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CARBON REPORTING AND RETURN ON INVESTMENT OF LISTED MANUFACTURING COMPANIES IN NIGERIA

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Abstract

This study examined the effect of carbon reporting specifically energy consumption disclosure and waste management disclosure on the return on investments of listed manufacturing companies in Nigeria. The study adopted the ex post facto research design and using a census sampling technique, the forty-three (43) companies listed on the Nigerian exchange group was used for this study. Using a robust regression analysis with the aid of STATA to test the relationship between the variables, results revealed that waste management disclosure was positively and significantly associated with ROI, while energy consumption disclosure showed a statistically significant negative relationship with ROI. The study therefore concludes that firms that invest in transparent waste handling processes are more likely to attract eco-friendly investors. The study recommends that corporate managers and board directors should integrate structured waste management reporting into their broader sustainability strategies, recognizing its positive impact on firm value and investment attractiveness.

Key words: Carbon reporting, waste management, energy consumption and return on investment.

Introduction

1.1 Background to the study

Recent calls for attention and focus on climate change have been made across the globe, and this has given rise to calls for an obligatory report on greenhouse gas emissions, which is the basic tenet of carbon reporting, and this is an environmental responsibility that will position companies for evaluation on environmental impact while generating useful returns from investments. In a developing economy like Nigeria, where manufacturing companies are operational on a large scale, it is expedient for them to embrace carbon reporting to boost business value alongside reducing environmental footprints in line with global best practices.

Carbon reporting basically seeks to present a precise estimate and disclosure of greenhouse gas emissions across operations, as this is a practice that will help not only to foster business strategies but also enable companies to maximize efficiency and optimize performance. These will ultimately yield substantial savings in energy use and materials, while ensuring adherence to environmental regulations (Luo & Tang, 2014) Moreover, transparent carbon reporting reinforces a company's brand image or perception, leading eco-

friendly investors to become interested in partnering with them and being open to green financing (Eccles et al. 2014). By aligning carbon reduction strategies with financial performance metrics, organizations can demonstrate strong return on investment (ROI) through both short-term operational gains and long-term market resilience.

During the 2015 United Nations Climate Change Conference (COP21), the Paris Agreement was established as a historic international treaty. Its key objective is to curb global warming to below 2°C (3.6°F) compared to pre-industrial levels, with an aspirational target of limiting the rise to 1.5°C (2.7°F). Through this agreement, countries globally are obligated to comply, with over 40 nations now legally requiring greenhouse gas emissions reporting (United Nations, 2015). The Paris agreement became enforceable on 4th November 2016, and it has so far garnered up to 195 parties as this is a legally binding international treaty. The demands of this agreement are hinged on commitments by all countries involved to reduce their emissions and work together collaboratively to adapt to the impacts of climate change, also strengthening each other's commitments over time from periodic reviews.

Nigeria is a signatory to the Paris Agreement, having ratified it in 2017, demonstrating its commitment to global climate action. In affiliation with the treaty's goals, Nigeria has pledged to reduce its greenhouse gas emissions by 20% unconditionally and 45% conditionally (with international support) by 2030, compared to business-as-usual levels. Nigeria is steering toward bold horizons of becoming a low-carbon economy, recognizing that climate mitigation is both a global obligation and a local opportunity for sustainable development. In alignment with its Nationally Determined Contributions (NDCs) under the Paris Agreement, the Nigerian government is committed to ensuring that the global temperature rise remains below 1.5°C by the year 2030 (Noah, 2025). This ambition entails a targeted reduction in greenhouse gas (GHG) emissions across key sectors such as energy, transportation, agriculture, oil and gas, and, critically, manufacturing. Eccles et al. (2020) posit that as global climate commitments tighten under the Paris Agreement, carbon reporting has progressed from a voluntary sustainability practice to a critical determinant of corporate financial resilience.

Return on investment is a key performance indicator for investors as they are mostly drawn to companies who are friendly to the environment and disclose their carbon emissions management. This is very vital for manufacturing companies as they are key drivers of the economy being responsible for making basic products available for consumption by individuals. Manufacturing processes are characterized by huge energy consumption due to the poor power infrastructure, and companies need to report and account for the energy consumed while powering their production plants and machines. Also, during production, waste is generated and should therefore be disposed appropriately. All of this contributes to the carbon emission from company operations and should be reported in the financial statement of these companies. Investors are drawn to companies who are friendly to the environment and evaluate the performance of a company based on its carbon accounting disclosures.

1.2 Statement of the problem

Nigeria's manufacturing sector is a dynamic and standout sector that currently contributes approximately 10% to the nation's Gross Domestic Product (GDP) and serves as a key driver of economic growth, employment, and food security. (Cookey, 2025; Owan et al., 2024). The expansion of the manufacturing industry is largely furled by strong consumer demand necessitating heavy reliance on power using diesel and natural gas. While this supports economic growth and job creation, it also leads to a notable increase in greenhouse gas (GHG) emissions, raising environmental and sustainability concerns. Investors are one of the vital stakeholders in the carbon accounting and reporting debate as they rely on

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companies to provide information that can be readily used in investment decision-making (Sullivan & Gouldson, 2012). While a review of literature shows that studies have been undertaken to evaluate the effects greenhouse gas emissions disclosure on financial performance focusing on various sectors such as oil and gas firms, quoted Nigerian financial services companies. This sector specifics may be limited in generalization since the manufacturing sector is heavily linked to emissions from the burning of energy used to power production machines. Manufacturing companies are expected to disclose how they account for their carbon emissions as this impacts on the company's brand image or perception, thereby bringing eco-friendly investors to become interested in partnering with them and open to financing. By aligning carbon reduction strategies with financial performance metrics, organizations can demonstrate strong return on investment (ROI).

Based on the above background, this study basically seeks to examine how carbon accounting is reported and how companies who report their energy consumption and waste management practices will impact on the return on investment (ROI) to build stakeholder trust in Nigeria's manufacturing sector.

1.3 Objectives of the study

The main objective of this study is to investigate the effect of carbon accounting reporting on return on investment of listed manufacturing companies in Nigeria. The specific objectives of the study were to:

i. Examine the effect of energy consumption disclosure on return on investment (ROI) of listed manufacturing companies in Nigeria.
ii. Investigate the effect of waste management disclosure on return on investment (ROI) of listed manufacturing companies in Nigeria.

Legitimacy Theory by John Dowling and Jeffrey Pfeffer (1975)

The legitimacy theory is concerned with a social contract between corporate entities and society where the companies socially accept the societal conditions for acceptance and for better understanding. The existence of an understanding between society and the corporate entities is essentially for legitimacy. Companies that make public their sustainability reports are doing so in a bid to legitimize their existence and meet stakeholder expectations (Joseph & Mshelia, 2015). It is usually referred to as a concept that helps firms maintain legitimacy by aligning with societal values and norms, especially in terms of environmental activities, to fulfill implicit social contracts with the society in which they operate. Legitimacy theory sheds light on the obligation perceived for large firms to substantiate their legitimacy and be held accountable by their stakeholders, calling for the responsibility of disclosing full and relevant information, which is necessary to all stakeholders (Chowdhury et al., 2020).

Legitimacy theory suggests that firms disclose environmental information to gain social acceptance, as it is a key concept in corporate social and environmental accounting that explains why companies disclose carbon emissions and other sustainability-related information (Akhter et al., 2021). It suggests that businesses operate within a social contract that mandates them to align their actions with societal expectations to maintain legitimacy and ensure long-term survival. The ideal expectation is that companies will publicly disseminate environmental information, particularly on carbon emissions, due to their unique position as central actors in both causing and addressing ecological damage (Li et al., 2018; Liesen et al., 2017).

The legitimacy theory suggests that when firms disclose information on carbon management and disclosure, this improves their reputation which in turn will attract investors. This attraction could lead to the influx of highly eco-friendly investors, hence

leading to better performance in the firm. This theory attempts to explain carbon reporting as a determinant of firm performance and expects a positive link from carbon reporting as a determinant of firm performance measured by return on investment.

Conceptual framework

2.2.1 Concept of carbon reporting

Carbon reporting is a key component oof Environmental, Social, and Governance (ESG) disclosures, as it involves following the path on greenhouse gas (GHG) emissions and publishing data on such emissions. According to Mohammad and Aisa (2020), carbon reporting helps stakeholders of firms to monitor and regulate their carbon emission as it is beneficial to them bringing advantage to improve the firms' carbon performance. When the carbon performance of a firm is stable and highly improved it leads to a drastic change and improvement in their financial performance on the long term. Ennis et al (2012) asserts that carbon reporting is an essential tool that provides an important mechanism to motivate firms to reduce their emissions; thereby achieving climate mitigation. Total emissions are calculated from a variety of sources, including industrial processes, energy use and transportation and reported on a recurring basis to inform business practices and international policies. Countries and corporations seek standards and policies that will address climate change and reduce environmental impact. Standardized GHG reporting offers consistent, transparent data to inform decision-making. Carbon accounting can also be referred to as Greenhouse gas accounting.

It is known to require two things: data collection and data processing. Businesses must ensure that they effectively collect data on their emissions and present a comprehensive report enabling a sound evaluation of their eco-friendly activities. According to Schaltegger and Burritt (2010), this practice helps organizations not only comply with environmental regulations but also enhance transparency and reputation among stakeholders. Carbon disclosure is perceived to be of immense benefits to stakeholders of firms since it helps in monitoring and regulating firms' carbon emissions, which is of advantage to improving the firms' carbon performance. Carbon disclosure practices remain largely voluntary in Nigeria today and have been explicitly stated as a requirement by the Financial Reporting Council of Nigeria to enable companies to increase stakeholder and regulatory pressure. This in turn has led some listed firms to adopt sustainability reporting frameworks like the GRI Standards.

Akhanolu et al (2023) reports that carbon emissions disclosure has over time reflected the importance of any governance organization, as this helps to promote awareness about climate change, sustainable energy, and energy efficiency. This phenomenon helps to legitimize the notion of accountability by companies to other external stakeholders. Carbon disclosure, which is a voluntary act by companies, is very crucial to the image of any company as it gets to show how viable a company is doing business as well as the potential benefits of carbon monitoring and reporting which are vital to maintaining company management reputation and how energy cost is managed by such companies so as attract investors. Carbon disclosures are beneficial to stakeholders, such as shareholders and creditors, to enable them to make better investment decisions. It also helps other stakeholders, such as regulatory agencies, institutional investors and the public, to better monitor and regulate a firm's carbon emissions, which is likely to contribute to its improved carbon performance. A carbon disclosure rating is a measure of the environmental sustainability of a company, based on voluntary disclosures by the company itself.

Energy consumption

Global Reporting Initiative (GRI) 103, which explicitly describes Energy consumption states that organizations are required to report their total energy consumption,

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which should be broken down by two sources namely renewable and non-renewable sources. This is divided into two types: Direct (scope 1) GHG emissions and indirect (scope 2) GHG emissions. David (2011) posits that carbon emissions are released into the atmosphere from burning fossil fuels that are used to power vehicles, generators.

2.2.4 Waste Management

Waste is unusable materials that are undesirable or unwanted. Waste is oftentimes a substance which is discarded after primary use, due to its worthless or defective status. Examples include municipal solid waste (household trash/refuse), hazardous waste, wastewater (such as sewage, which contains bodily wastes (faeces and urine) and surface runoff), radioactive waste, and others. Waste is part of the economy; it is a by-product of economic activity, by businesses, government and households. Waste is also an input to economic activity, whether through material or energy recovery. The management of waste has economic implications for productivity, government expenditure, and, of course, the environment (Yao-Jen & Min Der, 2013). Wastes are substances or objects, that are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law (UNSD Glossary of Environment Statistics, 1997). GRI 306: Effluents and Waste is the dedicated GRI Standard for reporting in this area. It specifies that organizations disclose information about their waste generation, waste management approaches, and the volume and characteristics of effluents they release. Firms' decisions over how to manage waste impact on their profitability.

2.2.5 Return on Investment (ROI)

According to Beattie (2025), return on investment (ROI) is a measure of performance that is used to evaluate the efficiency or profitability of an investment. It is a financial ratio often expressed as a percentage which measures profit generated by an investment relative to its cost. ROI is used to assess the profitability of corporate investments. It is a paramount Key Performance Indicator (KPI) that offers a refined perspective on the profitability and efficiency of an organization's investments. Expressed as a percentage, ROI quantifies the financial return generated relative to the initial cost incurred. This metric provides a comprehensive framework for evaluating investment decisions, enabling stakeholders to assess whether resources have been allocated effectively to yield desirable outcomes. (Majka, 2024). It provides a quantitative measure of the gains or losses relative to the initial investment cost.

2.3 Empirical reviews

Egbunike and Afodigbueokwu (2021) examined the effect of carbon management accounting and performance of quoted consumer manufacturing firms in Nigeria. It was specifically carried out to evaluate the effect of Greenhouse Gas Emissions (GHG) disclosure on Tobin's Q and Returns on Asset (ROA) of the companies. The ex-post facto research design was adopted for the study using all manufacturing firms quoted on the Nigerian Exchange Group (NGX) as at 31st December 2020 as the population of the study. Secondary sources of data were obtained from the annual financial statements of the sampled companies. The regression analysis was employed in validating the hypotheses from which findings revealed that Greenhouse Gas Emissions (GHG) disclosure has a significant effect on Tobin's Q of manufacturing firms. While Greenhouse Gas Emissions (GHG) Disclosure has no significant effect on Return on Assets (ROA) of manufacturing firms. Recommendations were made stating that manufacturing firms should make sustainability reporting a crucial aspect of the annual financial statements. This agrees with the findings of Akhanolu et al (2023) who carried out a study to examine the challenges of carbon disclosure and its impact

on the performance of quoted manufacturing firms in Nigeria. Using equity return (ROE) as the dependent variable and carbon performance (disclosure), board response, board climate incentives, and board environmental committee as the independent variables, the study used panel data analysis to analyze the secondary data gathered from 2014 till 2020. The Hausman test suggested the usage of fixed effect regression. Findings from the regression result showed that all the independent variables of carbon performance (disclosure), board response, board climate incentives, and board environmental committee positively and significantly impact ROE. A key strength of the study is its empirical approach, which enhances the generalizability of the findings. However, the study does not consider the effect of carbon disclosures on return on investment.

In South Africa, 63 South African CDP companies were examined by Ganda and Milondzo (2018) to evaluate the effect of carbon emissions (Scope 1, Scope 2) on the financial performance (ROE, ROI, and ROS) for the 2015 fiscal year. Using multiple regression techniques, the researchers found overwhelming evidence of a negative relationship between carbon emissions and corporate financial performance. Results from findings showed that companies which integrate green investment initiatives designed to lower carbon emissions can effectually manage financial performance. Hence, providing useful insights on how companies can fully utilize their organizational resources and capabilities as well as gain insight, resulting in a higher environmental and financial performance within a firm. This research is similar to Kurniawan et al (2024) study in terms of variable for measuring carbon emission although different in terms of sector (listed mining companies in IDX (Indonesian Stock Exchange), number of companies (forty-seven) and time frame (5 years).

Okeke et al. (2021) examined the effect of carbon emission disclosure on economic value added of oil and gas firm in Nigeria stock exchange between the periods 0f 2018-2019. Variables studied were Economic value added, effluent and waste treatment cost disclosure, revenue growth of firm and firm size and data were sourced from the annual report of the quoted oil and gas firms and analyzed using Panel Least Squared (PLS) method of data analysis. The study made use of Causality Test, Hausman Test. fixed effect as well as random effect to analyses the included variables. From the analysis result the study found that effluent and waste treatment cost disclosure, has significant effect on economic value added, revenue growth of firm has positive significant effect on economic value added. Firm size has positive insignificant negative effect on economic value added. It was recommended that Government should enact regulatory laws that will ensure that companies carry out the corporate social responsibility. Also, enforcement of extant laws should be encouraged. The findings of this study are limited to only one sector; oil and gas and may not have fully captured the relationship between the variables in different sectors.

Research Methodology

3.1 Research design

The research design employed in this study was ex-post facto research design. This design is chosen because it basically relies on historical data which has already taken place and recorded in the annual financial statements, and the researcher has no influence over the data. This is appropriate as it allows the researcher to establish the meaningful relationship between carbon reporting variables and Return on Investment (ROI) (Kothari & Garg, 2014).

3.2 Population and sample of the Study

The population and sample size comprises forty-three (43) listed Manufacturing companies in the Nigeria Exchange Group (NGX) from 2015 to 2024. The manufacturing industry consists of six sectors, including Agriculture, Conglomerates, Consumer Goods,

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Industrial Goods, Health Care, and Natural Resources. Purposive non-probability sampling technique was used to select the sample size of this study was which is. The selection criteria were based on manufacturing companies that consistently filed their annual reports with the Nigerian Exchange Group (NGX) for the study period (2015-2024) and based on the availability of sustainability reports provided by the firms under study to enable the researcher to measure carbon reporting variables.

Data analysis technique
Utilizing descriptive metrics like mean and standard deviation was part of the data analysis. The 10 year time series were analyzed using robust regressive analysis method with the aid of STATA. A significance level of 5% and a confidence level of 95% were used to calculate statistical significance.

3.4 Model specification
The following models were adopted by research.
Y = f (WMD, ECD, FSIZ)

where
Y = Return on Investment
WMD = Waste management disclosure
ECD = Energy Consumption disclosure
FMS = Firm size
F = function
When expressed in a linear expression of the model
$ROI = \beta_{0it} + \beta_1 WMD_{it} + \beta_2 ECD_{it} + \beta_3 FSIZ_{it} + \mu_{it}$
βoit= Intercept;
βo1-3 = Coefficients;
μit = Error term

3.5 Variables measurement
The dependent variable was Return on Investment (ROI) was expressed as a percentage which measures profit generated by an investment relative to its cost.
The independent variables - waste management disclosure (WMD) and energy consumption disclosure (ECD) were measured by scoring index based on indicators selected from Global Reporting Initiative guidelines as applied in previous studies. If a company disclosed how they managed the waste generated from production and the total energy consumption in their financial statement. Such a company was assigned 1 by the researcher. If the company failed to disclose any indicator, the researcher assigned 0.
A control variable, Firm size (FMS) was measured by the natural log of total assets of the companies.

Results and Discussion
4.1 Descriptive statistics and correlation analysis
The descriptive statistics presented in Table 1 show that the average return on investment (ROI) is 5.017, but with a very high standard deviation of 37.004, suggesting wide disparities in investment returns among the firms. The minimum ROI of –423.700 and maximum of 123.820 indicate that while some firms recorded significant losses, others achieved strong investment gains. This wide range reflects varying levels of profitability and operational efficiency in the Nigerian manufacturing sector. For waste management disclosure (WMD), the mean is 0.151 with a standard deviation of 0.359. Since WMD is a dummy variable, the mean implies that only about 15.1% of the firms sampled reported

waste-related disclosures. This low rate of disclosure may reflect a general reluctance or lack of regulatory pressure among manufacturing firms to engage in environmental transparency.

Similarly, energy consumption disclosure (ECD) has a mean of 0.170 and a standard deviation of 0.433. The range from –3.000 to 1.000 suggests potential coding issues or transformations that need clarification, but overall, the low average indicates that only 17% of firms disclosed information on energy use. Like WMD, this points to limited compliance or voluntary commitment to sustainability reporting. The average firm size (FSIZ), measured as the natural log of total assets, is 7.357 with a relatively low dispersion (standard deviation = 0.932), indicating that most firms in the sample are of similar scale.

Table 1:

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ROI	430	5.017	37.004	-423.700	123.820
WMD	430	0.151	0.359	0.000	1.000
ECD	430	0.170	0.433	-3.000	1.000
FSIZ	430	7.357	0.932	4.620	9.590

Source: Author's Compilation, 2025

The results of the correlation analysis in Table 2 reports the Spearman rank correlation coefficients for the key variables in this study. The coefficients provide insight into the degree of association among return on investment (ROI), waste management disclosure (WMD), energy consumption disclosure (ECD) and firm size (FSIZ). The analysis reveals a weak but positive association between ROI and WMD, with a correlation coefficient of 0.193. This suggests that firms disclosing more about their waste management practices tend to exhibit slightly higher investment returns. A similar but weaker positive relationship is observed between ROI and ECD (0.079), indicating that energy use disclosures are not strongly aligned with variations in investment returns during the study period. However, a more notable positive association exists between ROI and FSIZ, with a coefficient of 0.362. This implies that larger firms, in terms of asset base, are more likely to report higher ROI, potentially due to better resource capacity or reporting sophistication.

Among the environmental disclosure variables, WMD and ECD are strongly correlated at 0.712. This high degree of association suggests that firms engaging in waste management reporting are also highly likely to report on energy use, indicating an integrated approach to environmental sustainability disclosures. Both WMD and ECD are also moderately associated with FSIZ (0.429 and 0.358, respectively), which may imply that larger firms are better equipped or more obligated to engage in structured carbon reporting. Nevertheless, to ensure robustness in the regression analysis that follows, multicollinearity diagnostics using Variance Inflation Factor (VIF) were conducted (not tabulated). None of the VIF values exceeded the conservative threshold of 2.50, confirming that multicollinearity does not pose a concern in the subsequent estimation models.

Table 2

Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)
(1) ROI	1.000				
(2) WMD	0.193	1.000			
(3) ECD	0.079	0.712	1.000		
(4) FSIZ	0.362	0.429	0.358	1.000	

Source: Author's Compilation, 2025

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4.2 Regression Analyses

Table 3 shows the results of the regression analysis, which provides empirical evidence on the association between carbon reporting practices and investment outcomes among listed manufacturing companies in Nigeria. The regression began with an Ordinary Least Squares (OLS) estimation, which served as the baseline model. However, as expected in high-frequency panel data drawn from a heterogeneous sector such as manufacturing, key diagnostic tests revealed violations of classical assumptions, particularly the assumption of homoscedasticity. Specifically, the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity reported a significant chi-square statistic (591.77, p = 0.000), indicating the presence of non-constant error variance in the OLS model—a finding that threatens the efficiency and reliability of standard errors (Wooldridge, 2010). While the average Variance Inflation Factor (VIF) was 1.58, which is below the commonly accepted threshold of 10 (Gujarati & Porter, 2009), confirming that multicollinearity was not an issue, the breach in homoscedasticity prompted an adjustment in methodology. Therefore, in line with Greene's (2003) recommendation for addressing such distortions, the robust regression (rreg) model was employed to correct for heteroscedasticity and generate more reliable estimates. The robust model retains all variables but adjusts the estimation technique to minimize the influence of outliers and heteroscedasticity, thereby increasing the robustness and credibility of the statistical inferences drawn from the model (Huber, 1981; Long & Ervin, 2000).

Table 3

Regression Results

	(1)	(2)
Variables	OLS Regression	Robust Regression
WMD	0.154	6.087***
	(0.981)	(0.000)
ECD	-2.533	-5.009***
	(0.622)	(0.000)
FSIZ	9.605***	1.450***
	(0.000)	(0.008)
Intercept	-67.385***	-3.871
	(0.000)	(0.320)
Observations	430.000	430.000
R^2	0.148	0.350
Hettest	591.77{0.000}	
VIF	1.58	

*Notes: p-values are in parentheses. *** p<.01, ** p<.05*

The robust regression results in Table 3 indicate a positive and statistically significant relationship between waste management disclosure (WMD) and return on investment (ROI), with a coefficient of 6.087 (p < 0.01). This suggests that manufacturing firms that report on their waste management practices tend to achieve higher investment returns. The result contrasts sharply with the OLS model, where WMD was not significant, highlighting the limitations of standard estimation when assumptions are violated. The evidence aligns with stakeholder and legitimacy theories, which argue that environmental transparency enhances firm legitimacy and stakeholder trust (Freeman, 1984; Dowling & Pfeffer, 1975). It also resonates with findings by Akhanolu et al. (2023) and Okeke et al. (2021), who reported that environmental disclosures, particularly in waste and effluents, are positively associated with firm performance. The implication is clear—investors increasingly value firms that

demonstrate environmental responsibility, and such disclosures can serve as strategic tools for attracting sustainability-oriented capital and reinforcing regulatory trust.

Conversely, energy consumption disclosure (ECD) is negatively and significantly associated with ROI, with a coefficient of –5.009 ($p < 0.01$), suggesting that firms disclosing energy use tend to record lower investment returns. This finding, unlike the insignificant OLS result, becomes prominent under robust regression, emphasizing the need for methods that correct for heteroscedasticity. While this result contrasts with the resource-based view, which suggests that environmental transparency can be a strategic asset, it may reflect investor concerns about high energy costs or inefficiencies in energy management (Hart, 1995). The finding is consistent with Ganda and Milondzo (2018), who observed that higher emissions and related disclosures could correlate with weaker financial performance. For policymakers and regulators, the result underscores the need to frame energy disclosures in a way that highlights efficiency and innovation rather than risk exposure, especially in contexts like Nigeria where energy infrastructure challenges persist (David, 2011).

Summary and Conclusion

5.1 Summary

This study examined the relationship between carbon reporting practices and return on investment (ROI) among listed manufacturing companies in Nigeria, focusing specifically on two core dimensions: waste management and energy use. Drawing on stakeholder and legitimacy theories, the study employed robust panel regression techniques to overcome estimation challenges associated with heteroscedasticity. The descriptive results revealed generally low levels of carbon emission disclosure, particularly in waste and energy reporting, reflecting the voluntary nature of sustainability practices in Nigeria's corporate sector. However, the regression analysis offered deeper insight: while waste management disclosure was positively and significantly associated with ROI, energy use disclosure showed a statistically significant negative relationship with ROI. This suggests that firms that invest in transparent waste handling processes are more likely to experience financial rewards, while those that disclose energy use may inadvertently signal operational inefficiencies or cost burdens, particularly in a country where power infrastructure remains fragile and expensive.

5.2 Conclusion

These findings provide important takeaways for understanding how different types of carbon disclosures are received in financial markets. First, not all environmental disclosures are equally priced by investors some are viewed as signals of efficiency and legitimacy, while others may highlight exposure to environmental liabilities. Second, the results affirm that carbon reporting is not only a compliance or reputational tool but also a financial determinant that shapes the way firms are valued by investors and other stakeholders. The distinction between the financial implications of waste and energy disclosures illustrates the nuanced and evolving nature of sustainability communication in emerging markets. Moreover, the evidence that robust regression techniques produced markedly different results from the conventional OLS approach underscores the methodological importance of accounting for data irregularities, particularly in heterogeneous sectors such as manufacturing.

Most importantly, when carbon accountability is integrated into corporate performance strategies, the result is a tangible return on investment (ROI). Nigerian manufacturers can reduce energy costs, attract sustainability-focused investors, and future-proof their operations in a rapidly evolving global economy that increasingly rewards climate-conscious business practices. A robust carbon reporting system within Nigeria's industrial landscape makes a

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compelling case for how environmental transparency can drive economic performance and competitive advantage.

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