“Environmental regulatory stringency and corporate reporting quality: Evidence from waste, emissions, water, and energy regulations in Vietnamese firms”

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ARTICLE INFO	Minh Huong To and Binh Minh Tran (2025). Environmental regulatory stringency and corporate reporting quality: Evidence from waste, emissions, water, and energy regulations in Vietnamese firms. *Environmental Economics*, *16*(3), 67-81. doi:10.21511/ee.16(3).2025.05
DOI	http://dx.doi.org/10.21511/ee.16(3).2025.05
RELEASED ON	Wednesday, 03 September 2025
RECEIVED ON	Monday, 14 April 2025
ACCEPTED ON	Thursday, 24 July 2025

JOURNAL	"Environmental Economics"
ISSN PRINT	1998-6041
ISSN ONLINE	1998-605X
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
34	2	2

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

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ENVIRONMENTAL REGULATORY STRINGENCY AND CORPORATE REPORTING QUALITY: EVIDENCE FROM WASTE, EMISSIONS, WATER, AND ENERGY REGULATIONS IN VIETNAMESE FIRMS

Abstract

This study investigates how environmental regulatory stringency affects corporate environmental reporting (CER) among Vietnamese small and medium-sized enterprises (SMEs), focusing on four regulatory domains: waste management, greenhouse gas (GHG) emissions, water usage, and energy-saving measures. Utilizing a cross-sectional dataset of 645 SMEs and employing multiple linear regression analysis, variation in regulatory intensity is evaluated to check both the scope and quality of environmental disclosures.

Results reveal heterogeneous impacts. Stringent waste treatment regulations are significantly associated with lower levels of disclosure ($\beta = -0.1082$, $p = 0.008$), likely reflecting the burden of compliance costs. In contrast, energy-saving regulations show a positive and statistically significant effect on CER ($\beta = 0.1512$, $p = 0.045$), highlighting the role of economic incentives in driving transparency. No significant associations are observed for GHG emissions or water resource regulations, underscoring the limitations of weak enforcement and fragmented institutional oversight.

These findings raise important theoretical and policy considerations. They challenge the universal validity of the Porter Hypothesis within developing contexts, where institutional capacity and enforcement mechanisms remain constrained. Regulatory effectiveness is shown to depend not only on legal stringency but also on firms' readiness, technological support, and enabling policy environments. The paper contributes to the growing literature on environmental governance in transitional economies and offers practical insights for designing balanced, context-sensitive regulatory frameworks to enhance corporate environmental accountability in Vietnam.

Keywords environmental regulations, environmental reporting, waste treatment, greenhouse gas emissions, energy saving

JEL Classification Q56, Q58, M41, L51, G34

Type of the article: Research Article

Received on: 14th of April, 2025
Accepted on: 24th of July, 2025
Published on: 3rd of September, 2025

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Conflict of interest statement:
Author(s) reported no conflict of interest

INTRODUCTION

Environmental sustainability is an urgent priority for rapidly industrializing economies, where accelerated growth often results in severe environmental degradation. Vietnam, as one of Southeast Asia's fastest-growing nations, is facing rising pollution, natural resource depletion, and ecosystem deterioration as consequences of its industrial expansion. These challenges underscore the critical need for effective governance mechanisms to encourage sustainable corporate practices.

Although recent policy reforms, such as the 2020 Law on Environmental Protection and Vietnam's commitments under the Paris Agreement, reflect growing political will, enforcement gaps and institutional constraints continue to undermine regulatory effectiveness, particularly

in the area of corporate environmental practices. Against this backdrop, a key scientific question emerges: To what extent does environmental regulatory stringency influence corporate environmental reporting (CER) in a developing economy with limited enforcement capacity?

This question reflects a broader concern in the literature, i.e., whether environmental regulations in developing economies possess sufficient coercive and normative power to alter firm behavior, particularly in contexts characterized by fragmented oversight and institutional underdevelopment. Rather than assuming uniform outcomes across regulatory types, this paper builds on recent calls for a more granular understanding of how firms respond to diverse regulatory instruments under varying enforcement conditions. Such an approach enables a more precise assessment of regulatory effectiveness in transitional economies and addresses a critical gap in empirical evidence related to the Vietnamese context.

1. LITERATURE REVIEW

Environmental regulations are widely recognized as essential instruments for steering corporate behavior toward sustainability. However, the extent to which such regulations foster meaningful corporate environmental reporting (CER) varies substantially across contexts, depending on regulatory design, enforcement mechanisms, market dynamics, and institutional capacity.

The relationship between regulatory stringency and corporate environmental behavior is frequently analyzed through the lens of the Porter Hypothesis, which posits that well-crafted environmental regulations can spur innovation, enhance firm competitiveness, and improve environmental performance simultaneously (Porter & van der Linde, 1995; Ambec et al., 2011). The hypothesis challenges the traditional view that environmental regulation necessarily imposes a cost burden, proposing instead that stringent but flexible regulations can drive efficiency and technological advancement.

Empirical evidence from developed economies largely supports this hypothesis. For example, the EU Waste Framework Directive (2008/98/EC) led to significant improvements in recycling rates and reductions in landfilling (EC, 2016). In the corporate sector, mandatory disclosure frameworks, such as those aligned with the Global Reporting Initiative (GRI) and Task Force on Climate-related Financial Disclosures (TCFD), have demonstrably enhanced transparency, investor trust, and firm-level accountability (Kolk, 2008; GRI, 2020).

Moreover, the integration of digital innovations, including blockchain for carbon traceability, Internet of Things (IoT) for emissions tracking, and artificial intelligence for predictive analytics, has enabled firms in advanced economies to strengthen environmental monitoring, reduce reporting errors, and comply more efficiently with regulatory demands (Ho & Ran, 2018; Singhania & Saini, 2022). However, scholars caution that such benefits are highly dependent on the presence of mature institutions, strong enforcement mechanisms, and market-based incentives (Dasgupta et al., 2001; Blackman, 2010).

Vietnam represents a distinctive case among emerging economies, marked by rapid industrialization, a dynamic yet under-regulated business environment, and evolving policy reforms. The 2020 Law on Environmental Protection (LEP) signaled a major regulatory shift with stricter assessments, harsher penalties, and broader monitoring obligations (Vietnam National Assembly, 2020), while commitments to international accords like the Paris Agreement demonstrate growing alignment with global sustainability goals. However, the effectiveness of these efforts is undermined by fragmented and under-resourced enforcement, regional inconsistencies, and the presence of a substantial informal sector accounting for roughly 35% of GDP (World Bank, 2022; Le et al., 2022; Adenuga et al., 2021).

Empirical studies show substantial variation in CER practices among Vietnamese enterprises. Large firms, particularly those integrated into global supply chains, are more likely to adopt international reporting standards and demonstrate higher environmental performance (Nguyen & Duong, 2025). In contrast, SMEs, which account for over 97% of registered businesses, often strug-

http://dx.doi.org/10.21511/ee.16(3).2025.05

gle with high compliance costs, limited financial resources, and inadequate technical capacity (Phung et al., 2024).

At the sectoral level, Vietnam's environmental governance is hindered by persistent implementation gaps across waste management, emissions control, water resource regulation, and energy efficiency. Waste-related regulations suffer from inadequate infrastructure, weak enforcement, and poor oversight, particularly in rural and SME-dominated zones (Nguyen et al., 2018). GHG mitigation efforts are limited by unreliable monitoring systems, fragmented ministerial coordination, and restricted data access (Nguyen & Duong, 2025). Water governance remains fragmented, with overlapping mandates enabling unchecked over-extraction in unregulated areas (Gleick, 2003; Nguyen et al., 2023). Meanwhile, the Vietnam Energy Efficiency Program (VNEEP) has seen uptake among export-oriented firms but remains underutilized by domestic SMEs due to high retrofitting costs and limited policy awareness (Phung et al., 2024; Singhania & Saini, 2022). These challenges highlight the need for integrated institutional reform, stronger enforcement, and targeted incentives to translate regulatory ambition into tangible outcomes. Cumulatively, these questions result in low and inconsistent levels of CER, especially outside of export-driven sectors, raising concerns about the effectiveness of current regulatory instruments in enhancing corporate accountability.

Empirical understanding of how regulatory stringency affects corporate environmental reporting (CER) remains uneven across national contexts. In countries with constrained institutional capacity and inconsistent enforcement, such as Vietnam, the interplay between regulation and firm behavior is insufficiently theorized and under-examined (Nguyen et al., 2023). Despite a growing body of international scholarship linking environmental regulation to improved disclosure practices (Singhania & Saini, 2022), existing Vietnamese studies have largely adopted normative or descriptive approaches, offering limited quantitative analysis across specific regulatory domains. This lack of empirical granularity hampers efforts to assess the effectiveness of environmental governance in transitional economies.

To address this gap, the present study examines the impact of environmental regulatory stringency in four critical domains (waste treatment, greenhouse gas emissions, water resource utilization, and energy-saving measures) on the extent and quality of corporate environmental reporting among Vietnamese SMEs. This multidimensional approach allows for a nuanced understanding of how different types of regulatory pressure interact with firm behavior in a transitional economy.

Accordingly, the following hypotheses are proposed:

H1: Stringent waste treatment regulations negatively affect CER due to high compliance costs and weak enforcement.

H2: Greenhouse gas emissions regulations have no significant impact on CER, attributed to inadequate monitoring systems.

H3: Water resource utilization regulations exhibit limited influence on CER due to fragmented oversight.

H4: Energy-saving regulations positively affect CER, supported by economic incentives and clearer implementation frameworks.

By empirically testing these hypotheses, this study contributes to theory-building on environmental governance in developing contexts and offers practical guidance for designing regulatory interventions that are both stringent and feasible, in support of national policy goals and international sustainability targets.

2. METHODOLOGY

This paper employs a quantitative design to empirically examine the determinants of corporate environmental reporting (CER) practices within the Vietnamese context. A multiple linear regression (MLR) model is utilized to estimate the influence of environmental regulatory pressure alongside firm-specific and contextual factors. MLR is particularly suitable for modeling interdependent relationships where multiple explanatory variables may simultaneously affect a composite reporting

outcome (Gujarati & Porter, 2009). The approach also allows for the integration of control variables to account for heterogeneity across firms in terms of size, sector, governance structure, and innovation capacity.

Data were collected through a structured survey administered via Google Forms between 2021 and 2023 in partnership with the Vietnam Association of Small and Medium Enterprises (VINASME). The survey instrument was developed based on established environmental disclosure frameworks and underwent pilot testing to ensure clarity and relevance. A stratified purposive sampling strategy was adopted to ensure diversity across industries, regions, and firm characteristics. Eligible respondents included SMEs that had operated continuously for at least five years and were subject to a minimum of three environmental regulations.

The dependent variable, CER, is measured through a composite index capturing five core dimensions: reporting frequency, coverage breadth, alignment with international frameworks, external verification, and performance transparency. Each component is scored on a weighted scale informed by Global Reporting Initiative standards and prior academic studies. Independent variables include regulatory stringency indicators across distinct environmental domains, constructed from context-adapted indices reflecting legal scope, enforcement mechanisms, and compliance intensity. A set of control variables – such as firm size, age, industry type, governance practices, and innovation orientation – is also incorporated to isolate the effects of regulatory factors. This methodological framework enables a rigorous assessment of how institutional and organizational variables interact to shape environmental reporting behavior in a transitional economy.

CER in this study was measured using a five-point composite index, ranging from 1 (minimal reporting) to 5 (comprehensive reporting). The index captures multiple dimensions of disclosure, including frequency, scope, alignment with international standards, third-party verification, and the quality of performance-related disclosures. Among the 645 surveyed SMEs, the average CER score was 3.25, suggesting moderate levels of reporting overall. The distribution was relatively balanced, with both the median and mode at 3.0.

The questionnaire was developed based on a theoretical framework examining the impact of environmental regulations on corporate reporting behavior, focusing on three main groups of variables:

(i) the dependent variable – level of environmental reporting compliance, measured through reporting frequency, level of detail, and transparency;

(ii) the independent variable – regulatory stringency, assessed by the number of applicable policies, severity of penalties, and frequency of inspections; and

(iii) control variables, including firm size, firm age, governance structure, and technological capacity.

The final research sample consisted of 645 valid responses from small and medium-sized enterprises (SMEs) across the manufacturing, services, agriculture, and retail sectors, geographically distributed throughout Vietnam. All participating firms met the definition of SMEs as stipulated in METI (2019), which includes enterprises with fewer than 200 employees and annual revenues not exceeding VND 300 billion. This exclusive focus reflects the vital role of SMEs in Vietnam's economy and their particular sensitivity to regulatory and resource-related constraints. To ensure representativeness, the sample was stratified along three criteria. First, by industry sector: manufacturing (45%, 290 firms), services (20%, 129 firms), agriculture (15%, 97 firms), and retail (20%, 129 firms). Second, by geographic distribution: Hanoi (40%, 258 firms), Ho Chi Minh City (35%, 226 firms), and other provinces (25%, 161 firms), ensuring coverage of both urban and rural economic zones. Third, by eligibility criteria: participating firms were required to have operated continuously for at least five years, be subject to at least three environmental regulations (METI, 2019), and maintain a balanced respondent profile, with approximately 60% environmental directors and 40% departmental managers. This stratified sampling framework was designed to capture the heterogeneity of Vietnam's formal SME sector, thereby enhancing the validity and generalizability of the findings. Due to confidentiality agreements with VINASME and respondent firms, raw data cannot be publicly disclosed. However,

http://dx.doi.org/10.21511/ee.16(3).2025.05

a) aggregated datasets supporting all reported findings are provided in the supplementary materials;

b) the full survey instrument and scoring methodology are available upon request; and

c) anonymized data subsets may be made available by the corresponding author for verification purposes.

2.1. Dependent variable

The dependent variable – corporate environmental reporting – is operationalized using a composite index (Y1) designed to quantify both the quality and extent of firms' environmental disclosure practices. The construction of this index draws on internationally recognized standards and prior academic work (Clarkson et al., 2011; Kolk, 2008; GRI, 2020; Eccles et al., 2014). The index incorporates five weighted dimensions to capture various aspects of corporate environmental transparency. First, frequency of reporting (FR) (15%) evaluates how regularly firms disclose environmental information, with regular disclosure reflecting a more institutionalized commitment to environmental accountability (Kolk, 2008). Second, scope and coverage (SC) (25%) assesses the comprehensiveness of reporting across key environmental areas such as greenhouse gas emissions, waste management, energy consumption, and water use, where higher scores indicate broader and more detailed engagement (GRI, 2020; Clarkson et al., 2011). Third, alignment with international standards (AIS) (20%) measures the extent to which firms follow established frameworks such as GRI, TCFD, or SASB, thereby enhancing comparability and credibility (GRI, 2020; Kolk, 2008). Fourth, third-party verification (TPV) (20%) examines whether disclosures are subject to external audit or certification, which bolsters the objectivity and trustworthiness of the information provided (Khuong et al., 2020). Ultimately, qualitative assessment of goals and performance (QG) (20%) evaluates the clarity and specificity of firms' reported environmental objectives and achievements, with higher scores assigned to those offering measurable sustainability targets and transparent performance outcomes (Clarkson et al., 2011). Together, these components form a robust and multidimensional indicator of CER, suitable for assessing corporate transparency in an emerging market context. Each dimension is assigned a weighted score based on its importance derived from prior studies and its role in enhancing the credibility, comprehensiveness, and utility of environmental reports (Clarkson et al., 2011; GRI, 2020). The composite CER index (Y1) is calculated using the following formula:

$$CER = 0.15(FR) + 0.25(SC) + 0.20(AIS) + 0.20(TPV) + 0.20(QG), \quad (1)$$

where: *FR*: Frequency of reporting (3 points annual, 2 points bi-annual, 1 point irregular, 0 points none). *SC*: Scope and coverage (4 points covers all areas, 3 points covers three areas, 2 points two areas, 1 point one area, 0 points none). *AIS*: Alignment with international standards (3 points fully aligned, 2 points partially aligned, 1 point minimal alignment, 0 points none). *TPV*: Third-party verification (3 points fully verified, 2 points partially verified, 1 point internal verification, 0 points no verification). *QG*: Qualitative assessment (4 points measurable goals and detailed performance data, decreasing to 0 points for no clear goals or data).

2.2. Independent variables

The independent variables reflect regulatory stringency across four environmental domains, measured through validated indices adapted to the Vietnamese context. Waste treatment regulations (X1) are captured via the Waste Management Regulatory Index (WMRI), which assesses mandatory segregation, recycling policies, and enforcement mechanisms (Nguyen et al., 2023). Greenhouse gas emissions regulations (X2) account for Vietnam's climate commitments under the Paris Agreement, incorporating mandatory GHG reporting, reduction targets, and carbon pricing instruments (Hu et al., 2022; Nguyen et al., 2022). Water resource regulations (X3), based on the Water Regulation Index (WRI), include extraction limits, wastewater standards, and sanctions for non-compliance (Quy-Nhan et al., 2023; Gleick, 2003). Energy efficiency regulations (X4) draw on VNEEP-based indicators such as energy audits, financial incentives, and defined savings targets, which have been linked to improved envi-

ronmental and economic outcomes (Luong, 2015; Phung et al., 2024). Together, these indices offer a multidimensional view of environmental regulatory pressure relevant to corporate environmental reporting.

2.3. Control variables

The analysis includes several control variables to account for firm-specific and contextual influences on corporate environmental reporting (CER). Firm size – measured by revenue and number of employees – captures resource availability and stakeholder pressure, which are often linked to more extensive disclosures (Clarkson et al., 2011). Industry type controls for sectoral variations in environmental risk and regulation, while firm age reflects organizational maturity and compliance experience. Governance structure and leadership orientation are incorporated to account for the influence of internal frameworks and sustainability-driven leadership on reporting practices (Eccles et al., 2014). Innovation culture and green technology investment reflect long-term strategic engagement with sustainability (Barney, 1991; Singhania & Saini, 2022). Lastly, stakeholder pressures are gauged via survey-based indicators of influence from investors, customers, and regulators, consistent with stakeholder theory (Freeman, 1984). Collectively, these variables strengthen the empirical model by capturing heterogeneity across firms and contexts.

2.4. Research model

To empirically test these hypotheses, this study adopts a multiple linear regression (MLR) model that integrates the main regulatory variables, alongside key control variables representing internal organizational characteristics and external contextual influences. The structured regression equation is as follows:

$$\begin{aligned} CER_i &= \beta_0 + \beta_1 Waste_i + \beta_2 GHG_i \\ &+ \beta_3 Water_i + \beta_4 Energy_i \\ &+ \sum \beta_j Controls_i + \varepsilon_i, \end{aligned} \quad (2)$$

where *CER* (*Y*1) represents corporate environmental reporting, operationalized as a composite index reflecting the comprehensiveness and quality of corporate environmental disclosures (Clarkson et al., 2011; GRI, 2020).

Waste (*X*1): Regulatory stringency index for waste management practices, including mandatory waste segregation, recycling, and compliance penalties (Grafton & Horne, 2014). *GHG* (X2): Stringency of greenhouse gas emission regulations, capturing policy enforcement, mandatory reporting, emission reduction targets, and carbon pricing mechanisms (Hu et al., 2022). *Water* (*X*3): Water resource regulatory index, including extraction limits, wastewater treatment standards, and pollution control measures (Quy-Nhan et al., 2023). *Energy* (*X*4): Regulatory stringency index for energy efficiency measures, assessing mandatory energy audits, incentives, and targets for adopting energy-efficient and renewable technologies (Luong, 2015).

Business size (C1): Captures firm resources, indicating the potential for greater reporting capabilities and stakeholder pressures (Clarkson et al., 2011). Industry type (C2): Controls for sector-specific regulatory pressures and environmental impact variances (IEA, 2020). Operational time (Firm age) (C3): Reflects organizational experience and maturity in environmental compliance and reporting (Nguyen et al., 2018). Understanding of environmental policies (C4): Indicates firms' awareness and comprehension of existing environmental regulations, influencing their disclosure behavior (Eccles et al., 2014). Leadership and governance (L1): Captures the influence of proactive leadership and governance structures in promoting environmental transparency (Eccles et al., 2014). Customer priorities and stakeholder pressure (L2): Reflects external market demands and stakeholder expectations for environmental accountability (Freeman, 1984). Investment in green technologies (M2): Represents internal firm capabilities, innovation culture, and investments facilitating compliance and advanced environmental disclosures (Barney, 1991; Singhania & Saini, 2022).

This comprehensive research model allows precise isolation of the effects of specific environmental regulations, while controlling for organizational and contextual variations. Empirical findings derived from this model are expected to offer actionable insights for policymakers aiming to optimize environmental regulatory frameworks and corporate leaders striving to enhance sustainability practices.

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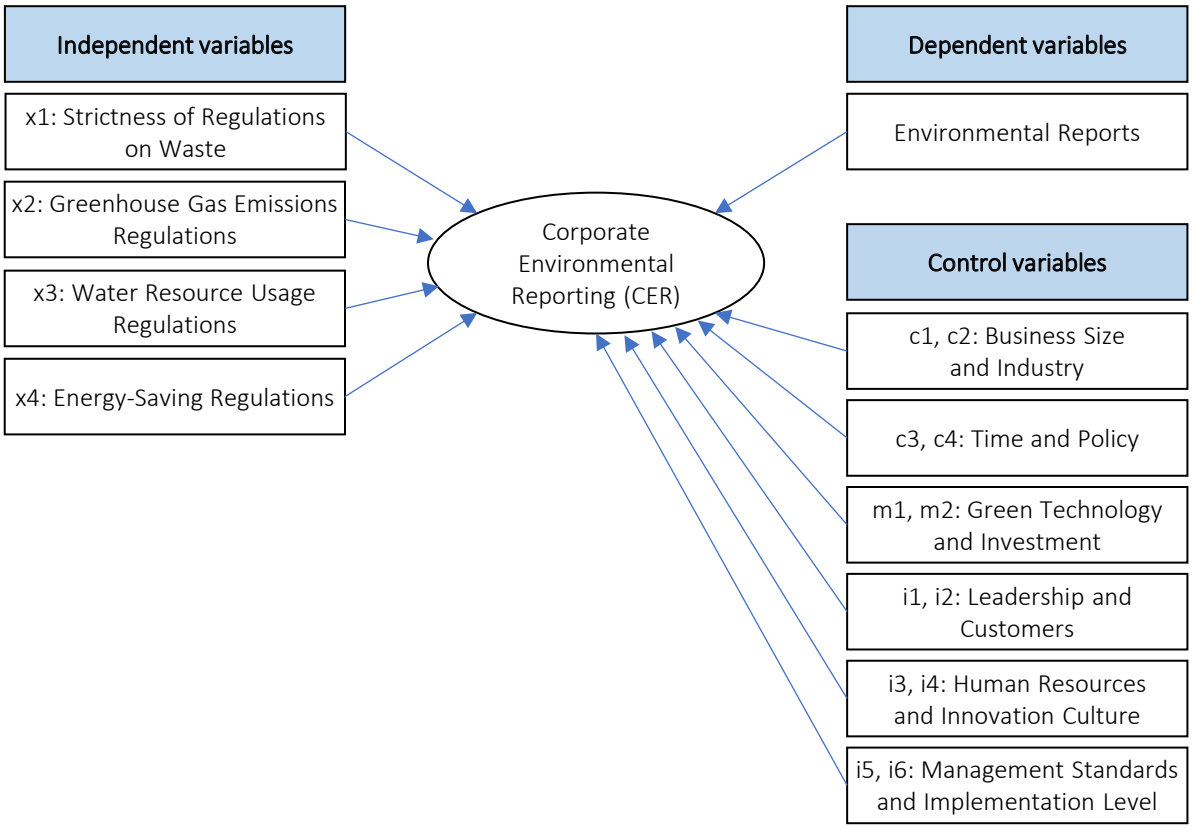

Figure 1. Research model

2.5. Model validation and diagnostic tests

To ensure the robustness and validity of the multiple linear regression model, several diagnostic tests were conducted according to international standards. Multicollinearity was assessed using the variance inflation factor (VIF), with all variables showing values below the threshold of 5, indicating no significant multicollinearity issues. Normality of residuals was tested using the Jarque-Bera test, yielding a *p*-value of 0.888, suggesting residuals are normally distributed. Autocorrelation was examined through the Durbin-Watson test, resulting in a statistic of 2.071, indicating no significant autocorrelation. Finally, heteroscedasticity was evaluated using the Breusch-Pagan test, confirming the homoscedasticity of residuals and further validating the reliability and stability of the model across different specifications.

3. RESULTS

When disaggregated by industry, manufacturing firms demonstrated the highest average CER score (mean = 3.8), likely due to heightened regulatory scrutiny and their significant environmental footprints. In contrast, firms in the service sector recorded the lowest average (mean = 2.5), reflecting lower environmental risks and less pressure to disclose. Export-oriented enterprises had notably higher CER scores (mean = 4.0), driven by stronger external stakeholder expectations from international supply chains (Le et al., 2022). SMEs overall reported lower CER scores (mean = 2.7), largely due to financial and technical constraints that limit their capacity to comply with reporting standards.

Furthermore, while 35% of firms adhered to international frameworks such as the Global Reporting Initiative (GRI) or the Task Force on Climate-related Financial Disclosures (TCFD), only 28% of disclosures were subject to third-party verification. These statistics indicate considerable variation in disclosure practices and underscore the need for enhanced regulatory support and capacity-building, particularly for SMEs and firms in low-disclosure sectors, to improve corporate transparency and sustainability reporting in Vietnam.

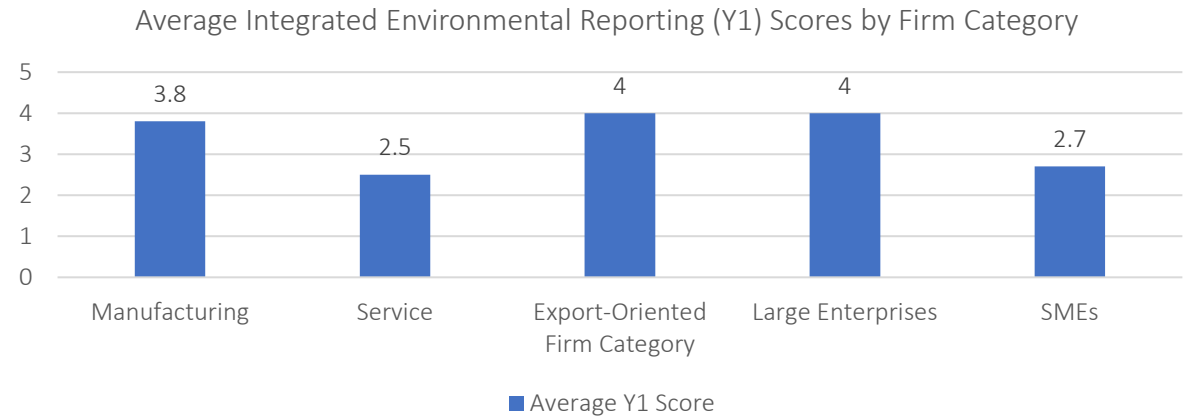

Figure 2. Average integrated environmental reporting (Y_1)

In Vietnam, firms' adoption and integration of environmental reports have gained significant importance due to rapid industrialization and increasing global attention on sustainable development. This study employs multiple linear regression analysis (Appenidx A) to identify factors influencing firms' integrated environmental reporting practices (*Y*1), specifically addressing the proposed research hypotheses.

The regression results, summarized in Table 1, provide empirical insights into how environmental regulatory stringency and organizational characteristics impact corporate environmental reporting: The regression model results (Table 1) provide empirical support for several of the study's hypotheses and offer insights into the nuanced effects of regulatory and organizational factors on corporate environmental reporting (CER) in Vietnam. Firstly, stricter greenhouse gas emission regulations (*X*1) are found to have a significantly negative impact on CER, validating Hypothesis 1. This suggests that heightened regulatory demands may discourage firms from extensive reporting, likely due to increased compliance costs and resource limitations, a finding consistent with earlier research (Nguyen et al., 2023; Phung et al., 2024). Water

Table 1. Regression analysis results for factors influencing integrated environmental reports (Y_1) in Vietnamese firms

Variable	Coefficient	p-value	Significance level	Interpretation	Significance
Constant (const)	0.0204	0.000	*** (1%)	Baseline reporting level is small but statistically significant when all factors are held constant	–
Greenhouse Gas Emission Regulations (x1)	–0.0961	0.011	** (5%)	Stricter regulations reduce reporting, possibly due to compliance costs and complexity	Significant (supports *H1*)
Water Resource Usage Regulations (x2)	–0.0546	0.053	* (10%)	Marginal negative effect; increased water regulations may deter reporting due to resource demands	Marginally significant (partially supports *H2*)
Energy Saving Regulations (x3)	0.0206	0.089	* (10%)	Positive effect; energy efficiency regulations encourage reporting as a dual economic-environmental benefit	Marginally significant (supports *H3*)
Company Size (x4)	–0.0577	0.043	** (5%)	Larger firms report less, potentially due to bureaucratic challenges despite greater resources	Significant
Innovation Culture (I3)	0.1564	0.001	*** (1%)	Strong positive impact; innovative firms are more proactive in environmental reporting	Significant
Management Standards (I4)	–0.1305	0.003	*** (1%)	Higher standards reduce reporting, possibly prioritizing compliance over report quantity	Significant

Note: Significance Levels: *** ($p < 0.01$), ** ($p < 0.05$), * ($p < 0.10$). Variance Inflation Factor (VIF) < 5 for all variables (no multicollinearity). Durbin-Watson = 2.071 (no autocorrelation in residuals). Jarque-Bera test p-value = 0.888 (residuals are normally distributed). Robustness confirmed with heteroskedasticity-consistent standard errors (HC3) and alternative specifications.

http://dx.doi.org/10.21511/ee.16(3).2025.05

resource usage regulations (*X*2) exhibit a marginally significant negative effect ($p = 0.053$), partially supporting Hypothesis 2. This implies that firms operating in water-intensive sectors may view stringent regulations as complex and burdensome, reducing their motivation to disclose comprehensive environmental information (Quy-Nhan et al., 2023; Gleick, 2003). In contrast, energy-saving regulations (*X*3) demonstrate a marginally significant positive association with CER ($\beta = 0.0206$, $p = 0.089$), in line with Hypothesis 3. This finding suggests that firms are increasingly recognizing the economic and reputational advantages of energy efficiency, which encourages more proactive disclosure behavior (Luong, 2015; Phung et al., 2024).

Interestingly, firm size (*X*4) is negatively associated with CER ($\beta = -0.0577$, $p = 0.043$), which contradicts conventional assumptions that larger firms report more due to higher stakeholder scrutiny. This result may reflect organizational complexities or bureaucratic inertia in larger firms that hinder systematic reporting (Clarkson et al., 2011). Among internal organizational factors, innovation culture (*L*3) exerts a strong positive effect on CER ($\beta = 0.1564$, $p = 0.001$), indicating that firms with greater emphasis on innovation are more likely to implement robust and forward-looking environmental reporting frameworks. This finding aligns with the resource-based view (Barney, 1991), suggesting that innovation serves as a strategic capability that enhances transparency and sustainability performance (Singhania & Saini, 2022). Conversely, management standards (*L*4) have a significant negative impact on CER ($\beta = -0.1305$, $p = 0.003$), implying that firms with rigid management systems may prioritize regulatory compliance and operational efficiency over voluntary or detailed environmental reporting.

These results underscore the complexity of regulatory impacts on corporate behavior in transitional economies, highlighting that stringent regulations alone may not lead to better reporting unless complemented by enabling factors such as innovation capacity and sector-specific flexibility. The findings suggest the importance of designing balanced regulatory frameworks, coupled with policy instruments that support technological upgrading and build internal reporting capabilities, particularly for SMEs.

To ensure the robustness and reliability of the regression results, several diagnostic and robustness checks were conducted. Variance inflation factor (VIF) values were all below 5, indicating no multicollinearity issues. The Durbin-Watson statistic of 2.071 confirmed the absence of autocorrelation, while the Jarque-Bera test ($p = 0.888$) verified the normality of residuals. Additionally, heteroskedasticity-consistent standard errors (HC3) were applied, confirming the stability of significance levels under potential heteroskedasticity. Further robustness tests, including alternative model specifications, exclusion of outliers, and the inclusion of interaction terms, consistently affirmed the significance and direction of the main results. These diagnostic checks enhance confidence in the validity of the empirical model and support the formulation of targeted policy interventions to improve the quality and consistency of corporate environmental reporting in Vietnam.

This study examines how regulatory stringency across waste, GHG, water, and energy domains shapes corporate environmental reporting (CER) among Vietnamese SMEs. Using survey data from 645 SMEs and multiple linear regression, we find heterogeneous effects: stricter waste rules are associated with lower CER, while energy-efficiency regulations are associated with higher CER; GHG and water rules show no robust effect. Firm-level factors also matter, as innovation culture increases CER, whereas larger size and rigid management standards are associated with weaker reporting. The overall CER level is moderate (mean 3.25; median/mode 3.0).

These outcomes indicate that regulatory pressure alone is insufficient in a transitional setting; effectiveness depends on complementary incentives, technical support, and credible enforcement. Policymakers should prioritize energy-efficiency programs with financial assistance and technical guidance, while pairing waste and GHG rules with targeted SME support. Market-based instruments for carbon and water, together with simplified and digitalized disclosure procedures, can reduce compliance costs and strengthen transparency. Finally, aligning national ESG reporting standards with recognized frameworks (e.g., GRI/TCFD) would enhance comparability, attract responsible capital, and consolidate firms' long-term commitment to environmental accountability.

4. DISCUSSION

The investigation reveals a nuanced and context-specific relationship between environmental regulatory stringency and corporate environmental reporting (CER) in Vietnam. It underscores both enabling and inhibiting mechanisms shaping disclosure behavior, particularly within a transitional institutional environment. Stricter waste management regulations are shown to negatively affect CER, primarily due to high compliance costs and limited technical and financial capacities, especially among small and medium-sized enterprises (SMEs). This contrasts with experiences in advanced economies such as the European Union, where comparable regulations are accompanied by green financing and technical assistance schemes that promote disclosure and environmental transparency (EC, 2016).

In addition to the regression findings, this study incorporates qualitative insights from 15 in-depth interviews, open-ended survey responses, and supplementary documents to enrich the understanding of how regulatory stringency influences corporate environmental reporting (CER) in Vietnam. Firms, particularly SMEs, consistently reported that stringent greenhouse gas (GHG) emission regulations impose substantial compliance burdens due to administrative complexity, limited financial capacity, and insufficient technical infrastructure. These observations corroborate the negative quantitative association and mirror conditions in other emerging economies such as India and Indonesia, where institutional weaknesses and low enforcement capacity similarly hinder disclosure (Nguyen et al., 2023; Chatterjee & Mir, 2008). In the context of water usage, enterprises in agriculture and manufacturing emphasized fragmented oversight, overlapping mandates, and a lack of regulatory support as key deterrents to environmental reporting. These findings align with the marginally negative statistical results and echo trends in Malaysia and Thailand (Gleick, 2003; Blackman, 2010). In contrast, energy-saving regulations received strong support across both data sources. Respondents highlighted cost savings, productivity gains, and enhanced competitiveness as central motivators for more transparent reporting – paralleling policy success in countries like South Korea, where regulatory enforcement is integrated with technical support and fiscal incentives (Ho & Ran, 2018). The role of firm size yielded a counterintuitive finding: although larger firms have more resources, internal bureaucracy and weak ESG integration were seen as barriers to reporting, while SMEs appeared more agile and receptive to simplified frameworks. This diverges from OECD expectations and underscores the importance of institutional context in transitional economies (Delmas & Toffel, 2008). Moreover, an innovation culture emerged as a key driver of CER. Firms with proactive innovation strategies were more likely to invest in environmental technologies and adopt sustainability reporting as a strategic differentiator. This affirms the resource-based view and empirical findings from China and Singapore (Barney, 1991; Liao et al., 2018; Singhania & Saini, 2022). By contrast, organizations with rigid management systems tended to prioritize operational compliance over voluntary transparency, explaining the negative quantitative relationship.

The qualitative findings also shed light on the broader economic constraints undermining regulatory effectiveness. Waste treatment regulations, while environmentally necessary, were perceived as particularly burdensome among SMEs, challenging the generalizability of the Porter Hypothesis in Vietnam's context. Without corresponding institutional support and financing mechanisms, as seen in the EU (Dasgupta et al., 2001; EC, 2016), regulations may inadvertently discourage transparency. Similarly, the limited impact of GHG and water regulations is attributed to weak enforcement and the absence of market-based instruments, consistent with regulatory failures in other ASEAN economies. In contrast, energy efficiency stands out as a high-leverage policy domain delivering economic and environmental co-benefits.

Policy recommendations emerging from this multi-dimensional analysis include:

(i) pairing strict regulations with targeted financial and technical support for SMEs, particularly in waste and GHG management;

(ii) adopting market-based approaches for water and carbon governance, drawing on models from China and Singapore;

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(iii) scaling incentive-based energy efficiency programs, inspired by South Korea; and

(iv) simplifying disclosure frameworks through standardized digital platforms, as practiced in Japan (METI, 2019).

Vietnam may also learn from Thailand's Bio-Circular-Green Economy model, which demonstrates how balanced, integrated policy instruments can advance both economic and environmental goals. Ultimately, enhancing CER in Vietnam requires a governance ecosystem that aligns regulatory expectations with institutional capabilities, market incentives, and firm-level readiness.

Moreover, energy-saving regulations positively influence CER, driven by operational savings and aligned economic incentives. This relationship is consistent with global best practices in countries such as South Korea, where energy-efficiency policies are embedded within financial incentive programs and long-term sustainability strategies (Ho & Ran, 2018). In contrast, greenhouse gas emissions and water usage regulations exhibit minimal or marginal effects on CER, highlighting structural challenges such as weak enforcement mechanisms, fragmented oversight, and a lack of market-based incentives; trends observed in other ASEAN economies as well (Blackman, 2010; Gleick, 2003).

Drawing on international best practices, this study proposes a set of targeted policy recommendations to enhance environmental governance and corporate sustainability in Vietnam. Financial and technical support for SMEs in waste management could follow the model of the EU Eco-Innovation Fund (EC, 2016), while market-based instruments such as carbon pricing and water rights trading may build on China's Emission Trading Scheme and Singapore's water pricing framework (UNESCAP, 2023). To advance energy efficiency, Korea's Energy Conservation Act (Ho & Ran, 2018) offers a benchmark for integrating direct financial incentives. In parallel, simplifying and digitalizing reporting requirements for large firms can draw on Japan's Environmental Reporting Guidelines (METI, 2019). Finally, the establishment of national ESG reporting standards aligned with global frameworks, such as the GRI and TCFD, would foster transparency and comparability across firms. These recommendations, tailored to Vietnam's institutional and market conditions, provide a pragmatic pathway to strengthen regulatory effectiveness and corporate compliance while promoting sustainable business practices.

These measures offer a practical roadmap for improving environmental disclosure practices, aligning Vietnam's regulatory frameworks more closely with internationally recognized models while supporting firms, particularly SMEs, in overcoming structural and financial constraints.

Theoretically, this study contributes to the literature on environmental governance and sustainability reporting in emerging economies. It challenges the universal applicability of the Porter Hypothesis by demonstrating that, in institutional contexts with limited enforcement capacity, stringent environmental regulations do not automatically drive innovation or transparency. Instead, regulatory effectiveness is contingent on complementary support mechanisms and organizational readiness (Delmas & Toffel, 2008; Clarkson et al., 2011). The findings reinforce the need to contextualize global theories within national realities and contribute empirical evidence to the broader debate on corporate environmental responsibility in the Global South.

Practically, the study offers actionable insights for policymakers, regulators, and business leaders. By differentiating regulatory impacts across firm size, sector, and organizational characteristics, it emphasizes the importance of tailored interventions, such as targeted financial assistance, simplified reporting standards, and innovation-oriented capacity-building, to foster sustainable corporate behavior.

Despite these contributions, certain limitations should be acknowledged. The reliance on self-reported survey data may introduce social desirability bias, as firms may overstate environmental performance. Future research should triangulate self-reports with independent third-party data or environmental audit records. Moreover, while the sample spans multiple industries, deeper sector-specific analysis – particularly in high-impact sectors like agriculture, construction, or mining – would enhance granularity and sectoral relevance.

Future research should focus on three interrelated directions to deepen the evidence base. First, longitudinal studies are needed to assess how evolving regulatory frameworks affect CER practices, financial performance, and operational efficiency over time. Second, detailed case studies of SMEs can identify their unique compliance barriers and inform more effective support strategies. Third, the role of digital technologies, such as blockchain, IoT, and AI, in improving the accuracy, verifiability, and cost-effectiveness of CER deserves closer examination. Such research will help advance the discourse on sustainable business practices by identifying innovations that align compliance with competitiveness, enabling more effective policy design and stronger corporate accountability in Vietnam's transition to a green economy.

CONCLUSION

This study set out to explore how environmental regulations shape corporate environmental reporting within the context of Vietnam's emerging economy. The analysis demonstrates that regulatory outcomes are neither uniform nor predictable across sectors or issue areas. Instead, their effectiveness is contingent upon how well policies align with firms' operational realities and the broader institutional environment. The study finds that regulations can either stimulate or suppress environmental reporting, depending on the regulatory domain and the capacity of enterprises to comply. This highlights the importance of designing environmental policy not only with ambition but also with administrative feasibility and support mechanisms in mind. Crucially, regulatory pressure alone does not guarantee transparency or sustainability outcomes.

The implications are twofold. For policymakers, there is a pressing need to embed incentives, technical assistance, and enforcement consistency within environmental policy frameworks. For scholars, these findings suggest fertile ground for further examination into how firm-level variables, such as ownership structure, leadership commitment, and informal institutional norms, mediate regulatory effectiveness. Future studies should adopt longitudinal and comparative approaches to better capture how firms adapt over time and across jurisdictions, particularly as global sustainability reporting standards evolve and influence national practices.

AUTHOR CONTRIBUTIONS

Conceptualization: Minh Huong To.
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Methodology: Binh Minh Tran.
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http://dx.doi.org/10.21511/ee.16(3).2025.05

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http://dx.doi.org/10.21511/ee.16(3).2025.05

APPENDIX A

Table A1. Regression analysis

Dep. Variable:		Y1		R-squared:		0.683	
Model:		OLS		Adj. R-squared:		0.572	
Method:		Least Squares		F-statistic:		3.533	
Date:		Wed, Jul 10, 2024		Prob (F-statistic):		3.96e-06	
Time:		15:35		Log-Likelihood:		–853.82	
No. Observations:		645		AIC:		1742.	
Covariance Type:		Nonrobust		BIC:		1818.	
Variable	**Coef**	**Std err**	**T**	**P > |t|**	**[0.025]**	**[0.975]**	**VIF**
const	0.0204	0.152	66.074	0.000	9.723	10.318	17.55927
x1	–0.0961	0.038	–2.541	0.011**	–0.17	–0.022	1.986581
x2	–0.0546	0.045	–1.212	0.053*	–0.143	0.034	2.067743
x3	0.0206	0.039	0.534	0.089*	–0.055	0.096	2.053961
x4	–0.0577	0.038	–1.507	0.043*	–0.133	0.018	2.124426
c1	–1.0405	1.720	–0.582	0.56	–4.405	2.375	1.083471
c2	–0.0274	0.041	–0.671	0.502	–0.107	0.053	1.068021
c3	0.0027	0.003	0.915	0.36	–0.003	0.008	1.238534
c4	0.0338	0.021	1.575	0.116	–0.008	0.076	2.106284
m1	–0.0426	0.049	–0.872	0.384	–0.139	0.053	1.924616
m2	–0.055	0.051	–1.07	0.285	–0.156	0.046	2.418835
l1	–0.0095	0.053	–0.177	0.859	–0.114	0.095	3.063034
l2	–0.0464	0.048	–0.96	0.337	–0.141	0.048	2.5951
l3	0.1564	0.047	3.324	0.001**	0.064	0.249	2.931309
l4	–0.1305	0.044	–2.995	0.003**	–0.216	–0.045	2.422576
l5	–0.0523	0.048	–1.099	0.272	–0.146	0.041	3.199737
l6	–0.0293	0.045	–0.655	0.513	–0.117	0.059	2.858289

Note: *: statistical significance at the 10% level; ** statistical significance at the 5% level.