ELECTRICITY CONSUMPTION AND MANUFACTURING OUTPUT IN NIGERIA: EVIDENCE FROM ARDL ANALYSIS

MUSA MUJTABA ABDULLAHI*
Department of Economics, Nigerian Defence Academy
Email:mmujtaba431@gmail.com; Phone: 08063751832 (Corres. Author)

BILKISU KABIR USMAN FAROUK
Department of Management Studies, Nigerian Defence Academy
Email: Billykis45@gmail.com; Phone: 08033063137

MOSES GOSELE DANPOME
Department of Economics, Nigerian Defence Academy
Email:mdanpome2010@gmail.com; Phone: 08036335930

ALIYU YAHAYA ALIYU
Department of Economics and Development Studies, El-Amin University, Minna.
Email: Ayaliyu6@gmail.com; Phone: 07051657799.

NURA HUSSAINI
Department of Economics and Development Studies, Federal University Dutse
Email: nurahussaini2020@gmail.com; Phone: 08100732569

HALIMA HARUNA MUHAMMAD
Department of Economics, Al-Qalam University, Katsina.
Email:halimaharunamuhammad1@gmail.com; Phone: 07039698757

AISHA ILIYASU RUNKA
Department of Economics, Federal College of Education, Katsina.
Email:aisharunka@gmail.com; Phone: 07065342166

ABSTRACT
This study examines the impact of electricity consumption and macroeconomic variables on manufacturing output in Nigeria from 1986 to 2023, using annual time series data from the World Development Indicators and the Central Bank of Nigeria. A short-run dynamic Autoregressive Distributed Lag (ARDL) model was employed due to the absence of co-integration among the variables, as revealed by the bounds test. The results indicate that electricity consumption has a positive but statistically insignificant impact on manufacturing output, with a 1% increase resulting in a 0.054% rise. Similarly, the exchange rate and inflation exhibit positive but insignificant impacts, with 1% increases associated with 0.051% and 0.012% rises in output, respectively. The current monetary policy rate (MPR) has a negative and insignificant impact, with a 1% rise reducing output by 0.016%. The first lag of MPR shows a positive but insignificant impact, while the second lag has a negative and statistically significant impact, indicating that a 1% increase in MPR at this lag reduces manufacturing output by 0.141%. This highlights the delayed negative impact of monetary tightening on industrial performance. Based on these findings, the study recommends improving electricity reliability, stabilizing exchange rates through economic diversification, and coordinating inflation management policies. Additionally, it urges the government to adopt interest rate strategies that are sensitive to the manufacturing sector.

Keywords: Electricity consumption, exchange rate, manufacturing output, ARDL model.
JEL Codes: Q43, E52, E31

1. INTRODUCTION

The manufacturing sector is pivotal for economic development by stimulating industrialization, generating employment, and enhancing value addition across value chains. In Nigeria, however, the sector has struggled to reach its full potential, contributing an average of only 8–10% to GDP over the past decade, despite its abundant natural and human resources (National Bureau of Statistics [NBS], 2023). One of the most critical constraints is the unreliable and inadequate electricity supply (Nwogwugwu, 2024). Electricity is indispensable as a fundamental input for industrial operations—powering machinery, supporting production processes, and ensuring operational efficiency (Adenikinju, 2005; Ebohon, 2016). Nonetheless, Nigeria continues to face chronic power deficits, with average access and reliability far below global benchmarks (International Energy Agency [IEA], 2022). The link between electricity consumption and manufacturing output has garnered growing attention in policy and academic circles, especially as Nigeria intensifies efforts to diversify its economy away from oil dependence. Despite reforms such as the Electric Power Sector Reform Act of 2005 and the unbundling of the Power Holding Company of Nigeria (PHCN), the electricity supply remains erratic. As a result, manufacturers often rely on self-generated power using diesel or gas generators (Iwayemi, 2008; Olaniyi & Oyinlola, 2020), driving up operational costs and undermining productivity and competitiveness (Akinlo, 2009).

In addition to energy constraints, macroeconomic instability, particularly exchange rate inflation and monetary policy rate, has emerged as a critical challenge for the country, which has become an increasingly significant factor affecting manufacturing performance. Given the sector's heavy reliance on imported raw materials, capital equipment, and spare parts, exchange rate fluctuations directly impact production costs and investment decisions. Exchange rate depreciation, in particular, raises input prices and weakens firms' purchasing power, further straining manufacturing output (Aliyu et al. 2015; Egwaikhide et al. 2001). Inflation exacerbates these challenges by increasing the cost of inputs, eroding consumer purchasing power, and creating uncertainty in production planning. High inflation often leads to volatile business conditions that deter long-term investment in the manufacturing sector (Alege & Ogundipe, 2015; Omoke & Ugwuanyi, 2010). Furthermore, the monetary policy rate (MPR)—used by the Central Bank of Nigeria to control inflation and stabilize the economy—has important implications for industrial performance. When MPR is high, borrowing costs increase, discouraging manufacturers from accessing credit needed for capital investment and working capital (Bakare, 2011; Uddin et al., 2020). Conversely, lower rates may stimulate investment but could also fuel inflationary pressures if not well managed.

While classical economic theory and several empirical studies (Chukwuedo et al. 2024; Akinlo, 2009; Wolde-Rufael, 2006) support a positive relationship between electricity consumption and manufacturing output, Nigeria presents a paradox. Despite increasing electricity consumption and infrastructural investments, manufacturing output has remained stagnant or even declined in some years (NBS, 2023; Ubi et al., 2012). This contradiction raises important questions: Does electricity consumption in Nigeria effectively translate into manufacturing growth? Or do persistent structural challenges—such as poor energy quality, distribution losses, and the high cost of self-generation—diminish its impact? Moreover, national electricity consumption statistics may not accurately capture sectoral realities, as many manufacturers depend on off-grid generation (Olasupo & Ibrahim, 2019). This makes it difficult to assess the true relationship between electricity consumption and manufacturing output. Compounding this is the exchange rate, which adds another layer of complexity. Naira depreciation inflates the cost of imported machinery and inputs, eroding profit margins and discouraging investment. Conversely, appreciation may ease import costs but could reduce export competitiveness.

Thus, any robust analysis of the electricity–manufacturing output relationship must account for exchange rate fluctuations as a critical control variable. There is a pressing need for empirical research that explores the magnitude, direction, and significance of this relationship within the Nigerian context. Clarifying this link is essential for informing energy, exchange rate, and industrial policies aimed at revitalizing the manufacturing sector and promoting inclusive economic growth in Nigeria. It is against this backdrop that this study seeks to analyze the impact of electricity consumption on manufacturing output in Nigeria from 1986-2023. The study is organized into five sections: introduction, literature review, methodology, results and discussion of findings, conclusion, and policy recommendation.

2. LITERATURE REVIEW

2.1 Theoretical Review

Neoclassical Growth/Production Theory

The Neoclassical Growth Theory, developed by Solow (1956), explains economic growth as a function of capital accumulation, labor, and exogenous technological progress. It assumes diminishing returns to capital and labor, resulting in a steady-state growth path where long-term per capita growth is driven solely by technological advancement. While electricity is not explicitly included in the original model, it can be interpreted as a capital input that enhances the productivity of labor and physical capital, especially in the manufacturing sector. From this perspective, electricity consumption indirectly affects manufacturing output by improving production efficiency. However, as technological change is considered exogenous, the model does not account for how improvements in electricity infrastructure or energy efficiency may endogenously influence growth outcomes (Solow, 1956).

Endogenous Growth Theory

Endogenous Growth Theory, advanced by Romer (1986) and Lucas (1988), incorporates technological change as an outcome of intentional investment in human capital, innovation, and knowledge spillovers. Electricity consumption is not just a passive input but can stimulate innovation, learning-by-doing, and productivity improvements, particularly within energy-intensive sectors such as manufacturing. Access to reliable and affordable electricity can contribute to capital deepening and technological adoption, which are key drivers of sustained growth in the endogenous framework. As such, electricity consumption may have both immediate and long-term effects on manufacturing output through enhanced efficiency and innovation capacity (Romer, 1986; Lucas, 1988).

2.2 Empirical Literature Review

A growing body of literature has explored the determinants of manufacturing output, particularly focusing on energy availability and macroeconomic stability. For instance, Gbarawae et al. (2025) examined the effect of exchange rate on the performance of the manufacturing industry between 1985 and 2022. The study proxied of exchange rate by real exchange rate, external reserve, and trade openness, while the manufacturing sector GDP measured the performance of the manufacturing industry. Annual temporal data for the study were sourced from the Central Bank of Nigeria (CBN) statistical bulletin and World Development Indicators (WDI) of the World Bank. The data analysis techniques adopted are the unit root test, the co-integration test, and the error correction model (ECM) approach. The study found that the real exchange rate has a substantial unfavourable effect on manufacturing sector GDP in Nigeria, external reserve has a favourable and substantial effect on manufacturing sector GDP in Nigeria, while trade openness has a favourable and substantial effect on manufacturing sector GDP in Nigeria. As per the findings, the study concluded that the exchange rate plays a substantial role in influencing the performance of the manufacturing industry in Nigeria.

Applying different approach, Gold et al (2024) examined electricity production, consumption, and its impact on Nigeria's industrial output, exploring the relationship between power availability and economic and industrial advancement. The time series data from 1985 to 2018 and the Autoregressive Distributed Lag (ARDL) bounds testing technique for cointegration were used. The findings reveal long-term relationships between the variables, indicating that manufacturing output benefits from electricity in the short and long term. However, this effect only becomes statistically significant over time. A multiple regression model also shows that interest rate, inflation rate, electricity, and gross fixed capital formation variables are positively associated with economic development. These results have significant policy implications, demonstrating that increasing the electricity supply is essential for boosting productivity in the manufacturing sector.

Similarly, Edet et al (2022) investigated the impact of electricity supply on manufacturing output in Nigeria using data from 1980 to 2019. By augmenting the endogenous growth model production function with key variables affecting manufacturing sector output, such as exchange rate and technology, which previous studies failed to capture. The result of the autoregressive distributed lag (ARDL) model revealed that electricity supply has a negative and insignificant relationship with the manufacturing sector output. Conversely, technology has a positive and significant relationship with manufacturing sector output in the short run. On the same direction, Omotosho and Ogu (2021) examined the effect of electricity consumption on manufacturing sector performance in Nigeria. Data were sourced from the CBN Statistical Bulletin and World Bank Development Indicators for the period of 1980-2019. The study employed Auto Regressive Distributed Lag techniques to analyse the data. The result revealed that Variables such as electricity supply, Exchange rate, Credit to the Manufacturing Sector, and Human capital development have long and short run relationships with manufacturing output. Subsequently, the ARDL test was carried out, with the bound test revealing that there is a long-run relationship between manufacturing output and electricity supply in Nigeria.

Furthermore, Ogungbenle (2021) examined the relationship among electricity, gas, coal, premium motor spirit and manufacturing output in Nigeria using the annual time series data spanning from 1981 to 2019 by employing the Autoregressive Distributed Lags (ARDL) Model application to cointegration and the Error Correction Model technique. The study finds evidence that electricity and premium motor spirit have a positive, significant, and dynamic impact on manufacturing output in Nigeria. Furthermore, gas consumption has a positive but not significant effect on manufacturing output in Nigeria. In addition, the study reveals that there is a long-run relationship among electricity, gas, coal, premium motor spirit and manufacturing output in Nigeria. Using Canonical Cointegrating Regression, Asaleye et al. (2021) investigated the long-run impact of electricity consumption on manufacturing sector performance, measured by output, employment, and capital, from 1981 to 2019. Evidence from the output equation indicates that electricity consumption and credit to the manufacturing sector have a negative relationship with output. In the employment equation, electricity consumption and interest rates adversely affect employment. In the capital equation, electricity consumption is not statistically significant.

Differently, Chukwuma and King (2020) examined electricity consumption and manufacturing sector output in Nigeria from 1981 to 2019. By employing the Autoregressive Distributed Lagged Model (ARDL) estimation technique, the variables considered for the study include electricity supply, unit of labour and gross capital formation, government expenditure on power, inflation, as independent variables, and Manufacturing sector output as the dependent variable. Furthermore, the outcome of the ADF unit root test showed a mixed order of integration among the variables employed. The study finds a stable long-run relationship amongst the variables, the ARDL Wald Test. Estimated results show that electricity consumption has a positive relationship with manufacturing sector output in the short-run and a negative relationship in the long run. However, there is a significant impact of electricity consumption and the manufacturing sector output in Nigeria.

Using different method, Akeem (2019) examined the impact of exchange rate on the performance of the manufacturing sector in Nigeria from 2000 to 2018. Secondary sources and time series data were gathered from the CBN Statistical Bulletin of 2018. The use of Ordinary Least Squares was most appropriate for the study in terms of goodness of fit and significance of the regression coefficient. Multiple regression of an econometric model was formulated for this study to examine the relationship between the independent variables, exchange rate, interest rate, and inflation rate, and the dependent variable, manufacturing output. The result of the analysis shows that interest rate and inflation rate are statistically insignificant in explaining manufacturing output. In contrast, the exchange rate is statistically significant in determining manufacturing output in Nigeria.

On a contrast, Akinmulegun and Falana (2018) examined the effects of exchange rate fluctuation on the Industrial Output Growth in Nigeria using time series data spanning from the period 1986 to 2015. Johansen‘s Co-Integration model was employed to explore the long-run relationship among the variables used, while the Vector Error Correction model (VECM) was used to evaluate the short and long-run dynamics among the variables, and the Granger Causality was used to measure the contemporaneous relationship among the endogenous variables. The dynamic correlation of the variables was captured by the analyses of impulse response and variance decomposition. The results of the analysis indicate a unidirectional causality from the Exchange rate to Industrial output. The response of industrial output to the shock from the exchange rate was positive and significant; more specifically, in the initial years, while the response to the shock from other variables was little in magnitude and not as significant as the exchange rate.

Ibrahim et al. (2017) used time series data from 1981 to 2015 to examine the symmetric relationship between electricity consumption, manufacturing output, and financial development in Nigeria. The results of Johansen cointegration indicate co-movement among the variables over a long-time horizon, meaning that any inefficiency in electricity supply would impede industrial output. Moreover, the Granger causality test based on the vector error correction framework shows the presence of causality between the power utilization of manufacturing firms and economic growth without feedback.

2.3 Gap in the Literature

Despite the growing body of literature exploring the nexus between electricity consumption and manufacturing output in Nigeria, a critical empirical gap remains regarding the short-run dynamics of this relationship. While several studies (for instance, Omotosho & Ogu, 2021; Ogungbenle, 2021; Chukwuma & King, 2020) have applied the Autoregressive Distributed Lag (ARDL) approach to investigate long-run equilibrium relationships, limited attention has been paid to the short-run adjustments and transmission impacts of electricity supply shocks on manufacturing output, especially in the presence of macroeconomic instability. Many of these studies primarily focus on long-run cointegration results, often overlooking the nuanced short-term fluctuations that may have immediate policy relevance in volatile economic environments like Nigeria. Moreover, electricity consumption is frequently modeled in isolation, without adequately controlling for short-run changes in key macroeconomic indicators such as the exchange rate, inflation, and monetary policy rate—factors that directly affect the cost of production and input availability in the short term. As such, the short-run dynamics of electricity consumption within a broader macroeconomic framework remain underexplored.

This study seeks to bridge this gap by adopting the ARDL framework with an emphasis on short-run dynamics while incorporating monetary and external sector variables to capture the more immediate and transitional responses of the manufacturing sector to electricity and macroeconomic shocks.

3. METHODOLOGY

3.1 Theoretical Framework

Neoclassical Production Theory

This study is anchored on the Neoclassical Production Theory, which posits that the output of a firm or economy is a function of the efficient combination of key input factors—capital, labor, and technology. The theory is typically operationalized using production functions such as the Cobb-Douglas production function, where output (Y) is expressed as:

$\mathbf{Y= AK^{\alpha}. L^{\beta}}$……………………………………….(1)

Where:

Y = Output,

A = Total factor productivity (a proxy for technology),

K = Capital input,

L = Labor input,

α, β = Output elasticities of capital and labor, respectively.

In applying this framework to the Nigerian manufacturing sector, this study treats electricity consumption as a proxy for capital input. This is justified on the basis that in manufacturing, capital is not only physical infrastructure and machinery but also includes energy resources necessary to operate such equipment. In developing economies like Nigeria, where power infrastructure is a key constraint, electricity functions as an enabling capital input, determining the extent to which installed capital can be effectively utilized. In this sense, electricity is not just an intermediate input but a critical determinant of productive capital use.

Furthermore, the role of technological change—commonly captured by the total factor productivity term A—is indirectly represented through macroeconomic variables such as the exchange rate, inflation, and monetary policy rate. These variables influence access to imported technology and capital goods (through exchange rate fluctuations), cost-push inflation pressures (which can erode investment in innovation and maintenance), and the cost and availability of credit (through monetary policy rates), all of which affect firms' ability to adopt new technologies and scale production.

Thus, while electricity consumption directly reflects the operational capacity of capital, the broader macro-financial environment, as reflected in exchange rate volatility, inflation, and monetary policy rates, indirectly captures the efficiency and adaptability of technological change in the manufacturing process. Applying the Neoclassical Production Theory in this context allows for the assessment of how variations in electricity supply (capital proxy) and macroeconomic volatility (technology proxies) jointly impact manufacturing output in Nigeria.

3.2 Model Specification

The functional model for the study is presented as;

MO =F(EXR, ELECT, INF, MPR)…………………….(2)

MO = Manufacturing sector output

EXR= Exchange rate per dollar /USD

ELECT= Electricity consumption in KWh

INF= Inflation in %

MPR= Monetary Policy Rate in % (as a proxy for monetary policy)

Equation one is transformed into an econometric model and logged to avoid heteroscedasticity and unify variables with different measurement forms, allowing the coefficients of the variables to be interpreted as elasticities and preventing both heteroskedasticity and multicollinearity.

Although there is debate regarding whether percentage variables (like exchange rate and inflation) should be transformed into logarithms, this study logged the variables to account for skewness, linearize trends in time series variables, and stabilize variance.

Although exchange rate and inflation are in percentage terms, they are logged to reduce skewness and stabilize variance, $LnMO = \beta 0 + \beta 1\ LnEXRt + \beta 2\ LnELECTt + \beta 3\ LnINFt + \beta 4\ LnMPRt + U_t$ ……………………………………………(2)

This denotes that manufacturing sector output is a function of exchange rates and electricity consumption.

Equation (2) can be transformed into an econometric model of the ARDL model as thus: $\Delta MSOt = \alpha 0 + \sum \alpha 1i\ j\ i=1\ \Delta MO_{t-i} + \sum \alpha 2i\ j\ i=1\ \Delta EXR_{t-i} + \sum \alpha 3i\ j\ i=1\ \Delta ELECT_{t-i} + \sum \alpha 4i\ j\ i=1\ \Delta INF_{t-i} + \sum \alpha 5i\ j\ i=1\ \Delta MPR_{t-i} + U_t$ ……………………….(3)

Where; α 1i, $\alpha 2i$, $\alpha 3i$, $\alpha 4i$, $\alpha 5i$ are parameters u_t = error term

3.3 Estimation Procedure

Before the application of the ARDL technique, the stationarity test was conducted using the ADF (Augmented Dickey-Fuller Test), Lag length selection was done, the ARDL bound test was employed to test for long run cointegration among the variables, and ARDL short-run dynamics was retained for the analyses. To ensure the reliability of the result, serial correlation, heteroskedasticity, normality, and stability tests were carried out.

3.4 Data and Data Sources

The Study employs secondary data obtained from the publications of various government agencies. The data on (Manufacturing output, exchange rates, inflation, and monetary policy rates) is obtained from the Central Bank of Nigeria (CBN). While data on electricity consumption in Nigeria is obtained from the World Development Indicators statistical bulletin.

3. RESULTS AND DISCUSSIONS

Table 1 presents the descriptive statistics for manufacturing output (MSO), Exchange rate (EXR), Electricity Consumption (Elect), Inflation (INF), and Monetary Policy Rates (MPR). The mean values of manufacturing output, Exchange rate, and Electricity Consumption are presented as 7.477%, 4.569%, and 4.862%, 2.655%, and 2.582%, respectively. The skewness of the variables is -0.470, -0.613, and 0.659, which are negative for Manufacturing output, exchange rate, and monetary policy rate, respectively. In contrast, 0.875 and 1.096 depict positive skewness for electricity consumption and inflation, respectively. The P-value of the Jarque-Bera test of the variables is 0.317, 0.243, and 0.086, suggesting that manufacturing output, exchange rates, and electricity consumption are normally distributed at P-values of 0.317, 0.2431, and 0.086, respectively. While inflation and exchange rate are not normally distributed at P-values of 0.043 and 0.025, respectively.

Table 1: Descriptive Statistics

	MO	MPR	INF	EXR	ELECT
Mean	7.477319	2.582048	2.655848	4.569788	4.862336
Median	7.641320	2.602690	2.555410	4.862599	4.875150
Maximum	9.102061	3.258097	4.288204	6.134482	5.390142
Minimum	4.434026	1.791759	1.684176	2.197236	4.559662
Std. Dev.	1.440923	0.289096	0.633709	1.147052	0.193677
Skewness	-0.470113	-0.659989	1.096751	-0.613288	0.875188

Kurtosis	2.113362	4.678972	3.722416	2.256977	3.700357
Jarque-Bera	2.296459	6.271772	7.333332	2.827786	4.887185
Probability	0.317198	0.043461	0.025562	0.243195	0.086848
Sum	246.7515	85.20759	87.64297	150.8030	160.4571
Sum Sq. Dev.	66.44028	2.674443	12.85080	42.10328	1.200350
Observations	33	33	33	33	33

Source: Authors' computation using Eviews 12

Unit Root

The unit root test result in Table 2 reveals that the variables exchange rates, electricity consumption and monetary policy rates are integrated of order one. They are non-stationary at the levels but become stationary after the first difference. However, manufacturing output and inflation revealed 1(0), meaning the data on manufacturing output and inflation are stationary at levels. This suggests that the null hypothesis is accepted. In an occasion where there exist some variables that are stationary at first difference and some variables are stationary at levels, the best model to use is the Auto Autoregressive Distributed lag Model as proposed by Pesaran and Shin (1999).

Table2: Stationarity test/Unit root test

Variables	**ADF**	**Critical Values@ 5%**	**Order of Integration**
MO	-3.332436	-2.945842	**I(0)**
EXR	-5.619748	-2.945842	**I(1)**
ELECT	-6.372435	-2.960411	**I(1)**
INF	-3.910537	-2.945842	**I(0)**
MPR	-7.243009	-2.945842	**I(1)**

Source: Authors' computation using Eviews 12

Lag Selection

After the unit root test, it is necessary to determine the lag length for the ARDL estimation. Table 3 shows that lag 2 is the best lag selected based on Sequential modified LR Statistics, Final Prediction Error, Akaike Information Criterion, and Human-Quinn Information. Therefore, the ARDL model is estimated using lag 2.

Table 3: Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-67.99374	NA	7.64e-05	4.709273	4.940562	4.784668
1	54.00237	196.7679	1.50e-07	-1.548540	-0.160811*	-1.096175
2	88.91505	45.04861*	9.07e-08*	-2.188067*	0.356103	-1.358731*

Source: Authors' computation using Eviews 12

ARDL BOUND CO-INTEGRATION

Having tested the stationarity status of the series under investigation, the variables will be cointegrated if they have a long-run or equilibrium relationship with each other. Pesaran and Shin (2001) developed a model to introduce an alternate co-integration technique known as the ARDL bounds testing approach. This approach has many advantages over the previous co-integration techniques. The table reveals that the bound test of the F-statistic (2.007) is lower than both the lower bound (2.56) and the upper bound (3.49) at 5% critical values. This suggests that the null hypothesis of no co-integration is accepted, thereby confirming the non-existence of a long-run equilibrium relationship among the variables under study. This implies that the variables do not share a long-run equilibrium relationship, and hence the analysis focuses on short-run dynamics only.

Table 4: ARDL BOUND COINTEGRATION

F-statistic	2.007144	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Authors' computation using Eviews 12

DYNAMIC ARDL SHORT RUN RESULT

The results of the dynamic short-run ARDL model presented in Table 4 indicate that the first and second lags of manufacturing output are statistically significant, suggesting strong autoregressive behaviour in the sector. Electricity consumption exhibits a positive but statistically insignificant impact on manufacturing output. Specifically, a 1% increase in electricity consumption is associated with a 0.054% rise in manufacturing output, although this impact is not significant at the 5% level. Similarly, the exchange rate has a positive and statistically insignificant impact, with a 1% increase in the exchange rate leading to a 0.051% increase in manufacturing output. Inflation also demonstrates a positive but insignificant impact, as a 1% rise in the inflation rate results in a 0.012% increase in manufacturing output.

Regarding monetary policy, the current value of the monetary policy rate (MPR) has a negative and statistically insignificant impact, implying that a 1% increase in MPR reduces manufacturing output by 0.016%. The first lag of the MPR shows a positive but insignificant effect, with a 1% increase in MPR at this lag associated with a 0.046% rise in manufacturing output. Notably, the second lag of the MPR is negative and statistically significant, indicating that a 1% increase in MPR at this lag reduces manufacturing output by 0.141%. This finding underscores the delayed adverse effect of monetary tightening on industrial performance in Nigeria. The R^2 of the model reveals that about 99.8% of the variations in the manufacturing output were explained by the electricity consumption, exchange rate, inflation, and monetary policy rate. Therefore, the model is a good fit. The Durbin-Watson statistic of 2.35 depicts the absence of serial correlation.

The results from the dynamic short-run ARDL model offer valuable insights into the factors influencing manufacturing output in Nigeria and align with, yet also extend, the existing empirical literature. Notably, the findings reveal that the first and second lags of manufacturing output are statistically significant, indicating the strong autoregressive nature of the sector and the presence of inertia in industrial production. Electricity consumption was found to have a positive but statistically insignificant impact on manufacturing output. This finding is consistent with Omotosho and Ogu (2021), who established a long-run relationship between electricity supply and manufacturing sector performance in Nigeria, as well as Gold et al. (2024), who observed that the beneficial effects of electricity consumption materialize more prominently over time. The positive coefficient, although insignificant, suggests that energy remains a critical input for manufacturing, yet the insignificant effect may be attributed to persistent power outages, reliance on alternative sources such as diesel generators, and inefficiencies in electricity distribution.

Similarly, the exchange rate exhibited a positive but statistically insignificant effect on manufacturing output. This aligns with the mixed evidence in prior studies. Akeem (2019) found that exchange rate changes significantly influence manufacturing output. Theoretically, exchange rate depreciation should make exports more competitive, thereby stimulating output. However, in Nigeria's context, where a large portion of manufacturing inputs are imported, depreciation can increase production costs, neutralizing potential gains from export competitiveness (Gbarawae et al., 2025). This study also found inflation to have a positive but statistically insignificant impact. While moderate inflation may signal robust demand and stimulate production, high inflation can distort input costs and consumer purchasing power. Akeem (2019) also reported an insignificant relationship between inflation and manufacturing output, suggesting that firms may have adapted to inflationary conditions or passed on cost increases to consumers.

Monetary policy, represented by the monetary policy rate (MPR), displayed a more complex dynamic. The current value of the MPR had a negative but insignificant impact on manufacturing output, suggesting limited immediate responsiveness of the sector to interest rate changes. The first lag of MPR was positive but statistically insignificant, while the second lag had a negative and statistically significant effect. This delayed contractionary impact indicates a lagged monetary transmission mechanism, in which monetary tightening adversely affects manufacturing output only after some time. This finding aligns with the work of Akinmulegun and Falana (2018), who identified a lagged and significant response of industrial output to macroeconomic shocks such as interest rate changes. The model exhibits strong diagnostic properties. The R^2 value of 99.8% signifies that the model explains nearly all variations in manufacturing output, while the Durbin-Watson statistic of 2.35 confirms the absence of serial correlation, supporting the robustness of the estimates.

Table 4: Dynamic ARDL Short Run Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LMO(-1)	1.535310	0.163070	9.415033	0.0000
LMO(-2)	-0.610065	0.155382	-3.926231	0.0006
LELECT	0.054253	0.100426	0.540235	0.5940
LEXR	0.051242	0.036101	1.419400	0.1686
LINF	0.012445	0.023064	0.539594	0.5944
LMPR	-0.016813	0.056750	-0.296258	0.7696
LMPR(-1)	0.046025	0.061362	0.750048	0.4605
LMPR(-2)	-0.141597	0.056112	-2.523471	0.0187
C	0.361933	0.408307	0.886423	0.3842

R-squared	0.998465	Mean dependent var	7.477319
Adjusted R-squared	0.997953	S.D. dependent var	1.440923
F-statistic	1951.528	Durbin-Watson stat	2.395115
Prob(F-statistic)	0.000000		

Source: Authors' computation using Eviews 12

DIAGNOSTIC TEST

Table 5: Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.651239	Prob. F(2,22)	0.0930
Obs*R-squared	6.409006	Prob. Chi-Square(2)	0.0406

Source: Authors' computation using Eviews 12

From the table, Prob-Value of the F-Statistics, it depicts that the null hypothesis of no serial correlation in the residuals is accepted. Meaning that the variables are free from serial correlation.

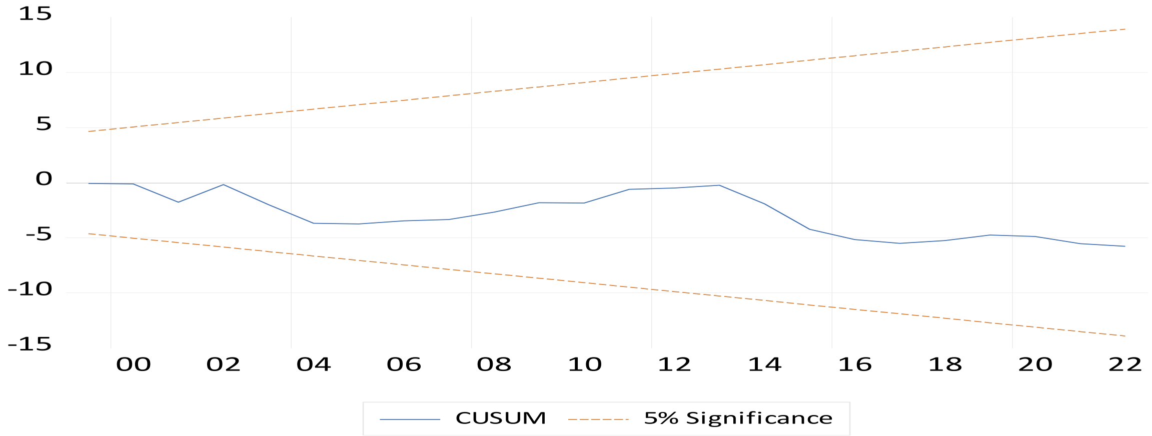

Figure 1: Stability Test of the variables under study

The Cumulative Sum presented reveals that the model employed is stable at a 5% level of significance. It shows that the model is stable because the CUSUM did not cross either of the top or bottom lines at a 5% level of Significance. It fluctuates within the Up and down region.

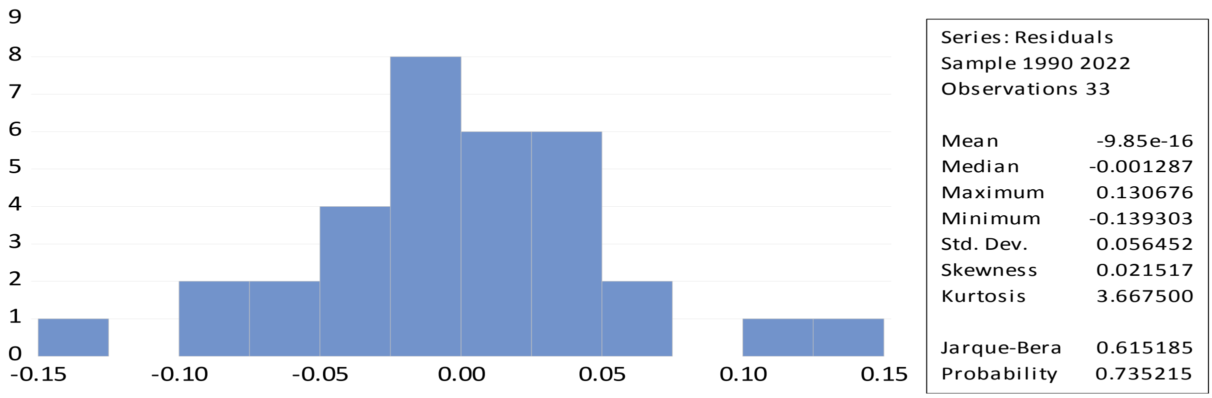

Figure 2: Normality test of the variables under study.

Figure 2 depicts the normality test of the variables under study. The probability value of 0.615 of the Jarque-Bera test depicts that the data used for the estimate is normally distributed. Hence, the variables are free from serial correlation, normally distributed, and stable. This means that the results or findings are valid for policy formulations and recommendations.

4. CONCLUSION AND POLICY RECOMMENDATIONS

This study revealed that while electricity consumption, exchange rate, and inflation were positively related to manufacturing output, their short-run impacts were not statistically significant, possibly due to underlying structural deficiencies, such as infrastructural bottlenecks and macroeconomic volatility. Notably, the significant negative impact of the second lag of the MPR reveals the delayed and contractionary influence of tight monetary policy on the manufacturing sector. This highlights the importance of policymakers recognizing time lags in policy transmission and tailoring their interventions accordingly. The findings support the argument that while macroeconomic variables matter, their effectiveness in influencing real sector outcomes such as manufacturing depends critically on timing, structure, and sectoral context.

Policy Recommendations

Based on the findings, this study therefore recommends that:

i) There is a need for the government to enhance the electricity infrastructure and energy efficiency, as a reliable energy supply is critical to manufacturing output growth. It is therefore recommended that the Federal Ministry of Power, in partnership with the Nigerian Electricity Regulatory Commission (NERC) and the Transmission Company of Nigeria (TCN), to prioritize sustained investment in electricity infrastructure. Specific interventions should include the modernization and expansion of the national grid to minimize outages, the integration of renewable energy sources through the Rural Electrification Agency (REA), and the regulation of alternative power sources such as diesel generators. These measures are essential to ensuring an affordable and stable energy supply for manufacturing firms.

ii) There is a need to stabilize the exchange rate through export diversification. This study found that exchange rate instability undermines manufacturing output, underscoring the need for a more stable naira. The Central Bank of Nigeria (CBN), in collaboration with the Federal Ministry of Industry, Trade, and Investment, should intensify efforts to diversify the country's export base beyond oil. This may be achieved through greater support for value-added sectors such as agro-processing, textiles, and solid minerals. Additionally, the Nigerian Export Promotion Council (NEPC) should lead initiatives that facilitate access to international markets for non-oil exporters. A more diversified export structure will reduce dependence on imported inputs, enhance foreign reserve buffers, and support exchange rate stability.

iii) The government should focus on coordinating fiscal and monetary policies to manage inflation. The moderate and statistically insignificant relationship between inflation and manufacturing output observed in the study suggests that manufacturers may have adapted to prevailing inflationary pressures. Nevertheless, persistent inflation poses a risk to production costs. To this end, the Federal Ministry of Finance, Budget, and National Planning, in conjunction with the CBN, should pursue a coordinated policy framework that keeps inflation within a moderate and predictable range. Inflation targeting must be informed by sector-specific data, which the National Bureau of Statistics (NBS) should produce regularly to support evidence-based policymaking.

iv) The government should focus on managing interest rate adjustments with sectoral sensitivity. The significant negative impact of the second lag of the Monetary Policy Rate (MPR) on manufacturing output highlights the importance of accounting for policy transmission lags. The CBN's Monetary Policy Committee (MPC) should carefully consider the timing and magnitude of interest rate adjustments, emphasizing the need to protect productive sectors from adverse effects. Moreover, the CBN Development Finance Department (DFD) should design and implement targeted credit interventions for the manufacturing sector, such as concessional interest rates and sector-specific lending facilities. Partnerships with the

Bank of Industry (BOI) and commercial banks are essential for facilitating affordable and accessible financing, especially during periods of monetary tightening.

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