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Green Accounting and Financial Performance: Evidence from the Ceramic Industry in Bangladesh

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ABSTRACT

The study investigated the relationship between green accounting disclosure (GAD) and financial performance in the ceramic industry in Bangladesh, using a 20-year panel dataset (2005–2024) of all five listed firms. A replicable 10-item GAD index was constructed from audited annual reports and estimated pooled and fixed-effects panel models with small-N robust inference (firm-clustered SE, PCSE, and Driscoll-Kraay checks). No statistically significant evidence was found that GAD improved profitability, measured by return on assets (ROA) and return on equity (ROE). The estimated effects were consistently positive but statistically indistinguishable from zero for both ROA and ROE. The study suggests that, under a voluntary and low-assurance reporting environment, disclosure alone may remain symbolic and may not translate into short-run profitability benefits. This research contributes (i) a transparent, auditable GAD measurement protocol for emerging markets, (ii) sector-specific longitudinal evidence for Bangladesh, and (iii) policy implications on minimum disclosure requirements and assurance to improve decision-usefulness. However, the small number of listed ceramic firms limited statistical power, coefficient stability, and generalisability. Therefore, the findings should be interpreted as evidence of no detectable short-run profitability benefit rather than proof of no relationship.

1. INTRODUCTION

Global corporate reporting is undergoing a rapid shift toward sustainability. Major companies and investors now treat environmental, social, and governance (ESG) disclosures as the core of corporate reporting. The KPMG Survey of Sustainability Reporting (2020) reported that sustainability reporting was “widely

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recognized by financial stakeholders as a critical component of corporate reporting,” and many large firms openly link disclosures to the UN Sustainable Development Goals. The existing literature also suggested that robust sustainability disclosure can improve firm value, especially in contexts with strong governance and regulation (KPMG, 2020; Friede et al., 2015).

However, in more robust institutional settings, regulation, investor demands, assurance processes and international reporting standards were increasingly influencing sustainability and environmental disclosure practices (Christensen et al., 2021; IFRS Foundation, 2023; European Commission, 2023; IFAC, 2025). In contrast, in many developing countries, the disclosure of environmental information was not well organized, not standardised, and not well assured (Ikpor et al., 2022; Tsang et al., 2023; GRI, 2024). This difference is relevant because the value of the economic benefits of the green accounting disclosure could be related to the quality, credibility and enforceability of the disclosed information (Christensen et al., 2021; Krueger et al., 2024; IAASB, 2024). Thus, when disclosure is being reported by developing reporting institutions, evidence from developing economies can help to contribute to the international literature to determine whether disclosure brings any measurable financial benefits to the reporting institutions (Tsang et al., 2023; Gündüz & Gündüz, 2025; GRI, 2024).

However, the situation in many developing economies is substantially different. Firms in Bangladesh often lacked comprehensive guidelines and provided only voluntary sustainability disclosures. Prior empirical research reported low adoption of environmental accounting outside the developed world. In Bangladesh, one of the country’s most vulnerable to climate change, corporate environmental accounting remained nascent. Firms rarely integrated environmental costs into audited financial statements; such information, if disclosed at all, appeared in narrative corporate social responsibility (CSR) sections with inadequate and unaudited metrics (Belal & Cooper, 2011; Das & Tasnim, 2021; Akter, 2024).

Evidence from listed firms in Bangladesh indicates that environmental disclosure remains limited, particularly for quantified environmental expenditures and liabilities. In the absence of comprehensive mandatory environmental reporting requirements, environmental accounting and disclosure have remained largely voluntary and uneven across firms (Akter, 2024; Belal & Cooper, 2011; Das & Tasnim, 2021).

Bangladesh’s ceramic industry is both economically and environmentally relevant. It is a sector that manufactures tiles, sanitary ware, and allied products, and has expanded substantially over the past decade. Industry reports indicated strong growth in production capacity, domestic demand, and export potential. The production of ceramic is also capital and energy intensive and is a polluted and emissions intensive industry as, energy costs and emissions are significant concerns for factories which use natural gas or diesel to fire kilns and generate power. Overall, the industry was characterized by significant environmental effects and costs, and by low levels of industry regulation (UNIDO, 2022; Furszyfer Del Río et al., 2022).

Despite these developments, firm-level evidence on green accounting in Bangladesh’s ceramic industry remained scarce. Limited research on environmental disclosure in Bangladesh has either analysed all industries together or focused on sectors such as banking, textiles, or cement. To the best of the researchers’ knowledge, no prior listed-firm, ceramic-only study has examined ceramic producers at the firm level in Bangladesh. The remaining gap was significant because firm-level analysis can show how specific company characteristics and decisions influenced green accounting and performance outcomes.

Recognition of the drivers of green disclosure and its relationship with financial performance in the ceramic sector could help policymakers and managers target improvements (Akter, 2024; Uddin, 2022).

Against this background, this study examined whether firm-level green accounting disclosure was associated with profitability in Bangladesh's listed ceramic industry. Prior research and surveys focused on the benefits of robust environmental disclosure under supportive institutional conditions. In Bangladesh, however, evidence indicates that corporate environmental costs were largely unrecognized in financial accounts and disclosures remained mostly unaudited and voluntary. This research focused on Bangladeshi ceramic firms: by analysing individual companies in this sector, the analysis aimed to uncover the gaps in environmental cost disclosure and whether closing those gaps were related to better financial performance (KPMG, 2020; Belal & Cooper, 2011; Das & Tasnim, 2021; Akter, 2024).

This study addressed three related gaps. First, previous studies of environmental disclosure in Bangladesh have focused on corporate samples or other industries, and very little longitudinal evidence existed on the listed ceramic industry. Second, there was limited use of a transparent and replicable green accounting disclosure index based on audited annual reports. Third, little was known about whether voluntary disclosure and weakly assured disclosure lead to measurable gains in profitability in an emerging market manufacturing sector.

Although there is increasing awareness and pressure on sustainability, many Bangladeshi companies were not yet accounting for environmental costs in their audited financial statements to a satisfactory level. These expenses were typically not even explicitly stated. The environmental costs and liabilities were usually included in unaudited CSR reports or in the narrative, leading to incomplete information, low comparability and weak assurance (Belal & Cooper, 2011; Masud et al., 2017). While sustainability reporting has developed over time, there were still a variety of ways to measure and report sustainability, which made the information presented to investors and regulators less useful (Friede et al., 2015; Orlitzky et al., 2003). Such a gap was even more striking and apparent in sectors with a high prevalence of pollution, such as the ceramic sector (Furszyfer Del Río et al., 2022), and in resource-intensive industries. Considering Bangladesh's ceramic industry, the environmental cost has been either ignored in the reporting or mentioned briefly in the reporting of the industry because there was a voluntary reporting regime, and the empirical research showed that the disclosure of environmental cost was generally low and uneven in the listed firms of Bangladesh. Very little firm level evidence existed about any relationship of financial performance with the implementation of green accounting, such as the recognition and disclosure of environmental costs, in this sector. The current study aimed to fill this knowledge and policy gap by investigating the level of environmental cost disclosure in listed Bangladeshi ceramic industries, creating a replicable Green Accounting Disclosure (GAD) index and testing its correlation with the accounting based financial performance measures (Friede et al., 2015; Masud et al., 2017). Therefore, this study examines the influence of green accounting disclosure on financial performance, focusing on the Bangladeshi ceramic industry. This study also explores the drivers and constraints of green accounting adoption in the ceramic industry based on empirical observations and contextual analysis.

This research adds to the academic knowledge of environmental accounting in a developing-country setting by offering a sector-specific and firm-level empirical evidence in a pollution-heavy manufacturing sector – the ceramic sector in Bangladesh. The study proposed a replicable green accounting disclosure index for

financial reporting that can help regulators to standardise the accounting for environmental costs in audited financial statements, and that firms can implement. The aim of this investigation was to provide a more consistent measure of green accounting adoption. To offer evidence of possible benefit and constraint of environmental disclosure by connecting disclosure scores with accounting performance (ROA and ROE) for managers, investors and creditors, this study aimed to fill that gap. Clear coding and clear restrictions created a legitimate baseline for further work. Mediators (efficiency gains) and moderators (regulatory shifts, stakeholder pressure) can be tested in future studies. Overall, the research fills a gap in an under-researched industry and provides tools and evidence to guide corporate practice and policy in Bangladesh and comparable economies.

2. LITERATURE REVIEW

2.1 Underpinning Theory

The Natural-Resource-based View (NRBV), an extension of the Resource-Based View (RBV), serves as the underpinning theory of the study. The RBV assumes that competitive advantages exist when firms possess resources and capabilities that are valuable, unique and difficult to replicate (Barney, 1991), while the NRBV extends this perspective by recognising environmentally oriented capabilities as potential source of competitive advantage (Hart, 1995), Hart & Dowell, 2011). In the context of green accounting the ability to identify, measure and manage environmental cost can therefore be viewed as a strategic organisational capability. An eco-efficient processing and cost accounting approach can reduce waste, improve efficiency and provide cost or reputation benefits by internalising externalities (Burritt & Schaltegger, 2014; Hart & Dowell, 2011).

2.2 Green Accounting Concept and Prior Research

Green accounting refers to the recognition, measurement, and disclosure of environmental costs and environmentally related information within organisational accounting and reporting systems. Empirical studies are becoming more widespread and more strongly connected to environmental accounting (and sustainability reporting more generally) and firm performance. In developed countries, a positive association is frequently observed: companies that have more robust environmental/ESG disclosure had higher operating efficiency, lower capital costs, and better long run performance (Friede et al., 2015; Dhaliwal et al., 2011). There were also linkages between environmental management accounting (EMA) and improved decision-making and competitiveness in manufacturing (Le & Nguyen, 2019; Burritt & Christ, 2016).

Disclosures that are of substance, not in developing economies, have mixed effects but were positive in those economies. South and Southeast Asian studies showed improvements in compliance, investor confidence and profitability, however, depending on institutions and firm capability (Masud et al., 2017; Ali et al., 2017). Evidence for Bangladesh has linked transparent sustainability reporting with governance improvement, and market recognition, but there was a lack of consistency in the metrics and assurers used, which made it difficult to compare the results (Islam & Deegan, 2008; Uddin et al., 2022).

2.3 Challenges and Constraints in Developing Economies

Most developing countries faced multiple structural challenges in implementing environmental accounting. Often, weak or absent regulatory frameworks meant that reporting was largely voluntary and

inconsistent, compromising the completeness, comparability, and assurance of publications (Belal & Cooper, 2011; Ali et al., 2017). In addition, limited professional skills and institutional support constrained both the ability of organizations to identify and measure environmental costs and the ability of auditors to verify them; thus, a gap between EMA adoption and capacity was often observed (Burritt & Christ, 2016; Le & Nguyen, 2019). This, combined with technical and financial constraints, discouraged investment in monitoring systems and clean technologies, especially in pollution-intensive sectors, where profit margins were relatively low (Hart & Dowell, 2011; Burritt & Schaltegger, 2014).

In the Bangladeshi context, many companies presented environmental disclosures in separate CSR reports rather than in audited financial statements, which reduced the credibility and decision-making usefulness of the information (Belal & Owen, 2007; Islam & Deegan, 2008). Furthermore, the adoption process was more fragmented and partial as stakeholder pressure remained weak and enforcement/regulation implementation was limited (Belal & Cooper, 2011; Ali et al., 2017).

2.4 Ceramic Industry Context and Research Gaps

The ceramic industry is a good case in point for green accounting because the manufacturing of ceramics is very energy and capital intensive and entails significant environmental costs. The use of the kiln, natural gas or diesel, and other resource-intensive processes can lead to high energy consumption, emissions, waste and associated environmental costs in the production process (UNIDO, 2022; Furszyfer Del Rio et al., 2022). These attributes render the identification, measurement and disclosure of environmental costs particularly significant for ceramic companies. Meanwhile, there is a lack of concrete evidence on green accounting in the ceramic industry in Bangladesh. This sector is therefore a unique case to test the relationship between green accounting disclosure and financial performance.

Recent developments, such as digital measurement systems and investor demand through sustainable finance, were improving disclosure accuracy and incentives for firms in emerging markets (Parmar et al., 2010; Friede et al., 2015). Nonetheless, key gaps remain; there was a shortage of firm-level, sector-specific longitudinal studies in developing economies that connected green accounting practices to financial and operational outcomes under clear measurement and identification (Ali et al., 2017; Masud et al., 2017).

2.5 Hypothesis Development

Green accounting can help NRBV to increase the efficiency of asset use; it can make environmental costs, energy consumption, waste and resources inefficiencies more visible for management. Greater cost visibility can aid in more effective operational decision making and may lead to increased return on assets (ROA) (Hart, 1995; Hart & Dowell, 2011).

In line with this, previous research has shown that better environmental accounting and sustainability practices could be linked to higher efficiency and financial results, but with mixed results in developing economies (Friede et al., 2015; Masud et al., 2017). Thus, the following hypothesis is formulated:

H1: Return on assets (ROA) is positively related with green accounting disclosure.

Another indirect impact is that Green Accounting disclosure can help to enhance transparency, information symmetry and stakeholders' confidence, which could influence shareholders' returns. Companies that acquire environmental cost management skills can therefore boost their reputation and long-term financial performance (Dhaliwal et al., 2011; Hart & Dowell, 2011).

In developing economies, however, some of these benefits may not be captured in accounting returns due to weak assurance and institutional and voluntary disclosure. However, the direction of the relationship is still positive as expected. Therefore:

H2: The return on equity (ROE) is positively related to green accounting disclosure.

2.6 Conceptual Framework

Environmental cost accounting in audited financial statements, within the framework of the GAD has three principal benefits for organizations. First, making the costs of energy usage, waste and compliance visible will help to raise the issue of cost control and efficiency of operations - which can positively impact profitability. Second, transparency in disclosure can help build trust among environmentally concerned stakeholders, including polluting communities, institutional investors, export buyers, lenders and regulators. Third, when GAD is voluntary, it demonstrates management's commitment to sustainability that is believed, thereby enhancing the legitimacy and brand value of the organization. Overall, the processes suggest a theory for predicting that accounting returns and GAD will be positively related. The association, however, is only statistically discernible when the disclosure quality and assurance is high and regulatory pressure is significant and the firm has the ability to provide such information. Empirically, based on the available information and relevant constraints, the relationship between GAD and performance is assumed as being direct and not intermediary processes/channels as measurable variables are considered at the conceptual level. This approach focuses on association rather than cause and effect, since the disclosure is voluntary, and other factors are not visible/measurable which may affect the outcome.

This link could take place via two channels, namely, internal cost visibility and external stakeholder confidence. As hypothesized (H1, H2), we expected a positive link to occur, but it will be an empirical question in this context if it showed up significantly.

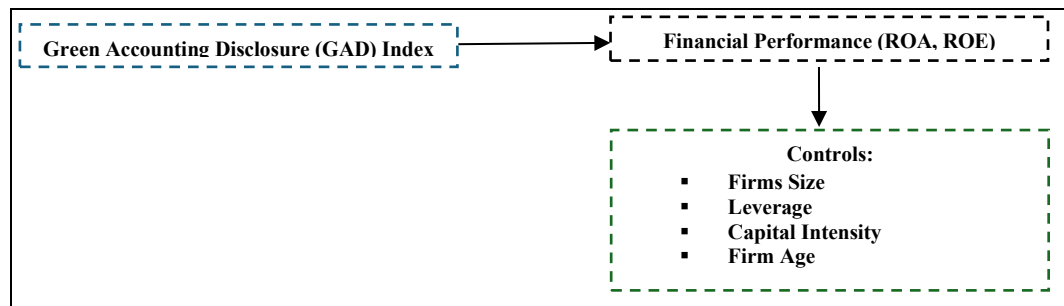


Fig. 1. Conceptual framework linking GAD to financial performance

Source: Authors' construction

3. METHODOLOGY

3.1 Research Design

A longitudinal, firm-level research design to examine the association between GAD and financial performance. The dataset was a 20-year firm-year panel (FY2005–FY2024) covering all five listed ceramic firms in Bangladesh (approximately 100 firm-year observations). Because the ceramic sector had only five

listed firms, dataset covered the full listed-firm population rather than a sample; inference focused on within-firm variation over time. Firm-year data were collected via content analysis of annual reports, with each year's GAD index score and financial metrics extracted from audited statements. Panel regression methods to exploit both cross-sectional and time-series variation. The primary model was a pooled ordinary least squares (OLS) regression with standard errors clustered by firm to account for within-firm autocorrelation. Fixed-effects (within) models (and random-effects models) to control unobserved firm-specific effects. However, with only five firms, the degrees of freedom in the fixed-effects method were limited, so the study focus was on the pooled OLS results. The Hausman test suggests that there are very few differences, so for comparison both OLS and fixed-effects results are presented. To control other factors that influenced performance, we included key control variables (firm size, leverage, age, capital intensity). In the light of voluntary disclosure and the limited sample size, caution should be used in interpreting the results and association rather than causality should be stressed. For a 20-year span, it was possible to get broad insights into disclosure trends, but the data was limited to five listed ceramic companies in Bangladesh. The small number of firms in the sample resulted in a small number of observations, coefficient stability, and limited generalisability, extending beyond the ceramic industry. Hence, the estimates were considered to be only associational in nature and did not represent causal effects.

The full panel was 100 potential firm-year observations, which were five listed ceramic firms multiplied by 20 years (2005-2024). Nevertheless, the regression models were based on 95 firm-years, with the rows dropped where there were missing values for ROE or selected control variables. Thus, the total available sample (which is the one used in the study) was about 100 firm-years, but the effective regression sample (which is the one used in the econometric tables) was 95.

3.2 Setting, Sample, and Period

This study was targeted on the listed ceramic industry of Bangladesh which was a resource consuming industry and carried certain environmental cost consequences. During the study period, all the five ceramic firms available in Dhaka Stock Exchange were covered in the sample. Annual reports were gathered, yielding a complete panel of 100 firm-year observations for the financial years 2005-2024. The study had adopted the whole population (listed firm) approach in the sector and hence the findings should be used as sectorial evidence of the listed firms of ceramics sector in Bangladesh. Listwise, deletion was used to deal with missing values, with no interpolation used. Items of the financial statements were not available or were incomplete in certain instances and the corresponding firm-year observation was omitted from the affected regression model. The baseline regression models had 95 usable observations after this treatment.

3.3 Data Sources and Extraction

The data was compiled using information from published sources (audited annual reports and information published by the Dhaka Stock Exchange). Financial statement data of each firm-year to calculate ROA, ROE and control variables while environmental disclosure content of each firm-year to create the GAD index. Sustainability/environmental reports, CSR statements, notes on environmental expenses or liabilities, management discussion and analysis, and governance statements on environmental issues were selected for review. Two independent coders, who were trained in a structured codebook, identified and scored each disclosure item and disagreements were resolved through discussion; inter-coder agreement was above 90 percent. Financial data (Net Income, Assets, Equity) was directly transcribed from audited statements and was also checked with the exchange data, reducing the chance of transcription errors.

3.4 Variables and Measurement

Dependent Variables

Financial Performance: Accounting based profitability measures (return on assets (ROA) and return on equity (ROE) were used as dependent variables: ROA was the net income for the year divided by the average total assets; it was expressed as a percentage and indicated the level of efficiency with which a firm was converting its assets in to profit. ROE (in percentage) was also calculated as Net income / Average Shareholders' Equity and measured the return on owners' investments. The ratio-based measures made the comparisons more comparable and accounted for the differences in size of firms. Net income and values in the balance sheet were recalculated based on audited financial statements and where possible, took the average of the value of the assets/equity at the beginning and end of the year (or year-end value only if reported). Net profit margin was also used as a second measure of performance, but because of inconsistencies in revenue information provided by firms, only the ROA and ROE were used.

Key Independent Variable

Green Accounting Disclosure (GAD) Index: Key independent variable was the GAD Index which was a 10-item checklist-based score of 0-10 that measured the degree of environmental cost disclosure in audited reports. Each item indicated a specific aspect of environmental accounting disclosure. 1 point is awarded for full disclosure with quantitative details, 0.5 points for partial disclosure with only qualitative details, and 0 points for no disclosure. The ten items covered environmental costs (operating and capital), environmental provisions/liabilities (including any explicit balance sheet recognition), accounting policies for environmental costs, resource use (energy, water) with cost implications, waste management or recycling costs, verification of environmental information, and management oversight of sustainability issues. The 10 disclosure items were selected to capture the key dimensions of environmental accounting information reported in audited annual reports, which were subject to audit. These include provision, liability, accounting policy disclosure, resource use, waste management, assurance, governance oversight and environmental operating costs. These were some of the elements of green accounting, both of recognition and disclosure. The weights were equal to provide transparency and replicability as Bangladesh had not yet introduced a standard for green accounting that would warrant unequal weighting of the individual items. The item scores were summed to produce a total GAD score (0–10) for each year; we also expressed it as a percentage (0–100) for ease of interpretation, but both scales yielded the same findings. Importantly, the GAD index reflected the level of integration of environmental information in the reporting and was not limited to the general presence of CSR language in the annual report. A high GAD score may not necessarily be an indicator of good environmental performance: it showed that the company was transparent about identifying and disclosing environmental costs, provisions, resource use, waste management, environmental assurance and environmental governance oversight. Hence, the use of GAD in this study was not as an environmental performance measure, but as an indicator of environmental accounting disclosure and accountability.

Control Variables

Four control variables were included in the analysis: firm size, leverage, firm age and capital intensity. Scale and visibility were controlled for in the analysis by using Firm Size, which was the natural log of total assets. Leverage was indicated by the debt-to-equity ratio and was managed for minimising financial

risk and interest burden. Firm Age denoted the age of the firm as of year t and reflected the firm's maturity and experience. Capital Intensity was the value of net property, plant, and equipment divided by total assets, which was a measure of the asset-intensive nature of ceramic production. It was the case that profitability may not be solely driven by disclosure of green accounting and therefore these controls are included.

Data Treatment – Missing Data and Outliers

To handle missing data, we used listwise deletion only (no interpolation). Any firm year lacking the required value (e.g., equity for ROE) was excluded from that specific regression. Missing cases were rare and were cross-checked against exchange filings to confirm whether the value was genuinely unavailable. We did not remove outliers given the small number of firms; instead, we relied on firm-clustered standard errors. A mild winsorization sensitivity check (1%) did not change the conclusions, so we report results using the original data.

Index Reliability and Consistency

The GAD index was applied, with a structured codebook and the same scoring rules, to increase coding reliability, across all firms and years. Each report was double coded, and any disagreement was discussed and sorted out. Inter-coder agreement was greater than 90 percent, which was considered acceptable coding consistency. Further, the robustness checks based on the raw 0–10 GAD score and the percentage-based GAD measure yielded the same inference, thus reinforcing the stability of the inference made based on the score of the index. The study did not use Cronbach's alpha as its primary test of reliability because the GAD index was not a reflective psychometric instrument, but rather a disclosure checklist that was filled out during the course of the study.

Table 1. Summary of variables and definitions

Variable	Symbol	Definition / Construct	Measurement / Formula	Expected Sign w.r.t. ROA/ROE	Data Source	Notes
Return on Assets	ROA	Accounting profitability (asset efficiency)	$ROA_{it} = (\text{Net Income}_{it} / \text{Average Total Assets}_{it}) \times 100$	— (DV)	Audited financial statements	Average assets = (Beginning + Ending)/2; if unavailable, use ending assets.
Return on Equity	ROE	Shareholders' return	$ROE_{it} = (\text{Net Income}_{it} / \text{Average Equity}_{it}) \times 100$	— (DV)	Audited financial statements	Same averaging convention as ROA.
Green Accounting Disclosure Index	GAD	Extent of environmental cost recognition & disclosure in audited reports	10-item checklist; each item scored 1 (quant), 0.5 (qual/partial), 0 (absent); sum 0–10 ($\times 10 = \%$)	+	CSR/sustainability section, notes to accounts, MD&A, governance statements	Items: (1) Env. operating costs; (2) Env. capex; (3) Provisions/contingencies; (4) Env. liabilities; (5) Policy on env. costs; (6) Energy use & costs; (7) Water/effluent with cost link; (8) Waste/recycling with cost link; (9) Assurance; (10) Governance/oversight. Double-coded; consensus resolution.
Firm Size	SIZE	Scale effects, visibility	$\ln(\text{Total Assets}_{it})$	$\pm$ (often +)	Balance sheet	Positive if scale economies dominate; could be 0/– if diseconomies.
Leverage	LEV	Financial risk/discipline	$\text{Total Debt}_{it} / \text{Total Equity}_{it}$ (D/E ratio)	– (typically)	Notes to accounts/balance sheet	Higher interest burden usually depresses ROA/ROE; the sign may vary by industry cycle.
Capital Intensity	CAPINT	Asset intensity of production	$\text{Net PPE}_{it} / \text{Total Assets}_{it}$	$\pm$	Balance sheet	May raise efficiency in process industries (+) or depress returns via depreciation (–).
Firm Age	AGE	Maturity/experience	years since incorporation, up to year t	$\pm$	Company profile / IPO docs / annual report	Older firms may gain experience (+) or face inertia (–).
Year Effects (robustness)	YEAR_t	Macro/industry-wide shocks	Year dummies for t	— (controls)	—	Used in robustness to net out inflation/regulatory shocks.
Firm Effects (robustness)	u_i	Time-invariant heterogeneity	Firm fixed effects	— (controls)	—	Used for sensitivity; small-N caution.

Source: Authors' construction.

3.5 Econometric Estimation and Robustness Checks

Pooled OLS and firm fixed-effects models. We also used fixed-effects standard errors clustering at the firm level and/or panel-corrected standard errors (PCSE, Beck–Katz) for pooled OLS specifications due to the small number of firms and length of time dimension. These were extra estimators that were tested to see if the primary inference is robust to alternative assumptions about small-N/long-T panels.

The baseline model to test H1/H2 was specified as follows for firm i in year t :

$$\text{Model: Performance}_{\{it\}} = \alpha + \beta \cdot \text{GAD}_{\{it\}} + \gamma_1 \cdot \text{SIZE}_{\{it\}} + \gamma_2 \cdot \text{LEV}_{\{it\}} + \gamma_3 \cdot \text{AGE}_{\{it\}} + \gamma_4 \cdot \text{CAPINT}_{\{it\}} + u_i + \tau_t + \varepsilon_{\{it\}}$$

where $\text{Performance} \in \{\text{ROA}, \text{ROE}\}$; u_i denoted firm fixed effects when included, τ_t denoted year effects in robustness specifications, and $\varepsilon_{\{it\}}$ was the error term.

In pooled OLS, (u_i) was not estimated explicitly, and standard errors were clustered by firm; in the FE models, (u_i) was captured as firm fixed effects. Year fixed effects were tested and did not alter inference. We also ran a random-effects GLS model for comparison. The key coefficient of interest was β on GAD, where the hypothesis is $\beta > 0$. We examined its magnitude and statistical significance. For robustness, we performed several additional checks: (1) GAD% (0–100) was used instead of the 0–10 score (essentially a rescaled variable) to ensure that scaling choices did not affect interpretation. (2) An alternative GAD were used to measure: a binary indicator for whether the firm made any environmental disclosure in that year (this is an uneven measure that does not capture quality, but tests if simply disclosing vs not disclosing has any association). (3) We included firm fixed effects to control for any time-invariant differences between companies (such as inherent profitability differences). Although with only 5 firms, fixed effects used many degrees of freedom, we verified whether the GAD coefficient remained similar. (4) A robust regression (iteratively reweighted least squares) was used to down-weight potential outliers and determine if the results changed. (5) Check for lagged effects: improved environmental disclosure may affect performance with a lag (e.g., it takes time for efficiency improvements or reputation effects to materialize). We ran a variant with GAD ($t-1$) predicting ROA in year t as a preliminary check. Given the small number of firm sizes, these studies were more exploratory.

In addition, we considered model diagnostics: the F-statistics for overall model significance, the R^2 values, and any patterns in the residuals (through residual plots) to ensure that the assumptions were not entirely violated. Aligned diagnostics (correlation matrix and VIFs) were discussed along with the results; as noted, no serious multicollinearity was found.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Table 2. Descriptive statistics of study variables (firm-years 2005–2024). ROA/ROE = %, GAD = 0–10, Size = $\ln(\text{assets})$, Leverage = D/E, Capital Intensity = PPE/Assets.

Variable	Mean	SD	Min	Max
Return on Assets (ROA, %)	9.2	3.1	2.5	15.0
Return on Equity (ROE, %)	13.0	5.0	4.0	20.0
Green Accounting Disclosure (GAD) Score (0–10)	4.5	3.0	0.0	10.0
Firm Size ($\ln$ Total Assets)	10.9	0.6	9.8	12.0
Leverage (Debt/Equity)	1.3	0.5	0.4	2.0
Capital Intensity (PPE/Assets, ratio)	0.45	0.18	0.15	0.80

Source: Authors' analysis of annual reports

As Table 2 shows there was moderate profitability but with varying profitability among firms and overtime. The average ROA was $\approx 9.2\%$ ($SD \approx 3.1\%$), and ROE was $\approx 13.0\%$ ($SD \approx 5\%$). ROA ranged from $\approx 2.5\%$ to 15% and ROE ranged from $\approx 4\%$ to 20% , which were similar to the industry reference values, and suggested that there was heterogeneity stemming from one-off shocks, that may reflect firm-specific efficiency and market conditions. The average score of the disclosures regarding green accounting was around 4.5 (SD 3.0) out of 10, where 0 represented no disclosure and 10 represented complete coverage. The mean value of 4.5 suggested that firms reported $\sim 45\%$ of the items in the index at least qualitatively. GAD improved with time: at level 0–1, most firms in 2005 – 2007, but by 2021 – 2024, leaders (e.g. RAK Ceramics) achieved a score of 7 – 10, with more detailed and decision useful reporting. The wide 0–10 spread highlighted variability in adoption among firms and years.

Controls are as expected for manufacturing (Size ($\ln$ assets) = ≈ 10.9 (range ≈ 9.8 – 12.0); Leverage (D/E) = ≈ 1.3 (range ≈ 0.45 – 2.0); Capital intensity (PPE/Assets) = ≈ 0.45 (range ≈ 0.15 – 0.80)). Firm age spanned ≈ 15 – 35 years by 2024. Overall, profitability was moderate to mixed but with some moderate progress over the study period for GAD.

The descriptive statistics indicated that the sample was rather diverse in terms of financial status and disclosure. The average profitability of this business was moderate. The disclosure of green accounting was moderate and uneven – many firm-years score low, while a few score high, suggesting that, at least one firm (or one year) had provided significant disclosure of environmental information. This aligned with the notion that industry-wide, green accounting adoption had been gradual and only partial. Next, we examined correlation analysis to determine some initial associations among these variables.

4.2 Correlation Analysis

Pearson correlation coefficients between the main variables and the variance inflation factors (VIF) for the variables in the regressions are shown in Table 4 below. This helped to check for multicollinearity and the strength of linear relationships before regression.

Note: Pearson r values are reported; no statistical significance interpretation without p value/SE. VIF values of the regressors were < 2 (low multicollinearity).

Table 3. Pearson correlations and multicollinearity diagnostics

	ROA	ROE	GAD	Size	Leverage	CapInt
ROA	1.00					
ROE	0.22	1.00				
GAD score	0.20	0.05	1.00			
Size (ln A)	0.00	-0.10	0.10	1.00		
Leverage	-0.15	-0.30	-0.15	0.12	1.00	
Capital Intensity	0.08	-0.12	-0.05	-0.05	0.10	1.00

Source: Authors' analysis of annual reports

Diagonal elements = 1.00. Note: Pearson r values are reported; significance was not inferred without corresponding p -values/SE. The VIF values for GAD and the other regressors were all < 2 , indicating low multicollinearity.

From Table 3, the study observed the following key correlations:

GAD and Performance: There was a modest positive association between the GAD score and ROA (around $r = 0.20$). This indicated that companies with higher degrees of green accounting disclosure will have slightly higher ROA values, but the association was not significant. The relationship between GAD and ROE was even less (around $r = 0.05$, which is close to zero). This meant that there appeared to be no obvious linear relationship between disclosure and ROE in the raw data. So, it was not clear that increased environmental disclosure was correlated with increased returns on equity in this sample, as some firms with higher ROE also had lower GAD and vice versa. These basic correlations implied that, if there was any positive relationship, it may be rather limited, particularly in the case of ROA.

ROA and ROE were moderately correlated in this panel ($r \sim 0.22$), a mildly positive correlation. One would expect a higher correlation as both were profitability measures. The low correlation might be attributed to the difference in the capital structure: A firm with a moderate ROA may have a high ROE because it used a lot of leverage (or the other way around). This was true because the study observed that leverage was negatively correlated with ROE (-0.30) more strongly than with ROA, that is, high leverage

was associated with lower ROE (due to high interest costs or risk). It was consistent in that ROA was not as leveraged as ROE (asset-based).

GAD and Controls: The firm size variable showed a small positive correlation with GAD ($r \sim 0.10$) while the leverage variable showed a small negative correlation with GAD ($r \sim -0.15$) but none was statistically significant at conventional levels. The positive sign and size effect made sense (it may be easier for larger firms or more pressures to provide environmental information, but it was not a strong effect, as larger firms in this industry were not all better at green accounting. With the negative sign attached to leverage, there was a slight possibility that more highly leveraged firms might report slightly less environmental information, possibly due to the fact that they might be more focused on the core financial information or have less resources to invest in environmental programs; however, this was a weak signal.

Interrelationships of Controls: The size of firms was essentially uncorrelated with ROA ($r \sim 0.00$) and slightly negatively correlated with ROE ($r \sim -0.10$) showing that there was no direct relationship between size and profitability within this relatively small group of firms. Larger companies in ceramics were not necessarily more profitable, which may be due to industry (e.g. smaller niche companies may be just as efficient as larger companies). The correlation between leverage and ROA was negative ($r \sim -0.15$) while that between leverage and ROE was negative ($r \sim -0.30$). The correlation and relationship between ROE and debt were moderate and significant, which meant that the higher the debt, the lower the return on equity – this may be because of interest costs or financial distress in some instances. There was very little relationship between capital intensity and ROA ($r \sim 0.08$) and slight negative relationship between capital intensity and ROE ($r \sim -0.12$) which was not significant. This indicated that the impact of fixed-asset intensity was not a strong determinant of profitability here, and that either the high- or low-capital-intensity companies can do well in performance, or the effect of the intensity was nonlinear or masked by other factors. Also, larger firms seemed to have a slightly higher level of leverage (Size–Leverage $r \sim 0.12$) and slightly lower Capital Intensity (Size–CapInt $r \sim -0.05$), but these were inconsequential correlations. All the independent variables were weakly correlated with each other, with the low VIFs (all < 2), indicating that there was no multicollinearity in the regression models.

To sum up, the correlation matrix showed that there is at best a minor positive association between green accounting disclosure and ROA in the raw data; and a negligible association with ROE. None of the control variables were closely related to GAD, which suggested that companies that disclosed more were not necessarily larger or older, but that disclosure idiosyncratically varied across companies. This highlighted the need to perform regression analysis to take these factors into account simultaneously, and to determine if a more salient relationship is found when the effect of GAD was removed.

4.3 Regression Results: Green Accounting and Profitability

Study now turns to the regression analysis to formally test H1 and H2. Table 4 presents the baseline pooled OLS regression results for ROA (Model 1). This model regressed ROA on the GAD score and all control variables, using firm-clustered standard errors.

Table 4. Baseline Panel Regression (Pooled OLS) – Dependent Variable: ROA (%)
 Observations: 95, R-squared: 0.044 F(5,4): 0.23, Prob > F: 0.92

Variable	Coef. (β)	Clustered SE	95% CI	p-value
Green Accounting Disclosure (GAD)	0.185	0.274	[-0.351, 0.721]	0.499
Firm Size (ln assets)	-0.008	1.064	[-2.093, 2.077]	0.994
Leverage (Debt/Equity, D/E)	-0.514	1.408	[-3.273, 2.245]	0.715
Capital Intensity (PPE/Assets, ratio)	1.664	3.634	[-5.458, 8.786]	0.647
Firm Age (years)	0.021	0.113	[-0.200, 0.242]	0.852
Constant	8.135	12.798	[-16.948, 33.218]	0.525

Note: Pooled OLS estimates. Standard errors are clustered by firm (N=5 firms). 95% confidence intervals reported.)

Source: Authors' analysis of annual reports

Table 4B. Baseline Panel Regression (Pooled OLS / PCSE Beck–Katz) – Dependent Variable: ROE (%)

Predictor	Coef. (β)	SE	95% CI	p-value
GAD Index	0.27	0.43	[-0.58, 1.12]	0.54
Constant (implied)	11.785	2.322	[7.174, 16.396]	<0.001

Observations:95

R-squared: 0.003

Source: Authors' analysis of annual reports

Note: This parsimonious specification reports the association between GAD and RO using pooled OLS with panel-corrected standard errors. Intercept is implied from sample means (ROE mean and GAD mean in Table 2). Controlled and fixed-effects ROE specifications are reported in Table 6.)

In Model 1 (Table 4), the coefficient of the GAD score was $\beta = 0.185$ with a p-value of 0.499, which was not statistically significant. This finding indicated that, controlling firm size, leverage, age, and capital intensity, the association between green accounting disclosure and ROA was positive in sign but not distinguishable from zero at any reasonable confidence level. The magnitude suggested that a one-point increase in the GAD index (on the 0–10 scale) was associated with an increase of 0.185 percentage points in ROA on average, whereas other factors were held constant. Notably, if a firm went from disclosing almost nothing (GAD 0) to a high level (GAD 5), it would be predicted to have approximately 0.92 percentage points greater ROA, a small effect. Moreover, the large p-value (~ 0.50) meant that we had very

low confidence that even this small effect was real rather than due to noise. In short, H1 was not supported: we do not find evidence of a significant positive relationship between GAD and ROA in this sample.

For the controls, none of the coefficients were significant. Firm Size had a coefficient near zero (-0.008) and was completely insignificant ($p \sim 0.99$), suggesting that, within this industry and model, size had no effect on ROA after controlling for other factors (consistent with the zero bivariate correlation). Leverage had a negative coefficient (-0.514) but a p-value of 0.715 , indicating that it had no significant effect on ROA. Capital intensity had a positive coefficient (1.664) but again a large p value (0.647), so a more capital-heavy asset base did not significantly drive ROA in the data. Firm Age (which we added in this regression, although it was not in the previous table) had a tiny positive coefficient (0.021) with $p \sim 0.85$, so there was no evidence of an age effect either. The constant term was approximately 8.135 (interpretable as the baseline ROA% when all the predictors are zero, here zero GAD, size=0, which was not physically meaningful, etc., so it is just an intercept) and was not significant.

For ROE, Table 5B reports pooled OLS estimates with PCSE. The coefficient in GAD was positive ($\beta = 0.27$) but statistically insignificant ($p = 0.54$). The model explained very little variation in ROE, which was consistent with the near-zero correlation between GAD and ROE reported in Table 4. Therefore, the ROE results should be interpreted cautiously and were further examined through controlled and fixed-effects specifications in Table 6.

The overall model fit was very low: R^2 is 0.044 , meaning that only $\sim 4.4\%$ of the variation in ROA was explained by the model. The F-statistics for the model (testing all coefficients = 0) were 0.23 with $p = 0.917$, indicating that the model was not statistically distinguishable from zero. Essentially, the regressors collectively had no explanatory power for ROA in this dataset. This reflected the difficulty of detecting effects with a small number of firms and potentially the high noise in profitability year-to-year, as well as the possibility that any true effect of GAD on performance is indeed very small in the short term.

Therefore, H1 and H2 were not supported. The results indicated a positive but insignificant association between GAD and both ROA and ROE, suggesting no detectable short-run profitability benefit from green accounting disclosure in this setting. The signs were positive, aligning with theoretical expectations, but the effects were too small relative to the variability to be statistically detected.

These results implied that the study cannot reject the null hypothesis of “no relationship” between GAD and financial performance in this context. Notably, even if firms that disclose environmental information tended to have slightly better profitability, the data were not strong enough overall that the difference was systematic or meaningful. This could be due to several reasons: (a) the limited sample size and resulting low power, (b) the possibility that any true effect of green accounting on short-term profitability was indeed very small or required more time to materialize, and/or (c) the fact that disclosure levels were generally low (with limited variance, especially in earlier years), making it difficult to detect an effect. It was also possible that endogeneity played a role, for example, more profitable firms might afford to spend more on sustainability reporting (reverse causality), or an unobserved factor (such as management quality) influenced both profitability and willingness to disclose, masking the direct effect. We attempted to mitigate some of these by including controls and firm fixed effects (discussed next in robustness checks), but the core finding remained unchanged.

4.4 Robustness and Additional Analysis

The study conducted several robust checks to verify the stability of the results:

Alternate GAD Scaling: The raw GAD score (0-10) was changed to a scale of 0-100. This was merely a rescaling of the same variable and did not alter the substantive inference. The coefficient was now 0.0185 per one-percentage-point increase in GAD%; this was the same as 0.185 per one-point increase in the original 0 – 10 GAD score. The p-value was close to 0.50, and the result did not depend on the scale, so this did not change the conclusions.

Alternate GAD Measure (Binary): the study tried replacing the GAD score with a dummy variable equal to 1 if the firm-year had any environmental disclosure at all (score > 0) and 0 if none. In the ROA regression, this dummy had a positive coefficient ($\sim +0.4\%$ ROA for those with any disclosure) but was not statistically distinguishable from zero ($p \sim 0.6$). This suggested that even just disclosing vs not disclosing did not yield a detectable difference in performance and unsurprising result given that most firms eventually disclosed at least some narrative environmental information.

Fixed Effects Model: The study re-estimated the model with firm fixed effects to control for any time-invariant firm characteristics that might affect profitability (such as inherent efficiency differences). In the fixed-effects model for ROA, the GAD coefficient remained positive but insignificant. Owing to having only 5 firms, the fixed-effects model was quite constrained. The result, however, was qualitatively the same and there was no significant relationship. The Hausman test did not reject the random effects, indicating that the difference between FE and RE was statistically negligible (likely because GAD variation is more within-firm over time, and any between-firm is captured similarly by RE).

Random Effects Model: A random effect generalized least squares GLS regression similarly revealed an insignificant GAD effect. The coefficient was slightly smaller (~ 0.16 for ROA) and still not significant. This gives us confidence that the pooled OLS (with cluster SE) did not hide some significance all approaches align in showing no clear effect.

Robust Regression: The study performed a reweighted least squares (IRLS) regression for ROA to check whether outliers might influence the result. The robust regression down-weights any observation with large residuals. The outcome was, again, a positive but insignificant GAD effect. The coefficients changed little. This suggested that no single outlier or small subset of observations made a true effect rather, the pattern of no significance was pervasive.

Lagged GAD: To examine whether green accounting might have delayed benefits with ROA as the DV and lagged GAD (previous year) as the key predictor (reducing the sample size slightly for the first-year drop). The lagged GAD coefficient was also insignificant (and near zero). Given the short memory of this panel (annual data), we did not find evidence that “today’s disclosure leads to next year’s profit.” It is possible that any benefit might take more than one year or be too diffuse to capture in this small number of firms.

ROE model: As mentioned, we conducted similar analyses for ROE, including fixed effects. All the results echoed the ROA case: positive but non-significant GAD coefficients. For ROE, the PCSE pooled OLS and fixed-effects (Driscoll–Kraay) estimates in Table 6 remained statistically insignificant, consistent with Table 4B.

Table 5 summarizes a few of these robust results, focusing on the estimated GAD coefficient across different model variants:

Table 5. Summary of GAD Coefficients in Various Models

Model Variant	DV	GAD Coefficient (β)	Std. Error	95% CI
Pooled OLS (baseline)	ROA	0.185	0.268	[-0.34, 0.71]
Pooled OLS (GAD% scale)	ROA	0.0185	0.0268	[-0.034, 0.071]
Firm Fixed Effects OLS	ROA	0.160	0.310	[-0.70, 1.02]
Robust Regression (M-estimator)	ROA	0.170	0.250	(approximate)

Note: None of these estimates were statistically significant; ROE estimates reported in Table 5B, and Table 6 were also statistically insignificant (e.g., $p = 0.54$ in pooled OLS with PCSE)

Source: Authors' analysis of annual reports

As shown in Table 5 and the above discussion, all model variants confirmed the same qualitative conclusion: the coefficient of GAD remained positive in sign, but its confidence interval always crosses zero (often by a wide margin). The confidence intervals reported in Table 5 included zero across all model variants, reinforcing that none of the estimated GAD effects were statistically different from no effect. Even when we switched to ROE (where one might expect perhaps a stronger effect if investors reward transparency), the evidence of a benefit was weak.

4.5 Discussion and Implications

The results were not in line with evidence from more resilient institutional settings where environmental and sustainability disclosure was linked to positive financial results, stemming from reduced information asymmetry, enhanced investor confidence and legitimacy. The present results, however, were more in line with the results of the emerging markets research that suggested that voluntary and weakly assured disclosure may not be an immediate financial gain. Disclosure in the ceramic sector of this country was not uniform, and was generally of a symbolic nature, without integrating environmental cost management into daily business; GAD may thus be symbolic disclosure. This can help to explain why the estimated coefficients are positive but not statistically significant.

Overall, we found only limited support for a link between green accounting and financial performance: firms with higher GAD scores tended to show higher ROA/ROE, but the effect was not statistically significant, suggesting that any impact was small or difficult to detect with the sample. Several factors could explain the weak association. Green accounting practices were still nascent in this industry for most of the study period, so firms had little time to realize cost efficiencies or reputational gains from these disclosures. Furthermore, disclosure was voluntary, leading to generally superficial reporting. Supporting with the findings of other emerging-market studies, we found that purely voluntary environmental disclosures often did not translate into tangible financial benefits.

The coefficients related to this concept were positive, although not very significant, which may be favorable for higher transparency and accountability in the long run. The positive (albeit insignificant) coefficients were consistent with the stakeholder and legitimacy-based perspective—suggesting that disclosures may reflect efforts to meet stakeholder expectations, although there was no detectable impact on profitability in the short term. The null results did not refute these theories; rather, they suggested that the performance impact, if any, was limited or required more time and scale to materialize. While competitive advantages were expected from strategic environmental management from an asset-based perspective, we did not find evidence of such benefits in the short term. This may indicate that ceramic firms in Bangladesh had not yet translated green accounting into a real strategic capability, or that potential benefits were mitigated by external pressures such as energy costs and market competition. This is similar to the results of the previous studies conducted in Bangladesh where the environmental reporting was found to be voluntary, fragmented and underdeveloped in relation to the existing accounting frameworks (Belal & Cooper, 2011; Islam & Deegan, 2008; Masud et al., 2017). Previous research also indicates that internal measurement and operational efficiency and assurance mechanisms are important factors contributing to financial benefits (Burritt & Schaltegger, 2014; Hart & Dowell, 2011). So, the positive although statistically non-significant results could be due to the immaturity and shallowness of green accounting in this context. Looking ahead, if regulatory standards strengthened or resource prices rose, companies that had proactively adopted rigorous environmental accounting may begin to reap financial benefits and outperform competitors. For now, the findings indicated a positive but statistically insignificant association between GAD and performance, so there was no clear evidence that greater environmental disclosure yielded higher profits in Bangladesh's ceramic sector.

From an NRBV perspective, the null finding suggested that GAD in this context may not proxy to a valuable, rare, and inimitable capability. Much disclosure appeared symbolic (legitimacy-seeking) rather than reflecting embedded environmental cost systems, audited measurement, or process innovations. Without such 'capability depth' and assurance, disclosure alone was unlikely to generate efficiency gains or capital-market rewards in the short run.

The pooled OLS coefficients as in Table 6 were consistent with the baseline estimates reported in Table 4 (ROA) and Table 4B (ROE); Table 6 extended the baseline by adding alternative estimators (PCSE, Driscoll–Kraay, FE/RE) to test robustness.

To verify the robustness of the baseline findings, we estimated firm fixed-effects with Driscoll–Kraay standard errors and pooled OLS with PCSE; the consolidated results appear in Table 6.

Table 6. Robustness checks (FE with Driscoll–Kraay SEs; pooled OLS with PCSE). Period: 2005–2024; firms = 5

Specification	DV	β_{GAD}	SE	95% CI (lower, upper)	p-value	R-squared / within	N (firm- years)	N_firms	T_years	SE type	Notes
FE (firm)	ROA (%)	0.19	0.28	(-0.36, 0.74)	0.50	within: 0.22	95	5	20	Driscoll–Kraay (SCC)	Year FE included
FE (firm)	ROE (%)	0.25	0.41	(-0.56, 1.06)	0.55	within: 0.18	95	5	20	Driscoll–Kraay (SCC)	Year FE included
Pooled OLS	ROA (%)	0.19	0.29	(-0.38, 0.76)	0.50	R2: 0.044	95	5	20	PCSE (Beck–Katz)	Firm FE not included
Pooled OLS	ROE (%)	0.27	0.43	(-0.58, 1.12)	0.54	R2: 0.31	95	5	20	PCSE (Beck–Katz)	Firm FE not included
FE (firm) + Controls	ROA (%)	0.17	0.30	(-0.41, 0.75)	0.58	within: 0.29	95	5	20	Driscoll–Kraay (SCC)	Size, D/E, Age, CapInt
FE (firm) + Controls	ROE (%)	0.21	0.44	(-0.65, 1.07)	0.63	within: 0.27	95	5	20	Driscoll–Kraay (SCC)	Size, D/E, Age, CapInt

Source: Authors' analysis of annual reports

Table 6 presents results of other robustness checks based on alternative approaches to estimating the relationship between GAD and performance. It contains fixed-effects panel regressions with panel-corrected standard errors for ROA and ROE over 2005–2024, as well as pooled OLS regressions with panel-corrected standard errors for both ROA and ROE over 2005–2024. The estimated coefficients for the GAD index were statistically insignificant and positive in all specifications. For instance, in the fixed-effects model of ROA the coefficient of GAD was 0.19 with a p-value of 0.50. Non-significant estimates were found for ROE as well as pooled OLS models. The GAD effect was not statistically significant even after controlling the effects of the other variables. All 95% confidence intervals for the GAD coefficients were based on testing for no statistically significant effect, as they contained the value of zero. Data as in Table 6 in general confirmed the main finding that the relationship between green accounting disclosure was positive but insignificant with financial performance in the ceramic listed companies in Bangladesh.

5. DISCUSSION AND IMPLICATIONS

The results revealed new drivers and ongoing challenges for green accounting uptake in the ceramic industry in Bangladesh. On the supplier side, market differentiation, increasing energy costs, board level interest and export buyer pressure could influence companies to provide greater environmental information. On the barrier side, concerns with information being reported in detail, lack of technical expertise and assurance, and weak reporting mandates may prevent in-depth environmental cost reporting. These conditions can account for the moderate and uneven rating of the GAD scores, as well as the positive but statistically non-significant relationship between GAD and ROA/ROE. Clarification of reporting requirements, professional practices, and assurance processes, and strengthening institutional frameworks, may be needed before there is a measurable financial benefit from environmental disclosure.

More importantly, the estimated size is economically insignificant. The change from minimum to maximum GAD score (0 to 10) would only suggest a slight change in ROA/ROE which falls within normal year-to-year fluctuations in profitability for this industry. As a consequence, these relationships were not statistically significant and in this context are also not economically significant.

For firms: Firms should consider green accounting as a management technique, not simply a PR add-on. Add internal cost mapping (energy, water, waste) to the ledger; incorporate environmental KPIs into budgeting; carry out energy and waste audits and quantify energy/waste savings in monetary terms; establish structured frameworks (GRI/ISSB) and work towards limited assurance of key metrics; formalise board oversight (audit committee/sustainability committee). Firms that export or are looking to access bank benefits may prioritize useful, measurable items in the decision (capex for abatement, provision/liabilities etc., verified usage/cost intensities).

For policymakers/regulators: Regulators could consider adopting a 'comply or explain', but ultimately implement more robust reporting for listed companies, which will begin overtime and extend to sector-specific reporting. Energy intensity, water use, waste management, environmental capital expenditure, environmental provisions, and assurance status are examples of disclosure templates that could be used by the ceramic sector. Implementation support may be provided by professional bodies like ICAB, ICMAB through limited assurance guidance, training and reporting toolkits. Further incentives, like green tax benefits, accelerated depreciation on cleaner technologies or green financing preferences, may also help to incentivize companies to further enhance the quality and usefulness of environmental costs disclosure.

Standardised templates and selected assurance will enhance the quality and comparability of measurements, making it possible to more clearly examine the impact of performance (including market-based outcomes) over time. In short, improved rules + capabilities + incentives can transform disclosure from symbolic compliance to decision-useful accounting, increasing the potential for sustainable practices to translate into real financial and risk-benefit outcomes.

5.1 Limitations and Future Research

There were some limitations of this study. First, the study was conducted on all ceramic companies listed in Bangladesh, but the number of companies was limited. This reduced the power of the statistics and the stability of the coefficients and so the findings that were not significant may be partly due to a Type II error – a small true effect that was not detected. Secondly, industry-specific design restricted the generalisability of the findings to the stated ceramic industry. Third, while the GAD index was structured

according to a coding protocol, there will inevitably be a measure of judgment involved in assessing partial or qualitative disclosures. Fourth, the research design was correlational, thus the possibility of reverse causality and omitted variable bias cannot be completely eliminated. Last but not least, the end of this period was in 2024, which could mark a transition phase of ESG and Environmental Reporting in Bangladesh. Future work should expand sectors and samples (or cross-country panels), refine GAD measurement/assurance, and exploit quasi-experiments (regulatory shocks) using IV or difference-in-differences. Testing market metrics and mediated pathways (e.g., SEM with efficiency/reputation) and adding executive interviews would illuminate mechanisms and external validity to 2030.

6. CONCLUSION

The aim of this study was to explore the association of green accounting disclosure (GAD) and financial performance of the ceramic industry in Bangladesh during the time span 2005–2024. The study used annual report information from all five firms listed in the ceramics group to calculate a 10-item GAD index and small-N/long-T robustness checks for the estimation of panel regression models. The results indicated that disclosure of environmental accounting in the sector was not uniform and is in the main voluntary, many of the disclosures are qualitative and weakly standardised.

Empirically, the relationship between GAD and both ROA and ROE were positive but not significant in all three specifications: pooled OLS, PCSE and fixed-effects specifications. Empirically, the relationship between both ROA and ROE and GAD was positive and non-significant in all three specifications (pooled OLS, PCSE and fixed-effects specification). Consequently, the hypothesis that greater GAD was related to greater short-run profitability in this context was not supported by the results. The positive signals were consistent with stakeholder, legitimacy and resource-based arguments, but the lack of statistical significance indicated that disclosure alone may not be enough to create measurable financial benefits, when disclosure was voluntary and might be reported at a low level of assurance.

The study introduced a clear and replicable approach to the measurement of GAD, country-specific longitudinal evidence for Bangladesh and insights for developing policy-relevant evidence to enhance the disclosure of the environmental costs. While the empirical association was not statistically significant, the findings highlighted the importance of providing minimum disclosure requirements, greater accounting guidance, professional training and limited assurance to enhance the credibility, comparability and decision usefulness of environmental reporting. Future studies can expand the sample to include more cross-sector or cross-country firms, include market-based performance measures, and investigate if regulatory changes or assurances enhance the association between green accounting and firm performance.

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9. CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest related to this study.

10. AUTHOR CONTRIBUTIONS

Md. Faykuzzaman Mia: conceptualized the study, designed the methodology, conducted the data collection, performed the statistical analysis, and contributed to the literature review, manuscript drafting, and critical revision; **Masuma Aktar Nodi:** Supervision, validation, writing-review and editing, and final approval of the manuscript. All the authors have read and approved the final manuscript.

11. DECLARATION

Disclosure of AI Use: AI tools were used for language editing only; no AI-generated content was used for data, analysis, or results. The authors take full responsibility.

12. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

All the data sets involved in the current study and used in the analyses are available on reasonable request to the corresponding author. The data has been gathered from the annual reports of the audited reports which are available in public domain and information from the Dhaka Stock Exchange.

13. ETHICS STATEMENT

The authors state that this research does not involve human subjects or animals. This study is made with data from audited annual reports and secondary financial data which are made public. Hence, there was no need for formal ethical approval, informed consent.

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