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The Effect of Greenhouse Gases (GHG) Emission Intensity Reduction and ESG Disclosure on Financial Performance in Energy & Basic Material Sector Companies at Period 2020 - 2023

Devinta Aulia Damayanti[1]*, Ulil Hartono[2]
Universitas Negeri Surabaya
Corresponding Author: Devinta Aulia D devinta.21050@mhs.unesa.ac.id

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A B S T R A C T

As climate concerns grow, companies—especially in high-emission sectors such as energy and basic materials—face pressure to adopt sustainability practices. This study examines how reducing GHG emission intensity, ESG individual and overall disclosure impact financial performance measured by Return on Asset. Panel data regression analysis have conducted using STATA 17 software to analyse 21 Indonesian-listed companies in year 2020 - 2023. Testing reveals that GHG reduction and environmental disclosure have no significant effect on financial performance while social, governance, and overall ESG disclosure positively influence it. The results suggest that comprehensive ESG reporting enhances stakeholder trust and legitimate. Companies are advised to prioritize robust social and governance disclosures, as these ESG components demonstrate a stronger positive impact on financial performance.

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INTRODUCTION

The financial performance of companies serves as a critical measure to assess their health, operational efficiency, and strategic effectiveness often evaluated through profitability ratios such as Return on Assets (Fadrul *et al.*, 2020). ROA reflects how effectively a company utilizes its assets to generate profits (Baby *et al.*, 2024). Historical data from Indonesia Stock Exchange (IDX) from 2019-2023 reveals fluctuating ROA trends across sectors. However, the energy and basic materials—despite being significant contributors to greenhouse gas (GHG) emissions and environmental degradation also economic disruption such as the COVID-19 pandemic—have demonstrated relatively stable historical ROA trends.

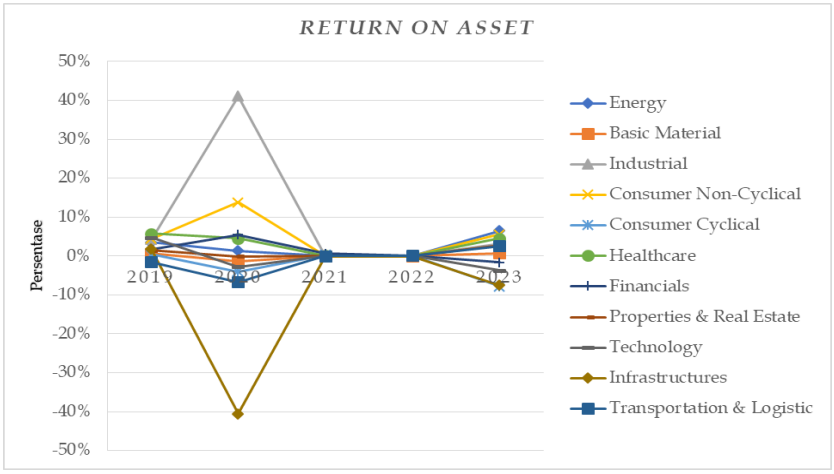

Figure 1. Historical ROA Year 2019 – 2023 (Processed by researcher, 2024)

Globally, the energy and materials sectors are the largest contributors to environmental issues, particularly carbon emissions, accounting for 42% and 40.4% of total environmental impacts, respectively (MSCI Industry Materiality Map, 2024). These sectors are major contributors to greenhouse gas (GHG) emissions, which rely heavily on natural resource exploitation and face increasing global scrutiny due to climate change concerns. Indonesia, as the highest GHG emitter in ASEAN which has 2.3% of global emissions, faces mounting pressure to align with international commitments like the Paris Agreement (IEC, 2024). The country's industries are pivotal in this transition, as they contribute 23% of direct and 15.6% of indirect emission (Bappenas, 2023). Despite regulatory frameworks, such as OJK Regulation No. 51/POJK.03/2017 require public companies to produce sustainability reports, only 3% of Indonesian firms integrate sustainability targets and linked into their financial performance (Loh & Thomas, 2020).

Given these contradictions, this study examines the influence of GHG emissions intensity reduction and ESG disclosure on the financial performance of Indonesian energy and basic materials IDX-IC listed firms from 2020 – 2023. By addressing phenomena gap, the study aims to provide actionable insights for policymakers, investor, and corporate leaders to align sustainability initiatives with financial success. This finding will contribute to broader discourse on sustainable business practices in emerging markets, where regulatory frameworks and stakeholder expectation are rapidly evolving.

LITERATURE REVIEW

Natural-Resource Based View Theory

The Natural Resource-Based View (NRBV) theory, introduced by Hart (1995), serves as the foundation for analysing the impact of greenhouse gas (GHG) emission intensity reductions on corporate financial performance. According to NRBV, firm that adopt proactive environmental strategies—such as pollution prevention, sustainable resource management, and clean technology adoption—gain competitive advantage by improving operational efficiency and reducing long-term costs. By minimizing emissions and transitioning to low-carbon production methods, companies can enhance resource allocation or operational, mitigate regulatory risks, and attract environmentally conscious investors, ultimately leading to improved profitability as measured by Return on Assets (ROA).

Empirical studies support NRBV's relevance, demonstrating that firms with lower carbon footprints achieve better financial outcomes (Gabr & ElBannan, 2024; Maji, 2024). For instance, energy and material sector firms that invest in emission-reducing technologies not only comply with global climate agreements such as Paris Agreements but also benefit from increased market demand for sustainable products. Contrary, Busch *et al.* (2022) findings robustly demonstrate that higher carbon emissions level enhanced short-term financial performance. Based on research gap and theoretical of Natural Resource-Based View theory justifies hypotheses H1

H1: Greenhouse gases (GHG) emission intensity reduction positively influence financial firm performance

Legitimacy Theory

Suchman (1995) provides a critical framework for understanding why firms engage in environmental, social, and governance disclosures, emphasizing the imperative for business to align their operations with societal norms and expectations. Transparent ESG individually such as environment, social, and governance disclosure enhance corporate reputation, mitigates risk of backlash, and fosters long-term stakeholder trust and legitimate. Prior research links has extensively examined the financial implications of individual ESG disclosure under the lens of Legitimacy Theory. In the context of environmental disclosures, studies demonstrate that firms with comprehensive environmental reporting experience improved investor confidence and lower cost of capital. Conversely, Alareeni & Hamdan (2020) note that in regions with weak enforcement of environmental reporting (e.g., certain emerging markets), inconsistent disclosure may initially depress financial performance due to higher compliance costs.

Regarding social disclosures, empirical evidence highlights their role in strengthening stakeholder relationship and driving financial gains. Research by Saygili *et al.* (2022) and Khanchel *et al.* (2023) finds that transparent reporting on social metrics—correlates with higher ROA, as it attracts socially conscious investors and improves workforce productivity. However, conflicting findings exist; for instance, Alareeni & Hamdan (2020) observe the excessive social spending without measurable outcomes can strain short-term profitability,

underscoring the need for strategic alignment between social initiatives and financial goals.

In the context of governance disclosure, studies from Gholami *et al.* (2022) and Lee & Isa (2023) establish a strong positive linkage between robust governance practices and financial performance. Effective governance reduces agency costs, deters fraud, and enhances decision-making efficiency. Meanwhile, Bătae *et al.* (2021) caution that overly rigid governance structures may inadvertently stifle innovation, leading to suboptimal financial outcomes in dynamic industries. This legitimate theory justifies hypotheses H2, H3 and H4:

H2: Environmental disclosure positively influence financial firm performance

H3: Social disclosure positively influence financial firm performance

H4: Governance disclosure positively influence financial firm performance

Stakeholder Theory

Freeman (1984) posits that firms must balance the interest of all stakeholders to achieve sustainable financial success. In the ESG context, this theory underscores how comprehensive sustainability disclosures address the demands of investors, employees, customers, and regulators. By proactively engaging stakeholders through ESG transparency, companies reduce conflicts, enhance brand loyalty, and unlock new market opportunities, all of which contribute to increasing financial performance. Empirical evidence shows that integrated ESG practices correlate with higher profitability, as stakeholder-aligned strategies reduce operational risks and drive innovation (Alareeni & Hamdan, 2020; Veeravel *et al.*, 2024). For instance, firms with strong ESG profiles often experience lower financing costs and higher financial performance. This Stakeholder theory justifies hypotheses H1

H5: ESG Disclosure positively influence financial firm performance

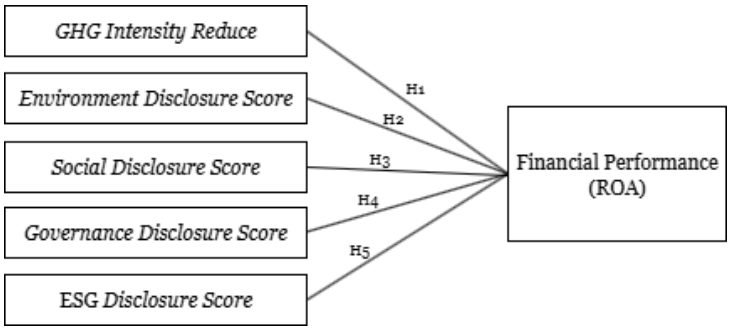

Figure 2. Conceptual Framework

METHODOLOGY

This study employs a quantitative method to examine the causal relationships between variables, specifically focusing on the impact of greenhouse gas (GHG) emission intensity reduction, environment (E), social (S), governance (G), and combined ESG disclosure scores on financial performance (ROA).

The dependent variable, Return on Assets, serves as a key profitability and financial performance metric reflects how effectively a company utilizes its assets

to generate profits and has been widely adopted in financial performance research due to its reliability (Aydoğmuş *et al.,* 2022). Prior studies by Velte (2017), Atan *et al.* (2018) and Ihsani *et al.* (2023) have consistently used ROA as a valid indicator of corporate financial performance, making it an appropriate choice for this analysis. For further information, below the author presents the measurement of variables in tabular form:

Tabel 1. Measurement of Variables

Variable	Measurements	Theoretical Foundations
ROA	$\frac{Net\ Income}{Total\ Asset}$	(Sudana, 2015; Aydoğmuş *et al.,* 2022; Velte, 2017; Atan *et al.,* 2018; Ihsani *et al.,* 2023
GHGIR	$\frac{\text{GHG Emission Scope 1 + Scope 2 (TonsCO2eq)}}{\text{Net Sales (Million IDR)}}\ x\ (-1)$	(Maji, 2024; Gabr & ElBannan, 2024; Busch *et al.,* 2022)
ENVDS	ENVDS = Σ(GHG Emissions, GHG Intensity, Energy Usage, Energy Intensity, Energy Mix, Water Usage, Environmental Operations, Climate Oversight/Management, Climate Oversight/Board, Climate Risk Mitigation, Forestry CSR)	(BGK Foundation; Ihsani *et al.,* 2023)
SOCDS	SOCDS = Σ(CEO Pay Ratio, Gender Pay Ratio, Employee Turnover, Temporary Worker Ratio, Non-Discrimination, Injury Rate, Global Health and Safety, Child and Forced Labor, Human Rights, CSR)	(BGK Foundation; Ihsani *et al.,* 2023)
GOVDS	GOVDS = Σ(Board Diversity, Board Independence, Incentivized Pay, Collective Bargaining, Supplier Code of Conduct, Ethics & Anti-Corruption Compliance, Data Privacy, ESG Reporting, Disclosure Practices, External Assurance, Tax Transparancy)	(BGK Foundation; Ihsani *et al.,* 2023)
ESGDS	$ESGDS = \frac{ENVDS + SOCDS + GOVDS}{3}$	(Zhao *et al.,* 2018; Ihsani *et al.,* 2023)

The research uses secondary data sourced from company annual reports, sustainability reports, and the Bumi Global Karbon (BGK) Foundation at period of time 2020 until 2023. The population consists of energy and basic materials sector companies listed on the Indonesia Stock Exchange Industrial Classification (IDX-IC). Purposive sampling has conducted using previous studies from Maji (2024) and Ihsani *et al.* (2023) with the following criteria:

Tabel 2. Purposive Sampling

Description	Quantity
Population: Energy and basic materials sector companies listed on the Indonesia Stock Exchange Industrial Classification (IDX-IC) in a period of time 2020 - 2023	184
Companies that did not upload their annual reports in a period of time 2020 - 2023	(57)
Companies that did not upload their sustainability reports in a period of time 2020 - 2023	(94)
Companies that did not have individual & overall ESG disclosure scores in BGK Foundation and did not disclose scope 1 and scope 2 emissions information in a period of time 2020 – 2023	(12)
Number of samples according to criteria:	21
x 4 years	84

The final sample comprised 21 companies, analysed over four years which has 84 observations.

RESEARCH RESULT

This study using panel data regression to analyse with STATA 17 as the statistical tools. Panel data regression has chosen for its ability to combine cross-sectional and time-series data, improving efficiency and reducing bias (Wooldridge, 2009). The analysis involves several key steps: descriptive statistics, model selection estimation using Chow, Hausman, and Langrange Multiplier tests to select the best-fit model between Common Effect, Fixed Effect, or Random Effect, and classical assumption tests including normality, multicollinearity, heteroskedasticity, and autocorrelation tests (Gujarati, 2003). The panel data regression equation model is written as follows:

$$Financial\ Performance\ (ROA)_{i,t} = \alpha + \beta_1 GHGIR_{i,t} + \beta_2 ENVDS_{i,t} + \beta_3 SOCDS_{i,t} + \beta_4 GOVDS_{i,t} + \beta_5 ESGDS_{i,t} + \varepsilon_{i,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Table 3. Statistic Descriptive

Variable	Obs	Mean	Std. Dev	Min	Max
ROA	84	0.062	0.085	-0.099	0.462
GHGIR	84	-0.150	0.241	-0.817	-0.001
ENVDS	84	0.543	0.285	0.050	0.980
SOCDS	84	0.528	0.256	0.060	0.950
GOVDS	84	0.503	0.259	0.040	0.980
ESGDS	84	0.511	0.264	0.050	0.960

The descriptive statistical analysis examined six key variables across 84 observations. The mean ROA is 0.062 indicating that on average, companies generated a 6.22% profit from their assets. The analysis revealed substantial performance variations across companies, particularly in financial returns and emissions reductions. The value of standard deviations in ROA and GHGIR are higher than the mean indicates that sector-wide averages mask important differences in individual company performance. While most firms showed moderate ESG transparency (mean: 51.1%) and each of the individual ESG which are environmental, social, governance have the standard deviation less than the

mean value, suggesting limited variability. These findings highlight the heterogeneous nature of sustainability and financial performance within Indonesia's energy and basic materials sector during the 2020 – 2023 study period.

Table 4. Panel-Model Selection Test

Tests	Results	Best-Fit Model
Chow	Prob > F = 0.0001	FEM
Hausman	Prob > chi2 = 0.0219	FEM
LM	Prob > chibar2 = 0.0003	REM

Based on these outcomes, the Fixed Effect Model (FEM) was ultimately chosen as the most appropriate panel data regression model approach. Consequently, subsequent classical assumption tests were required to validate the model's robustness before proceeding with further analysis.

Table 5. Normality Test

Variable	Prob > z	Description
Data_residual	0.00001	Non-normal

Table 5. reveals a residual probability value of 0.00001 ($p < 0.05$), indicating non-normal data distribution tested by Shapiro-Wilk. To address this normality violation, the study employed the Interquartile Range (IQR) method for outlier detection and removal (Dash *et al.,* 2023). The analysis identified outliers in both ROA and GHGIR by removing 25% of the initial sample. Consequently, the final sample size was reduced to 63 observations. This adjustment ensured data normality post-treatment $p = 0.907 > 0.05$. Thus, the data has been declared normally distributed.

After ensuring normal data distribution through outlier removal, two variables—ROA and GHGIR—were identified as containing outliers. Consequently, descriptive statistics were reanalysed with 63 observations. New results of descriptive statistics, ROA had a mean of 0.043 and standard deviation of 0.052, indicating that firms generally maintained positive asset returns. However, the new standard deviation suggests moderate variability in profitability across firm post-outlier adjustment. Meanwhile GHGIR averaged -0.054, with values closer to zero signalling better GHG emission reduction performance. The low standard deviation of 0.049 also confirms minimal variation among firms and no extreme values remained.

Table 6. Multicollinearity Test

Variable	VIF
ESGDS	150.06
ENVDS	84.03
SOCDS	21.95
GOVDS	15.39
GHGIR	2.17
Mean VIF	54.92

Table 6. reveals extreme multicollinearity among several independent variables (VIF > 10). Wooldridge (2009) note that in small samples, high intercorrelation among predictors compromises the accuracy of partial effect estimation. For further research, author has tested the correlation between all of the independent variables. The result's showing ESGDS correlates above 80% with other ESG individual components particularly with ENVDS (r > 95%). Ridge regression has used in this study as the multicollinearity remedy to reduce variance among predictors (Gujarati, 2003; Hair *et al.*, 2014), which introduces a bias parameter *(k)* to stabilize coefficient estimates.

Nayem *et al.* (2024) propose a robust method for determining the optimal ridge parameter *(k)* that remains effective despite the presence of outlier. This study faced dual challenges which are extreme multicollinearity and a 25% outlier reduction. Outliers can significantly distort regression coefficient signs. Thus, following Kibria & Lukman (2020) approach for high-correlation (95%) in a small-sample contexts, we calculated the optimal *k*-value using:

$$k = \sigma p^{(1+\frac{p}{n})} \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where deviation standard denoted from sigma_e fixed effect regression model, p is the predictors, and n is the post-outlier observations:

σ = 0.04228446

p = 5

n = 63

$$k = 0.04228446 \text{ x } 5^{(1+\frac{5}{63})}$$

The optimal ridge parameter was calculated as k = 0.240229. This value was then multiplied by the identity matrix (I) to implement the ridge regression correction in STATA 17:

Table 7. Post-VIF Remedy with Ridge

Variable	**VIF_ridge**
ESGDS	0.5086
ENVDS	0.7013
SOCDS	0.8494
GOVDS	0.8664
GHGIR	0.3927

With all ridge-adjusted VIFs below the threshold (VIF < 10). Notably, ESGDS—previously exhibiting extreme multicollinearity (VIF > 100)—stabilized at 0.5086. The ridge regression effectively resolved multicollinearity while retaining all variables.

Table 8. Heteroscedasticity Test

Chi2(1)	2.52
Prob > chi2	0.1122

Table 8. shows significance value of 0,1122. The number is greater than 0.05. There is no indication of heteroscedasticity.

Table 9. Autocorrelation Test

Z	-1,9
Prob > | z |	0.06

Table 9. shows that the probability value of 0.06 which exceeds the conventional 0.05 significance threshold. This result confirms the absence of autocorrelation in the observation groups.

Table 10. Panel Data Regression with Ridge

ROA	**Coef.**	**Std. err.**	**t**	**P>|t|**
GHGIR	-0.021400	0.1161644	-0.18	0.855
ENVDS	-0.000706	0.0129612	-0.05	0.957
SOCDS	0.038563	0.0187862	2.05	0.047
GOVDS	0.043953	0.020731	2.12	0.041
ESGDS	0.024437	0.0094707	2.58	0.014
_cons	-0.015527	0.0179336	-0.87	0.392
Ridge k Value = 0.24023				
P-Value > F = 0.0101				
R2 Adj = 0.2019				

The empirical analysis employing ridge regression with an optimal shrinkage parameter (k=0.24023) revealed distinct patterns in how sustainability—related independent variables influence corporate financial performance. The F-test confirmed the model's overall validity (p=0.0101), indicating collective explanatory power of all independent variables. However, the t-test revealed non-significant impact for Greenhouse Gases (GHG) Emission Intensity Reduction (GHGIR, p=0.855) and environmental disclosure score (ENVDS, p=0.957). Meanwhile, three key independent variables demonstrated statistically significant positive relationships: Social Disclosure Score (SOCDS, p=0.047), Governance Disclosure Score (GOVDS, p=0.041), ESG Disclosure Score (ESGDS, p=0.014). These coefficients indicate that a one-unit increase in SOCDS, GOVDS, and ESGDS corresponds to ROA improvements of 3.86%, 4.39% and 2.44% respectively, suggesting that enhanced social and governance disclosures positively influence profitability.

The model explained 20.19% of ROA variance, while the remaining 79.81% stems from external factors, such as; leverage, liquidity, capital expenditure, R&D investment, firm size, etc.

DISCUSSION

The results indicate that the reduction of GHG emission intensity has no significant effect on financial performance. This phenomenon is attributed to several factors. First, the limited four-year research timeframe may be too short for emission reduction efforts to significantly affect financial performance. Additionally, not all data are considered high-quality precise, posing a potential limitation (Busch *et al.,* 2022). The study's focus on Indonesia—a developing

country—reveals suboptimal government policies in emission reduction aligned with the Paris Agreement. Reliance on coal and fossil fuels persists (Pramusakti, 2024). The United Nations Environment Programme further warns that Indonesia may miss its 2030 climate targets without accelerated action (Olhoff *et al.,* 2024). This finding does not support the Natural Resource-Based View (NRBV) theory, which posits that proactive environment action (e.g., GHG reduction) enhance competitiveness and profitability (Daud *et al.,* 2023). However, this finding in line with King *et al.* (2001) found no significant evidence linking lower emissions to better financial performance. Practical implications of this result are investments in green technology or GHG reduction programs are not yet prioritized by investors or markets in this sector, which remains reliant on traditional practices. Environmental disclosure has no significant effect on financial performance. This aligns with critiques of ESG transparency in Indonesia (Loh & Thomas, 2020) and contradicts legitimacy theory Suchman (1995), Stakeholders in Indonesia, particularly investors, often overlook environmental factors in decision-making (Husada & Handayani, 2021). Empirical support comes from Chung *et al.* (2024) who found that environmental reporting lacks financial impact. Sumaryati *et al.* (2023) note that environmental disclosures serve compliance rather than profit motives.

Three others variables have positive significant effect on financial performance proxied by ROA. Social disclosure positively affects financial performance, in which gender diversity, anti-discrimination, human rights, and CSR stimulate financial gains. Internally, policies promoting employee welfare and safety enhance productivity; externally, stakeholder engagement improves brand loyalty and sales. Governance disclosure significantly improves financial performances. Transparency in ethics, anti-corruption enhances stakeholder trust and operational efficiency, reducing fraud risks. ESG overall disclosure score has also positively impacts financial performance. Combining environmental, social, and governance efforts—such as energy efficiency, CSR action, anti-fraud measures—yields stronger results than individual ESG pillars. This aligns with legitimacy theory, Suchman (1995:574) explaining why transparent social and governance disclosure enhance stakeholder trust and financial outcomes. Dowling & Pfeffer (1975:122) emphasize that organizations must align their activities with societal expectations to maintain legitimacy, which is achieved through comprehensive ESG Disclosures that address environmental, social, and governance concerns. By addressing the interest of all stakeholders—including employees, communities, and investors—through comprehensive ESG disclosures, companies can achieve financial success, as meeting stakeholder expectations enhances reputation, reduce risks, and drives sustainable value creation (Freeman, 1984).

Empirical studies that support the results, Lee & Isa (2023) and Aydoğmuş *et al.* (2022) found that robust social disclosures enhance profitability by improving employee productivity and stakeholder trust, echoing the current study's emphasis on internal welfare and external loyalty. Similarly, Gholami *et al.* (2022)linked governance transparency to higher ROA, citing reduced fraud risks and operational efficiency. The positive effect of combined ESG aligns with

Hussain *et al.* (2024) and Veeravel *et al.* (2024), who argued that integrated ESG strategies yield synergistic financial benefits.

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that while GHG emission intensity reduction and environmental disclosure do not significantly impact financial performance, social and governance, as well as overall ESG disclosures, positively influence Return on Assets (ROA). These findings highlight the importance of comprehensive ESG reporting in enhancing legitimacy, stakeholder trust and operational efficiency. To align sustainability with financial success, companies should prioritize robust social and governance disclosures, while policymakers and investors should encourage standardized ESG reporting frameworks.

ADVANCED RESEARCH

This study has several limitations, including a short research period and incomplete ESG data coverage from the Bumi Global Karbon Foundation. Lack information and inconsistent GHG emissions reporting units, some of them are not using Tons CO2eq as a unit of measurement. Thus, the author required manual adjustments. Future studies should extend the observation period, focus solely on Scope 1 emissions—which more widely available and consider absolute emission intensity rather than reduction metrics (not multiplying by -1). Subsequent researchers should consider employing an n+1 proxy for financial performance measurement, this is because sustainability—related predictors typically demonstrate lagged effects on financial outcomes rather than immediate concurrent impact. Researchers could also use more comprehensive ESG databases like Refinitiv Eikon or Bloomberg, expand financial metrics beyond ROA and incorporate moderating, mediating, or even control variables for deeper analysis.

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