sustainability

MDPI

Article

The Impact of Energy Efficiency on Financial Performance: Evidence from Polluters in South Africa

Mziwendoda Cyprian Madwe [1,*], Zwelihle Wiseman Nzuza [2] and Odunayo Magret Olarewaju [3]

[1] Department of Accounting and Auditing, University of Zululand, Richards Bay 3900, South Africa
[2] Department of Management Accounting, Durban University of Technology, Durban 4001, South Africa; zwelihlen@dut.ac.za
[3] Department of Accounting, Metro State University, St. Paul, MN 55106, USA; drmagolar@yahoo.com
* Correspondence: madwem@unizulu.ac.za; Tel.: +27-071-840-6323

Abstract

The global fight to mitigate greenhouse gas emissions and address climate change demands that firms implement energy-saving strategies while maintaining firm financial performance. However, the impact of energy efficiency on corporate financial performance remains underexplored, especially in South Africa. This study applied a two-step system generalized method of moments (SGMM) to explore the impact of energy efficiency on the financial performance of higher polluters and emitters listed on the Johannesburg Stock Exchange (JSE) over the period from 2015 to 2023. The sample for the study was 58 companies listed on the JSE. The data was sourced from the firm's annual reports covering the period of 9 years (2015–2023). Our study reveals no significant association between energy-saving strategies and firm financial performance within high-polluting and emitting firms listed on the JSE. Notably, the study reports that leverage positively affects both firm profitability and market valuation, suggesting that debts may serve as a dynamic capability for improving firm performance if it is used strategically. Our findings underscore the importance of mandatory independent assurance of ESG reports to mitigate greenwashing risks.

Keywords: energy-saving strategies; ESG reports; financial performance; Greenhouse Gas Emission (GHG); mandatory assurance

Academic Editor: Jungho Baek

Received: 9 August 2025
Revised: 19 September 2025
Accepted: 14 October 2025
Published: 27 November 2025

Citation: Madwe, M.C.; Nzuza, Z.W.; Olarewaju, O.M. The Impact of Energy Efficiency on Financial Performance: Evidence from Polluters in South Africa. *Sustainability* **2025**, *17*, 10630. https://doi.org/10.3390/su172310630

1. Introduction

Enhancing energy efficiency is crucial for attaining sustainable development goals (SDGs) and improving firm profitability [1]. Globally, energy efficiency has received more attention from firms, governments, researchers, and policymakers as an energy-saving strategy for lowering energy intensity, reducing carbon emissions, addressing climate change problems, and promoting SDGs [2–7]. It also promotes eco-friendly practices and environmental sustainability by promoting a green economy and addressing carbon emission challenges [8–10].

The energy efficiency strategies can generate financial benefits by lowering energy costs, enhancing corporate competitiveness, improving the company's reputation, and complying with stakeholder demands for firm environmental responsibility [11–17]. However, promoting energy efficiency requires substantial investment in energy efficiency technologies, which can prevent the adoption and implementation of energy-saving technologies [18–23].

However, prior research yields mixed results on the impact of energy efficiency and energy-saving strategies on firm financial performance [24–41]. This limited empirical evidence highlights the urgent need for further exploration of this contested issue.

In South Africa, the issue of energy intensity is pressing because of high-energy consumption industries, including mining, manufacturing, and construction, which substantially contribute to both economic growth and national carbon emissions [42]. According to Samour et al. [43], high levels of energy consumption emanate from the high levels of these sectors. Therefore, JSE-listed polluters encounter increasing pressure from external forces to lower energy intensity that causes GHG, while maintaining financial viability. The empirical evidence on the benefits associated with energy efficiency is increasingly critical for introducing interventions that can drive the attainment of more energy-efficient and sustainable firm operation systems. However, there is limited empirical evidence on whether energy-saving investments produce financial returns in South African polluting companies.

Therefore, our research explores the effect of energy-saving strategies proxied by EIIR on the firm's financial performance of 58 JSE-listed high-emitting companies for the period of 2015–2023. This study adopted SGMM to present empirical evidence from South Africa to the international debate on the firm financial performance–energy efficiency relationship. Based on the above argument, indicating that energy-saving strategies can lower firm operational costs and improve corporate competitive advantage, this research theorized the following.

Hypothesis (H1). *Energy-saving strategies have a positive effect on corporate financial performance.*

The findings of this study are intended to provide empirical evidence from JSE-listed polluter firms, which have been ignored in the existing literature. Second, it also focuses on energy intensity as a sub-pillar of environmental performance, providing valuable insights on how energy efficiency interacts with corporate firm financial performance. Thus, our study will advance the existing literature on the financial impact of energy efficiency practices and inform policy and management investment decisions on decarbonization.

The research of this paper is structured as follows: Section 2 reviews the theories underpinning the study, reviews relevant literature, Section 3 details the methodology, and Section 2.5 presents key findings on the relationship between energy efficiency and firm financial performance. Section 4 discusses core insights and broader implications, and Section 5 concludes with a summary and recommendations for future research.

2. Review of Literature

2.1. Agency Theory

Agency theory elucidates the conflicts of interest between shareholders (principals) and managers (agents), and influences firm investment decisions on energy efficiency technologies [44]. Managers may implement energy-saving practices in response to external pressures, but sometimes these investments may serve as a greenwashing action, designed to placate stakeholders rather than maximize shareholder value [45–48]. Researchers who produce negative or insignificant relationships align with this view. This implies that agency-driven energy efficiency investments may increase costs without producing tangible financial benefits [49]. Conversely, a positive relationship between energy efficiency and firm financial performance emerges when managers align investment in energy-saving technologies with shareholder and stakeholder anticipation, lowering energy costs and improving firm financial performance [50,51].

2.2. Stakeholder Theory

Stakeholders posit that firms should respond and protect the needs of stakeholders [52]. This theory postulates that organizations aim to protect and to generate benefits for stakeholders [53]. Companies that address stakeholder expectations for carbon emission reduction may benefit from stakeholder trust, improved legitimacy, and improved firm financial performance [54]. However, some companies may superficially implement energy-saving strategies due to external pressures, leading to reputational gains without tangible financial benefits, while some may fail to translate stakeholder-oriented energy-saving mechanisms into financial returns [55–58]. Given the expectations and external pressure applied by stakeholders, firms are facing challenges to enhance climate change through initiatives such as energy intensity reduction while maintaining financial performance.

Therefore, this study employed this theory to assess how pressure from stakeholders impacts the relationship between energy efficiency and firm financial performance.

2.3. Institutional Theory

Institutional theory posits that firm behavior is shaped by accepted and appropriate norms in the sector [19]. This theory postulates external institutional pressure, and these pressures include regulatory, standards and policy, and stakeholder expectations [59]. According to this theory, companies operating in sectors and countries with strong regulatory frameworks are more likely to implement environmentally responsible initiatives [60]. Firms must conform to established acceptable social and environmental frameworks to meet stakeholder expectations. Engaging in environmentally responsible practices, such as energy efficiency strategies, is a license to gain legitimacy, secure resources, and ensure sustainability [61]. Non-compliance with energy-saving strategies may negatively impact firm legitimacy, leading to poor firm performance [62]. These non-compliances with environmentally responsible practices come with unbearable fines and penalties, which are relatively higher than the costs of implementing environmentally responsible practices [59,63,64]. Therefore, environmental compliance, such as the adoption of energy-saving mechanisms, may enable organizations to obtain production efficiency, thereby improving their competitive advantage in the sector.

2.4. Resource-Based Review (RBV) Theory

The resource-based review (RBV) theory states that firms attain competitive advantages through using organizational capabilities and resources, which are valuable, inimitable, unique, and rare [65]. According to this theory, energy-saving technologies are valuable resources that mitigate climate change issues, enabling firms to meet stakeholders' and societal expectations, and, consequently, positively impact firm financial performance [66]. Energy efficiency technologies are the resources that are employed to reduce production costs (energy costs), enhance production efficiency, and reflect commitment to environmentally responsible activities, thereby improving firm reputation and investor confidence [67].

This study adopted these four theories to explain the relationship between energy efficiency and firm financial performance.

2.5. Relationship Between Energy Efficiency and Firm Financial Performance

There is growing interest in ESG-firm performance research to understand how energy efficiency affects firm financial performance. Firms that adopt energy efficiency strategies may mitigate energy costs and improve operational resilience [68]. Endrikat et al. [69] argue that firms with energy efficiency strategies benefit from lower electricity costs, while those

with high energy intensity experience exorbitant energy production costs. The impact of energy efficiency on firm financial performance has been extensively studied [70].

However, prior research on relationships between energy efficiency and firm performance has yielded contradictory results [24–41]. For instance, [24–33] found that environmentally responsible practices positively impact firm performance. Similarly, ref. [28] examined the relationship between energy conservation and firm performance using 400 manufacturing firms in Thailand and reported a positive relationship. Li et al. [32] explored energy intensity and firm performance, and the findings indicated a positive relationship between energy efficiency and firm value. In the same vein, ref. [29] examined the impact of energy on the firm performance of the 400 Thai companies. Their study revealed a positive relationship. The results showed that energy efficiency significantly influences firm performance. Issa [33] investigated the association between firm financial performance and firm energy efficiency in European non-financial companies and revealed positive relationships between these variables.

Conversely, some researchers reported a negative relationship between energy-saving strategies and firm performance. For example, Chlyen et al. [34] investigated the impact of energy efficiency on the firm performance of 563 firms in 46 countries. The findings reported that energy performance has a negative impact on firm financial performance due to high initial costs. Similarly, refs. [33,35] found a negative relationship between energy efficiency and firm performance in multinational firms. Wlodarczyk et al. [36] reported that energy saving strategies reduced profits and returned assets in high-polluting firms listed on the Western Stock Exchange.

On the other hand, some researchers found no association between energy efficiency and firm financial position. For instance, Dopierala et al. [37] found no impact of the adoption of energy efficiency on firm performance in the Baltic Sea Region. Similarly, refs. [38,39] found no relationship between energy efficiency and financial performance.

In the South African context, there is limited research exploring this relationship. Dzomonda and Fatoki [40] examined the impact of environmental commitment on the financial performance of 32 JSE-listed companies, finding a positive relationship. However, ref. [41] investigated the impact of water and energy performance on financial performance measured by TQ of JSE-listed companies, and discovered a negative relationship.

The prior research produces inconsistent findings on the relationship between these two variables: those that promote a relationship (positive), those that inhibit the association (negative), and no significant relationship.

3. Research Methodology

3.1. Data Description and Data Sources

The sample of the study consists of 58 polluters and emitters listed on the JSE. These firms were included in the sample due to their high energy intensity, high levels of emitting and pollution, and significant consumption of natural resources. Table 1 illustrates the sample of the study consisting of four sectors, namely, basic material/mining, consumer goods, industrial, and the oil and gas sector. 50% of the top companies in each sector are selected and included in the sample based on market capitalisation, revenue, and profit margin [71]. Understanding the impact of investing in energy efficiency technologies on corporate performance, it may contribute to mitigating climate change, public health issues, and advance the attainment of SDGs.

Table 1. Polluters and emitters listed on the JSE.

Sector	Number of Companies Per Sector	Included in the Sample
Basic Material/Mining	45	23
Consumer Goods	20	10
Industrial	46	23
Oil and Gas Production	3	2
TOTAL	114	58

Source: [72] (https://www.listcorp.com/jse) (accessed on 10 May 2025).

The financial data was obtained from firms' annual reports covering the period of nine years (2015–2023). The study period (2013–2023) was selected because 2015 marks the adoption of the 2015 Paris agreement, which sets firm GHG reduction commitments. Secondly, ESG data for many firms included in the sample were not yet available for the 2015 to 2025 financial years in the ESG/sustainability reports. Energy efficiency data was extracted from ESG reports. The two-step system GMM was utilized to explore the impact of energy efficiency on the firm performance of JSE polluters and emitters. The system GMM is widely recognized as a powerful econometric model that addresses issues of endogeneity [73]. Two-step GMM enhances accuracy and addresses finite sample bias [74].

3.2. Variable Measurements

The research examines the impact of energy efficiency on financial performance. Following [70,75–79], return on assets (ROA), return on equity, earnings per share (EPS), and Tobin's Q (TQ) were employed as indicators of financial performance. In line with [80,81], the study employed the energy intensity improvement ratio (EIIR) to capture energy efficiency. EIIR was calculated using MSCI and LSEG rating methodology [80,81]. The energy efficiency was measured by energy used per output unit per MWh/ton. The EIIR is a year-on-year efficiency indicator that measures how much a firm has improved its energy efficiency compared to energy efficiency in the previous year. Table 2 illustrates the MSCI's sector-specific weighting method employed to calculate the EIIR score. MSCI and LSEG rating methodology breaks down environmental performance pillars into sub-pillars, namely GHG, MWIR, LRR, WUIR, and EIIR [80,81], then assigns raw weights based on the materiality of each sub-pillar within a specific sector. These raw weights are then normalized to ensure a consistent approach across different sectors.

Table 2. Environmental performance and EIIR weights.

Sector	Sub-Pillars of Environmental Performance				Normalized Attributable to Resource Use
	Resource Use	GHG	Innovation	Total Weights	
Basic Material	0.16	0.16	0.03	0.35	0.457
Industrial	0.15	0.12	0.15	0.357	0.420
Oil and Gas	0.11	0.10	0.13	0.324	0.339
Consumer Goods	0.11	0.05	0.08	0.458	0.240

3.3. Control Variables

In line with prior research, this study controls specific factors to address the issue of omitted variables [82–85]. The study controls for firm size, age, and leverage [82]. The company's size is commonly used as a control variable when investigating the relationship between environmental performance and firm performance [83]. Prior research indicates that larger companies are more likely to engage in environmentally responsible activities because they have more resources and stakeholder pressure [84]. The age of a company is widely adopted as a measure of experience and maturity. Highly leveraged companies may be reluctant to invest in environmentally responsible practices due to limited financial resources. Table 3 indicates financial performance indicators employed in this study.

Table 3. Variable Measurements.

Variable	Description	Formula	Source
Dependent Variable	ROA	$\text{ROA} = \frac{Net\ Income}{Total\ Assets}$	[70,75]
	ROE	$\text{ROE} = \frac{Net\ Income}{Shareholder's\ Equity}$	[76,77]
	EPS	$\text{EPS} = \frac{Net\ Income - Pref\ Div}{Weighted\ Ave\ No\ of\ share}$	[78,79]
	TQ	$\text{TQ} = \frac{Market\ Value\ for\ the\ firm}{Replacement\ cost\ of\ assets}$	
Independent Variable	EIIR	$\text{EIIR} = \frac{EIIR_{t-1} - EIIR_t}{EIIR_{t-1}}$	[80,81]
	Sectoral Normalization	$\chi_i, \text{EIIR} = \frac{EIIR_{i,t} - min_{Jep\ (s)}\ GHG_{j,t}}{max_{j\epsilon P\ (s)}\ EIIR_{j,t} - min_{j\epsilon P}\ GHG_{j,t}}, \chi_i, \text{GHG}$	[80,81]
	Weight Assignment and Aggregation	$\varpi_{EIIR} = \frac{\varpi_{EIIR}}{\varpi_{GHG} + \varpi_{Innov+}\ \varpi_{Res}}$ $\frac{0.16}{0.16 + 0.03 + 0.16} = 0.4571$	[80,81]
Control Variables	Lev	$\text{Lev} = \frac{Total\ Debt}{Total\ Equity}$	[82–85]
	Firm Size	In (Number of employees)	[82–85]
	Firm Age	Current year-founding year	[82–85]

3.4. Data Analysis

The study analyzed the association between energy efficiency and firm financial performance utilizing STATA software, version 18. The descriptive analysis was first employed to determine the trend and pattern of energy efficiency and financial performance in integrated or annual reports of 58 firms listed on the JSE. The two-step system GMM was adopted to empirically examine the relationship between energy efficiency and firm financial performance. The SGMM model estimated in this research is specified as follows:

Short model:

$$FS_{it} = \alpha_0 + FS_{it-1} + EE_{it} + \varepsilon_{it} \quad (1)$$

Full model:

$$FS_{it} = \alpha_0 + \alpha_1 \cdot FS_{it-1} + \beta_1 \cdot EIIR_{it} + \beta_2 \cdot CONTROL_{it} + \varepsilon_{it} \quad (2)$$

Model *ROA*, *ROE*, *EPS*, and *TQ*:

$$ROA_{it} = \alpha_0 + \alpha_1 \cdot ROA_{it-1} + \beta_1 \cdot EIIR_{it} + \beta_2 \cdot SIZE_{it} + \beta_3 \cdot AGE_{it} + \beta_4 \cdot LEV_{it} + \varepsilon_{it} \quad (3)$$

$$ROE_{it} = \alpha_0 + \alpha_1 \cdot ROE_{it-1} + \beta_1 \cdot EIIR_{it} + \beta_2 \cdot SIZE_{it} + \beta_3 \cdot AGE_{it} + \beta_4 \cdot LEV_{it} + \varepsilon_{it} \quad (4)$$

$$EPS_{it} = \alpha_0 + \alpha_1 \cdot EPS_{it-1} + \beta_1 \cdot EIIR_{it} + \beta_2 \cdot SIZE_{it} + \beta_3 \cdot AGE_{it} + \beta_4 \cdot LEV_{it} + \varepsilon_{it} \quad (5)$$

$$TQ_{it} = \alpha_0 + \alpha_1 \cdot TQ_{it-1} + \beta_1 \cdot EIIR_{it} + \beta_2 \cdot SIZE_{it} + \beta_3 \cdot AGE_{it} + \beta_4 \cdot LEV_{it} + \varepsilon_{it} \quad (6)$$

where FS_{it}: financial performance (ROA, ROE, EPS, and TQ); α_0: coefficient for the lagged variable; β_1–β_5: coefficients for EIIR; ε_{it}: error term controlling for other variables not included in the financial performance models.

4. Results and Discussion

4.1. Descriptive Statistics

Table 4 depicts the descriptive statistics from a dataset of 522 firm-year observations (9 × 58). Table 4 indicates that firms included in the sample reduce energy consumption by 3% per year. The findings reveal that companies in the high-polluting sectors are engaging in energy-saving practices. It is observed that the sample yields 9.1% of profit

from invested assets. Table 4 shows that the sample included both strong performers and underperforming firms.

Table 4. Descriptive analysis.

Variable	Mean	Std. Dev	Min	Max
ROE	1.691	19.278	−27,402	416.195
ROA	0.081	0.347	−1.136	7.397
EPS	5.780	13.994	−69.91	147.45
	122,202	326,961	−4.399	4738.10
TQ	0.033	0.094	−0.893	0.403

4.2. Energy Efficiency on Firm Performance Using a Two-Step System GMM

Table 5 presents the two-step system GMM results from four financial performance models. A two-step system GMM was employed to explore the relationship between energy efficiency and the firm's financial performance of 58 polluters and emitters listed on the JSE. The findings in all models indicate that there is no association between firm financial performance, measured by ROA, ROE, EPS, and TQ, and energy efficiency. This indicates that the adoption of an energy efficiency mechanism may not be immediate and might take time for firms to generate tangible benefits (profitability or market valuation benefits) in the study period. These findings reinforce the argument that although environmentally responsible practices are important for long-term sustainability, they may not generate short-term financial benefits, especially in resource-intensive industries. These results challenge previous findings by [51–57], who reported a positive relationship between energy efficiency and firm financial performance. This study is consistent with prior results [24–27], which reported no relationship between energy efficiency and firm financial performance. The study's findings question RBV theory and suggest that energy efficiency is an ordinary capability with a high probability of imitation and may not be a dynamic and unique asset that creates competitive advantage, since it is extensively adopted and now easily imitable, limiting its power to generate higher profits. Agency theory explains these results as where agents may be implementing environmentally responsible practices to conform with regulatory frameworks rather than maximizing principal interests. From stakeholder theory, these results indicate that stakeholder loyalty in the sample may take time to impact firm financial performance. According to institutional theory, these results may suggest that the sample is engaging in greenwashing strategies that may be more about compliance rather than incorporating these environmentally responsible practices into core strategies and objectives of the firms. As a result, the proposed hypothesis H1 is rejected in all models.

Regarding control variables included in model A, all control variables have an insignificant impact on firm financial performance. This indicates that factors such as external pressures, regulatory framework, and tax incentives may matter more than control variables included in model A. Leverage exhibits a positive relationship with ROA and TQ, consistent with the notion that firms with higher debt utilize their assets to fund energy efficiency practices to enhance productivity. Table 4 indicates that larger companies perform better than smaller firms in terms of market valuation. This indicates that larger firms may have access to valuable resources that offset complexity and inefficiencies.

Table 4 highlights that energy efficiency in the sample is shaped and explained more by external pressures such as legitimacy and compliance than by tangible financial benefits. It is also observed that firm size and age may not fully influence both environmental performance and financial performance.

Table 5. Two-Step System GMM.

Variable	ROE Model A	ROA Model B	EPS Model C	TQ Model D
FP (t − 1)	0.076 (1.40)	−0.028 (−1.21)	0.263 (1.13)	0.202 * (1.72)
EIIR	0.078 (0.02)	0.004 (0.04)	2.751 (0.96)	−25.18 (−0.36)
AGE	−0.001 (0.04)	0.000 (0.64)	0.006 (0.81)	0.051 (0.46)
LEV	0.000 (0.11)	0.001 (7.68) ***	−0.000 (−0.31)	0.285 *** (6.89)
SIZE	−0.932 (0.90)	0.005 (0.03)	−1.075 (−0.91)	−40,753 *** (−2.16)
Constant	11.520 (1.03)	0.161 (0.84)	14.951 (1.10)	491,031 ** (2.25)
Observations	522	522	522	522
AR (1)	0.309	0.478	0.224	0.305
AR (2)	0.342	0.723	0.633	0.573
Hansen Test	0.032	0.115	0.269	0.616

Z-statistics in parentheses, * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

This paper applied the Hansen test to test for overidentifying restrictions. This test was employed to determine whether the instruments applied in the models are valid. The instruments are valid if *p*-values are greater than 0.05. All models (ROA, EPS, and TQ) have *p*-values greater than 0.05, except ROE. Therefore, the study instruments applied in three models are valid and uncorrelated with the error term.

The Arellano–Bond test indicates that all *p*-values of the first-order serial correlation are all greater than 0.05, indicating that models may not adequately capture the expected AR (1), but this does not automatically invalidate models. The second-order serial correlation *p*-values are all above 0.05, suggesting a good sign as the key requirement for the validity of the instruments in GMM estimation [86,87].

The present study applied a two-step system GMM to explore the impact of energy efficiency on the firm financial performance of 58 polluters and emitters listed on the JSE. The firm's financial performance was measured using both accounting-based indicators (ROA, ROE, and EPS) and market-based indicators (TQ), and a proxy of energy efficiency was EIIR. This paper reported no relationship between energy efficiency and firm financial performance among 58 JSE-listed polluters and emitters. This insignificant statistical relationship could be attributed to costs associated with environmental protection practices and environmental compliance associated with environmentally sustainable practices. Our findings are consistent with [36–38], who found that corporate environmental performance does not produce financial benefits in the short term. Our results suggest that firm reluctance to engage in environmental abatement initiatives may be due to short-term financial targets that guide environmental protection investment decision making. This study challenges the view that it pays to be green, suggesting that energy efficiency strategies may be costly in both the short and long term.

5. Conclusions and Recommendations

This study examines the impact of energy efficiency on firm financial performance of 58 polluters and emitters listed on the JSE in South Africa over a period of nine years (2015–2023). The study applied a two-step system GMM to explore the relationship between energy efficiency and firm financial performance. The study reveals no relationship between energy efficiency and firm financial performance in the sample. The study found that energy-saving strategies are often framed as valuable, rare, and inimitable, and are insufficient for ensuring better financial performance, even if it is widely adopted and easily imitable in the sectors, since they lose their power to derive a competitive advantage.

We advance the existing knowledge by exploring a mainly ignored association between energy efficiency and firm financial performance, especially in high-pollution and high-carbon emission sectors listed on the JSE in South Africa. Prior research in the South African

setting has focused on overall environmental performance, neglecting disaggregated sub-pillars such as energy efficiency. This study extends the body of knowledge by uncovering that an environmentally responsible initiative that is extensively implemented becomes an ordinary capability with a high probability of imitation and may not fully explain firm performance. In advancing agency theory, this study found information asymmetry as a major barrier in the integration of environmentally responsible initiatives in key operational activities. The results suggest that managers may prioritize environmentally responsible practices at the expense of shareholders to gain legitimacy, firm reputation, and avoid public scrutiny. The study underscores an urgent need for mandatory assurance of ESG performance reports to mitigate greenwashing strategies.

For practical contribution, our findings have important implications for managers, policymakers, and stakeholders in South Africa. For managers, the lack of tangible financial gains from investing in environmentally responsible practices highlights the necessity to implement these practices into key firm operational strategies. Managers should not treat environmentally responsible practices as only marketing and compliance practices. Our findings urge investors to critically assess ESG reports in situations where independent assurance is not compulsory. For policymakers, the insignificant association encourages the need for stronger regulation, including mandatory ESG assurance to ensure that disclosure performance represents true environmental performance.

While our study provides a valuable contribution, it is subject to some limitations. The study focuses only on polluters and emitters listed on the JSE; this may limit generalizability to other sectors. The reported ESG data employed in this study relied on self-reported annual reports without mandatory independent assurance, which may trigger biased reporting or greenwashing strategies. The study employed secondary data, which failed to capture the experiences and opinions of managers regarding factors hindering this relationship.

Future researchers could address these gaps by considering a broader range of sectors to analyze the impact of energy efficiency on firm performance. Future studies could expand our study by using a mixed method with qualitative and quantitative methods to offer valuable insights on whether and how energy efficiency affects firm performance. Furthermore, studies could extend this research by comparing South Africa's context with other developing countries encountering the same energy poverty to comprehensively understand how institutional, regional, and market conditions explain the ESG–firm performance nexus.

Author Contributions: Conceptualization, M.C.M. and Z.W.N.; methodology, O.M.O.; software, Z.W.N.; validation, O.M.O., M.C.M. and Z.W.N.; formal analysis, Z.W.N.; investigation, M.C.M.; resources, M.C.M.; data curation, Z.W.N.; writing—original draft preparation, M.C.M.; writing—review and editing, Z.W.N. and O.M.O.; visualization, M.C.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are available from the corresponding author upon request.

Acknowledgments: We sincerely thank the editor and anonymous reviewers for their time, effort, and insightful feedback, which significantly improved the clarity and rigor of this work.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Chien, F.S. The mediating role of energy efficiency on the relationship between sharing economy benefits and sustainable development goals (Case of China). *J. Innov. Knowl.* **2022**, *7*, 100270. [CrossRef]
2. Adom, P.K.; Agradi, M.; Vezzulli, A. Energy efficiency-economic growth nexus: What is the role of income inequality? *J. Clean. Prod.* **2021**, *310*, 127382. [CrossRef]
3. Akram, R.; Chen, F.; Khalid, F.; Irfan, M. Heterogeneous effects of energy efficiency and renewable energy on economic growth of BRICS countries: A fixed effect panel quantile regression analysis. *Energy* **2021**, *215*, 119019. [CrossRef]
4. Sarpong, F.A.; Wang, J.; Cobbinah, B.B.; Makwetta, J.J.; Chen, J. The drivers of energy improvement among nine selected West African Countries: A two-stage DEA method. *Energy Strat. Rev.* **2022**, *43*, 100910. [CrossRef]
5. Pavel, T.; Polina, S.; Liubov, N. The research of the impact of energy efficiency on mitigating greenhouse gas emissions at the national level. *Energy Convers. Manag.* **2024**, *314*, 118671. [CrossRef]
6. Dunlop, T. Energy efficiency: The evolution of a motherhood concept. *Soc. Stud. Sci.* **2022**, *52*, 710–732. [CrossRef]
7. Chen, W.; Alharthi, M.; Zhang, J.; Khan, I. The need for energy efficiency and economic prosperity in a sustainable environment. *Gondwana Res.* **2024**, *127*, 22–35. [CrossRef]
8. Herman, R.; Nistor, C.; Jula, N.M. The influence of the increase in energy prices on the profitability of companies in the European Union. *Sustainability* **2023**, *15*, 1504. [CrossRef]
9. Naseer, M.M.; Hunjra, A.I.; Palma, A. Sustainable development goals and environmental performance: Exploring the contribution of governance, energy, and growth. *Res. Int. Bus. Financ.* **2025**, *73*, 102646. [CrossRef]
10. Jinapor, J.A.; Suleman, S.; Cromwell, R.S. Energy consumption and environmental quality in Africa: Does energy efficiency make any difference? *Sustainability* **2023**, *15*, 2375. [CrossRef]
11. Garcia-Quevedo, J.; Jove-Llopis, E. Environmental policies and energy efficiency investments. An industry-level analysis. *Energy Policy* **2021**, *156*, 112461. [CrossRef]
12. Osorio-Aravena, J.C.; Aghahosseini, A.; Bogdanov, D.; Caldera, U.; Ghorbani, N.; Mensah, T.N.; Khalili, S.; Muñoz-Cerón, E.; Breyer, C. The impact of renewable energy and sector coupling on the pathway towards a sustainable energy system in Chile. *Renew. Sustain. Energy Rev.* **2021**, *151*, 111557. [CrossRef]
13. Dong, F.; Li, Y.; Goa, Y.; Zhu, J.; Qin, C.; Zhang, X. Energy transition and carbon neutrality: Exploring the non-linear impact of renewable energy development on carbon emission efficiency in developed countries. *Resour. Conserv. Recycl.* **2022**, *177*, 106002. [CrossRef]
14. Lv, Y. Transitioning to sustainable energy: Opportunities, challenges, and the potential of blockchain technology. *Front. Energy Res.* **2023**, *11*, 1258044. [CrossRef]
15. Wang, H.; Ghasemi, M.; Ghadiri Nejad, M.; Khandan, A. Assessing the potential growth of Iran's hospitals with regard to the sustainable management medical tourism. *Health Soc. Care Commun.* **2023**, *2023*, 8734482. [CrossRef]
16. Tirkolaee, E.B.; Goli, A.; Mirjalili, S. Circular economy application in designing sustainable medical waste management systems. *Environ. Sci. Pollut. Res.* **2022**, *29*, 79667–79668. [CrossRef] [PubMed]
17. Dalla Valle, N.; Bertoldi, P. Promoting energy efficiency: Barriers, societal needs and policies. *Front. Energy Res.* **2021**, *9*, 804091. [CrossRef]
18. Gennitsaris, S.; Oliveira, M.C.; Vris, G.; Bafilios, A.; Ntinou, T.; Frutuoso, A.R.; Queiroga, C.; Giannatsis, J.; Sofianopoulou, S.; Dedoussis, V. Energy efficiency management in small and medium-sized enterprises: Current situation, case studies and best practices. *Sustainability* **2023**, *15*, 3727. [CrossRef]
19. Villanthenkodath, M.A.; Pal, S. Empowering tomorrow: Unleashing the role of technology driven energy efficiency for sustainable development in China. *J. Econ. Technol.* **2024**, *2*, 155–165. [CrossRef]
20. Bergmann, A.; Rotzek, J.N.; Wetzel, M.; Gunther, E. Hang the low-hanging fruit even lower-Evidence that energy efficiency matter for corporate financial performance. *J. Clean. Prod.* **2017**, *147*, 66–74. [CrossRef]
21. Abbisa, L.T. Power outages, economic cost, and firm performance: Evidence from Ethiopia. *Util. Pole* **2018**, *53*, 111–120.
22. Mintalbano, P.; Nenci, P. Energy efficiency, productivity and exporting: Firm-level evidence in Latin America. *Energy Econ.* **2019**, *79*, 97–110. [CrossRef]
23. Madwe, M.; Nzuza, Z.; Olarewaju, O. How does corporate environmental responsibility (CER) contribute to corporate financial performance (CFP)? *Int. J. Appl. Res. Bus. Manag.* **2025**, *6*, 2700–8983. [CrossRef]
24. Caragliu, A. Energy efficiency-enhancing policies and firm performance: Evidence from the paper and glass industries in Italy. *Energy Policy* **2021**, *156*, 112415. [CrossRef]
25. Dybowski, M. Evaluation of Energy Efficiency Impact on Corporate Financial Performance in Western Europe. Master's Dissertation, Utrecht University, Utrcht, The Nethelands, 2023. Available online: https://studenttheses.uu.nl/bitstream/handle/20.500.12932/45002/Dybowski%2C%20M._9105395.pdf?sequence=1&isAllowed=y (accessed on 30 July 2025).
26. Moon, H.; Min, D. A DEA approach for evaluating the relationship between energy efficiency and financial performance for energy-intensive firm in Korea. *J. Clean. Prod.* **2020**, *255*, 120283. [CrossRef]

27. Lakkanawanit, P.; Dungtripop, W.; Suttipun, M.; Madi, H. Energy conservation and firm performance in Thailand: Comparison between energy efficiency-intensive and non-energy-intensive industries. *Energy* **2022**, *15*, 7532. [CrossRef]
28. Suttipun, M.; Duriyarattaka, S. The influence of energy management on Thai Manufacturing firm performance. *Manag. Res. Pract.* **2019**, *11*, 52–61.
29. Lin, W.L.; Cheah, J.H.; Azali, M.; Ho, J.A.; Yip, N. Does firm size matter? Evidence on the impact of green innovation strategy on corporate financial performance in the automative sector. *J. Clean. Prod.* **2019**, *229*, 974–988. [CrossRef]
30. Fan, L.T.; Pan, S.; Li, G.; Zhou, P. Does energy efficiency affect financial performance? Evidence from Chinese energy-intensive firms. *J. Clean. Prod.* **2017**, *151*, 53–59. [CrossRef]
31. Li, S.; Ngniatedema, T.; Chen, F. Understanding the impact of green initiatives and green performance on financial performance in the US. *Bus. Strategy Environ.* **2017**, *26*, 776–790. [CrossRef]
32. Issa, A.; Hanayska, R. Powering profits: How renewable energy boosts financial performance in European non-financial companies. *Int. J. Account. Inf. Manag.* **2023**, *31*, 600–622. [CrossRef]
33. Ruggiero, S.; Lehkonene, H. Renewable energy growth and the financial performance of electric utilities: A panel data study. *J. Clean. Prod.* **2017**, *142*, 3676–3688. [CrossRef]
34. Chlyeh, D.; Bayraktar, E.; Yilmaz, M.K.; Tatoglu, E.; ve Zaim, S. Sustainability to financial realities: A comparative study of renewable energy's impact on financial performance. In Proceedings of the PILMET 2024—2024 Portland International Conference on Management of Engineering and Technology: Technology Management in the Artificial Intelligence Era, Proceedings içinde (1–11 ss.), Portland, OR, USA, 4–8 August 2024; Institute of Electrical and Electronics Engineers: Portland, OR, USA, 2024.
35. Arslan, F.T.; Islamoglu, M. The impact of tendency towards renewable energy sources on company profitability. *Finans. Ekon. Sos. Araştırmalar Derg.* **2025**, *10*, 293–308. [CrossRef]
36. Wlodarczyk, A.; Szczepanska-Woszczyna, K.; Urbanski, M. Carbon and financial performance nexus of the heavily polluting companies in the context of resource management during COVID-10 period. *Resour. Policy* **2024**, *89*, 104514. [CrossRef]
37. Dopierala, L.; Mosionek-Schweda, M.; Laskowicz, T.; Ilczul, D. Financial performance of renewable energy producers: A panel data from the Baltic Sea Region. *Energy Rep.* **2022**, *8*, 11492–11503. [CrossRef]
38. Marti-Ballester, C.P. Sustainable energy systems and company performance: Does the implementation of sustainable energy improves company's financial performance? *J. Clean. Prod.* **2017**, *162*, S35–S50. [CrossRef]
39. Hulshof, D.; Mulder, M. The impact of renewable energy use on firm profit. *Energy Econ.* **2020**, *92*, 104957. [CrossRef]
40. Dzomonda, O.; Fatoki, O. Environmental sustainability commitment and financial performance of firms listed on the Johannesburg Stock Exchange (JSE). *Int. J. Environ. Res. Public Health* **2020**, *17*, 7504. [CrossRef] [PubMed]
41. Ganda, F.; Olarewaju, O. The impact of water and energy performance on waste performance in South African JSE-listed companies. *Int. J. Energy Res.* **2025**, *2025*, 9642568. [CrossRef]
42. Matenda, F.R.; Raihan, A.; Sibanda, M. Influence of economic growth, fossil and renewable energy, technological, innovation, and globalisation on carbon dioxide emission in South Africa. *Carb. Res.* **2024**, *3*, 69. [CrossRef]
43. Samour, A.; Moyo, D.; Tursoy, T. Renewable energy, banking sector development, and carbon dioxide emission nexus: A path toward sustainable development in South Africa. *Renew. Energy* **2022**, *193*, 1032–1040. [CrossRef]
44. Yang, Y.; Gao, S.; Huang, H.Z. Sustainability agency theory: A new agency framework for social enterprises. *Sustainability* **2025**, *17*, 4778. [CrossRef]
45. Al-Faryan, M.A. Agency theory, corporate governance and corruption: An integrative literature review approach. *Cogent Soc. Sci.* **2020**, *10*, 2337893. [CrossRef]
46. Ongsakul, V.; Chatjuthamard, P.; Chintrakam, P.; Jiraporn, P.; Lee, S.M. Climate change, managerial ownership, and agency conflicts: Insights form the Paris Agreement. *J. Sustain. Financ. Invest.* **2025**, *15*, 2479554. [CrossRef]
47. Fan, Y.; Wang, R.; Alkaraan, F.; Wu, W. Decoding greenwashing practices toward sustainability: The synergistic influence of governance structure and policy-derive rhetorical strategies. *Energy Econom.* **2025**, *148*, 108632. [CrossRef]
48. Purnamasari, P.; Umiyati, I. Greenwashing and financial performance of firms: The moderating role of internal audit quality and digital technologies. *Cogent Bus. Manag.* **2024**, *11*, 2404236. [CrossRef]
49. Liu, Z.; Zheng, H.; Gu, J.; Xu, S.; Ye, Y. Exploring the nexus between green finance and energy efficiency. *Heliyon* **2024**, *10*, e30141. [CrossRef]
50. Zhang, Q.; Ma, Y. The impact of environmental management on firm performance: The mediating effects of green innovation and the moderating effects of environmental leadership. *J. Clean. Prod.* **2021**, *292*, 126057. [CrossRef]
51. Salahuddin, M.; Gow, J.; Ali, M.I.; Hossain, M.R.; Al-Azami, K.S.; Akbar, D.; Gedikli, A. Urbanization-globalization-CO_2 emission nexus revisited: Empirical evidence from South Africa. *Heliyon* **2019**, *5*, e01974. [CrossRef]
52. Zhou, D.; Saeed, U.F.; Agyemang, A.O. Assessing the role of sustainable disclosure on firms; financial performance: Evidence from the energy sector of Belt and Road initiatives countries. *Sustainability* **2024**, *16*, 930. [CrossRef]
53. Awa, H.O.; Etim, W.; Ogbonda, E. Stakeholders, stakeholder theory and corporate social responsibility (CSR). *Int. J. Corp. Soc. Responsib.* **2024**, *9*, 11. [CrossRef]

54. Donkor, A.; Appiagyei, K.; Korankye, G. Carbon emission and firm value: Does firms' commitment to sustainable development goals matter? *Account. Res. J.* **2025**, *38*, 141–160. [CrossRef]
55. Alnaim, M.; Metwally, B.M. Institutional pressures and environmental management accounting adoption: Do environmental strategy matter? *Sustainability* **2024**, *16*, 3020. [CrossRef]
56. Zhang, Q.; Zhu, X.; Lee, M. Exploring institutional pressures, green innovation, and sustainable performance: Examining the mediated moderation role of entrepreneurial orientation. *Sustainability* **2024**, *16*, 2058. [CrossRef]
57. Mahajan, R.; Lim, W.M.; Sareen, M.; Kumar, S. Stakeholder theory. *J. Bus. Res.* **2023**, *166*, 114104. [CrossRef]
58. Seroka-Stolka, O. Enhancing environmental sustainability: Stakeholder pressure and corporate CO_2-related performance—An examination of the mediating and moderating effects of corporate decarbonisation strategies. *Sustainability* **2023**, *15*, 14257. [CrossRef]
59. Handoyo, S.; Anas, S. The effect of environmental, social, and governance (ESG) on firm performance: The moderating role of country regulatory quality and governance effectiveness in ASEAN. *Cogent Bus. Manag.* **2024**, *11*, 2371071. [CrossRef]
60. Cho, Y. ESG and firm performance: Focusing on the environmental strategy. *Sustainability* **2022**, *14*, 7857. [CrossRef]
61. Schaltegger, S.; Horisch, J.; Freeman, R. Business cases for sustainability: A stakeholder theory perspective. *Organ. Environ.* **2019**, *32*, 191–212. [CrossRef]
62. Baah, C.; Opoku-Agyeman, D.; Acquah, I.S.K.; Agyabeng-Mensah, Y.; Afum, E.; Faibil, D.; Abdoulaye, F.A.M. Examining the correlation between stakeholder pressures, green production practices, firm reputation, environmental and financial performance: Evidence from manufacturing SMEs. *Sustain. Prod. Consum.* **2021**, *27*, 100–114. [CrossRef]
63. Eitrem, A.; Meidell, A.; Modell, S. The use of institutional theory in social and environmental accounting research: A critical review. *Account. Bus. Res.* **2024**, *54*, 775–810. [CrossRef]
64. Singhania, M.; Saini, N. Quantification of ESG regulations: A cross-country benchmarking analysis. *Vis. J. Bus. Perspect.* **2022**, *26*, 163–171. [CrossRef]
65. D'Oria, L.; Crook, R.R.; Ketchen, D.J.; Sirmon, D.G.; Wright, M. The evolution of resource-based inquiry: A review and meta-analytic integration of the strategic resources-actions-performance pathway. *J. Manag.* **2021**, *47*, 1383–1429. [CrossRef]
66. Islam, T.; Arunachalum, M.; Wellalage, N.; Benjamin, S. Corporate environmental performance leading financial performance: Impacts of social media sentiment and corporate reputation. *Bus. Strategy Environ.* **2025**, *34*, 4274–4290. [CrossRef]
67. Sun, Y.; Rahman, M.; Xinyan, X.; Siddik, A.B.; Islam, M.E. Unlocking environmental, social, and governance (ESG) performance through energy efficiency and green tax: SEM-ANN approach. *Energy Strategy Rev.* **2024**, *53*, 101408. [CrossRef]
68. Stojceska, V.; Parker, N.; Tassou, S.A. Reducing GHG emissions and improving cost effectiveness via energy efficiency enhancement: A case study in a biscuit industry. *Sustainability* **2022**, *14*, 69. [CrossRef]
69. Endrikat, J.; Guenther, E.; Hoppe, H. Making sense of conflicting empirical findings: A meta-analytic review of the relationship between corporate environmental and financial performance. *Eur. Manag. J.* **2014**, *32*, 735–751. [CrossRef]
70. Al Mahi, M. Gaining more from energy efficiency: The role of firms' environmental concerns. *J. Environ. Manag.* **2025**, *373*, 123918. [CrossRef] [PubMed]
71. Buitendag, N.; Fortuin, G.S.; de Laan, A. Firm characteristics and excellence in integrated reporting. *S. Afr. J. Econ. Manag. Sci.* **2017**, *20*, 8. [CrossRef]
72. Listcorp. A List of the 267 Listed Companies on the Johannesburg Stock Exchange (JSE), with Market Cap, Share Price, Sector Information. Available online: https://www.listcorp.com/jse (accessed on 1 June 2025).
73. Tubik, D.; Herberger, T.A. How endogeneity problems are addressed in analysing the relationship between diversity in top management teams and company financial performance—A systematic literature review. *Manag. Rev. Q.* **2024**. [CrossRef]
74. Nacken, T.; Karreman, B.; Pennings, E. Addressing endogeneity in the relationship between early entry and performance: The case of foreign market expansion. *Long Range Plan.* **2024**, *57*, 102478. [CrossRef]
75. Simionescu, L.N.; Gherghina, S.C.; Sheikha, Z.; Tawil, H. Does water, waste, and energy consumption influence firm performance? Panel data evidence from S&P 500 information technology sector. *Int. J. Environ. Res. Public Health* **2020**, *17*, 5206. [CrossRef]
76. Aydogmus, M.; Gulay, G.; Ergun, K. Impact of ESG performance on firm value and profitability. *Borsa Istanb. Rev.* **2022**, *22*, S119–S127. [CrossRef]
77. Setyaningsih, W.; Wibowo, R.S. Does earnings per share contribute to the effect of ESG score on share price of mining sector? *Adv. Account. Innov.* **2024**, *1*, 39–51.
78. Chininga, E.; Alhassan, A.L.; Zeka, B. ESG ratings and corporate financial performance in South Africa. *J. Account. Emerg. Econ.* **2023**, *14*, 692–713. [CrossRef]
79. Wu, S.; Du, X.; Li, Z. The impact of ESG performance on firm value: The moderating role of ownership structure. *Sustainability* **2022**, *14*, 15507. [CrossRef]
80. MSCI ESG Research LLC. MSCI ESG Ratings Methodology 2024. MSCI Inc. Available online: https://www.msci.com/esg-and-climate-methodologies (accessed on 5 September 2025).

81. LSEG DATA & ANALYSTICS. Environmental. Social and Governance Scores from LSEG 2024. Available online: https://www.lseg.com/content/dam/data-analytics/en_us/documents/methodology/lseg-esg-scores-methodology.pdf (accessed on 1 June 2025).
82. Fu, T.; Li, J. An empirical analysis of the impact of ESG on financial performance: The moderating role of digital transformation. *Front. Environ. Sci.* **2023**, *11*, 1256052. [CrossRef]
83. Ahmad, N.; Mobarek, A.; Roni, N.N. Revisiting the impact of ESG on financial performance of FTS350 UK firms: Static and dynamic data analysis. *Cogent Bus. Manag.* **2021**, *8*, 1900500. [CrossRef]
84. Masongweni, V.; Simo-Kengne, B.D. The impact of sustainable investment on firm performance in South Africa. *S. Afr. J. Account. Res.* **2024**, *38*, 2306701. [CrossRef]
85. Li, Q.; Tang, W.; Li, Z. ESG systems and financial performance in industries with significant impact: A comprehensive analysis. *Front. Sustain.* **2024**, *5*, 1454822. [CrossRef]
86. Basturk, M.F. Does green finance reduce carbon emissions? Global evidence based on system generalised method of moments. *Sustainability* **2024**, *16*, 8210. [CrossRef]
87. Lundell, R.; Bond, S.; Windmeijer, F. Estimation in dynamic panel data models: Improving on the performance of the standard GMM estimator. In *Nonstationary Panels, Panel Cointegration, and Dynamic Panel*; Emerald Publishing Limited: Leeds, UK, 2001; pp. 53–91.