International Journal of Finance and Business Management (IJFBM)
Vol. 4 No. 5, 2026: 545 - 562

Green on Paper, Profitable on the Balance Sheet? Green Accounting Disclosure and Financial Performance of Energy Firms Listed on the Indonesia Stock Exchange, 2020–2025

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A R T I C L E I N F O

Keywords: Green Accounting; Disclosure Index; Financial Performance; Return On Assets; Energy Sector; Indonesia Stock Exchange

Received : 26 June
Revised : 26 Augut
Accepted: 26 September

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A B S T R A C T

This study examines whether the extent of green accounting disclosure is associated with the financial performance of Energy-sector companies listed on the Indonesia Stock Exchange (IDX). Financial performance is measured by Return on Assets (ROA), and disclosure by a Green Accounting Disclosure Index (GADI), the proportion of environmental cost and activity checklist items disclosed. Data were hand-collected from the sustainability and annual reports of 26 firms with complete data, drawn from a population of 74, giving 149 firm-year observations for 2020–2025. A baseline pooled OLS model controlling for firm size (SIZE) and leverage (LEV) is complemented by firm-clustered standard errors and fixed- and random-effects estimators. In the baseline model GADI is positively associated with ROA ($\beta = 0.177$, $p < 0.001$; $R^2 = 0.140$), while SIZE and LEV are not significant at the 5% level. The association remains positive under firm-clustered inference ($p = 0.03$ to 0.04 using normal and t critical values), random effects ($p = 0.013$), and year effects ($p = 0.043$), but is only marginally significant under the wild cluster bootstrap ($p = 0.053$) and firm fixed effects ($p = 0.097$); it reflects mainly differences between firms, is not found within firms once 2020 is excluded, and a lagged specification does not show that earlier disclosure predicts later profitability. The results are observational associations in a complete-data sample and do not establish that disclosure causes higher profitability; reverse causality and omitted variables cannot be ruled out. The study provides item-level firm-year evidence from a resource-intensive, environmentally sensitive industry, with implications for how managers and regulators evaluate environmental cost reporting.

INTRODUCTION

The Energy sector is among the most environmentally exposed industries listed on the Indonesia Stock Exchange (IDX), as its core operations are closely tied to natural resource extraction, greenhouse gas emissions, and waste management. Growing pressure from regulators, investors, and civil society has pushed energy companies toward green accounting practices, that is, the recognition and disclosure of environment-related costs and activities such as waste management expenditure, energy conservation programs, environmental certifications, and pollution control within annual and sustainability reports. The enforcement of environmental policy on mining, energy, mineral, and gas activities in Indonesia has itself received empirical attention (Hidjaz, 2019).

In theory, greater green accounting disclosure may be associated with better financial performance through lower exposure to environmental fines and litigation, improved relations with investors and other stakeholders, and, potentially, a lower cost of capital. Arguments running in other directions are equally plausible: environmental compliance and reporting impose costs that may depress short-term profitability, and more profitable firms may simply have more resources to prepare comprehensive environmental reports (reverse causality). The studies reviewed in this paper differ in setting, disclosure measure, and research question (Table 1). Nguyen and Tran (2019) report a significant relationship between environmental accounting disclosure and return on assets among listed Vietnamese firms over 2013–2017, whereas Egbunike and Okoro (2018) find no significant relationship between green accounting and profitability among ten Nigerian non-consumer-goods firms over 2012–2016. The closest Indonesian study among those reviewed, Deswanto and Siregar (2018), asks a different question, namely whether financial performance drives environmental disclosure, and does not find such an effect. Qiu et al. (2016) likewise find no relation between environmental disclosures and profitability among large listed firms, although past profitability drives social disclosure. For Indonesian mining firms, Rahim et al. (2024) find that the environmental aspect of sustainability reports has no effect on ROA in 50 listed firms over 2018–2022, while Suhartini et al. (2024) report a positive effect of sustainability reports on firm value in 25 mining firms over 2020–2022. These studies rely on sustainability-report dimensions rather than an item-level green accounting index, and the profitability evidence for the pharmaceutical sub-sector ends in 2021 (Situmeang et al., 2024).

Table 1. Evidence map of the closest prior studies

Study	Setting	Question studied	Reported finding	Difference from this study
Nguyen & Tran (2019)	Vietnam; listed firms, 2013–2017	Disclosure level of environmental accounting information and ROA	Close relationship between disclosure level and financial performance	Different country and period; not Energy-specific
Egbunike & Okoro (2018)	Nigeria; ten non-consumer-goods firms, 2012–2016	Green accounting and profitability (ROE, Tobin's Q)	No significant relationship	Different country and sector; very small sample
Qiu et al. (2016)	Large listed firms	Environmental and social disclosures, profitability, and market value	No relation between environmental disclosure and profitability; past profitability drives social disclosure	Not Indonesian or Energy-specific; separates environmental from social disclosure
Deswanto & Siregar (2018)	Indonesia	Environmental disclosure, financial performance, environmental performance, and firm value	Financial performance does not affect disclosure; lagged environmental performance raises it	Tests performance → disclosure, not disclosure → profitability; not Energy-specific
Shoeb et al. (2022)	Cross-country review	Bibliometric and systematic review of disclosure practices	Positive effect on firm performance, depending on firm characteristics	Review, not a primary test
Situmeang et al. (2024)	Indonesia, pharmaceutical sub-sector, 2018–2021	Environmental accounting and CSR disclosure and financial performance	Positive and significant effect on financial performance (36 observations)	Different sector and earlier period; very small sample
Rahim et al. (2024)	Indonesia; 50 listed mining companies, 2018–2022	Sustainability report aspects and ROE, ROS, and ROA	Environmental aspect has no effect on ROA; social aspect is significant for ROA	Sustainability-report aspects, not an item-level green accounting index
Suhartini et al. (2024)	Indonesia; 25 listed mining firms, 2020–2022	Sustainability report, ROA, and firm value (Tobin's Q)	Sustainability report has a positive effect on firm value	Firm-value outcome; sustainability report, not item-level index

Note: Findings are as reported in the abstracts of the cited works.

Accordingly, this study examines the association between the Green Accounting Disclosure Index (GADI) and financial performance (proxied by ROA) among Energy-sector companies listed on the IDX during 2020–2025, controlling for firm size and leverage. The contribution is deliberately specific: (i) an item-level, hand-coded disclosure index for Energy-sector firms over a period that includes the post-pandemic recovery and recent commodity-price cycles; (ii) a transparent sample-construction and coding procedure; and (iii) inference that accounts for the panel structure of the data (firm-clustered standard errors and fixed- and random-effects estimators) rather than relying on pooled OLS alone. The study does not claim to identify a causal effect of disclosure on profitability.

LITERATURE REVIEW

Green Accounting Disclosure

Green accounting refers to the branch of accounting concerned with identifying, measuring, and disclosing environment-related costs and benefits within a firm's reporting system; the practice and its disclosure are reviewed by Shoeb et al. (2022). In this study, the extent of green accounting disclosure is measured through the Green Accounting Disclosure Index (GADI), constructed as the proportion of environmental disclosure items that a firm discloses out of a fixed checklist, scaled between 0 and 1. The checklist template covers environmental policy, waste-management, energy-efficiency, and pollution-control costs, investment in environmentally friendly technology, environmental certifications (e.g., PROPER, ISO 14001), greenhouse-gas emissions, reclamation and rehabilitation programs, water and effluent management, and environmental compliance costs (Table 4).

GADI captures the quantity (extent) of environmental cost and activity disclosure. It is not a measure of actual environmental performance, such as emissions intensity or PROPER rating, nor of the quality or credibility of the disclosed information. A firm may disclose many items while performing poorly, or perform well while disclosing little. Disclosure and environmental performance are related but not interchangeable constructs, and all inferences in this paper concern the extent of disclosure only.

Indonesian studies of mining firms have treated environmental disclosure as a form of corporate social responsibility (Murdifin et al., 2019; Asmeri et al., 2017) and have examined its determinants, including environmental performance, profitability, and leverage (Digdowiseiso et al., 2022).

Financial Performance

Financial performance is proxied by Return on Assets (ROA), calculated as net income divided by total assets. ROA is widely used in environmental accounting research because it reflects how efficiently a firm converts its asset base, including environment-related investments, into profit (Deswanto & Siregar, 2018). As an accounting-based measure, ROA is also sensitive to accounting choices and, in the Energy sector, to commodity-price cycles.

Theoretical Framework

Two theories motivate the expected relationship, each through a distinct channel. Legitimacy theory holds that firms disclose environmental and social information to obtain and maintain legitimacy within the societal contract in which they operate (Deegan, 2019; Touboul & Kozan, 2020). It explains why energy firms, which face heightened public scrutiny, disclose; its implication for profitability is indirect, operating through avoided penalties, preserved licence to operate, and more favorable stakeholder relations. Signaling theory (Hummel & Schlick, 2016; Touboul & Kozan, 2020) provides the more direct channel: credible voluntary environmental disclosure signals the quality of environmental risk management to investors and creditors, reducing information asymmetry and, potentially, the cost of capital. The two theories can differ on who discloses more: legitimacy arguments allow poorer performers to disclose more, whereas

voluntary-disclosure (signaling) arguments predict that superior performers disclose more (Hummel & Schlick, 2016). Touboul and Kozan (2020) find that conformity to disclosure norms affects financial performance in both the short and the long term, while the revelation of actual performance matters only in the short term, so the timing of any effect matters. Voluntary-disclosure perspectives on green accounting in Indonesia are also discussed by Rahmawati and Hamzah (2025), and the broader question of whether sustainability pays has been synthesised in meta-analyses and reviews (Busch & Friede, 2018; Alshehhi et al., 2018).

Both channels predict a positive association, and their strength is expected to depend on industry characteristics and the credibility of disclosed information. Neither channel is tested here: the data contain no measure of cost of capital, stakeholder pressure, regulatory penalties, or operating efficiency. A reverse-causality argument, in which more profitable firms have the slack resources to disclose more, predicts the same sign; Qiu et al. (2016) interpret their finding that past profitability drives social disclosure through the resource-based view and voluntary disclosure theory. The estimated coefficient therefore cannot by itself discriminate among these explanations.

Hypothesis Development

Prior empirical evidence on this relationship is not uniform (Table 1). Using data from Vietnamese listed firms, Nguyen and Tran (2019) find a significant relationship between the level of environmental accounting disclosure and financial performance. Egbunike and Okoro (2018), by contrast, find no significant relationship between green accounting and profitability among Nigerian non-consumer-goods firms. A systematic bibliometric review by Shoeb et al. (2022) concludes that environmental accounting disclosure practices generally exert a positive effect on firm performance, though this relationship is contingent on firm characteristics such as size, leverage, and time since listing. Busch and Friede (2018), combining 25 earlier meta-analyses, conclude that the case for good social and environmental performance is strong, and Alshehhi et al. (2018) find that 78% of 132 reviewed papers report a positive sustainability–financial performance relationship while noting that evidence from developing countries is scarce. Velte (2017) finds that ESG performance has a positive impact on ROA but not on Tobin's Q in Germany, Velte (2020) reports a positive ESG–ROA link using fixed-effects panel regressions, and Zhao et al. (2018) study the corresponding question for listed power generation companies in China. Deswanto and Siregar (2018), studying Indonesian firms, do not find that financial performance drives environmental disclosure, which underscores the sensitivity of results to context, sample, and model specification. Situmeang et al. (2024) report a positive and significant effect of environmental accounting and CSR disclosure on financial performance in the Indonesian pharmaceutical sub-sector over 2018–2021, a different sector and an earlier period with only 36 observations. Because the direction of the expected association is supported by both legitimacy and signaling arguments and by several of the studies reviewed,

although Egbunike and Okoro (2018) find no relationship, the following hypothesis is proposed:

H1: The Green Accounting Disclosure Index (GADI) is positively associated with the financial performance of Energy sector companies listed on the IDX.

METHODOLOGY

Research Design, Population, and Sample

This is a quantitative, explanatory (associational) study using hand-collected secondary panel data. The population comprises all 74 Energy-sector companies listed on the IDX. The sample was selected using purposive sampling based on three criteria: (1) the firm was listed on the IDX Energy sector before 1 January 2020 and remained listed through 2025; (2) the firm published annual and/or sustainability reports for the 2020–2025 period; and (3) complete data were available for all research variables (FP, GADI, SIZE, and LEV) in the year concerned. Table 2 shows the sampling flow and Table 3 the number of observations per year. The procedure yielded 26 firms and 149 firm-year observations, an unbalanced panel with between 22 and 26 observations per year.

Table 2. Sample selection flow

Step	Criterion	Firms excluded	Firms remaining
0	Population: Energy-sector firms listed on the IDX (IDX-IC sector A, March 2025 list)	–	74
1	Listed on the IDX after 1 January 2020 (fails criterion 1; listing dates verified)	9	65
2–3	No data collected for the remaining firms (includes two firms flagged as possible post-2020 listings whose dates could not be verified); the specific criterion is not recorded	39	26
	Potential firm-years (26 firms × 6 years)		156
	Firm-years excluded for missing data		7
	Final firm-year observations		149

Note: The nine firms listed after 1 January 2020 are ADMR (3 January 2022), MCOL (7 September 2021), CUAN (8 March 2023), MAHA (25 July 2023), SUNI (January 2023), HILL (February 2023), ALII (February 2024), AADI (5 December 2024), and RATU (IPO announced December 2024). Of the 14 firms flagged as possible post-2020 listings, the three that are in the sample (SHIP, listed 16 June 2016; PSSI, 5 December 2017; TEBE, 18 November 2019) were listed before 2020. The records do not state which criterion excluded each of the other 39 firms. The sample is concentrated on the Main Board: 23 of the 26 sample firms are Main Board firms, whereas 31 of the 34 Development Board firms in the population are not in the sample.

Table 3. Firm-year observations per year

	2020	2021	2022	2023	2024	2025	Total
Firm-years	26	25	25	25	26	22	149

Note: Yearly counts must sum to 149 (26 firms × 6 years = 156 potential firm-years; 7 missing).

Of the 156 potential firm-years (26 firms × 6 years), seven were dropped listwise because at least one of the four variables was unavailable, which produces the unbalanced panel: DEWA 2025 (no data for any variable); MBSS 2021 and PTRO 2025 (GADI unavailable); WINS 2023 (ROA, SIZE, and LEV

unavailable); SHIP 2025 (SIZE unavailable); and WINS 2022 and 2025 (SIZE and LEV unavailable; the tabulated ROA and GADI values for these two firm-years, 1.10 and 20.00 for ROA and 61.0 and 48.6 for GADI, lie outside possible ranges and were treated as data-entry errors). Criterion 3 therefore operates at the firm-year level, and criterion 2 is read as requiring that reports exist for the firm, not that every year be complete. WINS contributes only three observations. These reasons are taken from the data notes; the two out-of-range WINS entries could not be verified against the source reports and are treated as missing. Because the sample requires continuous listing through 2025 and reporting, it is likely to over-represent larger, established, and better-reporting firms; the results apply to this selected complete-data sample and may not extend to the 48 excluded firms.

Disclosure and financial data were hand-collected from sustainability reports for most firm-years and from annual reports for the others (for example, ENRG 2020–2022 relies on annual reports only). Net income, total assets, and total liabilities were taken from the financial statements or financial summaries in these reports. Three firm-years rely on less direct sources and are flagged as lower confidence: MEDC 2020–2022 total assets and liabilities come from the company's investor-relations fact book; TOBA 2022 net income is estimated from the reported profit growth rate; and DEWA 2024 total liabilities are derived as total assets minus equity because the printed figure was inconsistent with the balance-sheet identity. Their exclusion is tested in Table 10. Reporting units differ across firms (USD million, USD thousand, USD, and rupiah in millions, billions, or thousands), so all amounts were converted to USD million, and rupiah amounts were converted at annual average exchange rates (Rp14,559, Rp14,308, Rp14,853, Rp15,416, Rp16,162, and Rp16,475 per USD for 2020 to 2025; source: exchange-rates.org). Total assets of AKRA (2020–2025), DEWA (2023–2024), and TEBE (2021) were reported in rupiah billions and are converted accordingly in the SIZE variable. The SGER rates (about Rp14,850 for 2022 and Rp15,250 for 2023 per USD) are approximations.

GADI Construction and Coding Procedure

GADI was constructed by content analysis of each firm-year's sustainability and annual report against a fixed checklist (Table 4). Each item is scored 1 if disclosed and 0 otherwise, and GADI is the number of items disclosed divided by the total number of items, so that it lies between 0 and 1. Items are equally weighted. The checklist template lists ten items, but every GADI value in the data is a multiple of 0.125 and the data notes report scores as fractions of eight (for example, 6/8), so GADI appears to have been scored on eight of the ten items, and takes at most nine distinct values. The data do not record which two items were not scored; Table 4 lists the full ten-item template, and GADI is read as a share of eight items.

Table 4. GADI checklist structure

No	Checklist item (template)	Corresponding framework
1	Environmental policy / commitment	GRI 2-23 (policy commitments)
2	Waste-management costs	GRI 306 (waste)
3	Energy conservation / efficiency costs	GRI 302 (energy)
4	Pollution-control costs	GRI 303 and 305 (effluents and emissions)
5	Investment in environmentally friendly technology	No direct GRI counterpart
6	Environmental certification / awards (e.g., PROPER, ISO 14001)	PROPER (Ministry of Environment and Forestry); ISO 14001
7	Greenhouse-gas (GHG) emission disclosure	GRI 305-1 to 305-3 (emissions)
8	Greening / reclamation / land rehabilitation programs	GRI 304 (biodiversity); GRI 12 (coal sector) closure and rehabilitation
9	Water and effluent management	GRI 303 (water and effluents)
10	Environmental compliance costs / fines (if any)	GRI 2-27 (compliance with laws and regulations)
	Scored in the data: 8 of 10 items (multiples of 1/8); the two unscored items are not recorded	

Note: Frameworks indicate the closest corresponding standard for each template item; they are not a record of how the items were originally derived.

Scoring follows the template's binary rule (1 = disclosed, 0 = not disclosed). The template defines no separate rule for partial disclosure, so an item is scored 1 whenever it is disclosed in the report. Because every firm is scored out of the same eight items, an item that does not apply to a firm (for example, reclamation items for shipping firms) appears to score 0, which biases GADI downward for non-extractive firms. Items are coded at the item level for each firm-year report. No inter-coder reliability statistic is documented for these data. Firm-years with missing reports are excluded, not scored zero (Table 2). Because the source document differs across firm-years (sustainability report or annual report), GADI is not strictly comparable across them.

Operational Definition of Variables

Table 5. Variable definitions

Variable	Type	Definition	Measurement and scale
FP	Dependent	Financial performance, proxied by Return on Assets (ROA)	Net income / total assets; decimal (0.12 = 12%)
GADI	Independent	Extent of green accounting disclosure based on a checklist of environmental cost and activity items	Items disclosed / total items; 0–1 scale (not a percentage)
SIZE	Control	Firm size	Natural log of total assets in USD million; non-USD amounts converted at annual average exchange rates
LEV	Control	Proportion of debt financing relative to total assets	Total liabilities / total assets; ratio

Estimation Strategy

The baseline specification is a pooled OLS regression of ROA on GADI and two controls:

$$ROA_{it} = \alpha + \beta_1 GADI_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \varepsilon_{it} \quad (1)$$

Pooled OLS treats all 149 firm-year observations as independent. This is unlikely to hold because observations of the same firm share unobserved characteristics (business model, ownership, subsector) and are serially correlated. Pooled OLS is therefore reported as a baseline that is comparable with studies using the same estimator, while inference rests on estimators that respect the panel structure. The following steps were applied: (i) baseline estimation with conventional standard errors; (ii) the same model with firm-clustered standard errors, with p-values also computed from a t distribution with 25 degrees of freedom (G − 1) and from a wild cluster bootstrap-t (Rademacher weights, null imposed, 2,000 replications), because only 26 clusters are available and conventional clustered errors can be too small with few clusters, whereas the wild cluster bootstrap is generally more reliable (MacKinnon & Webb, 2018; MacKinnon et al., 2023), implemented here as a restricted wild cluster bootstrap-t following Roodman et al. (2019); (iii) firm fixed-effects and random-effects models with firm-clustered standard errors, with specification guided by the Chow (F) test for pooled versus fixed effects, the Breusch–Pagan Lagrange Multiplier test for pooled versus random effects, and the Hausman test for fixed versus random effects; (iv) year effects, as in equation (2), to absorb common shocks such as commodity-price cycles; (v) GADI lagged one year to mitigate, though not eliminate, reverse causality, together with a reverse-direction model in which GADI is regressed on lagged ROA; (vi) winsorisation of ROA at the 1st and 99th percentiles, because the maximum ROA in the sample is 60.3%; (vii) re-estimation excluding 2020, the year of lowest average ROA, and leave-one-firm-out estimation; (viii) subsector controls and a coal-and-integrated-energy subsample, because the sample mixes 14 coal and integrated energy firms, 2 upstream oil and gas firms, and 10 service, trading, and distribution firms (classification based on the data notes and company business profiles); and (ix) exclusion of the two firm-years flagged as lower confidence in the data (TOBA 2022 and DEWA 2024).

$$ROA_{it} = \alpha + \beta_1 GADI_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where μ_i denotes firm effects and λ_t year effects. Diagnostics comprise variance inflation factors, a heteroskedasticity test (Breusch–Pagan), and the Wooldridge test for serial correlation in panel data. The Durbin–Watson statistic from the pooled model, computed on the OLS residuals with observations stacked firm by firm and year by year, is reported only as a rough indicator: the standard statistic assumes a single ordered time series, so applied to stacked firm-year data it ignores firm boundaries and gaps in an unbalanced panel. H1 is supported if β_1 is positive and statistically significant under panel-appropriate inference, and is interpreted as an association, not a causal effect.

RESEARCH RESULT

Descriptive Statistics

Table 6 reports descriptive statistics for the 149 firm-year observations. ROA is expressed as a decimal (0.1209 = 12.1%) and GADI on a 0–1 scale.

Table 6. Descriptive statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
FP (ROA)	0.1209	0.1363	−0.0990	0.6026
GADI	0.7349	0.2566	0.0000	1.0000
SIZE	6.7550	1.3522	3.8527	9.2856
LEV	0.4256	0.1975	0.0495	0.9613

The mean GADI of 0.735 indicates that, on average, sample firms disclose about three-quarters of the checklist items. Because the checklist is the authors' own, this level reflects the checklist content and should not be compared with other indices. The minimum of 0.000 and maximum of 1.000 show that at least one firm-year discloses none of the items and at least one discloses all. Mean ROA of 12.1% conceals considerable dispersion (−9.9% to 60.3%), consistent with the Energy sector's sensitivity to commodity-price cycles; the upper tail motivates the winsorisation check described above. GADI is discrete: it takes only the nine values 0, 0.125, …, 1, and only 13.9% of its variance is within firms (nine of the 26 firms report the same GADI in every year in which they are observed).

Correlation Matrix

Table 7. Pearson correlation matrix

	FP	GADI	SIZE	LEV
FP	1.000			
GADI	0.308	1.000		
SIZE	−0.032	0.390	1.000	
LEV	−0.221	−0.076	0.430	1.000

GADI is positively and moderately correlated with SIZE (r = 0.390), indicating that larger firms tend to disclose more. This means that size is a plausible confounder, and the single SIZE control may only partly absorb it. The bivariate correlation between FP and GADI is 0.308, and FP is negatively correlated with LEV (r = −0.221). Variance inflation factors are 1.29 (GADI), 1.57 (SIZE), and 1.34 (LEV), far below conventional thresholds, so multicollinearity is not a concern.

Baseline Regression Results

Table 8 presents the baseline pooled OLS estimates with conventional standard errors. The overall model is statistically significant ($F = 7.879$, $p < 0.001$) and explains 14.0% of the variation in ROA (Adjusted $R^2 = 0.122$). The Durbin–Watson statistic is 0.806, which suggests positive serial correlation in the pooled residuals; conventional standard errors are therefore likely to be understated, and the p-values in Table 8 should not be treated as final.

Table 8. Baseline pooled OLS estimates (dependent variable: ROA)

Variable	Coefficient	Std. Error	t	Sig. (p)	95% CI
Constant	0.1015	0.055	1.859	0.065*	−0.006 to 0.209
GADI	0.1772	0.046	3.815	<0.001***	0.085 to 0.269
SIZE	−0.0097	0.010	−0.992	0.323	−0.029 to 0.010
LEV	−0.1070	0.062	−1.738	0.084*	−0.229 to 0.015

Note: Conventional (non-robust) standard errors. *** p < 0.01; ** p < 0.05; * p < 0.10. N = 149; R^2 = 0.140; Adjusted R^2 = 0.122; F = 7.879 (p < 0.001); Durbin–Watson = 0.806. 95% confidence intervals use t(145) = 1.976.

Panel-Appropriate Estimates and Robustness

Table 9 reports the estimates that account for the panel structure. The diagnostic tests point to a panel specification: the Chow test rejects pooled OLS in favor of fixed effects (F(25, 120) = 5.05, p < 0.001), the Breusch–Pagan LM test rejects pooled OLS in favor of random effects ($\chi^2(1)$ = 51.04, p < 0.001), the Wooldridge test indicates serial correlation (F(1, 25) = 77.25, p < 0.001), and the Breusch–Pagan test indicates heteroskedasticity ($\chi^2(3)$ = 13.89, p = 0.003). The Hausman test does not reject the random-effects specification ($\chi^2(3)$ = 4.97, p = 0.174), so random effects is the preferred efficient estimator. Fixed effects are retained as a more conservative benchmark, but only 13.9% of the variance in GADI is within firms, so the Hausman test and the fixed-effects estimates have limited power.

The contemporaneous GADI coefficient is positive in every specification in columns (1) to (4), ranging from 0.117 to 0.177, but its statistical strength varies with the inference used. With firm-clustered errors the pooled-OLS p-value is 0.030 (0.040 using t with 25 degrees of freedom, and 0.053 from the wild cluster bootstrap). The coefficient is significant at the 5% level under random effects (p = 0.013) and with fixed firm and year effects (p = 0.043), but only at the 10% level under firm fixed effects alone (p = 0.097). Neither SIZE nor LEV is significant at the 5% level in any specification. The lagged specification in column (5) behaves differently, and Table 10 shows that the within-firm result is sensitive to the sample window.**Table 9. Panel-appropriate and robustness estimates (dependent variable: ROA)**

	(1) Pooled OLS, clustered SE	(2) Fixed effects	(3) Random effects	(4) FE + year effects	(5) FE, lagged GADI
GADI	0.177** (0.082)	0.117* (0.070)	0.158** (0.063)	0.124** (0.061)	−0.369*** (0.092)
SIZE	−0.010 (0.016)	0.055 (0.034)	0.002 (0.013)	0.022 (0.047)	−0.001 (0.053)
LEV	−0.107 (0.090)	−0.032 (0.097)	−0.076 (0.072)	−0.007 (0.111)	0.149 (0.129)
Constant	0.102 (0.063)	absorbed	0.023 (0.057)	absorbed	absorbed
Firm effects	No	Fixed	Random	Fixed	Fixed
Year effects	No	No	No	Yes	No
Observations	149	149	149	149	121
Firms	26	26	26	26	26
R^2	0.140	0.060	0.122	0.049	0.194

Note: Coefficients with firm-clustered standard errors in parentheses; column (1) p-values use the normal distribution (see text for t(25) and wild-bootstrap p-values). *** p < 0.01; ** p < 0.05; * p < 0.10. R^2 is the overall R^2 for columns (1) and (3) and the within R^2 for columns (2), (4), and (5). Column (5) uses GADI lagged one year, which reduces the sample to 121 observations.

Table 10 reports sensitivity checks. Winsorising ROA leaves the results essentially unchanged. Excluding 2020 (123 observations) leaves the pooled-OLS and random-effects coefficients positive and significant (0.218 and 0.167) but reduces the fixed-effects coefficient to 0.010 (p = 0.940); with year effects it is positive but insignificant (0.096, p = 0.223). In the lagged specifications the fixed-effects coefficient on GADI(t−1) is negative (−0.369; −0.234 with year effects), and the pooled-OLS coefficient is positive but insignificant (0.113, p = 0.220). The contemporaneous fixed-effects coefficient on the same 121-observation sample is −0.036 (p = 0.799), so the sign change reflects the sample window and within-firm timing, not lagging as such. In the reverse direction, lagged ROA is positively associated with GADI under fixed effects (0.187, p = 0.023) but not once year effects are added (0.144, p = 0.150). Controlling for subsector groups lowers the pooled coefficient to 0.134 (p = 0.057; random effects p = 0.020); in the 14 coal and integrated energy firms alone the coefficient is larger (0.307 pooled, p = 0.011; 0.249 random effects, p = 0.020) and insignificant under fixed effects (0.161, p = 0.208). Excluding the two lower-confidence firm-years changes little. Leave-one-firm-out fixed-effects coefficients range from 0.056 to 0.151, and pooled-OLS coefficients from 0.123 to 0.222. Year-by-year cross-sections give positive GADI coefficients for 2021 to 2025 (0.126 to 0.317), significant at the 5% level only in 2021 and 2022 and declining thereafter, but a negative, insignificant coefficient for 2020 (−0.076, p = 0.307).

Table 10. Sensitivity checks (GADI coefficient unless stated)

Check	N	Coefficient	Std. error	p
Pooled OLS, p from t(25)	149	0.177	0.082	0.040
Pooled OLS, wild cluster bootstrap-t	149	0.177	–	0.053
Winsorised ROA, pooled OLS	149	0.177	0.081	0.030
Winsorised ROA, fixed effects	149	0.118	0.070	0.093
Excluding 2020, pooled OLS	123	0.218	0.087	0.012
Excluding 2020, random effects	123	0.167	0.072	0.022
Excluding 2020, fixed effects	123	0.010	0.125	0.940
Excluding 2020, fixed + year effects	123	0.096	0.078	0.223
GADI(t−1), pooled OLS	121	0.113	0.092	0.220
GADI(t−1), fixed effects	121	−0.369	0.092	<0.001
GADI(t−1), fixed + year effects	121	−0.234	0.094	0.015
GADI(t), fixed effects, same lagged sample	121	−0.036	0.140	0.799
Reverse: ROA(t−1) → GADI, fixed effects	121	0.187	0.081	0.023
Reverse: ROA(t−1) → GADI, fixed + year	121	0.144	0.099	0.150
Subsector dummies, pooled OLS	149	0.134	0.070	0.057
Subsector dummies, random effects	149	0.133	0.057	0.020
Coal & integrated energy only, pooled OLS	84	0.307	0.120	0.011
Coal & integrated energy only, random effects	84	0.249	0.105	0.020

Coal & integrated energy only, fixed effects	84	0.161	0.127	0.208
Excluding TOBA 2022 and DEWA 2024, pooled OLS	147	0.185	0.081	0.022
Excluding TOBA 2022 and DEWA 2024, fixed effects	147	0.116	0.070	0.098

Note: Firm-clustered standard errors except where stated. In the two reverse rows the coefficient is on lagged ROA, with GADI as the dependent variable. Subsector groups follow the data notes: coal and integrated energy (14 firms), upstream oil and gas (2), and services, trading, and distribution (10).

DISCUSSION

In the baseline pooled OLS model, GADI is positively associated with ROA ($\beta = 0.177$; conventional 95% confidence interval 0.085 to 0.269). The association remains positive under firm-clustered inference ($p = 0.030$; 0.040 with t critical values; wild cluster bootstrap $p = 0.053$), random effects ($p = 0.013$), and year effects ($p = 0.043$), but it is only marginally significant under firm fixed effects ($p = 0.097$). This is consistent with H1 in its contemporaneous form, though weaker statistically once few-cluster and within-firm inference are used. Evidence for a within-firm or lagged relationship is weak and inconsistent, as discussed below.

A full one-unit change in GADI (from disclosing no checklist item to disclosing all) corresponds to a 17.7-percentage-point difference in ROA, which extends across the entire index range and is not a realistic comparison for most firms. A more practical reading uses the sample standard deviation: a one-standard-deviation higher GADI (0.257) is associated with ROA that is about 4.5 percentage points higher (approximately 0.2 to 8.9 using the firm-clustered 95% confidence interval of 0.009 to 0.345), or about 0.33 standard deviations of ROA, against a sample mean ROA of 12.1%.

The direction is consistent with Nguyen and Tran (2019), Situmeang et al. (2024), the general tendency reported by Shoeb et al. (2022) and Busch and Friede (2018), and Velte's (2017) positive ESG–ROA result, but not with the null relationships reported by Egbunike and Okoro (2018) for Nigerian firms, by Qiu et al. (2016) for environmental disclosure, or by Rahim et al. (2024) for the environmental aspect of sustainability reports and ROA among Indonesian mining firms. Differences in samples, disclosure measures, and specifications mean that these comparisons are tentative (Table 1).

The pattern across specifications indicates that the association is mainly a difference between firms rather than a change within firms. The fixed-effects coefficient is smaller and weaker than the random-effects one, it falls to 0.010 when 2020 is excluded, the lagged fixed-effects coefficient is negative, and lagged ROA predicts GADI under fixed effects. Firms with higher disclosure thus earn higher ROA in the cross-section, but there is no consistent evidence that a firm that raises its disclosure subsequently earns more. The association is not driven by the service firms in the sample: it is larger among coal and integrated energy firms (0.307 pooled; 0.249 random effects), although with 14 firms it is imprecisely estimated under fixed effects. In the year-by-year cross-sections the

association is positive from 2021 to 2025 but fades over time and is absent in 2020, the year of lowest average ROA (3.2%); this is consistent with the conditions of that period, although the data cannot test it.

The association is compatible with the signaling and legitimacy arguments, but this study does not test them, and other explanations fit the same coefficient equally well. First, reverse causality: more profitable firms may have the resources to produce fuller environmental reports; the positive effect of lagged ROA on GADI under fixed effects (Table 10) is consistent with this, although it disappears with year effects. Second, omitted variables: ownership structure, subsector (e.g., coal, oil and gas, renewables), commodity-price exposure, governance quality, and regulatory attention may raise both disclosure and profitability; the GADI–SIZE correlation of 0.390 points to size-related confounding. Third, sample selection: only 26 of the 74 firms have complete data, and these are probably larger and better-reporting firms. Fourth, measurement: GADI captures the extent of disclosure, not its quality or the firm's actual environmental performance.

In the baseline model neither control is significant at the 5% level (SIZE $p = 0.323$; LEV $p = 0.084$, significant only at the 10% level), and neither is significant at the 5% level in any other specification, so the evidence on firm size and leverage is weak. The negative baseline signs are consistent with, respectively, a possible offsetting effect of heavier fixed-cost and regulatory burdens in larger capital-intensive producers and the conventional cost-of-debt argument, but these readings are speculative.

CONCLUSIONS AND RECOMMENDATIONS

This study finds that, in a sample of 26 Energy-sector firms listed on the IDX (149 firm-year observations, 2020–2025), a higher Green Accounting Disclosure Index is positively associated with ROA in the baseline pooled OLS model, after controlling for firm size and leverage. The association remains positive under firm-clustered inference, random effects, and year effects, although it is only marginally significant under the wild cluster bootstrap ($p = 0.053$) and firm fixed effects ($p = 0.097$). It is chiefly a difference between firms: it is not found within firms when 2020 is excluded, and lagged specifications do not show that earlier disclosure predicts later profitability. The result is therefore an association in a selected complete-data sample that depends on model specification, and it does not show that disclosure raises profitability.

Implications supported by the results

Within this sample, firms that disclose more environmental cost and activity items did not report lower profitability; the association was positive in the baseline model. Researchers should treat the estimate as a descriptive benchmark for the Indonesian Energy sector, to be tested with designs that address reverse causality and omitted variables.

Broader suggestions not tested here

Regulators and standard setters may consider encouraging consistent environmental cost reporting on accountability and transparency grounds. This

suggestion rests on those grounds and not on the results of this study, which do not show that greater disclosure improves profitability.

LIMITATIONS AND FUTURE RESEARCH

Limitations

First, the sample covers only 26 of the 74 firms in the Energy-sector population, and the records do not state why each of the other 39 firms was excluded; the sample is concentrated on Main Board firms (23 of 26), which are likely to be larger and better established; continuous listing through 2025 is required, selection effects are therefore likely, and the results should be generalised with caution. The sample also mixes coal and integrated energy producers with oil and gas, service, trading, and distribution firms. Second, the baseline pooled OLS model has a Durbin–Watson statistic of 0.806, indicating potential positive autocorrelation and unmodelled firm-specific heterogeneity; this is addressed through clustered errors and panel estimators, but with only 26 firms inference remains sensitive to small-sample issues. Third, only 13.9% of the variance in GADI is within firms and nine firms report a constant GADI, so the fixed-effects estimates rest on limited variation and are sensitive to the inclusion of 2020 (Table 10). Fourth, the association-based design does not permit causal claims; reverse causality cannot be ruled out, and a one-year lag only partly mitigates it. Fifth, GADI measures the extent of disclosure using an equally weighted, binary checklist scored on eight of ten template items, coded by content analysis without a documented reliability check, and drawn from sustainability reports for most firm-years but annual reports for others; it does not capture disclosure quality or actual environmental performance. Sixth, some financial inputs are lower-confidence (an estimated net income, a derived liability figure, externally sourced assets, and approximate exchange rates for some firm-years), and reporting units had to be standardised. Seventh, the model includes only two controls, so omitted variables such as ownership, subsector, governance, and commodity-price exposure may bias the estimate. Finally, ROA is an accounting-based measure and may reflect accounting choices.

Future Research

Future studies should extend the observation period and the number of firms, include additional controls (e.g., prior-year profitability, institutional ownership, audit committee quality, subsector indicators, and commodity prices), and use designs that better address causality, such as lagged or instrumental-variable specifications or settings with exogenous changes in disclosure regulation. Complementing the disclosure index with measures of disclosure quality and of environmental performance (e.g., PROPER ratings or emissions data) would help separate what is disclosed from what is done. Comparative studies across other environmentally exposed sectors, such as mining, basic industry, and chemicals, would assess generalisability.

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