

ROA is positive but statistically insignificant in all four models ($p = 0.2786–0.2853$). Firm size is negative but insignificant ($p = 0.1986–0.2139$), and leverage is also negative and insignificant ($p = 0.1683–0.1788$). The analysis therefore provides no evidence that these controls explain variation in Tobin's Q within the reported specifications. The models are jointly significant, but their explanatory power is modest: R-squared ranges from 0.143 to 0.154 and adjusted R-squared ranges from 0.104 to 0.116.

The interaction terms for Scope 1, Scope 2, and Scope 3 are statistically insignificant; therefore, H5a–H5c are not supported. The interaction between emission intensity and government ownership is positive and marginally significant at the 10% level ($\beta = 7.07E-07$; $p = 0.0787$). H5d therefore receives tentative, rather than conclusive, support. The positive interaction suggests that higher direct government ownership may attenuate the negative conditional association between emission intensity and firm value. However, this

interpretation requires marginal-effect estimates and confidence intervals across meaningful ownership levels and should not be treated as causal evidence.

DISCUSSION

Direct Greenhouse Gas Emissions and Firm Value

Scope 1 has a small positive coefficient but is statistically insignificant (β = 3.56E-07; p = 0.7168). H1, which predicts a negative association, is therefore not supported. The estimate provides no evidence that investors systematically penalize direct operational emissions in the sampled SOEs.

This non-result qualifies the agency- and signaling-theory arguments developed earlier. Although Scope 1 is under comparatively direct managerial control, its market relevance depends on whether investors can compare emissions consistently and translate them into expected costs, transition risk, or operational inefficiency. Sectoral differences, reporting quality, regulatory exposure, and extreme observations may obscure that relationship. The finding differs from evidence that actual emissions are negatively valued (Cooper et al., 2018; Matsumura et al., 2014; Matthews et al., 2024), but it is compatible with the broader observation that environmental information is not uniformly incorporated into market valuation across institutional settings.

For Indonesian SOEs, the absence of statistical significance means that the study cannot claim that direct emissions already function as a priced economic-risk indicator. A more cautious interpretation is that the market response may be heterogeneous across sectors or conditional on disclosure credibility, regulatory exposure, and investors' ability to benchmark emissions. This interpretation should be reassessed using transformed emissions, sector controls, and influential-observation diagnostics.

Indirect Greenhouse Gas Emissions from Energy Consumption and Firm Value

Scope 2 has a negative but statistically insignificant coefficient (β = -4.17E-06; p = 0.2092); therefore, H2 is not supported. The estimate indicates direction only and does not establish that purchased-energy emissions reduce firm value.

Theoretically, this result is understandable because Scope 2, although still related to corporate decisions, is more influenced by external factors, such as the national energy mix, electricity supply structure, and energy system efficiency, that management cannot directly control. In the agency theory framework, the relationship between Scope 2 and the quality of a company's internal management is weaker than that of Scope 1. From a signaling-theory perspective, Scope 2 information can also be less emphatic because investors need additional context to assess whether these emissions reflect management quality or merely the broader state of the energy system.

The result is consistent with the possibility that investors do not assess all emission categories uniformly (Matthews et al., 2024). Scope 2 may be difficult to attribute exclusively to management because it depends on the national electricity mix and energy infrastructure. The insignificant coefficient should not be interpreted as evidence that Scope 2 is economically unimportant; it indicates that this study does not identify a reliable association with Tobin's Q.

Accordingly, improvements in energy efficiency may remain operationally and environmentally relevant even though the present model does not detect an immediate market-valuation effect.

Other Indirect Greenhouse Gas Emissions and Firm Value

Scope 3 has a small positive and statistically insignificant coefficient (β = 5.03E-08; p = 0.4401); therefore, H3 is not supported. The estimate provides no evidence that the market consistently prices value-chain emissions in the sampled SOEs.

Scope 3 is the broadest and most complex emissions category because it includes supplier activities, distribution, product use, and other upstream and downstream processes. From a stakeholder theory

perspective, Scope 3 matters because it shows that a company's environmental responsibility extends beyond its own operations. However, from a market perspective, this complexity can make Scope 3 less easy to understand. Investors may struggle to link the magnitude of Scope 3 to immediate economic consequences, especially since most of those emissions are beyond the company's operational control.

From a signaling perspective, Scope 3 information may be less comparable because organizational boundaries, estimation methods, and value-chain coverage differ across firms. The insignificant result should therefore be interpreted as an absence of reliable evidence in this sample, not as proof that value-chain emissions have no economic consequences.

This measurement complexity, together with sectoral heterogeneity and the strongly skewed distribution, provides plausible reasons for the imprecise estimate and warrants sensitivity analysis using standardized reporting boundaries and transformed data.

Emission Intensity and Firm Value

Emission intensity has a negative coefficient that is marginally significant at the 10% level (β = -3.15E-05; p = 0.0745). H4 therefore receives tentative support, but the result does not meet the conventional 5% threshold. The direction is consistent with a market penalty for producing more emissions per unit of economic activity, although the evidence is not sufficiently strong for a definitive conclusion.

Conceptually, emission intensity can be more comparable than absolute emissions because it relates environmental pressure to the scale of economic activity. The result is consistent with agency theory insofar as higher intensity may signal weaker operational efficiency, and with signaling theory insofar as investors may find a scale-adjusted indicator easier to interpret. However, the estimate is sensitive to the emissions numerator, revenue denominator, sectoral structure, and extreme observations. Researchers must standardize and test these measurement choices before drawing strong theoretical or practical implications.

The Moderating Role of Government Ownership

Government ownership does not significantly moderate the Scope 1, Scope 2, or Scope 3 relationships. However, the interaction between government ownership and emission intensity is positive and marginally significant at the 10% level (β = 7.07E-07; p = 0.0787). Thus, H5a–H5c are not supported, whereas H5d receives tentative support only at the 10% level.

The positive interaction coefficient suggests that the negative conditional association between emission intensity and firm value becomes less negative as direct government ownership increases. One possible explanation is that investors expect stronger state support, policy protection, or longer adjustment horizons in firms with higher direct state ownership. An alternative explanation is that direct ownership imperfectly measures state control after the formation of SOE holding companies. Because the interaction is only marginally significant, these explanations remain provisional.

This result refines the legitimacy- and stakeholder-theory interpretation. Government ownership may influence reporting incentives or public accountability (Nguyen et al., 2025), but it does not consistently change the valuation relevance of every emissions category. The tentative intensity interaction suggests that ownership may matter only when emissions are scaled to economic activity. Marginal-effect plots with confidence intervals are needed to determine the ownership levels at which the intensity slope differs statistically from zero.

Accordingly, the evidence does not support a general claim that state ownership either strengthens or weakens the market consequences of emissions. At most, it indicates a tentative boundary condition for emission intensity that requires confirmation through centered interaction models, marginal effects, and robustness checks.

Theoretical and Practical Implications

The findings do not establish that the market prices absolute Scope 1, Scope 2, or Scope 3 emissions in the sampled SOEs. The only direct relationship approaching conventional significance concerns emission intensity, which is consistent with the view that scale-adjusted environmental efficiency may convey a more interpretable signal than absolute emissions. Agency and signaling theories therefore receive limited, indicator-specific support rather than general confirmation. Legitimacy and stakeholder theories may help explain why state ownership could alter market interpretation, but the positive intensity interaction is marginal and does not extend to the three absolute-emissions measures.

The practical implications should remain proportional to the evidence. Managers should improve the consistency and comparability of emissions measurement and monitor emission intensity alongside absolute emissions. Regulators can strengthen standardized reporting boundaries and assurance so that investors can distinguish genuine environmental performance from differences in disclosure practice. Investors may use intensity as one supplementary indicator, but the present estimates do not justify treating it as a stand-alone valuation signal. No causal policy recommendation can be made from these associations.

CONCLUSION

This study examines whether Scope 1, Scope 2, Scope 3, and emission intensity are associated with the value of listed Indonesian SOEs and whether direct government ownership moderates those relationships. Scope 1, Scope 2, and Scope 3 are not statistically significant. Emission intensity is negative and marginally significant at the 10% level, providing tentative evidence that firms with higher emissions relative to economic activity may receive lower market valuations. Government ownership does not moderate the three absolute-emissions relationships, but its interaction with emission intensity is positive and marginally significant at the 10% level. This result suggests a possible attenuation of the negative intensity–value relationship at higher levels of direct government ownership, although marginal-effect analysis is required. Overall, the evidence is associative, modest in explanatory power, and sensitive to measurement and sample limitations; it does not support claims that investors systematically penalize direct emissions or that government ownership broadly changes the valuation of GHG emissions.

RESEARCH LIMITATIONS

This study has several limitations. First, the sample contains only 14 firms and 140 firm-year observations, which limits statistical power, sector-specific analysis, and generalizability. Second, firms enter the sample based on the availability of annual, sustainability, emissions, and financial information, creating potential selection bias. Third, emissions disclosures may differ in organizational boundaries, calculation methods, assurance, and reporting units. Zero entries must be audited because a non-disclosure coded as zero would bias descriptive statistics and regression estimates. Fourth, the highly asymmetric emissions distributions and influential observations may affect level-form coefficients. Fifth, the random-effects assumption may fail if unobserved firm characteristics correlate with emissions or ownership. Finally, reverse causality and omitted variables remain possible, so the estimates should not be interpreted causally. The modest R-squared values indicate that factors outside the models explain much of the variation in firm value.

FURTHER RESEARCH SUGGESTIONS

Future research should use larger and preferably unbalanced panels that preserve valid observations without treating non-disclosure as zero. It should standardize emissions boundaries and intensity denominators, distinguish direct from ultimate state control, and compare carbon-intensive and less-intensive industries. Robustness analysis should include log-transformed emissions, fixed effects, year and sector effects, influential-observation diagnostics, and alternative firm-value measures. Where data permit, lagged specifications, instrumental-variable approaches, or dynamic panels could help address reverse causality and endogeneity. Marginal-effect plots and confidence intervals are also needed to evaluate how the emission-intensity slope changes across government-ownership levels. Additional variables such as climate-governance

quality, external assurance, decarbonization commitments, and regulatory exposure may explain when emissions matter for market valuation.

REFERENCES

1. Arniati, T., Muslichah, M., & Nurastuti, N. (2025). Environmental disclosure and firm value: The moderating role of board size. *International Journal of Accounting, Management, Economics and Social Sciences (IJAMESC)*, *3*(2), 605–614. https://doi.org/10.61990/ijamesc.v3i2.474
2. Cooper, S. A., Raman, K. K., & Yin, J. (2018). Halo effect or fallen angel effect? Firm value consequences of greenhouse gas emissions and reputation for corporate social responsibility. *Journal of Accounting and Public Policy*, *37*(3), 226–240. https://doi.org/10.1016/j.jaccpubpol.2018.04.003
3. Deegan, C. (2002). Introduction: The legitimising effect of social and environmental disclosures---A theoretical foundation. *Accounting, Auditing \& Accountability Journal*, *15*(3), 282–311. https://doi.org/10.1108/09513570210435852
4. Freeman, R. E., & McVea, J. (2005). A stakeholder approach to strategic management. In M. A. Hitt (Ed.), *The Blackwell handbook of strategic management* (pp. 183–201). Blackwell Publishing. https://doi.org/10.1111/b.9780631218616.2006.00007.x
5. Fuadah, L., Mukhtaruddin, M., Andriana, I., & Arisman, A. (2022). The ownership structure and the environmental, social, and governance disclosure, firm value and firm performance: The audit committee as moderating variable. *Asian Journal of Accounting Research*, *7*(3), 321–337. https://doi.org/10.1108/AJAR-10-2021-0165
6. Gabrielle, & Toly, A. A. (2019). The effect of greenhouse gas emissions disclosure and environmental performance on firm value: Indonesia evidence. *Jurnal Ilmiah Akuntansi Dan Bisnis*, *14*(1), 106–119. https://doi.org/10.24843/JIAB.2019.v14.i01.p10
7. Global Reporting Initiative. (2016). *GRI 305: Emissions*.
8. Griffin, P. A., Lont, D., & Sun, E. Y. (2017). The relevance to investors of greenhouse gas emission disclosures. *Contemporary Accounting Research*, *34*(2), 1265–1297. https://doi.org/10.1111/1911-3846.12298
9. Intergovernmental Panel on Climate Change. (2021). *Climate Change 2021: The Physical Science Basis. Summary for Policymakers*.
10. Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X
11. Kurnia, P., Darlis, E., & Putra, A. (2020). Carbon emission disclosure, good corporate governance, financial performance, and firm value. *The Journal of Asian Finance, Economics and Business*, *7*(12), 223–231. https://doi.org/10.13106/jafeb.2020.vol7.no12.223
12. Kurnia, P., Nur, D. E., & Putra, A. A. (2021). Carbon emission disclosure and firm value: A study of manufacturing firms in Indonesia and Australia. *International Journal of Energy Economics and Policy*, *11*(2), 83–87. https://doi.org/10.32479/ijeep.10730
13. Liu, Y. S., Zhou, X., Yang, J. H., Hoepner, A. G. F., & Kakabadse, N. (2023). Carbon Emissions, Carbon Disclosure and Organizational Performance. *International Review of Financial Analysis*, *90*, 102846. https://doi.org/10.1016/j.irfa.2023.102846
14. Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. *The Accounting Review*, *89*(2), 695–724. https://doi.org/10.2308/accr-50629
15. Matthews, L., Gerged, A. M., & Elheddad, M. (2024). Carbon disclosure, greenhouse gas emissions and market value of FTSE 350 firms---Evidence from voluntary carbon disclosers versus non-disclosers. *Accounting Forum*, *49*(4), 778–802. https://doi.org/10.1080/01559982.2024.2377470
16. Nguyen, H. T., Trinh, V. Q., & Chen, W. (2025). Ownership structure and climate-related corporate reporting. *Accounting Forum*, *49*(2), 336–368. https://doi.org/10.1080/01559982.2024.2301850
17. Nilasakti, A. O., Aryani, Y. A., & Setiawan, D. (2024). Carbon emissions disclosure: An overview of research in Indonesia. *Journal of Accounting and Investment*, *25*(3), 1043–1060. https://doi.org/10.18196/jai.v25i3.21913
18. Noor, A., & Ginting, Y. (2022). Influence of carbon emission disclosure on firm value of industrial firms in Indonesia. *International Journal of Contemporary Accounting*, *4*(2), 151–168.

https://doi.org/10.25105/ijca.v4i2.15247

19. Otoritas Jasa Keuangan. (2017). *Peraturan Otoritas Jasa Keuangan No. 51/POJK.03/2017 tentang penerapan keuangan berkelanjutan*.
20. Rachmawati, S. (2021). Green strategy moderate the effect of carbon emission disclosure and environmental performance on firm value. *International Journal of Contemporary Accounting*, *3*(2), 133–152. https://doi.org/10.25105/ijca.v3i2.12439
21. Rahmianingsih, A., & Malau, M. (2022). Carbon emission disclosure and firm value: Does eco-efficiency moderate this relationship? *International Journal of Social Service and Research*, *2*(12), 1310–1324.
22. Sari, K., & Budiasih, I. (2022). Carbon emission disclosure dan nilai perusahaan. *E-Jurnal Akuntansi*, *32*(1), 222–228. https://doi.org/10.24843/EJA.2022.v32.i01.p16
23. Spence, M. (1973). Job market signaling. *Quarterly Journal of Economics*, *87*(3), 355–374. https://doi.org/10.2307/1882010
24. Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of Management Review*, *20*(3), 571–610. https://doi.org/10.5465/amr.1995.9508080331
25. Suhartini, D., Putri, M. I., & Putri, S. Y. (2024). Examining the sustainability report, financial performance, and value of mining companies in Indonesia. *Ilomata International Journal of Tax and Accounting*, *5*(1), 266–279. https://doi.org/10.52728/ijtc.v5i1.1064
26. Suhartini, D., Tjahjadi, B., & Fayanni, Y. (2024). Impact of sustainability reporting and governance on firm value: Insights from the Indonesian manufacturing sector. *Cogent Business \& Management*, *11*(1), 2381087. https://doi.org/10.1080/23311975.2024.2381087
27. Susilawati, S., Rini, N., Saleh, R., & Suryaningsih, M. (2025). Carbon emission disclosure and corporate value: Does company size play a critical role? *Jurnal Ilmiah Raflesia Akuntansi*, *11*(1), 331–338. https://doi.org/10.53494/jira.v11i1.867
28. United Nations Framework Convention on Climate Change. (2015). *Paris Agreement*.
29. Wijaya, J. A., & Handoko, J. (2025). Green advantage, integrated reporting, and carbon disclosure on firm value. *Journal of Contemporary Accounting*, *7*(1), 14–29. https://doi.org/10.20885/jca.vol7.iss1.art2
30. Wu, S., Li, X., Du, X., & Li, Z. (2022). The Impact of ESG Performance on Firm Value: The Moderating Role of Ownership Structure. *Sustainability (Switzerland)*, *14*(21), 14507. https://doi.org/10.3390/su142114507