

Interest Rate Volatility and Manufacturing Sector Growth in Nigeria

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DOI: <https://doi.org/10.51583/IJLTEMAS.2026.150900066>

Received: 23 September 2026; Accepted: 28 September 2026; Published: 12 October 2026

ABSTRACT

This study examines the relationship between interest rate volatility and manufacturing sector growth in Nigeria using annual secondary time-series data for 1981–2023. Manufacturing sector output-to-GDP (MQ/GDP) is used as the principal measure of manufacturing sector growth, while lending rate (LR), inflation rate (INFR), manufacturing sector capacity utilization (MANCU), and an economic-reform dummy (D01) are included in the empirical framework. The study adopts an ex-post facto research design and combines descriptive statistics, correlation analysis, augmented Dickey–Fuller unit-root testing, the ARDL bounds approach to cointegration, Granger causality, and post-estimation diagnostics. The results indicate that interest-rate dynamics are statistically important for manufacturing performance. The long-run ARDL coefficient of lending rate is positive but statistically insignificant (0.0304; $p=0.8449$). The ARDL bounds test produces an F-statistic of 4.0388, exceeding the 5% upper bound of 4.01, confirming a long-run relationship among the model variables. The error-correction coefficient is negative (-0.3120), indicating adjustment toward long-run equilibrium. Granger-causality results show one-way causality from MQ/GDP to inflation and from MQ/GDP to manufacturing capacity utilization, while the direct lending-rate/MQ/GDP pair is not statistically causal at the selected lag length. Diagnostic tests indicate no serious autocorrelation or heteroskedasticity and support the stability of the estimated model. The study concludes that predictable and investment-supportive interest-rate conditions are important for sustained manufacturing development in Nigeria.

Keywords: interest rate volatility; manufacturing sector; lending rate; capacity utilization; inflation; ARDL; Nigeria.

INTRODUCTION

Background to the Study

A nation's investment activity and, consequently, its economic growth are largely determined by the behavior of interest rates (Adeleke & Ogunleye, 2020). The rate of interest charged when borrowing money from the market determines investment, but the amount of investment has a significant impact on economic growth. Interest can be simply defined as the cost of using someone else's money, or, from a different perspective, as the cost of granting permission to use someone else's money. The incentive for giving up liquid for a predetermined amount of time is the function of interest rates. Eze, & Okonkwo, (2021). asserts that a high rate indicates low investment. Promoting an interest rate regime that will guarantee “inexpensive” spending for investment and thereby enhance economic growth at low financial cost is essential because low interest rates encourage investment. The government may believe that it is vital to address the drawbacks of the price fixing procedure in order to guarantee that what is economically sane for one bank is rightly logical for all. Bank interest rates could be controlled to promote saving, guarantee and expedite sufficient investment for swift expansion and development.

Given its function in facilitating the efficient collection and distribution of financial resources, interest rate fluctuations are a crucial factor in the loanable funds market. The Nigerian government set the interest rate's level and structure before the Structural Adjustment Programme (SAP) was adopted in 1986. Interest rate regulation was primarily done to support an orderly expansion of the financial markets, reduce the responsibility of government debt servicing, fight inflation, and achieve the ideal social situation in resource allocation to the desired sector. Credit to manufacturing, residential house development, and agricultural was subject to below-market interest rates and prejudiced terms in order to promote the distribution of domestic credit to the sectors of greatest need. In general, this policy resulted in negative selection and ethical risk, which were unforeseen outcomes (Akinlo & Lawal, 2020). Beginning in July 1986, market forces were the foundation of the financial sector reforms. In order to guarantee allocative efficiency and enhance the incentive structure, its goal was to eradicate financial repression. Developments in the financial markets and overall economic health have influenced the regulatory bodies' policy approach. Reforms in policy had occurred at different points in time as a result of the necessity to address new issues. The Central Bank of Nigeria's minimum rediscount rate, which averaged 19.8% in 1980–1986; 28.6% in 1987–1996; and 42.9 percent in the 1997–2000s, respectively, became the nominal foundation of its interest rate in the movement of bank credit after all forms of interest rate control were lifted by October 1996 as a result of further financial sector openness.

However, interest rates have increased as an unexpected outcome of the policy change from controls to liberalization, particularly between 1986 and 1993. The interest rate fluctuated after being rather constant from 1994 to 1997 (CBN, 2022). The purpose of this study is to conduct a scientific investigation of the effects of interest rate movement on the growth of Nigeria's manufacturing sector from 1981 to 2025, taking into account the aforementioned.

Problem Statement and Research Gap

The Nigerian manufacturing sector has experienced recurrent periods of weak performance despite repeated financial and monetary reforms. A central concern is that the cost and predictability of finance may not have evolved sufficiently to support long-term industrial investment. When lending rates rise unexpectedly or fluctuate substantially, firms face uncertainty over financing costs and may postpone investment, reduce inventories, operate below capacity or abandon expansion plans. Such effects can be especially consequential in an environment where firms already face high energy, transport and imported-input costs.

The evidence available in the source study is inconclusive. Ajayi et al. (2023) report that interest rates did not have a discernible effect on industrial production, whereas Tiaga and Adofu (2021) found a positive but insignificant relationship between lending rate and manufacturing-sector growth. By contrast, Ozigbo (2020), Idisi et al. (2019), Ogar et al. (2018) and Odeleye and Taiwo (2017) report negative effects of interest rates or interest-rate fluctuations on manufacturing performance. These differences may partly reflect differences in samples, dependent variables, model specifications and methods used to represent volatility.

Three gaps are therefore emphasized. First, several earlier studies focus on the level of interest rates rather than estimating a conditional measure of volatility. Second, the manufacturing sector is sometimes represented by broad industrial output rather than a manufacturing-output-to-GDP measure that captures the sector's relative contribution to the economy. Third, the source study argues that manufacturing capacity utilization and the policy-reform environment should be considered alongside interest-rate dynamics.

The article consequently addresses the following questions: (i) What is the effect of interest-rate dynamics/volatility on manufacturing-sector growth in Nigeria? (ii) What causal direction exists between manufacturing output and the key macroeconomic variables? and (iii) Is there a long-run relationship among manufacturing output, lending rate, inflation, capacity utilization and economic reform?

The study's contribution is thus methodological and contextual: it evaluates interest-rate dynamics using

EGARCH, tests long-run relationships using ARDL bounds, and places the results within Nigeria's history of financial liberalization and industrial policy.

Objectives, Hypotheses and Significance

The broad objective is to evaluate the impact of interest-rate volatility on manufacturing-sector growth in Nigeria. Specifically, the study seeks to: (1) evaluate the impact of interest-rate dynamics/volatility on manufacturing output; (2) investigate the direction of causality between manufacturing output and the model variables; and (3) determine whether a long-run relationship exists among manufacturing output, interest rate, inflation, manufacturing capacity utilization and economic reform.

The hypotheses are stated in null form as follows:

H01: Interest-rate volatility has no significant impact on manufacturing output in Nigeria.

H02: There is no significant causal relationship between interest-rate dynamics and manufacturing output in Nigeria.

H03: Interest-rate volatility has no significant long-run relationship with manufacturing output in Nigeria.

The study is relevant to monetary authorities because interest-rate policy affects the financing environment in which productive firms operate. It is also relevant to commercial banks because lending-rate movements influence the demand for credit, loan pricing and the risk profile of manufacturing borrowers. For government and industrial-policy institutions, the evidence can inform policies intended to improve productive investment, domestic production and employment. Researchers and students may also use the framework as a basis for further work on monetary transmission and industrial development.

A scope clarification is necessary for publication. The original document occasionally states a 1981–2023 scope, but the reported econometric estimations, EGARCH output, Granger tests and ARDL results are based on observations through 2023. This journal version therefore uses 1981–2023 as the empirical study period, because that is the period actually represented by the reported estimation results. The source text itself confirms that the reported annual data were drawn from the CBN Statistical Bulletin and World Bank Indicators Database and cover 1981–2023.

LITERATURE REVIEW

Conceptual Literature

Concept of Interest Rate

Interest rate refers to the cost of borrowing money or the return earned on savings or investments, expressed as a percentage of the principal amount over a specified period. It represents the price paid by borrowers to lenders for the use of funds and serves as one of the most important instruments of monetary policy. In Nigeria, the Central Bank of Nigeria (CBN) influences interest rates through the Monetary Policy Rate (MPR), which affects commercial banks' lending and deposit rates. Changes in interest rates influence the decisions of households, businesses, and investors regarding consumption, saving, borrowing, and investment, (Acha, & Acha, 2022).

Interest rates play a critical role in determining the level of economic activity. When interest rates are low, borrowing becomes less expensive, encouraging businesses to obtain loans for investment in machinery, technology, and expansion of production. Consumers are also more likely to finance purchases of homes, automobiles, and other durable goods, thereby stimulating aggregate demand and economic growth. Conversely, high interest rates increase the cost of borrowing, discourage investment, reduce consumer spending, and may slow economic growth. For the manufacturing sector, high lending rates often translate

into increased production costs, reduced profitability, and lower competitiveness, especially in developing economies where firms rely heavily on bank credit, (Mishkin, 2022).

Interest rates can be classified into several categories, including nominal interest rates, real interest rates, fixed interest rates, floating (or variable) interest rates, lending rates, and deposit rates. The nominal interest rate is the stated rate before adjusting for inflation, while the real interest rate reflects the inflation-adjusted cost of borrowing. Lending rates refer to the rates commercial banks charge borrowers, whereas deposit rates are paid to individuals and organizations that save money with financial institutions, (Adewale, & Bello, 2025).

In Nigeria, fluctuations in interest rates have significant implications for the manufacturing sector. High lending rates can discourage firms from accessing credit needed to finance production, purchase equipment, and adopt modern technologies. This often results in reduced manufacturing output, lower employment generation, and slower industrial growth. On the other hand, stable and moderate interest rates improve access to finance, encourage investment in productive activities, and enhance the overall performance of the manufacturing sector. Therefore, maintaining an appropriate interest rate environment remains essential for promoting sustainable industrial development and economic growth, (Adewale, & Bello, 2025).

Interest rate Volatility

Interest rate volatility refers to the degree of fluctuation or variability in interest rates over a given period of time. These changes can be driven by a multitude of economic, political, and market-based factors, and they play a critical role in shaping the financial landscape. For investors, borrowers, financial institutions, and policymakers, understanding and managing interest rate volatility is of paramount importance due to its wide-reaching implications, (Chen, 2024)

At the core of interest rate movements lies monetary policy, typically guided by a country's central bank. Central banks adjust benchmark interest rates, such as the federal funds rate in the United States, as a means of controlling inflation, encouraging investment, and stabilizing economic growth. When inflation is high, central banks may raise interest rates to curb excessive spending. Conversely, during periods of economic slowdown, lowering interest rates can stimulate borrowing and investment. These policy shifts, especially when unexpected, can lead to heightened interest rate volatility.

Macroeconomic indicators such as inflation rates, GDP growth, employment data, and fiscal policy decisions also influence interest rate movements. For instance, a sudden surge in inflation could trigger market fears of tighter monetary policy, resulting in rapid upward movement in interest rates. Similarly, geopolitical tensions, natural disasters, and shifts in global demand and supply chains can introduce uncertainty, causing interest rates to swing unpredictably, (Ac-Ogbonna, 2021).

Inflation Rate

Inflation rate refers to the rate at which the general level of prices for goods and services in an economy rises over a specific period, usually measured annually. It is a key economic indicator that reflects the purchasing power of money and the cost of living. When inflation is moderate, it is generally considered a sign of a growing economy, but when it becomes too high or too low, it can create significant challenges for consumers, businesses, and policymakers alike.

At its core, inflation represents the erosion of money's value. For example, if the inflation rate is 5%, something that costs \$100 today would cost \$105 a year from now. This gradual increase in prices affects how much consumers can buy with their income. When wages do not keep pace with inflation, people may find it more difficult to afford basic necessities such as food, housing, and healthcare. Over time, this reduces their standard of living and can lead to social and economic stress, (Eze, & Obi, 2025).

Several factors contribute to inflation. One of the most common is demand-pull inflation, which occurs when the demand for goods and services exceeds their supply. This can happen in a growing economy where consumer confidence is high and spending increases rapidly. Another type is cost-push inflation, which arises when the cost of production increases due to rising prices of raw materials, labor, or energy and businesses pass these costs onto consumers. Structural issues, such as supply chain disruptions or regulatory policies, can also play a role in driving inflation. Monetary policy, particularly actions taken by central banks, plays a critical role in managing the inflation rate. Central banks may raise interest rates to cool down an overheating economy and reduce inflationary pressure, or they may lower interest rates to stimulate borrowing and spending during periods of low inflation or deflation. In this way, central banks aim to maintain price stability, which is vital for economic growth and investor confidence, (Laurenceson, & Chai, 2021).

Manufacturing Sector Growth and Manufacturing Sector Output

A subset of the industrial sector, the manufacturing sector transforms raw resources into intermediate, producer, or final consumer goods (Ac-Ogbonna, 2021). The manufacturing sector generates jobs, contributes to economic diversification, raises foreign exchange revenues, increases agricultural output through backward linkage, and helps make the most of the country's resources. All of Nigeria's sectors that produce goods and services add up to the country's manufacturing sector's total output. A measure of the sector's output is the manufacturing production index. Nigeria's foreign exchange profits from the sale of crude oil have been significantly impacted by the worldwide economic crises that followed in the 1980s, and the production growth rates have been typically low and occasionally negative (Ac-Ogbonna, 2021). The manufacturing output, according to Ogar, Eja, and Gbenga, (2021), is the sum of the output from all of the facilities in the nation that produce items. A nation's manufacturing output, which is a subset of its industrial output, is the total output of its factories. Manufacturing production is the overall output of industries that produce things in factories or plants over a given period of time.

Theoretical Literature

Liquidity Preference Theory

The **Liquidity Preference Theory** was developed by the British economist **John Maynard Keynes** in 1936 and was presented in his influential book, *The General Theory of Employment, Interest and Money*. Keynes introduced the theory to explain how interest rates are determined through the interaction between the demand for money (liquidity preference) and the supply of money. According to Keynes, people prefer to hold a portion of their wealth in liquid form (cash or cash equivalents) because it provides flexibility and security. The interest rate, therefore, is the reward paid to individuals for giving up liquidity and holding less liquid financial assets. Keynes argued that interest rates are primarily a monetary phenomenon rather than being determined solely by the supply and demand for savings and investment. This theory remains one of the most influential frameworks in macroeconomics and monetary policy analysis, particularly in explaining the relationship between money supply, interest rates, investment decisions, and economic growth.

Assumptions of the Liquidity Preference Theory

The Liquidity Preference Theory is based on several key assumptions:

Individuals prefer liquidity. People prefer holding cash because it offers immediate purchasing power and flexibility in meeting unexpected financial obligations.

Money is demanded for three motives. Keynes identified the transaction motive (to meet everyday expenses), the precautionary motive (to meet unforeseen emergencies), and the speculative motive (to take advantage of future investment opportunities).

Interest is the reward for parting with liquidity. Investors require compensation in the form of interest for

sacrificing the convenience and security associated with holding cash.

The money supply is controlled by the central bank. The central bank influences interest rates by increasing or decreasing the supply of money through monetary policy instruments.

Interest rates influence investment decisions. Lower interest rates encourage businesses to borrow and invest, while higher interest rates discourage borrowing and reduce investment activities.

People make rational financial decisions. Economic agents allocate their wealth between cash and interest-bearing assets based on expected returns and future interest rate movements.

EMPIRICAL LITERATURE

The empirical literature on interest rate, exchange rate, macroeconomic instability and manufacturing-sector performance in Nigeria reveals a generally important, but not entirely consistent, relationship between financial-market conditions and productive-sector outcomes. Across the reviewed studies, interest rate and exchange rate conditions emerge as important determinants of firms' investment decisions, production costs, access to credit and ultimately sectoral performance. However, the direction and magnitude of these effects vary considerably, suggesting that the relationship is sensitive to the type of volatility considered, the period covered, the sector examined, and the estimation technique employed.

For instance, **Osazevaru (2021)** provides evidence that financial-market volatility has a long-run relationship with SME performance in Nigeria. Using annual data from 1981–2018 and combining ARCH modelling with ARDL bounds testing, the study found that both interest-rate and exchange-rate volatility were positively associated with SME performance, although only exchange-rate volatility was statistically significant. This finding is particularly important because it challenges the conventional assumption that macroeconomic volatility necessarily constrains productive activity. The positive association may reflect the ability of some firms to adjust their pricing, sourcing and investment decisions in response to exchange-rate movements. However, the result for SMEs should not be generalized automatically to the manufacturing sector, where firms may have greater dependence on imported machinery, intermediate inputs and foreign exchange. Thus, Osazevaru's findings demonstrate the importance of **sectoral differences** in understanding the consequences of macroeconomic volatility.

In contrast, **Ac-Ogbonna (2021)** reports a more adverse relationship between macroeconomic instability and manufacturing production. By examining inflation, lending rates and exchange rates, the study concludes that macroeconomic instability negatively affects manufacturing output. This finding provides a stronger theoretical basis for expecting unstable financial conditions to constrain manufacturing activity because increases in production costs, financing costs and imported-input prices can reduce firms' productive capacity. Nevertheless, the use of descriptive analysis limits the extent to which the study can establish dynamic or causal relationships among the variables. The difference between this result and Osazevaru (2021) therefore suggests that the effect of macroeconomic instability may depend partly on **sectoral characteristics and methodological design**.

The evidence concerning lending rates is similarly mixed. **Tiaga and Adofu (2021)**, using OLS for the period 1986–2020, found that lending rates had a positive but statistically insignificant effect on manufacturing-sector growth. Rather than interpreting the result as evidence that interest rates are irrelevant, the finding may indicate that the manufacturing sector's response to lending costs is more complex than a simple contemporaneous relationship. Firms may rely on retained earnings, informal financing, trade credit or other sources of capital, thereby weakening the immediate effect of bank lending rates on output. However, the study's OLS framework may not adequately capture the dynamic adjustment between interest rates and manufacturing output.

A different conclusion is reported by **Ozigbo (2020)**, who examined interest-rate fluctuations and manufacturing performance between 1980 and 2019 using cointegration and ARCH/GARCH techniques.

The study found that high interest rates constrained manufacturing performance and that interest-rate dynamics were relevant to the sector's behaviour in both the short and long run. The existence of a long-run relationship is particularly relevant because it implies that the effect of financing conditions may extend beyond temporary changes in manufacturing output. When considered alongside Tiaga and Adofu (2021), the contrasting findings demonstrate an important empirical inconsistency: while one study finds a positive but insignificant effect of lending rates, another identifies adverse effects from high and volatile interest rates. This inconsistency creates a need for further investigation using methods capable of distinguishing **short-run effects from long-run equilibrium relationships**.

The role of financial-sector development also emerges from **Omonzejie and Madueme (2020)**. Using quarterly data from 1985Q1 to 2018Q4 and an ARDL framework, the study found positive but insignificant relationships between manufacturing-sector output and selected financial-development indicators in both the short and long run. This suggests that simply increasing the availability or size of financial-sector resources may not automatically translate into significant improvements in manufacturing production. The finding shifts attention from the **quantity of finance** to its cost, accessibility, allocation and productive utilization. It also complements the interest-rate literature by suggesting that manufacturing performance depends not only on whether credit exists but also on the conditions under which firms obtain and utilize it.

Further evidence of an adverse interest-rate effect is provided by **Idisi, Ugwu and Safugha (2019)**. Using OLS and data covering 2000–2017, the study reported that higher interest rates negatively affected manufacturing-sector output in both the short and long run. This result is consistent with Ozigbo (2020) and contrasts with the statistically insignificant positive effect reported by Tiaga and Adofu (2021). The consistency between Idisi et al. and Ozigbo is important because both suggest that expensive financing can weaken manufacturing performance. Nevertheless, differences in sample periods and estimation approaches may partly account for the divergent findings across studies.

Similarly, **Opusunju, Akyüz and Santeli (2019)** found that interest rates significantly affected the growth of Nigeria's manufacturing sector using OLS and data from 1985–2015. Their recommendation that banks reduce lending rates reflects the argument that lower financing costs can facilitate investment and expansion. However, the study's focus on a direct relationship between interest rates and manufacturing growth leaves room for further examination of whether the effect operates through investment, production costs, exchange-rate exposure or other transmission channels.

Taken together, the reviewed studies reveal **three major patterns**. First, there is considerable evidence that interest rates and broader macroeconomic conditions are relevant to manufacturing-sector performance. Second, the direction and statistical significance of the relationship are inconsistent: some studies report negative effects, others positive but insignificant effects, while exchange-rate volatility has also been found to have a positive significant effect in the SME context. Third, methodological differences are prominent. Earlier studies relying mainly on OLS or descriptive analysis may not fully capture dynamic interactions, whereas studies employing ARCH/GARCH, cointegration and ARDL approaches provide evidence of volatility and long-run relationships.

The literature therefore points to an important **research gap**. Existing studies have largely examined interest rates, exchange rates, inflation, financial development and manufacturing output either individually or in relatively broad combinations, while comparatively less attention has been given to how these macroeconomic variables jointly influence manufacturing performance while explicitly distinguishing **short-run dynamics from long-run relationships**. In addition, the contradictory findings regarding the direction and significance of interest-rate effects indicate that the relationship remains empirically unsettled. The present study can therefore contribute by employing a dynamic framework capable of identifying both short-run responses and long-run equilibrium relationships among the selected macroeconomic variables and manufacturing-sector performance. This approach moves the literature beyond merely asking whether macroeconomic variables affect manufacturing output to examining **how, in what direction, and over what time horizon such effects occur**.

METHODOLOGY

Research Design

Claybaugh (2020) views research design as the overall strategy utilized to carry out research that defines a succinct and logical plan to tackle established research question(s) through the collection, interpretation, analyses, and discussion of data. In view of the analytical nature of this study, being a purely secondary data analysis research, the *Ex-Post Facto* (a Latin maxim meaning “after the fact”) research design was adopted for the study. This involves the use of published (secondary) data to explain past events by identifying the extent to which the data relate to the events.

THEORETICAL FRAMEWORK

The theoretical underpinning of this work is the liquidity preference theory. The theory explain how interest rates are determined through the interaction between the demand for money (liquidity preference) and the supply of money. the theory to explain how interest rates are determined through the interaction between the demand for money (liquidity preference) and the supply of money. This theory remains one of the most influential frameworks in macroeconomics and monetary policy analysis, particularly in explaining the relationship between money supply, interest rates, investment decisions, and economic growth. Lower interest rates encourage businesses to borrow and invest, while higher interest rates discourage borrowing and reduce investment activities. Economic agents allocate their wealth between cash and interest-bearing assets based on expected returns and future interest rate movements.

Pre-Estimation Tests

Unit -Root Test

In order to avoid spurious regression estimates, a time series data should be examined for stationarity or order of integration. Time series data is accepted to be stationary if “it exhibits mean reversion in that it fluctuates around a constant long-run mean, has a finite variance that is time invariant and has a theoretical correlogram that diminishes as the lag length increases” (Asteriou, 2006).

There are many tests trying to find the order of integration of series and among them Dickey-Fuller, Augmented Dickey-Fuller and Phillips and Perron tests are the most widely used ones in testing the presence of unit roots. Dickey-Fuller (DF) test is based on the following model:

$$\Psi_t = \lambda \Psi_{t-1} + \varepsilon_t \quad (3.7)$$

The model can also be expressed as:

$$\Delta \Psi_t = \varpi \Psi_{t-1} + \varepsilon_t \quad (3.8)$$

where $\varpi = (\lambda - 1)$. This model is called pure random walk model. Null hypotheses are $H_0 : \lambda = 1$ for model (3.7) and $H_0 : \varpi = 0$ for model (3.8). The corresponding alternative hypotheses are $H_a : \lambda < 1$ and $H_a : \varpi < 1$ respectively. If DF test statistic (t-statistic of lagged dependent variable) is less than the critical value, we reject the null hypothesis and conclude that the series is stationary (there is no unit root). Model (3.8) can be extended by including a constant term and/or the trend.

The corresponding models are called random walk with drift and random walk with drift and time trend:

$$\Delta \Psi_t = \alpha_0 + \Omega \Psi_{t-1} + \varepsilon_t \quad (3.9)$$

$$\Delta \Psi_t = \alpha_0 + \beta_2 t + \Omega \Psi_{t-1} + \varepsilon_t \quad (3.10)$$

where: $\Omega = (\lambda - 1)$. The two models have same testing procedures with the random walk model.

However, Equation (3.9) does not consider autocorrelation. Augmented Dickey-Fuller (ADF) test is used to test existence of unit root when there is autocorrelation in the series and lagged terms of the dependent variable are included in the equation. The following three models represent pure random walk, random walk with drift and random walk with drift and trend used in Augmented Dickey Fuller tests:

$$\Delta \psi_t = \Omega \psi_{t-1} + \sum_{i=1}^p \beta_i \Delta \psi_{t-i} + \varepsilon_t \quad (3.11)$$

$$\Delta \psi_t = \alpha_0 + \Omega \psi_{t-1} + \sum_{i=1}^p \beta_i \Delta \psi_{t-i} + \varepsilon_t \quad (3.12)$$

$$\Delta \psi_t = \alpha_0 + \Omega \Psi + \beta_2 t + \sum_{i=1}^p \beta_i \Delta \psi_{t-i} + \varepsilon_t \quad (3.13)$$

Decision Rule

where: $\Omega = (\lambda - 1)$ The null hypothesis is $H_0 : \Omega = 0$ and the alternative hypothesis is $H_a : \Omega < 0$ If ADF test statistic (t-statistic of lagged dependent variable) is less than the critical value, we reject the null hypothesis and conclude that the series is stationary (there is no unit root).

Model Specification

$$MQ/GDP = f(LR, INFR, MANCU, DOI) \quad (3.1)$$

However, in order to capture the other relevant control variable germane to the achievement of the stated objectives; the study incorporates manufacturing sector capacity utilization (*MANCU*) and a dummy variable (*D01*) to capture the periods of interest rate regulation and deregulation in the economy.

Model Specification

$$MQ/GDP_t = \beta_0 + LR_t + \beta_2 INFR_t + \beta_3 MANCU_t + \beta_4 D01_t + \mu_t \dots \dots \dots (3.2)$$

Where;

MQ/GDP = manufacturing sector output-to-GDP

f = functional relationship

$INFR$ = inflation rate (Control Variable)

$MANCU$ = manufacturing sector capacity utilization

D01 = economic reforms (used to proxy the periods of interest rate regulations and deregulations in the economy)

β_0 = constant

β_1 - β_4 = coefficients

μ = unpredictable random variable

t = time period

On the a priori, it is expected that: $\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 > 0$, $\beta_4 > 0$.

Method of Estimation

The specified model will be estimated with autoregressive distributed lag (ARDL) model.

Post Estimation Tests

Normality Test

The normality test will be carried out to ascertain if the residuals of the model are normally distributed. The basis of the decision will be based on the value of the Jaque-Berra [JB]. If the JB statistics yields a value close to or equal to zero, we accept the null hypothesis of normal distribution, but if otherwise we reject the normal distribution hypothesized value.

ANALYSIS OF RESULTS

Result of Preliminary Tests

The study uses 43 annual observations for the principal variables. The descriptive statistics indicate considerable variation in the macroeconomic environment over the sample period. The mean values of MQ/GDP, lending rate (LR), inflation rate (INFR), manufacturing capacity utilization (MANCU), and the reform dummy (D01) are 14.2868, 22.6105, 88.1898, 47.1019 and 0.5581, respectively. The relatively large variation in the macroeconomic variables is consistent with changes in Nigeria's monetary, exchange-rate, inflationary and industrial-policy environment over the period under investigation.

Pair	Correlation	Interpretation
MQ/GDP – LR	−0.3134	Moderate negative association
MQ/GDP – INFR	0.2810	Weak positive association
MQ/GDP – MANCU	−0.1241	Weak negative association
LR – INFR	0.1016	Very weak positive association
LR – MANCU	0.4234	Moderate positive association
INFR – MANCU	−0.1050	Very weak negative association

The minimum, maximum, standard deviation, skewness and kurtosis statistics should also be reported if they are available in the original EViews output. They should not be reconstructed from the means alone.

The correlation matrix provides preliminary evidence regarding the linear association among the variables. MQ/GDP is negatively correlated with LR (-0.3134), suggesting that periods of higher lending rates were generally associated with lower manufacturing output relative to GDP. MQ/GDP has a positive correlation of 0.2810 with inflation and a weak negative correlation of -0.1241 with manufacturing capacity utilization. Among the explanatory variables, LR and MANCU have the largest reported correlation (0.4234).

The correlation coefficients do not, by themselves, establish causality or statistical significance. Nevertheless, they provide useful preliminary evidence concerning the direction of association among the variables. More importantly, none of the reported correlations among the explanatory variables approaches the commonly used **0.80 diagnostic threshold** for potentially serious pairwise multicollinearity. The highest explanatory-variable correlation is 0.4234 between LR and MANCU. This suggests that severe pairwise multicollinearity is unlikely to be the principal problem in the estimated model. However, a more rigorous assessment should ideally supplement the correlation matrix with **variance inflation factors (VIFs)** or tolerance statistics.

Unit Root and Cointegration Results

Variable	Level ADF p-value	First-difference ADF p-value	Order
MQ/GDP	0.8182	<0.01	I(1)
LR	0.2305	<0.01	I(1)
INFR	<0.01	—	I(0)
MANCU	0.1892	<0.01	I(1)

Before estimating the ARDL model, the time-series properties of the variables were examined using the Augmented Dickey-Fuller (ADF) test. This step is important because conventional regression involving non-stationary variables may produce misleading or spurious relationships.

The results indicate that the variables are a mixture of **I(0) and I(1)** processes. INFR is stationary at level, whereas MQ/GDP, LR and MANCU become stationary after first differencing. This combination is compatible with the ARDL bounds-testing approach, provided that none of the variables is integrated of order two, I(2).

For stronger econometric reporting, the complete ADF table should ideally include the **ADF test statistic, 5% critical value, number of lags, deterministic specification (constant/trend), and p-value**, rather than reporting p-values alone.

The ARDL bounds-testing procedure was employed to determine whether a long-run equilibrium relationship exists among MQ/GDP, LR, INFR, MANCU and the reform dummy. The calculated bounds-test F-statistic is 4.038849 .

Table 4.X: ARDL Bounds Test

Test	Statistic	5% Lower Bound I(0)	5% Upper Bound I(1)	Decision
F-statistic	4.038849	2.86	4.01	Reject H_0

Null hypothesis (H_0): No long-run relationship exists among the variables.

Alternative hypothesis (H_1): A long-run relationship exists among the variables.

Since the calculated F-statistic of **4.038849 exceeds the 5% upper-bound critical value of 4.01**, the null hypothesis of no long-run relationship is rejected at the 5% level. The result therefore provides evidence of a long-run relationship among the variables.

The margin, however, is relatively narrow: the calculated F-statistic exceeds the reported upper bound by approximately **0.02885**. Consequently, the result should be reported precisely rather than described as overwhelmingly strong evidence of cointegration.

For a complete ARDL presentation, the table should also report the **2.5%, 10% and/or 1% bounds**, the number of regressors (**k**), and the critical-value source/version used. These should be copied from the actual ARDL output.

ARDL Short-Run and Long-Run Results

Variable	Short-run coefficient	p-value	Long-run coefficient	p-value
ΔLR	-0.133429	0.0149	0.030377	0.8449
$\Delta INFR$	-0.000014	0.9992	-0.009427	0.7263
$\Delta MANCU$	0.049360	0.2023	0.420058	0.2283
$\Delta D01$	-3.081731	0.0113	-15.028677	0.0077
ECM(-1)	-0.311986	0.0698	—	—

The coefficient of ΔLR is **-0.133429 with a p-value of 0.0149**, indicating a statistically significant negative short-run relationship between lending-rate changes and MQ/GDP at the 5% level. Thus, increases in lending rates are associated with reductions in manufacturing output relative to GDP in the short run, holding other factors constant.

However, the long-run coefficient of LR is **0.030377 with a p-value of 0.8449**. Although the coefficient is positive, its very high p-value indicates that the estimated long-run effect is statistically insignificant. Consequently, the result should **not** be interpreted as evidence that lending rates positively affect manufacturing performance in the long run. Rather, the appropriate conclusion is that the study does not find statistically significant evidence of a long-run lending-rate effect within the estimated specification.

Inflation is also statistically insignificant in both horizons. Its short-run coefficient is -0.000014 ($p=0.9992$), while its long-run coefficient is -0.009427 ($p=0.7263$). Hence, the estimated model provides no statistically significant evidence that inflation independently affects MQ/GDP over either horizon.

MANCU has positive coefficients in both the short and long run, with coefficients of 0.049360 ($p=0.2023$) and 0.420058 ($p=0.2283$), respectively. Despite the positive signs, neither coefficient is statistically significant at the 5% level.

The reform dummy has a negative and statistically significant coefficient in both reported horizons. The short-run coefficient is -3.081731 ($p=0.0113$), while the long-run coefficient is -15.028677 ($p=0.0077$). These coefficients should be interpreted as **estimated regime effects associated with the period represented by the dummy**, rather than as proof that reforms intrinsically reduce manufacturing performance. The interpretation depends on how D01 was coded and the precise reform period it represents.

The estimated ECM coefficient is **-0.311986**, with a p-value of **0.0698**. The negative sign is consistent with

the theoretical requirement for convergence toward long-run equilibrium. Its magnitude suggests that approximately **31.20% of the previous period's disequilibrium is corrected in the subsequent period**, conditional on the estimated specification.

However, the statistical evidence requires qualification. Since $0.0698 > 0.05$, the ECM coefficient is not statistically significant at the conventional 5% level. It is, however, below 0.10 and can therefore be described as **marginally significant at the 10% level**, assuming a two-sided test and the reported p-value. The appropriate interpretation is consequently that there is **weak evidence of adjustment toward long-run equilibrium**, rather than conclusive evidence of a statistically significant adjustment mechanism.

This qualification is particularly important because the bounds test provides evidence of cointegration while the ECM coefficient itself has only marginal statistical support. The two results should therefore be reported separately rather than treating the bounds-test finding as automatically establishing a statistically strong error-correction process.

Granger Causality

The results indicate a statistically significant one-way predictive relationship from MQ/GDP to MANCU, while the reverse direction is not significant. Similarly, MQ/GDP Granger-causes INFR at the 5% level, whereas the reverse relationship is not statistically significant.

For the direct relationship between lending rate and manufacturing output, neither direction is statistically significant at the 5% level. In particular, the p-value of **0.1422** for $LR \rightarrow MQ/GDP$ means that the null hypothesis cannot be rejected. Likewise, the p-value of **0.8691** for $MQ/GDP \rightarrow LR$ provides no evidence of reverse predictive causality.

It is important to emphasize that **Granger causality is a test of predictive precedence, not structural causality**. Therefore, these results should not be interpreted as proof that changes in MQ/GDP literally cause changes in inflation or capacity utilization in a structural economic sense.

Diagnostic Tests

Test	Statistic / probability	Decision
Jarque–Bera	$p=0.5166$	No rejection of normality
Breusch–Godfrey LM	$F\ p=0.9236; \chi^2\ p=0.8706$	No autocorrelation detected
Breusch–Pagan–Godfrey	$F\ p=0.7362; \chi^2\ p=0.5865$	No heteroskedasticity detected
CUSUM	Within 5% bounds	Model stable
Ramsey RESET	Specification test reported	No evidence of major misspecification

The diagnostic tests provide generally favourable evidence concerning the adequacy of the estimated ARDL model. The Jarque–Bera result ($p=0.5166$) indicates that the null hypothesis of normally distributed residuals is not rejected. Similarly, the Breusch–Godfrey LM test produces p-values of 0.9236 and 0.8706, providing no evidence of residual serial correlation.

The Breusch–Pagan–Godfrey results also provide no evidence of heteroskedasticity, with F-statistic and χ^2 p-values of 0.7362 and 0.5865, respectively. The CUSUM test remains within the 5% critical boundaries, supporting parameter stability over the sample period.

However, the current presentation of the **Ramsey RESET test is incomplete**. A statement such as "no evidence of major misspecification" should only be made if the actual RESET statistic and its probability value are available. The recommended table should therefore report the RESET F-statistic, degrees of freedom and p-value from the original estimation output.

CONCLUSION AND POLICY IMPLICATIONS

This article examined interest-rate volatility and manufacturing-sector growth in Nigeria over 1981–2023. Using the supplied study's ARDL, Granger-causality and diagnostic results, the evidence indicates that interest-rate movements are an important component of the manufacturing environment. The ARDL model confirms a negative and significant short-run lending-rate effect. However, the long-run lending-rate coefficient is positive and statistically insignificant.

The ARDL bounds test establishes a long-run relationship among the variables, with an F-statistic of 4.038849 exceeding the 5% upper bound of 4.01. The negative error-correction coefficient suggests that deviations from equilibrium are gradually corrected. Granger tests reveal significant one-way predictive relationships from manufacturing output-to-GDP to inflation and to capacity utilization, but no significant direct two-way predictive relationship between lending rate and manufacturing output at two lags.

The central policy implication is not simply that interest rates should always be forced downward. Rather, the evidence supports an interest-rate environment that is predictable, investment-supportive and consistent with price stability. Excessive short-run financing costs can weaken manufacturing activity, while persistent volatility can make investment planning difficult. Monetary authorities should therefore consider the effect of rate changes on productive credit, especially where firms face simultaneous infrastructure and input-cost constraints.

POLICY RECOMMENDATIONS

1. Promote predictable and investment-supportive lending conditions. Monetary and financial authorities should strengthen frameworks that reduce unnecessary volatility in the cost of productive credit while maintaining macroeconomic stability.
2. Expand targeted long-term industrial finance. Manufacturing firms require finance for machinery and capacity expansion, not only short-term working capital. Development-finance interventions should therefore complement commercial-bank lending.
3. Strengthen domestic production and industrial linkages. Policies that encourage local sourcing, agro-allied production, export diversification and domestic value addition can reduce the manufacturing sector's vulnerability to imported-input and foreign-exchange shocks.
4. Improve the policy environment around financial reforms. Reform measures should be evaluated not only in terms of financial-market efficiency but also in terms of their transmission to productive investment, manufacturing capacity utilization and employment.

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