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ENERGY COST AND PROFITABILITY OF NIGERIAN QUOTED MANUFACTURING FIRMS

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ABSTRACT
The study examined the impact of energy costs on the profitability of quoted manufacturing firms in Nigeria from 1990 to 2023. Specifically, it analyzed the relationship between energy costs, electricity consumption, and carbon dioxide emissions, and their effects on the profitability of these firms. Using annual secondary data from the World Bank Development Indicator and adopting the multiple regression technique to analyze the data, the results demonstrated that changes in energy costs, electricity consumption, and carbon dioxide emissions significantly affect the profitability of these firms. Specifically, the study found that a reduction in electricity consumption is positively correlated with profitability, while an increase in carbon dioxide emissions is negatively correlated with profitability. The findings suggest that quoted manufacturing firms in Nigeria can enhance their profitability by reducing their electricity consumption and implementing sustainable practices to decrease carbon dioxide emissions.
Keywords: energy, carbon emission, manufacturing, electricity, profitability
JEL: Q4, Q43, G32, L15

INTRODUCTION
Energy is a crucial component across various sectors, including business, manufacturing, healthcare, education, and agriculture, serving as a foundation for economic advancement and social progress. As Omotor (2008) highlights, energy has become a primary driver of a nation's development and growth. Nigeria possesses a wealth of energy resources, such as oil, natural gas, and hydroelectric power. Nevertheless, the country's energy infrastructure struggles with inadequate capacity in generation, transmission, and distribution, resulting in frequent power outages and shortages (Okonkwo, 2009). This situation leads to increased energy costs for manufacturing companies, which often resort to expensive alternative sources like diesel generators. The National Bureau of Statistics (NBS) reported that in 2019, the average energy cost for Nigerian manufacturing firms was N215.4 per kWh, significantly higher than the global average of N130.3 per kWh (NBS, 2021). Such high energy costs reduce the competitiveness of local manufacturers, complicating efforts to maintain profitability.

Omri and Mabrou (2014) note that Nigeria's energy sector has recently undergone significant reforms, including deregulation and restructuring. The deregulation of the diesel market in 2009 and the removal of substantial petrol subsidies in 2012 aimed to generate revenue for infrastructure development (Mesbah, 2016). Despite these efforts, the poor performance of power plants has led to widespread electricity shortages nationwide. To tackle rising energy costs, the government initiated the National Integrated Power Project (NIPP) in 2004, a major initiative intended to

rapidly boost electricity generation through gas-powered plants. This initiative was complemented by transmission, distribution, and gas infrastructure investments, financed partly through the Excess Crude Oil Fund (Menegaki, 2011). However, despite NIPP and other initiatives like the Niger Delta Power Holding Company Limited (NDPHC), Nigeria continues to face energy crises that adversely affect its economy. These issues have decreased foreign investment, lowered agricultural yields, raised prices, increased unemployment, and business closures (Medee, Ikue-John, & Amabuike, 2018).

Menegaki (2011) emphasizes that energy costs make up a significant portion of operational expenses for many businesses, with notable differences across industries. Even a small share of energy expenditure can greatly impact a company's financial performance, especially in energy-intensive manufacturing sectors, affecting the entire supply chain (Milewska & Milewski, 2021). The Nigerian manufacturing industry has struggled to maintain profitability amid rising energy prices, which have altered cost structures and influenced investment decisions. Poor electricity supply has adversely affected firms' productivity and profitability, hindering economic growth. Omri and Mabrou (2014) identify key challenges businesses face due to energy issues, particularly unreliable electricity and frequent outages. According to the World Bank Enterprise Survey (WBES), roughly 25% of large industries and 12% of medium-sized firms view electricity shortages as a major obstacle to their operations.

Despite its crucial role in Nigeria's economy, the manufacturing sector faces ongoing challenges related to high energy costs, availability, and reliability (Yıldırım, Sukruoglu, & Aslan, 2022; International Energy Outlook, 2021). Studies that examine the impact of energy costs on firm profitability have produced mixed results (see Ozturk, 2010; Payne, 2010; Ouedraogo, 2013; Ferriani & Gazzani, 2022; Faiella & Mistretta, 2020). These discrepancies are often attributed to variations in research methodologies, time frames, countries studied (considering their economic or development levels), and variable selection. Consequently, this research aims to analyze how energy costs—particularly those related to renewable energy, electricity consumption, and carbon dioxide emissions—affect the profitability of publicly listed manufacturing firms in Nigeria from 1999 to 2023.

LITERATURE REVIEW

Theoretical framework

The theory of energy efficiency

The theory of energy efficiency posits that firms that adopt energy-efficient practices and technologies can reduce their energy consumption and costs, thereby increasing their profitability (Ouedraogo, 2013). This is because energy-efficient firms can achieve the same level of production or output while using less energy, which reduces their variable costs and improves their competitiveness. A study by the International Energy Agency (IEA) found that every 1% increase in energy efficiency can lead to a 0.5% decrease in energy costs (IEA, 2018). This suggests that investments in energy-efficient technologies can lead to significant cost savings for firms. This suggests that investments in energy-efficient technologies can lead to significant cost savings for firms (Aworinde, 2002). The theory of energy efficiency is relevant to the study because energy costs are a significant component of a firm's operating expenses, and reducing these costs can directly impact profitability.

Empirical review

The existing empirical research presents various findings, often conflicting, indicating no clear consensus regarding the causal link between energy costs and profitability in the manufacturing sector. For example, Milewska and Milewski (2023) analyzed how energy expenditure as a revenue share affects corporate profitability by examining various industries through literature reviews, expert opinions, and statistical data. They also simulated how fluctuations in energy prices could influence company profits.

Xu, Akhtar, Haris, Muhammad, Abban, and Taghizadeh-Hesary (2023) studied 424 non-financial firms listed in Pakistan from 2001 to 2017, exploring the relationship between energy crises, profitability, and productivity. Using fixed effects and the generalized method of moments (GMM), they assessed seven indicators, including electricity shortages (neutral, increasing, worst, and decreasing shortfalls), energy consumption, energy prices, and electricity access, measuring their effects on return on assets (ROA), return on equity (ROE), and asset turnover ratio (ATO). Their findings indicated that energy shortages, especially increasing, worsening, and decreasing shortfalls, significantly reduce profitability by approximately 33-39%. Conversely, stable or neutral energy supply periods positively impacted profitability, suggesting that reliable energy access is vital for business success. The study offers policy recommendations to mitigate energy crises.

Akkemik and Goksal (2012) argued that many panel studies on the link between energy consumption and economic growth often assume homogeneity among countries, which may not be accurate. They employed a more sophisticated Granger causality approach that accounts for heterogeneity across 79 countries from 1980 to 2007. Their results indicated bi-directional causality in 57 countries, unidirectional causality in 7, and no causality in 15, highlighting a complex and varied relationship between energy consumption and economic growth.

Ouedraogo (2013), employing panel cointegration over 1980–2008 for 15 ECOWAS countries, found that, in the short term, economic growth (GDP) influences energy consumption, while, in the long term, energy consumption affects GDP. Similarly, Mohammadi and Parvaresh (2014) analyzed 14 oil-exporting countries from 1980 to 2007, finding a stable bidirectional relationship between energy use and output in the short and long run. Chaudhry, Safdar, and Farooq (2012) examined Pakistan's data from 1972 to 2012, revealing that electricity consumption positively affects economic growth. In contrast, oil consumption negatively impacts growth, likely due to high import dependence.

Using GMM, Sama and Tah (2016) studied Cameroon from 1980 to 2014, finding a positive relationship between petroleum and electricity consumption and gross domestic product (GDP). Similarly, To, Wijeweera, and Charles (2013), applying the ARDL bounds testing approach to Australian data (1970–2011), found no causal relationship between energy consumption and economic growth, supporting the 'neutrality' hypothesis.

Matei (2013), utilizing panel data from 26 OECD countries spanning 1971 to 2013, found that increases in per capita GDP positively affect energy consumption, with a 1% increase in GDP resulting in a 0.3% rise in energy use, and vice versa. A related study by Matei (2016) for seven Black Sea countries (1990–2012) corroborated these findings, suggesting that GDP growth has a

slightly less effective on energy consumption than energy consumption has on GDP.

Dedeoglu and Piskin (2014) employed a dynamic panel approach for 15 former Soviet Union countries from 1992 to 2009, finding that energy consumption causes economic growth in the long run but not in the short run, with some evidence of bidirectional causality among energy-importing nations. Gbadebo and Okonkwo (2009) analyzed Nigeria's data from 1970 to 2005, confirming a positive link between energy use and economic growth using co-integration and error correction models. Using various causality tests, Orhewere and Henry (2011) established unidirectional causality between electricity and gas consumption and GDP, both in the short and long term. Oil consumption only affected GDP in the long run. Akinwale, Jesuleye, and Siyanbola (2013) found unidirectional causality from GDP to electricity consumption in Nigeria, employing VAR and ECM techniques. In contrast, Ogundipe and Ayomide (2013) identified bidirectional causality between electricity use and economic growth from 1980 to 2008.

Onakoya et al. (2013) employed co-integration and OLS methods for Nigeria (1975–2010), concluding that overall energy consumption, except for coal, moved in tandem with economic growth over the long term. Akomolafe and Danladi (2014), using VECM and causality tests, found that electricity consumption causes economic growth unidirectionally, emphasizing its positive long-term effect. Similarly, Okoligwe and Ihugba (2014) confirmed unidirectional causality from energy consumption to GDP. Mustapha and Fagge (2015) found no causal relationship in Nigeria, suggesting that capital and labour play more significant roles in growth than energy consumption.

METHODOLOGY

The paper employs an ex-post facto research approach, using the panel multiple regression technique to explore the long-run relationship between the criterion variable and the predictors. The target population was manufacturing firms listed on the Nigerian Exchange (NGX). As of 2023, approximately eighty-two (82) manufacturing companies publicly traded on the NGX. However, from this pool, a purposive sampling method was utilized to select five (5) top-performing firms based on criteria such as revenue growth, increases in operating profit, profit margins, improvements in gross profit margins, and rises in average return on equity (ROAE). The companies selected for the study period spanning 2014 to 2023 are Cadbury PLC, International Breweries PLC, Nigerian Breweries PLC, Champion Breweries PLC, and Dangote Sugar PLC.

Model specification

Concerning the primary objective of this study, which was to assess the impact of energy costs on the profitability of manufacturing firms in Nigeria, the model developed for the study is presented below: The panel regression model used is as stated below:

$$ROA = f(CRNWE, ELCTC, CABODIXE) \quad 1$$

When transformed into an econometric form, the model becomes:

$$ROA = a_0 + a_1 CRNWE + a_2 ELCTC + a_3 CABODIXE + U \quad 2$$

Where:

ROA = return on assets of quoted manufacturing firms (proxy for profitability)

CRNWE = cost of renewable energy
ELCTC = electricity consumption
CABODIXE = carbon dioxide emission
a_0 is the intercept or constant;
a1–a3 are the coefficients of the independent variables of the research, and U is the error term.

DATA ANALYSIS, RESULTS AND DISCUSSIONS

Descriptive statistics

The trend behaviour of the dependent and independent variables was summarized and presented in the descriptive statistics as shown in Table 1

Table 1: Summary statistics of the variables used in the study.

	ROAA	CRNWE	ELCTC	CCADIOE
Mean	7.431176	87.69750	140.9086	10.07603
Median	7.860000	85.11500	119.9484	11.05414
Maximum	32.15000	187.0170	352.0320	13.96855
Minimum	-13.61000	58.67200	74.14614	4.249597
Std. Dev.	9.445160	18.53033	77.67039	2.540158

Source: E-views 12.0 statistical software

The descriptive results indicated that the profitability of manufacturing firms, measured by the average return on assets (ROAA), was approximately 7.43% over the studied period, with a standard deviation of 9.45%. This suggests that profitability levels did not fluctuate significantly around the mean. The cost of renewable energy (CRNWE) ranged from a minimum of N58.67 billion to a maximum of N187.07 billion, with an average of N87.69 billion and a standard deviation of N18.53 billion. The average electricity consumption (ELCTC) was N140.90 billion, with a standard deviation of N77.67 billion. Notably, electricity consumption peaked at N352.03 billion in 2023 and was lowest at N74.14 billion in 2004, indicating considerable variability in electricity usage in Nigeria. Lastly, carbon dioxide emissions (CCADIOE) averaged N10.07 billion, with a standard deviation of N2.54 billion, and ranged from N4.24 billion to N13.96 billion during the period.

Correlation of the study variables

The data underwent correlation analysis to identify highly correlated variables and thereby prevent the issue of multicollinearity in the model. This is summarized in the correlation results presented in Table 2 below.

Table 2: Correlation results

	ROAA	CRNWE	ELCTC	CCADIOE
ROAA	I	-0.0503191	-0.4561410	-0.4779891
CRNWE	-0.0503191	I	0.4274059	0.10026414
ELCTC	-0.4561410	0.4274059	1.00000	0.33721117
CCADIOE	-0.4779891	-0.13698	0.33721117	1.0000

Source: E-views 12.0 statistical software

The table above illustrates the relationships between the explanatory and dependent variables. The findings reveal that the correlation coefficient for the cost of renewable energy was -0.0503, indicating a significant negative relationship between renewable energy costs and manufacturing firm profitability. In other words, an increase in renewable energy costs is associated with declining profitability. The correlation coefficient for electricity consumption was -0.4561, suggesting that reducing electricity usage corresponds to increased manufacturing firm profitability. Additionally, the correlation between carbon dioxide emissions and firm profitability was -0.4779, indicating a negative association. These results demonstrate that none of the explanatory variables exhibits multicollinearity issues.

Analysis of OLS regression

The Ordinary Least Squares (OLS) multiple regression results in Table 3 indicate that the constant term of 20.6938 suggests variations in CRNWE, ELCTC, and CCADIOE will significantly influence the profitability of quoted manufacturing firms in Nigeria. Specifically, the analysis demonstrates a positive relationship between energy costs and firm profitability in Nigeria. Further examination shows that the estimated coefficient for the cost of renewable energy (CRNWE) is 0.0804, implying that a 1% increase in CRNWE would lead to approximately a 0.0804% rise in manufacturing firm profitability; however, this effect is not statistically significant. Conversely, the coefficient for electricity consumption (ELCTC) is -0.0489, indicating that a 1% increase in electricity consumption results in about a 0.0489% decrease in ROAA, and this relationship is statistically significant. This suggests that higher electricity consumption is associated with lower profitability. Lastly, carbon dioxide emissions (CCADIOE) negatively impact ROAA, with a coefficient of -1.3310, meaning that a one-unit increase in CCADIOE decreases ROAA by approximately 1.3310 units.

Table 3: Analysis of OLS regression result
Dependent Variable: ROAA
Sample: 1990 2023
Included observations: 34

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20.69380	8.570024	2.414673	0.0221
CRNWE	0.080410	0.083297	0.965341	0.3421
ELCTC	-0.048990	0.021003	-2.332559	0.0266
CCADIOE	-1.331007	0.583526	-2.280973	0.0298

R-squared	0.346922	Mean dependent var	7.431176
Adjusted R-squared	0.281614	S.D. dependent var	9.445160
S.E. of regression	8.005494	Akaike info criterion	7.108264
Sum squared resid	1922.638	Schwarz criterion	7.169503
Log likelihood	-116.8405	Hannan-Quinn criterion.	7.169503
F-statistic	5.312112	Durbin-Watson stat	1.362271
Prob(F-statistic)	0.004671		

Source: E-views 12.0 statistical software

Based on the regression results in Table 4.3, the R-squared value is 0.3469, indicating that approximately 35% of the variation in manufacturing firm profitability can be explained by energy costs. The adjusted R-squared is 0.2816, which differs from the R-squared by about 7%, remaining within the acceptable range for a stable model. Additionally, the Durbin-Watson statistic is 1.36. Since this value falls between 0 and 2, it suggests no autocorrelation among the successive values of the variables in the model, confirming its stability.

Discussion of findings

The OLS multiple regression analysis (Table 3) reveals a positive relationship between the cost of renewable energy (CRNWE) and the profitability of quoted manufacturing firms in Nigeria, which aligns with Götz et al. (2017). In agreement with Kline (2013), the estimated coefficient for CRNWE is statistically insignificant, implying that the association between CRNWE and ROAA is not strong enough to be deemed reliable. Consistent with the study by Ouedraogo (2013), the coefficient for electricity consumption (ELCTC) is statistically significant and negative, indicating that a percentage increase in ELCTC leads to a corresponding decrease in manufacturing firm profitability (ROAA) in Nigeria. Specifically, a unit increase in ELCTC is associated with approximately a 0.0489% decline in ROAA. This suggests that reducing electricity consumption could potentially enhance manufacturing firm profitability in Nigeria (Bresnahan et al., 1991). Furthermore, carbon dioxide emissions (CCADIOE) negatively impact ROAA, with a coefficient of -1.3310, meaning that a one-unit increase in CCADIOE decreases ROAA by roughly 1.3310 units. This indicates that lowering carbon dioxide emissions may also improve manufacturing

firms' profitability in Nigeria, aligning with findings from Mankiw et al. (2018). Lastly, the variations in CRNWE, ELCTC, and CCADIOE significantly influence the profitability of quoted manufacturing firms in Nigeria. However, the nature of these relationships varies: while the positive link between CRNWE and ROAA is not statistically significant, the negative relationship between ELCTC and ROAA is significant. Additionally, reducing carbon dioxide emissions appears to benefit profitability, highlighting the importance of managing environmental factors for corporate performance.

CONCLUSION AND RECOMMENDATIONS

The study investigated the impact of energy costs on the profitability of quoted manufacturing firms in Nigeria. From the statistical computations, analyses, and findings of the tests conducted, it was discovered that the joint variables of energy costs, as explained by the F-statistics, significantly impact the profitability of quoted manufacturing firms in Nigeria. While the individual impacts of electricity consumption and carbon dioxide emissions exert a negative and significant impact on the profitability of quoted manufacturing firms in Nigeria, the cost of renewable energy had an insignificant impact. The findings therefore conclude that energy costs influence the profitability of manufacturing firms, which in turn affects the cost of production. Based on these findings, it is recommended that manufacturing firms focus on reducing their electricity consumption by implementing energy-efficient technologies and practices through collaborations with energy providers to develop sustainable energy solutions.

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