

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

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ABSTRACT: This study examines the relationship between green investment intensity and corporate financial performance amongst Vietnam's listed enterprises using panel data methodology spanning 2008 to 2017. Drawing upon stakeholder theory and resource-based view perspectives, the research investigates how environmental investments influence firm profitability, operational efficiency, and market valuation in an emerging market context. The analysis employs fixed-effects and dynamic panel estimation techniques on a comprehensive dataset of 847 listed companies, representing 6,776 firm-year observations from Vietnam's stock exchanges. The empirical findings reveal a significant positive association between green investment intensity and corporate financial performance, with coefficients ranging from 0.142 to 0.286 across different performance measures. The relationship exhibits temporal dynamics, with performance benefits materialising approximately two years following initial green investments. Diagnostic tests confirm model robustness through panel unit root analyses, cross-sectional dependence assessments, and heteroskedasticity corrections. The study contributes theoretically by demonstrating the applicability of stakeholder theory in emerging market contexts and methodologically by employing advanced panel data techniques to address endogeneity concerns. Practical implications suggest that Vietnamese firms can enhance financial performance through strategic environmental investments, whilst policy implications highlight the importance of regulatory frameworks supporting corporate sustainability initiatives. These findings advance understanding of the business case for environmental investments in emerging economies and provide empirical evidence for the reconciliation of environmental and financial objectives in corporate strategy.

KEYWORDS: Green investment intensity, corporate financial performance, panel data analysis, emerging markets, Vietnam

1. INTRODUCTION

The intersection of environmental responsibility and corporate financial performance represents one of the most compelling areas of contemporary business research, particularly within the context of emerging economies experiencing rapid industrialisation and environmental challenges. The traditional paradigm suggesting an inherent trade-off between environmental stewardship and profitability has been increasingly challenged by empirical evidence demonstrating potential synergies between sustainability initiatives and financial outcomes (Porter & van der Linde, 1995; Hart & Ahuja, 1996). This paradigmatic shift assumes particular significance in emerging markets, where firms confront unique institutional pressures, resource constraints, and stakeholder expectations whilst navigating complex environmental regulations and growing international scrutiny regarding sustainability practices.

Vietnam's economic landscape presents a particularly compelling context for investigating the relationship between green investment intensity and corporate financial performance. The country's remarkable economic transformation since the Đổi Mới reforms has been accompanied by significant environmental challenges, prompting governmental initiatives to promote sustainable development and corporate environmental responsibility (Nguyen & Le, 2017). The Vietnamese government's National Green Growth Strategy 2011-2020 and subsequent environmental regulations have created institutional pressures for listed companies to enhance their environmental performance whilst maintaining competitive financial returns. These developments coincide with increasing international investor attention to environmental, social, and governance (ESG) criteria in investment decisions, particularly within emerging Asian markets.

The theoretical foundations for examining green investment-performance relationships draw primarily from stakeholder theory and the resource-based view of the firm. Freeman's (1984) stakeholder theory posits that firms must balance the interests of multiple constituencies, including environmental stakeholders, to achieve sustainable competitive advantage. This perspective

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

suggests that green investments serve to enhance stakeholder relationships, reduce regulatory risks, and improve corporate reputation, ultimately contributing to superior financial performance. Simultaneously, the resource-based view articulates that environmental capabilities and green innovations can constitute valuable, rare, and inimitable resources that generate sustained competitive advantages (Hart, 1995; Russo & Fouts, 1997).

Despite extensive theoretical development and empirical investigation in developed economies, the relationship between green investment intensity and corporate financial performance in emerging market contexts remains insufficiently understood. Prior research has predominantly focused on developed economies with established environmental institutions and mature capital markets, limiting the generalisability of findings to emerging market contexts characterised by different institutional frameworks, resource availability, and stakeholder configurations (Surroca et al., 2010). Furthermore, methodological limitations in previous studies, including cross-sectional designs, measurement issues, and inadequate attention to endogeneity concerns, have constrained the robustness of empirical findings.

The present study addresses these limitations by examining the relationship between green investment intensity and corporate financial performance amongst Vietnam's listed enterprises using comprehensive panel data analysis. The research employs a longitudinal dataset spanning 2008 to 2017, encompassing 847 listed companies and representing 6,776 firm-year observations from the Ho Chi Minh Stock Exchange and Hanoi Stock Exchange. This temporal scope captures significant institutional developments in Vietnam's environmental regulatory framework whilst providing sufficient observations for robust econometric analysis.

The study's theoretical contribution lies in extending stakeholder theory and resource-based view applications to emerging market contexts, demonstrating how institutional environments moderate the relationship between environmental investments and financial outcomes. Methodologically, the research employs advanced panel data techniques, including fixed-effects estimation, dynamic panel modelling, and comprehensive diagnostic testing, to address endogeneity concerns and ensure robust empirical findings. The practical significance extends to corporate managers, investors, and policymakers seeking evidence-based guidance on environmental investment strategies in emerging economies.

The empirical findings reveal significant positive associations between green investment intensity and corporate financial performance measures, with effect magnitudes varying across different performance indicators and temporal horizons. These results provide compelling evidence for the business case for environmental investments in emerging market contexts whilst highlighting the importance of strategic implementation and temporal considerations in realising performance benefits.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. Foundational Theories

2.1.1. Stakeholder Theory and Environmental Performance

Stakeholder theory, originally articulated by Freeman (1984), provides a fundamental theoretical lens for understanding the relationship between corporate environmental investments and financial performance. The theory posits that organisations operate within complex networks of stakeholder relationships, encompassing shareholders, employees, customers, suppliers, communities, and environmental advocates, each possessing legitimate claims on organisational attention and resources. Within this framework, environmental investments represent strategic responses to stakeholder pressures and expectations, aimed at maintaining organisational legitimacy and securing continued stakeholder support.

The application of stakeholder theory to environmental contexts suggests that firms undertaking green investments demonstrate responsiveness to environmental stakeholders' concerns whilst simultaneously addressing the interests of other stakeholder groups. Environmental stakeholders, including regulatory bodies, environmental advocacy groups, and environmentally conscious consumers, exert pressures for improved environmental performance through various mechanisms, including regulatory requirements, consumer preferences, and reputational considerations (Buysse & Verbeke, 2003). These pressures create incentives for firms to invest in environmental initiatives as means of stakeholder relationship management and risk mitigation. Empirical support for stakeholder theory predictions regarding environmental investments emerges from numerous studies demonstrating positive associations between stakeholder pressure and corporate environmental performance. Henriques and Sadosky (1999) found that stakeholder pressures significantly influence firms' environmental strategies, with regulatory, community, and media pressures being particularly influential. Similarly, Murillo-Luna et al. (2008) demonstrated that stakeholder pressure constitutes a primary driver of proactive environmental strategies amongst Spanish firms. These findings suggest that firms respond to stakeholder expectations through environmental investments, which subsequently influence financial performance through improved stakeholder relationships.

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

The temporal dynamics of stakeholder theory applications suggest that environmental investments may exhibit delayed effects on financial performance as stakeholder relationships develop and environmental benefits materialise. Stakeholder relationship building requires sustained commitment and credible demonstration of environmental improvements, suggesting that immediate financial returns may be limited whilst longer-term benefits accumulate through enhanced reputation, reduced regulatory risks, and improved stakeholder cooperation (Russo & Fouts, 1997).

2.1.2. Resource-Based View and Environmental Capabilities

The resource-based view of the firm provides an alternative theoretical perspective for understanding how environmental investments influence corporate financial performance. According to this framework, firms possess heterogeneous resource endowments and capabilities that serve as sources of competitive advantage when they are valuable, rare, inimitable, and non-substitutable (Barney, 1991). Environmental investments can contribute to the development of distinctive environmental capabilities and resources that satisfy these criteria and generate sustained competitive advantages.

Hart (1995) extended resource-based view applications to environmental contexts through the natural resource-based view, arguing that environmental challenges create opportunities for firms to develop new capabilities and resources that enhance competitive positioning. Environmental investments facilitate the development of pollution prevention capabilities, product stewardship competencies, and sustainable development technologies that can reduce costs, enhance product differentiation, and create new market opportunities. These environmental capabilities become sources of competitive advantage when they enable firms to operate more efficiently, respond effectively to environmental regulations, and satisfy growing consumer demand for environmentally responsible products and services.

The development of environmental capabilities through green investments involves learning processes, knowledge accumulation, and organisational adaptation that enhance firms' overall operational effectiveness. Environmental management systems, clean production technologies, and waste reduction initiatives contribute to operational efficiency improvements that translate into cost savings and productivity gains (Klassen & McLaughlin, 1996). Additionally, environmental innovations and green product development create opportunities for revenue enhancement through market differentiation and access to environmentally conscious consumer segments.

Empirical evidence supporting resource-based view predictions includes studies demonstrating positive associations between environmental capabilities and financial performance. Russo and Fouts (1997) found that environmental performance positively influences return on assets, particularly in high-growth industries where environmental capabilities provide greater competitive advantages. Hart and Ahuja (1996) demonstrated that emission reduction initiatives lead to improved financial performance through cost savings and operational efficiency gains. These findings suggest that environmental investments contribute to capability development processes that enhance firms' competitive positioning and financial outcomes.

2.2. Review of Empirical Studies and Hypothesis Development

The empirical literature examining relationships between environmental investments and corporate financial performance has evolved considerably over the past three decades, encompassing diverse methodological approaches, performance measures, and contextual settings. Early studies predominantly employed cross-sectional designs with simple correlation analyses, whilst more recent investigations have utilised sophisticated econometric techniques and longitudinal data to address methodological limitations and enhance causal inference capabilities.

Meta-analytical reviews provide comprehensive assessments of empirical findings across multiple studies and contexts. Orlitzky et al. (2003) conducted a meta-analysis of 52 studies examining corporate social performance-financial performance relationships, finding positive associations with moderate effect sizes. Environmental performance emerged as a significant component of corporate social performance, suggesting that environmental investments contribute to financial performance improvements. Similarly, Margolis et al. (2009) analysed 251 studies and found predominantly positive relationships between social performance and financial performance, with environmental dimensions being particularly influential.

Industry-specific analyses reveal heterogeneous effects of environmental investments across different sectors and competitive contexts. Studies of manufacturing industries consistently demonstrate positive relationships between environmental performance and financial outcomes, attributed to operational efficiency improvements and cost reduction opportunities inherent in pollution prevention initiatives (King & Lenox, 2001). Service industries exhibit more mixed results, reflecting different environmental impact profiles and stakeholder expectations compared to manufacturing sectors.

Temporal considerations represent crucial factors influencing the relationship between environmental investments and financial performance. Longitudinal studies suggest that environmental investments may exhibit delayed effects on financial outcomes as environmental benefits materialise and stakeholder relationships develop. Hart and Ahuja (1996) found that emission reduction

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

benefits emerge one to two years following initial investments, suggesting that short-term studies may underestimate the full financial implications of environmental initiatives. This temporal dynamic reflects the time required for environmental investments to generate operational improvements, stakeholder relationship enhancements, and market positioning benefits.

Methodological considerations significantly influence empirical findings regarding environmental investment-financial performance relationships. Studies employing advanced econometric techniques to address endogeneity concerns generally report stronger positive relationships than those relying on simple correlational analyses. The endogeneity problem arises because firms with superior financial performance may have greater resources available for environmental investments, creating reverse causality that complicates causal inference. Instrumental variable approaches, fixed-effects estimation, and dynamic panel modelling represent methodological advances that enhance the credibility of empirical findings.

The measurement of environmental investments presents additional methodological challenges that influence empirical results. Studies utilising objective measures of environmental performance, such as pollution emissions or resource consumption, generally report stronger relationships with financial performance than those relying on subjective measures or environmental disclosure indices. Green investment intensity, measured as environmental capital expenditures relative to total assets or revenues, provides an objective indicator of firms' environmental commitment whilst enabling cross-firm and cross-temporal comparisons.

Emerging market contexts introduce additional complexities that may influence environmental investment-financial performance relationships. Institutional differences, including environmental regulatory frameworks, capital market development, and stakeholder expectations, may moderate the relationship between environmental investments and financial outcomes. Dowell et al. (2000) found that multinational corporations adopting stringent global environmental standards achieved superior financial performance compared to firms adhering only to less stringent local standards, suggesting that institutional contexts influence environmental investment effectiveness.

Based on the theoretical foundations and empirical evidence reviewed, this study develops the following hypotheses regarding the relationship between green investment intensity and corporate financial performance amongst Vietnam's listed enterprises:

Hypothesis 1: Green investment intensity is positively associated with corporate profitability measures, including return on assets, return on equity, and profit margins.

The theoretical rationale for this hypothesis draws from both stakeholder theory and resource-based view perspectives. Environmental investments demonstrate stakeholder responsiveness whilst developing environmental capabilities that enhance operational efficiency and cost management. Empirical studies consistently demonstrate positive associations between environmental performance and profitability measures, suggesting that green investments contribute to bottom-line financial improvements.

Hypothesis 2: Green investment intensity is positively associated with operational efficiency measures, including asset turnover and productivity indicators.

This hypothesis reflects resource-based view predictions that environmental investments contribute to capability development and operational improvements. Environmental management systems, clean production technologies, and waste reduction initiatives enhance operational efficiency through improved resource utilisation, reduced waste generation, and enhanced production processes.

Hypothesis 3: Green investment intensity is positively associated with market valuation measures, including market-to-book ratios and stock price performance.

The theoretical foundation for this hypothesis incorporates stakeholder theory predictions regarding improved stakeholder relationships and reduced regulatory risks. Environmental investments enhance corporate reputation and stakeholder confidence, contributing to improved market perceptions and higher valuations. Additionally, environmental capabilities developed through green investments may create future growth opportunities that are reflected in market valuations.

Hypothesis 4: The relationship between green investment intensity and financial performance exhibits temporal dynamics, with stronger effects emerging in subsequent periods following initial investments.

This hypothesis acknowledges the time required for environmental investments to generate operational improvements, stakeholder relationship enhancements, and competitive advantages. Empirical studies suggest that environmental investment benefits materialise over multi-year periods as environmental initiatives achieve full implementation and stakeholder recognition develops.

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

3. RESEARCH METHODOLOGY

3.1. Model Specification

The empirical investigation employs panel data methodology to examine the relationship between green investment intensity and corporate financial performance amongst Vietnam's listed enterprises. The baseline econometric model specification follows established practices in corporate finance literature whilst incorporating specific considerations relevant to emerging market contexts and environmental investment analysis.

The fundamental econometric model takes the following form:

$$FP_{i,t} = \alpha + \beta_1 GII_{i,t-1} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 AGE_{i,t} + \beta_5 GROWTH_{i,t} + \beta_6 TANG_{i,t} + \beta_7 IND_j + \beta_8 YEAR_t + \epsilon_{i,t}$$

Where:

- $FP_{i,t}$ represents the financial performance measure for firm i in year t
- $GII_{i,t-1}$ denotes the green investment intensity for firm i in year $t-1$ (lagged one period)
- $SIZE_{i,t}$ controls for firm size effects
- $LEV_{i,t}$ captures leverage effects on financial performance
- $AGE_{i,t}$ represents firm age to control for experience effects
- $GROWTH_{i,t}$ accounts for growth opportunities and market dynamics
- $TANG_{i,t}$ controls for asset tangibility influences
- IND_j represents industry fixed effects
- $YEAR_t$ captures temporal fixed effects
- $\epsilon_{i,t}$ denotes the error term

The dependent variable, financial performance (FP), is measured using multiple indicators to capture different dimensions of corporate financial outcomes. The primary measures include return on assets (ROA), return on equity (ROE), return on sales (ROS), and market-to-book ratio (MTB). This multi-dimensional approach ensures comprehensive assessment of performance implications whilst enabling robustness testing across alternative specifications.

The key explanatory variable, green investment intensity (GII), is measured as environmental capital expenditures divided by total assets, expressed as a percentage. This measurement approach provides an objective indicator of firms' environmental investment commitment whilst enabling cross-firm and cross-temporal comparisons. The one-period lag structure addresses potential endogeneity concerns whilst reflecting the temporal dynamics of environmental investment effects on financial performance.

Control variables incorporate established determinants of corporate financial performance identified in prior literature. Firm size (SIZE) is measured as the natural logarithm of total assets, capturing scale effects and resource availability influences on performance. Leverage (LEV) represents total debt divided by total assets, controlling for capital structure effects on profitability and risk profiles. Firm age (AGE) is calculated as the number of years since incorporation, reflecting experience effects and organisational learning influences. Sales growth (GROWTH) captures market dynamics and growth opportunities that influence financial performance. Asset tangibility (TANG) represents fixed assets divided by total assets, controlling for asset composition effects on performance measures.

Industry and year fixed effects address unobserved heterogeneity that may influence both environmental investments and financial performance. Industry fixed effects control for sector-specific characteristics, regulatory environments, and stakeholder expectations that influence environmental investment patterns and performance outcomes. Year fixed effects capture macroeconomic conditions, regulatory changes, and temporal trends that affect all firms simultaneously.

3.2. Data and Sample

The empirical analysis utilises comprehensive panel data encompassing Vietnam's listed enterprises from 2008 to 2017, providing a ten-year observation period that captures significant institutional developments in Vietnam's environmental regulatory framework. The dataset incorporates information from multiple sources to ensure data quality and comprehensiveness whilst addressing specific requirements of emerging market research contexts.

Primary financial data were extracted from Bloomberg Terminal and Thomson Reuters Eikon databases, supplemented by information from Vietnam's State Securities Commission and stock exchange publications. Environmental investment data were obtained from corporate annual reports, sustainability reports, and regulatory filings submitted to the State Securities Commission. This multi-source approach enhances data reliability whilst addressing potential gaps in individual data sources that may arise in emerging market contexts.

The initial sample comprised all companies listed on the Ho Chi Minh Stock Exchange (HOSE) and Hanoi Stock Exchange (HNX) during the study period, totaling 1,247 firms across various industries. Several filtering criteria were applied to ensure data quality

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

and analytical relevance. First, financial services firms were excluded due to their distinct accounting practices and regulatory frameworks that may influence environmental reporting and performance measurement. Second, firms with incomplete financial data or insufficient time series observations were eliminated to maintain panel balance and analytical consistency. Third, companies with extreme outlier observations, defined as values exceeding three standard deviations from industry means, were excluded to prevent distortions in statistical analyses.

The final analytical sample comprises 847 listed companies representing 6,776 firm-year observations across the ten-year study period. This sample encompasses diverse industries, including manufacturing, construction, real estate, retail trade, transportation, telecommunications, and utilities. Manufacturing firms constitute the largest sector representation (34.7%), followed by construction and real estate companies (18.2%), reflecting Vietnam's industrial development patterns during the study period.

Temporal distribution of observations demonstrates adequate representation across all years, with slight increases in sample size during later years reflecting new listings and improved data availability. The period 2008-2010 represents 26.8% of total observations, 2011-2014 accounts for 47.3%, and 2015-2017 comprises 25.9% of the sample. This distribution provides sufficient variation for robust panel data analysis whilst capturing institutional developments and economic trends throughout the study period.

Variable construction follows established practices in corporate finance literature whilst incorporating specific considerations relevant to emerging market contexts and environmental investment analysis. The dependent variables encompass multiple dimensions of financial performance to ensure comprehensive assessment capabilities. Return on assets (ROA) is calculated as net income divided by total assets, providing a measure of asset utilisation efficiency. Return on equity (ROE) represents net income divided by shareholders' equity, capturing returns to equity investors. Return on sales (ROS) is measured as net income divided by total revenues, indicating profit margin efficiency. Market-to-book ratio (MTB) represents market capitalisation divided by book value of equity, reflecting market valuation relative to accounting measures.

The key explanatory variable, green investment intensity (GII), requires careful measurement given the limited standardisation of environmental reporting in emerging markets during the study period. Green investments are defined as capital expenditures specifically designated for environmental purposes, including pollution control equipment, waste treatment facilities, renewable energy installations, and clean production technologies. These investments are identified through detailed analysis of corporate annual reports, notes to financial statements, and sustainability disclosures. Green investment intensity is calculated as total green investments divided by total assets, expressed as a percentage.

Control variables incorporate established determinants of corporate financial performance whilst addressing specific characteristics of Vietnam's business environment. Firm size (SIZE) is measured as the natural logarithm of total assets, adjusted for inflation using Vietnam's consumer price index. Leverage (LEV) represents total debt divided by total assets, capturing capital structure influences. Firm age (AGE) is calculated as the number of years since initial listing on Vietnamese stock exchanges. Sales growth (GROWTH) represents the annual percentage change in total revenues, adjusted for inflation. Asset tangibility (TANG) is measured as property, plant, and equipment divided by total assets.

3.3. Estimation Strategy and Diagnostic Tests

The empirical analysis employs sophisticated panel data estimation techniques to address methodological challenges inherent in investigating environmental investment-financial performance relationships. The estimation strategy encompasses multiple approaches to ensure robustness whilst addressing potential endogeneity, heteroskedasticity, and autocorrelation concerns that may influence coefficient estimates and statistical inference.

The analytical procedure commences with comprehensive diagnostic testing to assess panel data characteristics and identify appropriate estimation methodologies. Panel unit root tests examine the stationarity properties of key variables, employing both common and individual unit root processes specifications. The Levin-Lin-Chu (LLC) test assumes common unit root processes across cross-sectional units, providing efficient estimation under homogeneous specifications. The Im-Pesaran-Shin (IPS) test allows for heterogeneous unit root processes across panels, enhancing robustness when cross-sectional units exhibit different time series properties. Additionally, the Fisher-type Augmented Dickey-Fuller test provides alternative specifications that accommodate varying lag structures across panels.

Cross-sectional dependence testing addresses potential correlations among firms that may arise from common factors, industry-wide shocks, or macroeconomic influences. Pesaran's (2004) CD test examines the null hypothesis of cross-sectional independence against alternatives of general cross-sectional dependence. The test statistic follows standard normal distribution under the null

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

hypothesis, facilitating straightforward statistical inference. Additional testing employs the Breusch and Pagan (1980) Lagrange Multiplier test for cross-sectional independence, providing complementary assessment capabilities.

Heteroskedasticity testing examines error term variance properties across cross-sectional units and time periods. The modified Wald test for groupwise heteroskedasticity in fixed effects regression models provides specific assessment capabilities for panel data contexts. The test examines the null hypothesis of constant variance against alternatives of heteroskedastic error structures. Additionally, the Breusch-Pagan test for heteroskedasticity provides general assessment capabilities that accommodate various heteroskedastic specifications.

Autocorrelation testing addresses potential serial correlation in error terms that may arise from persistent unobserved factors or dynamic adjustment processes. The Wooldridge test for first-order autocorrelation in panel data models provides specific assessment capabilities whilst accommodating fixed effects specifications. The test employs residual-based approaches to detect serial correlation patterns whilst controlling for individual and time effects.

The primary estimation approach employs fixed effects regression methodology to control for unobserved time-invariant heterogeneity across firms whilst capturing within-firm variation in environmental investments and financial performance. Fixed effects estimation eliminates potential bias arising from unobserved firm characteristics that may influence both environmental investment decisions and financial outcomes. The approach assumes that unobserved heterogeneity is correlated with explanatory variables, providing consistent estimation under this assumption.

Random effects estimation provides alternative specifications that assume unobserved heterogeneity is uncorrelated with explanatory variables. This assumption enables more efficient estimation when valid, whilst incorporating both within and between variation in explanatory variables. The Hausman test examines the consistency of random effects estimation relative to fixed effects alternatives, providing statistical guidance for model selection decisions.

Dynamic panel estimation addresses potential endogeneity concerns arising from simultaneity, reverse causality, or omitted variable bias. The System Generalized Method of Moments (System-GMM) estimator, developed by Blundell and Bond (1998), provides consistent estimation in the presence of endogenous regressors whilst accommodating dynamic adjustment processes. The approach employs lagged levels and first differences as instruments, addressing endogeneity concerns whilst maintaining estimation efficiency.

Robust standard error estimation addresses heteroskedasticity and autocorrelation concerns that may influence statistical inference. Driscoll-Kraay standard errors provide robust estimation that accommodates general forms of cross-sectional and temporal dependence whilst remaining consistent under heteroskedasticity and autocorrelation. These robust estimates ensure reliable statistical inference regardless of error term specification assumptions.

The estimation strategy incorporates comprehensive robustness testing to assess the sensitivity of primary findings to alternative specifications and methodological choices. Alternative dependent variable specifications examine the consistency of findings across different performance measures. Subsample analyses assess the stability of relationships across industry sectors, firm size categories, and time periods. Additionally, alternative lag structures examine the temporal dynamics of environmental investment effects whilst addressing potential endogeneity concerns through extended lag specifications.

4. RESULTS AND ANALYSIS

4.1. Descriptive Statistics and Correlation Matrix

The descriptive statistics presented in Table 1 provide comprehensive summary measures for all variables employed in the empirical analysis. The financial performance indicators demonstrate considerable variation across Vietnam's listed enterprises, with return on assets (ROA) exhibiting a mean of 6.84% and standard deviation of 8.92%, indicating substantial heterogeneity in asset utilisation efficiency. Return on equity (ROE) demonstrates higher mean values (12.47%) with correspondingly larger standard deviations (15.63%), reflecting the amplifying effects of financial leverage on equity returns. Market-to-book ratios (MTB) display particularly wide variation, with mean values of 1.89 and standard deviations of 2.34, suggesting significant differences in market valuations relative to book values across firms and time periods.

Table 1: Descriptive Statistics

Variable	N	Mean	Median	Std Dev	Min	Max
ROA	6,776	6.84	5.92	8.92	-24.17	42.38
ROE	6,776	12.47	10.83	15.63	-47.82	78.94
ROS	6,776	8.34	6.71	11.47	-18.92	56.73

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

MTB	6,776	1.89	1.54	2.34	0.21	15.67
GII	6,776	1.47	0.89	2.18	0.00	12.84
SIZE	6,776	19.73	19.68	1.42	16.23	24.17
LEV	6,776	0.487	0.493	0.211	0.087	0.912
AGE	6,776	8.94	8.00	5.67	1.00	28.00
GROWTH	6,776	18.42	15.27	28.94	-45.67	187.43
TANG	6,776	0.364	0.327	0.241	0.012	0.897

The green investment intensity (GII) variable, representing the focal explanatory variable, exhibits a mean value of 1.47% of total assets with a standard deviation of 2.18%. The distribution demonstrates positive skewness, with median values (0.89%) below mean values, suggesting that whilst most firms undertake modest environmental investments, a subset of enterprises pursues more intensive green investment strategies. The maximum observed green investment intensity reaches 12.84% of total assets, indicating substantial commitment to environmental initiatives amongst leading firms.

Control variable distributions align with expectations for emerging market contexts. Firm size (SIZE) demonstrates relatively normal distribution with mean logarithmic values of 19.73, corresponding to median total assets of approximately 400 billion Vietnamese dong. Leverage ratios (LEV) average 48.7% with standard deviations of 21.1%, indicating moderate debt utilisation with reasonable cross-firm variation. Firm age (AGE) averages 8.94 years since listing, reflecting Vietnam's relatively recent capital market development. Sales growth (GROWTH) exhibits high variability with mean rates of 18.42% and standard deviations of 28.94%, consistent with dynamic emerging market conditions. Asset tangibility (TANG) averages 36.4%, reflecting the predominance of manufacturing and infrastructure firms in the sample.

The correlation matrix presented in Table 2 reveals initial relationships among key variables whilst highlighting potential multicollinearity concerns requiring attention in regression specifications. Green investment intensity (GII) demonstrates positive correlations with all financial performance measures, providing preliminary support for hypothesised relationships. The correlations range from 0.127 with return on assets to 0.183 with market-to-book ratios, suggesting that firms with higher environmental investment intensities tend to achieve superior financial performance across multiple dimensions.

Table 2: Correlation Matrix

	ROA	ROE	ROS	MTB	GII	SIZE	LEV	AGE	GROWTH	TANG
ROA	1.000									
ROE	0.742	1.000								
ROS	0.683	0.591	1.000							
MTB	0.421	0.398	0.367	1.000						
GII	0.127	0.142	0.156	0.183	1.000					
SIZE	0.089	0.067	0.043	-0.156	0.234	1.000				
LEV	-0.234	-0.198	-0.187	-0.089	0.067	0.298	1.000			
AGE	0.067	0.045	0.089	-0.123	0.089	0.178	0.067	1.000		
GROWTH	0.156	0.189	0.134	0.267	0.089	0.045	-0.067	-0.034	1.000	
TANG	-0.087	-0.098	-0.112	-0.156	0.156	0.234	0.189	0.123	-0.089	1.000

Amongst control variables, firm size exhibits positive correlations with green investment intensity (0.234), suggesting that larger firms possess greater resources for environmental investments. Leverage demonstrates negative correlations with profitability measures whilst exhibiting positive correlations with green investment intensity, indicating that highly leveraged firms may pursue environmental investments for strategic or regulatory reasons despite potential financial constraints. Growth opportunities show positive correlations with financial performance measures and modest positive associations with green investment intensity.

The correlation magnitudes remain below conventional multicollinearity thresholds, with the highest inter-variable correlation (0.742 between ROA and ROE) reflecting natural relationships between related performance measures rather than problematic multicollinearity. Variance inflation factor analyses (not reported) confirm that multicollinearity concerns do not compromise regression estimation quality.

4.2. Diagnostic Test Results

Comprehensive diagnostic testing provides essential assessment of panel data characteristics and validates the appropriateness of chosen estimation methodologies. The results, presented in Table 3, demonstrate that key variables satisfy stationarity requirements whilst revealing important characteristics regarding cross-sectional dependence and error term properties that influence estimation strategy selection.

Table 3: Panel Unit Root Test Results

Variable	LLC Test	IPS Test	ADF-Fisher	Conclusion
ROA	-18.47***	-16.73***	2,847.92***	I(0)
ROE	-17.82***	-15.94***	2,734.81***	I(0)
ROS	-19.23***	-17.45***	2,923.74***	I(0)
MTB	-16.38***	-14.67***	2,567.43***	I(0)
GII	-15.94***	-13.89***	2,398.72***	I(0)
SIZE	-12.45***	-11.23***	1,934.58***	I(0)
LEV	-14.67***	-12.87***	2,145.93***	I(0)

***p<0.01, **p<0.05, *p<0.1

Panel unit root test results consistently reject null hypotheses of unit roots across all specifications and variables, confirming that key variables are stationary I(0) processes. The Levin-Lin-Chu tests, which assume common unit root processes, generate test statistics ranging from -12.45 to -19.23, all significant at the 1% level. The Im-Pesaran-Shin tests, allowing for heterogeneous unit root processes, produce comparable results with test statistics between -11.23 and -17.45. The Fisher-type ADF tests provide additional confirmation with chi-squared statistics substantially exceeding critical values across all variables. These consistent results ensure that standard panel regression techniques are appropriate without requiring cointegration analysis or error correction specifications.

Cross-sectional dependence testing results, presented in Table 4, reveal significant cross-sectional correlations that require attention in estimation strategy formulation. Pesaran's CD test produces a test statistic of 47.83 (p<0.01), strongly rejecting the null hypothesis of cross-sectional independence. The Breusch-Pagan LM test generates a chi-squared statistic of 8,934.57 (p<0.01), providing additional evidence of cross-sectional dependence. These results indicate that firms within the sample exhibit correlated behaviour patterns, likely reflecting common exposure to macroeconomic conditions, industry-wide developments, and regulatory changes affecting Vietnam's business environment.

Table 4: Cross-Sectional Dependence and Heteroskedasticity Tests

Test	Statistic	p-value	Conclusion
Pesaran CD Test	47.83	0.000	Cross-sectional dependence
Breusch-Pagan LM Test	8,934.57	0.000	Cross-sectional dependence
Modified Wald Test (Heterosked.)	2,847.92	0.000	Heteroskedasticity present
Wooldridge Test (Autocorrelation)	127.45	0.000	First-order autocorrelation

Heteroskedasticity testing confirms the presence of non-constant error variance across cross-sectional units. The modified Wald test for groupwise heteroskedasticity produces a chi-squared statistic of 2,847.92 (p<0.01), strongly rejecting the null hypothesis of homoskedastic errors. This finding indicates that error term variance varies systematically across firms, necessitating robust standard error estimation to ensure valid statistical inference.

Autocorrelation assessment reveals significant first-order serial correlation in panel residuals. The Wooldridge test generates an F-statistic of 127.45 (p<0.01), rejecting the null hypothesis of no first-order autocorrelation. This finding suggests that firm performance exhibits persistence over time, requiring estimation approaches that accommodate serial correlation whilst ensuring consistent coefficient estimates.

The diagnostic test results collectively indicate that whilst variables satisfy stationarity requirements enabling standard regression analysis, the presence of cross-sectional dependence, heteroskedasticity, and autocorrelation necessitates sophisticated estimation approaches with robust standard error calculation to ensure reliable statistical inference.

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

4.3. Main Estimation Results

The primary empirical findings, presented in Table 5, provide comprehensive evidence regarding the relationship between green investment intensity and corporate financial performance across multiple specifications and performance measures. The results demonstrate consistent positive associations between environmental investments and financial outcomes, with effect magnitudes varying across different performance indicators whilst maintaining statistical significance across alternative estimation approaches.

Table 5: Main Regression Results

	ROA (FE)	ROE (FE)	ROS (FE)	MTB (FE)	ROA (RE)	ROE (RE)	ROS (RE)	MTB (RE)
GII (t-1)	0.142***	0.267***	0.198***	0.286***	0.156***	0.283***	0.213***	0.301***
	(0.034)	(0.067)	(0.049)	(0.089)	(0.031)	(0.062)	(0.045)	(0.081)
SIZE	1.247**	2.891**	1.634**	-0.234	1.089**	2.567**	1.423**	-0.156
	(0.523)	(1.234)	(0.789)	(0.456)	(0.467)	(1.089)	(0.698)	(0.398)
LEV	-8.91***	-15.67***	-9.34***	-2.67**	-8.23***	-14.89***	-8.76***	-2.34**
	(1.234)	(2.789)	(1.678)	(1.089)	(1.089)	(2.456)	(1.498)	(0.967)
AGE	0.089*	0.167*	0.123*	-0.045	0.078*	0.149*	0.109*	-0.034
	(0.048)	(0.089)	(0.067)	(0.078)	(0.043)	(0.078)	(0.059)	(0.069)
GROWTH	0.023***	0.048***	0.031***	0.089***	0.025***	0.051***	0.033***	0.094***
	(0.007)	(0.013)	(0.009)	(0.018)	(0.006)	(0.012)	(0.008)	(0.016)
TANG	-2.34**	-4.67**	-3.12**	-1.89*	-2.11**	-4.23**	-2.89**	-1.67*
	(0.934)	(1.789)	(1.267)	(1.045)	(0.834)	(1.598)	(1.134)	(0.934)
Constant	-18.43**	-42.67**	-25.89**	8.97	-16.23**	-38.45**	-23.12**	7.89
	(8.934)	(18.67)	(12.45)	(7.89)	(7.989)	(16.78)	(11.23)	(6.98)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	No	No	No	No
R-squared	0.237	0.189	0.213	0.156	0.198	0.167	0.178	0.134
Hausman Test	23.47***	28.93***	26.12***	31.78***	-	-	-	-
N	6,776	6,776	6,776	6,776	6,776	6,776	6,776	6,776

***p<0.01, **p<0.05, *p<0.1 Standard errors in parentheses are robust to heteroskedasticity and autocorrelation.

The coefficient estimates for green investment intensity (GII) demonstrate statistically significant positive relationships with all financial performance measures across both fixed effects and random effects specifications. The magnitudes range from 0.142 for return on assets in fixed effects models to 0.301 for market-to-book ratios in random effects specifications. These results provide strong empirical support for Hypotheses 1, 2, and 3, indicating that environmental investments contribute positively to profitability, operational efficiency, and market valuation measures.

The fixed effects results, which control for unobserved time-invariant firm characteristics, reveal that a one percentage point increase in green investment intensity is associated with increases of 0.142 percentage points in return on assets, 0.267 percentage points in return on equity, 0.198 percentage points in return on sales, and 0.286 points in market-to-book ratios. These effect magnitudes are both statistically significant and economically meaningful, suggesting that environmental investments generate substantial financial benefits for Vietnamese listed enterprises.

Hausman test statistics consistently favour fixed effects specifications over random effects alternatives, with test values ranging from 23.47 to 31.78, all significant at the 1% level. These results indicate that unobserved firm characteristics are correlated with explanatory variables, validating the fixed effects approach as the preferred estimation methodology. Consequently, subsequent analysis focuses primarily on fixed effects results whilst acknowledging the consistency of findings across alternative specifications. Control variable coefficients align with theoretical expectations and prior empirical evidence. Firm size exhibits positive associations with profitability measures, consistent with scale economy advantages and resource availability benefits. Leverage demonstrates strong negative relationships with all performance measures, reflecting the costs of financial distress and reduced financial flexibility associated with higher debt levels. Firm age shows modest positive effects on profitability indicators, suggesting learning curve benefits and experience advantages. Sales growth exhibits positive associations with all performance measures, confirming the beneficial effects of market expansion and revenue growth opportunities. Asset tangibility demonstrates negative

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

relationships with performance measures, potentially reflecting lower flexibility and higher sunk costs associated with tangible asset concentration.

The R-squared values range from 0.156 to 0.237 across different specifications, indicating that the model explains a reasonable proportion of performance variation whilst acknowledging that unmeasured factors continue to influence financial outcomes. Industry and year fixed effects contribute significantly to explanatory power, highlighting the importance of controlling for sector-specific characteristics and temporal trends in performance analysis.

4.4. Robustness Checks

Comprehensive robustness analysis ensures that primary findings remain consistent across alternative specifications, methodological approaches, and sample configurations. Table 6 presents results from dynamic panel estimation using System-GMM methodology to address potential endogeneity concerns whilst accommodating dynamic adjustment processes in firm performance.

Table 6: Dynamic Panel GMM Results and Robustness Tests

	ROA (GMM)	ROE (GMM)	ROS (GMM)	MTB (GMM)
L.ROA/ROE/ROS/MTB	0.267***	0.234***	0.189***	0.156***
	(0.067)	(0.056)	(0.048)	(0.043)
GII (t-1)	0.156***	0.289***	0.213***	0.324***
	(0.048)	(0.089)	(0.067)	(0.098)
SIZE	1.089*	2.456**	1.567**	-0.189
	(0.598)	(1.234)	(0.798)	(0.487)
LEV	-7.89***	-14.23***	-8.67***	-2.89**
	(1.456)	(2.987)	(1.789)	(1.234)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
AR(1) Test	-3.47***	-3.82***	-3.61***	-3.29***
AR(2) Test	-1.23	-0.98	-1.09	-0.87
Hansen Test	47.82	52.39	49.73	51.24
(p-value)	(0.234)	(0.178)	(0.198)	(0.189)
N	5,929	5,929	5,929	5,929

The System-GMM results confirm the robustness of primary findings whilst addressing endogeneity concerns through instrumental variable approaches. Green investment intensity coefficients remain positive and statistically significant across all performance measures, with magnitudes comparable to fixed effects estimates. The lagged dependent variable coefficients indicate significant persistence in firm performance, validating the dynamic specification whilst ensuring that environmental investment effects are identified beyond performance persistence.

Diagnostic tests for GMM specification validity demonstrate appropriate instrument selection and absence of problematic serial correlation. First-order autocorrelation (AR(1)) tests produce significant negative statistics, consistent with expectations for first-differenced equations. Second-order autocorrelation (AR(2)) tests yield insignificant results, confirming that original error terms are serially uncorrelated as required for GMM validity. Hansen tests for overidentifying restrictions generate insignificant results across all specifications, indicating that instruments are valid and exogenous.

Alternative sample configurations examine the stability of findings across different time periods, industry sectors, and firm characteristics. Results from subsample analysis (not fully reported due to space constraints) demonstrate consistent positive relationships between green investment intensity and financial performance across manufacturing and non-manufacturing sectors, large and small firms, and early versus later time periods. These findings confirm that the environmental investment-performance relationship is not driven by specific sector dynamics or firm characteristics but represents a general phenomenon across Vietnam's listed enterprise population.

Temporal analysis examining different lag structures provides evidence supporting Hypothesis 4 regarding the dynamic nature of environmental investment effects. Results indicate that environmental investment benefits strengthen over time, with coefficients increasing from 0.089 (contemporaneous) to 0.142 (one-year lag) to 0.167 (two-year lag) for return on assets

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

measures. This temporal pattern suggests that environmental investments require time to generate full operational improvements and stakeholder relationship benefits, consistent with theoretical predictions and prior empirical evidence. Alternative measurement approaches for key variables confirm the consistency of primary findings. Environmental investment intensity calculated using alternative denominators (sales revenue, market capitalisation) generates comparable coefficient estimates and significance levels. Financial performance measures computed using alternative specifications (industry-adjusted returns, risk-adjusted measures) produce consistent positive associations with environmental investment intensity.

5. DISCUSSION AND CONCLUSION

5.1. Discussion of Findings

The empirical findings provide compelling evidence for positive associations between green investment intensity and corporate financial performance amongst Vietnam's listed enterprises, with important theoretical and practical implications for understanding environmental investment strategies in emerging market contexts. The consistent positive coefficients across multiple performance measures and estimation specifications demonstrate that environmental investments contribute meaningfully to corporate financial success, challenging traditional paradigms suggesting inherent trade-offs between environmental responsibility and profitability.

The magnitude of observed effects proves both statistically significant and economically meaningful, with green investment intensity coefficients ranging from 0.142 to 0.324 across different performance measures and specifications. These effect sizes suggest that firms increasing environmental investment intensity by one percentage point of total assets can expect improvements in return on assets of approximately 14-16 basis points, return on equity improvements of 27-29 basis points, and market-to-book ratio increases of 28-32 basis points. For Vietnamese listed enterprises with median total assets of 400 billion dong, these relationships imply that additional environmental investments of 4 billion dong generate annual profit increases of 560 million to 1.16 billion dong, representing substantial economic benefits that exceed typical investment hurdle rates.

The theoretical implications align with both stakeholder theory and resource-based view predictions whilst extending their applicability to emerging market contexts. Stakeholder theory explanations find support through the positive associations between environmental investments and market valuation measures, suggesting that stakeholder recognition and approval translate into improved market perceptions and reduced risk premiums. The stronger effects observed for market-based performance measures compared to accounting-based indicators indicate that capital market participants in Vietnam increasingly value environmental initiatives, potentially reflecting growing international investor attention to ESG criteria and regulatory developments promoting corporate sustainability.

Resource-based view perspectives receive support through positive associations with operational efficiency measures, including return on assets and return on sales. These relationships suggest that environmental investments contribute to capability development and operational improvements that enhance resource utilisation efficiency and cost management effectiveness. The empirical evidence indicates that Vietnamese firms successfully develop environmental capabilities that generate competitive advantages through improved operational performance, consistent with natural resource-based view predictions regarding the strategic value of environmental resources.

The temporal dynamics revealed through lag structure analysis provide important insights into the realisation of environmental investment benefits. The strengthening effects observed over multi-year periods confirm theoretical predictions that environmental investments require time to generate full operational improvements and stakeholder relationship benefits. This temporal pattern has significant implications for managerial decision-making, suggesting that firms must maintain commitment to environmental initiatives over extended periods to realise maximum financial benefits whilst recognising that immediate returns may be limited.

Industry heterogeneity analysis reveals important contextual factors that moderate environmental investment-performance relationships. Manufacturing firms demonstrate stronger positive associations compared to service sector enterprises, consistent with greater opportunities for operational efficiency improvements and pollution reduction benefits in industrial contexts. However, the presence of positive relationships across diverse industry sectors indicates that environmental investment benefits extend beyond traditional pollution-intensive industries to encompass broader corporate sustainability strategies.

The robustness of findings across alternative estimation approaches addresses important methodological concerns regarding endogeneity and reverse causality that have complicated prior research in this domain. The consistency of results across fixed effects, random effects, and dynamic panel GMM specifications provides confidence that observed relationships reflect genuine causal effects of environmental investments on financial performance rather than spurious correlations arising from unobserved heterogeneity or reverse causality.

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

Comparisons with international evidence reveal both similarities and differences that highlight the unique characteristics of Vietnam's business environment. The positive environmental investment-performance relationships observed in this study align with findings from developed economies whilst exhibiting somewhat stronger effect magnitudes. This pattern may reflect greater opportunities for efficiency improvements in emerging market contexts where environmental management systems and clean technologies represent more significant departures from existing practices compared to developed economy contexts where such initiatives may be more incremental.

5.2. Conclusion, Implications, and Limitations

The comprehensive empirical analysis provides robust evidence that green investment intensity positively influences corporate financial performance amongst Vietnam's listed enterprises, with important theoretical contributions and practical implications for multiple stakeholder groups. The research advances academic understanding of environmental investment-performance relationships in emerging market contexts whilst providing evidence-based guidance for managerial decision-making and policy formulation.

Theoretical contributions encompass extensions of stakeholder theory and resource-based view applications to emerging market contexts, demonstrating that these frameworks retain explanatory power despite different institutional environments and stakeholder configurations. The findings suggest that stakeholder expectations regarding corporate environmental responsibility exist within Vietnam's business environment and that firms responding to these expectations achieve superior financial performance through improved stakeholder relationships and reduced regulatory risks. Similarly, the evidence supports resource-based view predictions that environmental investments contribute to capability development and competitive advantage creation, even within emerging market contexts characterised by resource constraints and institutional limitations.

Methodological contributions include the application of advanced panel data techniques to address endogeneity concerns that have complicated prior research in this domain. The comprehensive diagnostic testing, sophisticated estimation approaches, and extensive robustness analysis demonstrate the importance of rigorous econometric methodology in environmental finance research whilst providing a framework for future investigations in similar contexts.

Practical implications extend to corporate managers, investors, and policymakers seeking evidence-based guidance regarding environmental investment strategies. For corporate managers, the findings demonstrate that environmental investments represent economically viable strategic choices that enhance rather than compromise financial performance. The temporal dynamics suggest that firms must maintain long-term commitment to environmental initiatives whilst recognising that benefits accumulate over multi-year periods. The positive associations across multiple performance measures indicate that environmental investments contribute to comprehensive performance improvements rather than isolated benefits.

For investors, the empirical evidence suggests that firms with intensive environmental investment strategies represent attractive investment opportunities that may generate superior risk-adjusted returns. The stronger effects observed for market valuation measures indicate that capital market participants increasingly recognise the value creation potential of corporate environmental initiatives. These findings support the integration of environmental criteria into investment decision-making processes whilst highlighting the importance of temporal perspectives in evaluating environmental investment effectiveness.

Policy implications encompass the design of regulatory frameworks and incentive structures that promote corporate environmental investments whilst ensuring economic competitiveness. The positive environmental investment-performance relationships provide economic justification for policies supporting corporate sustainability initiatives, including tax incentives, preferential financing arrangements, and regulatory frameworks that recognise environmental leadership. The findings suggest that environmental regulations need not compromise economic performance when designed to encourage innovation and efficiency improvements rather than merely imposing compliance costs.

The research acknowledges several limitations that provide opportunities for future investigation whilst circumscribing the generalisability of findings. First, the measurement of green investment intensity relies on corporate disclosure practices that may vary across firms and time periods, potentially introducing measurement error that could attenuate coefficient estimates. Future research employing standardised environmental accounting frameworks or third-party environmental performance assessments could enhance measurement precision and result reliability.

Second, the focus on listed enterprises may limit the generalisability of findings to smaller firms or private companies that face different resource constraints, stakeholder expectations, and institutional pressures. Future research examining environmental investment-performance relationships across different firm size categories and ownership structures could enhance understanding of contextual factors that moderate these relationships.

Green Investment Intensity and Corporate Financial Performance: Panel Data Evidence from Vietnam's Listed Enterprises

Third, the temporal scope concluding in 2017 may not capture recent developments in Vietnam's environmental regulatory framework or changing stakeholder expectations regarding corporate sustainability. Future research extending the analysis to more recent periods could examine whether environmental investment-performance relationships have strengthened with evolving institutional contexts and increased ESG awareness.

Fourth, the exclusive focus on financial performance measures may not capture the full range of benefits generated by environmental investments, including reputational advantages, employee satisfaction, regulatory compliance benefits, and risk reduction effects. Future research incorporating broader performance measures could provide more comprehensive assessments of environmental investment value creation.

Finally, the single-country focus, whilst providing important insights into emerging market contexts, limits the international generalisability of findings. Future research employing cross-country analysis or comparative studies across different emerging markets could enhance understanding of how institutional contexts moderate environmental investment-performance relationships.

Despite these limitations, the research provides valuable contributions to academic understanding and practical guidance regarding environmental investments in emerging market contexts. The robust empirical evidence for positive environmental investment-performance relationships challenges traditional paradigms whilst supporting the business case for corporate sustainability initiatives. The findings demonstrate that Vietnamese firms can pursue environmental responsibility and financial success simultaneously, providing a foundation for continued research and policy development in this increasingly important domain.

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