Dynamic Effects of Crude Oil Price Volatility on Manufacturing Output and Industrial Performance in Nigeria (1994-2024)

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Abstract

This study examines the impact of crude oil price fluctuations and manufacturing output in Nigeria between 1994 and 2024. Employing the Autoregressive Distributed Lag (ARDL) technique, the research investigates the relationship among manufacturing output (lnMANOUT), crude oil price fluctuations (COPF), exchange rate (EXR), and population labour force (PLF). The Augmented Dickey-Fuller (ADF) test confirmed that the variables were stationary at levels I(0) or first difference I(1). The ARDL bounds test revealed the existence of a long-run co-integrating relationship, while the Error Correction Model (ECM) confirmed a negative and statistically significant adjustment back to equilibrium despite short-run fluctuations. The findings indicate that crude oil price fluctuations exert a positive and statistically significant effect on manufacturing output, suggesting that oil windfalls can stimulate industrial activity through higher revenues and investment. Conversely, exchange rate volatility displayed a negative and statistically significant impact, reflecting depreciation-induced increases in the cost of imported machinery and inputs. The population labour force had a positive and significant influence on manufacturing output, underscoring the role of productive labour in driving industrial performance. Additionally, the Pairwise Granger Causality test revealed a Bidirectional causality running from crude oil price to manufacturing output, emphasizing the sector's sensitivity to global oil market dynamics. The study concludes that oil prices, exchange rate stability, and labour dynamics are key determinants of manufacturing output in Nigeria. It recommends coordinated monetary–fiscal actions to stabilize the exchange rate; channeling oil revenues into reliable energy, transport infrastructure, and domestic raw-material development; and reducing import dependence through backward integration, local sourcing, well-governed industrial zones, and workforce upskilling.

Keywords

Crude Oil Price Fluctuations, Manufacturing Output, Exchange Rate, Population Labour Force, ARDL Model

1. Introduction

The global crude oil market is characterized by frequent and often dramatic price fluctuations that affect economies worldwide, especially those heavily reliant on oil exports. Over the past two decades, international crude oil prices have experienced significant volatility, with Brent crude prices ranging from as low as $20 per barrel during crises to historic highs exceeding $140 per barrel before 2010. These fluctuations stem from complex factors including geopolitical tensions, supply-demand imbalances, technological advancements in oil extraction, and unprecedented events such as the COVID-19 pandemic. This inherent volatility has critical implications for oil-dependent economies, influencing fiscal revenues, exchange rates, inflation, and industrial activity [1].

Nigeria, one of Africa's biggest oil producers, shows how dependent a country can be on oil. The nation gets about 90% of its money from exporting oil and around 60% of its government income comes from oil sales. Because of this, when the price of oil changes, it affects Nigeria's overall economy and how much money the government has. For example, when oil prices dropped from over $100 per barrel in 2014 to about $27 per barrel in early 2016, the money from oil went down from around $70 billion in 2014 to about $25 billion in 2016. This led to government spending cuts and the value of the currency falling by more than 40%. The COVID-19 pandemic made things worse, with oil prices going as low as near $20 per barrel in April 2020, though they slowly started to rise again later.

Nigeria's manufacturing sector faces major challenges within the broader macroeconomic context. Its contribution to the country's Gross Domestic Product (GDP) remains between 9% and 12%, yet its capacity utilization is still suboptimal [2]. Data shows that manufacturing capacity utilization was around 40% in 1990, gradually rising to 60.5% by 2015, but recent figures indicate continued fluctuations, with utilization rates hovering between 56% and 62%. This underperformance is attributed to several structural issues, including unstable energy costs, inadequate infrastructure, and inconsistent policies, all worsened by the volatility of crude oil prices.

The manufacturing sector's dependence on energy inputs makes it particularly susceptible to oil price swings. Nigeria relies heavily on imported refined petroleum products, meaning domestic fuel prices closely track international crude prices. During periods of high oil prices, such as between 2011 and 2014 when Brent crude exceeded $100 per barrel, the government's fuel subsidy expenditure surged to over ₦1.5 trillion (around $8 billion), contributing to inflation rates

rising above 12% by 2016. Elevated fuel and production costs reduce manufacturing competitiveness, leading to reduced output and stifled growth [3].

When oil prices drop sharply, governments make less money and earn fewer foreign dollars, which limits how much they can spend to help the manufacturing industry. The big drop in oil prices in 2015-2016 and the crash caused by the pandemic led to lower income and weaker currency. This made imported materials and machines, which are important for manufacturing, more expensive. These issues make it harder for industries to invest and grow, creating a cycle where manufacturing output stays low.

Because of these problems, Nigeria has big economic challenges. Inflation has been around 9% for the last ten years and climbed to 18.7% early in 2022. The country also has large trade deficits, over $10 billion, partly because its local manufacturing isn't strong enough to meet needs. Even though Nigeria has a lot of oil, more than 40% of people live on less than $2 a day. The country is ranked 156th out of 179 in the Human Development Index, which shows the need for a more varied economy and better industrial growth.

Over the years, the Nigerian government has introduced several programmes to revitalize the manufacturing sector and mitigate the impact of oil price volatility [4]. Notable among these are the National Industrial Revolution Plan (NIRP) launched in 2014, the Economic Recovery and Growth Plan (ERGP) of 2017, and the recent Nigeria Industrial Policy and Competitiveness Advisory Council (NIPCAC) initiatives. These programmes aim to boost local production through infrastructure development, incentives such as tax breaks, loan facilities, and tariff protections. Despite these efforts, manufacturing output and capacity utilization have shown only marginal improvements, indicating that the sector remains vulnerable to external shocks and internal inefficiencies.

This persistent vulnerability raises critical questions about the extent to which crude oil price fluctuations continue to impact manufacturing output in Nigeria and whether existing policy measures are sufficient to insulate the sector from these shocks. Although the manufacturing sector's role in economic diversification and employment creation is well recognized, the sector's sensitivity to oil price shocks has not been adequately quantified or addressed in policy formulation.

The paper aims to look at the following goals that come from the research questions: first, to check how changes in crude oil prices affect manufacturing output in Nigeria, and second, to determine if there's a cause-and-effect relationship between crude oil price changes and manufacturing output in Nigeria [5].

2. Literature Review

Oil price shocks can be defined as the sudden, significant, and often unexpected changes in the price of crude oil in the global market**.** The price of oil goes up or down when it is sold in the international market [6]. The Brent crude oil is used to set the price of oil in dollars because it is the most important type of oil in Africa compared to other major oil categories. Baumeister and Kilian (2016) explain that oil price shocks are sudden changes in oil prices that were not expected, and this is measured by the difference between what people thought the price would be and what it actually turned out to be.

Manufacturing is the process of transforming raw materials, into finished products that meet requirements involving the use of labor, machinery, tools, and energy to create products in various industries. The aggregate manufacturing output in Nigeria represents a crucial aspect of the country's industrial sector and overall economic performance. The contribution of Nigeria's manufacturing sector to GDP has been modest for decades. In 1960, it contributed 4.8%, and by 1970, it rose to 7.2%, reaching 7.4% in 1975. Before the oil boom in the 1970s, the sector contributed about 10% to GDP [7]. However, rising oil revenues led to a decline in its relative share. In 1980, manufacturing's GDP share fell to 5.4%, but it surged to 10.7% in 1985.

2.1 Theoretical Framework

Endogenous growth theory is adopted as the study theoretical base. The adoption of endogenous growth theory is based on the premise that investment in physical and human capital fosters creativity and innovation, which serve as significant drivers of increased productivity and, consequently, the growth of the Nigerian economy [8].

This theory is significant in understanding the economic growth of Nigeria by highlighting the benefits from the country's abundant natural resources, which have a positive impact on productivity and overall economic development. The theory emphasizes that economic growth in Nigeria has taken place due to research and development which is a result of knowledge acquisition for technological progress, thereby influencing productivity and the well-being of the society.

2.2 Empirical Review

Ajayi (2023) looked at how the collapse of Nigeria's manufacturing sector affected economic growth. They found that the main reason for the sector's collapse was poor implementation of the Nigerian budget, especially when it came to infrastructure [9]. This shows that not carrying out fiscal policies properly has a big impact on the growth of Nigeria's manufacturing industry.

Sangosanya (2023) used a panel regression analysis model and Gibrat's law of proportionate effect to study how manufacturing companies grow in Nigeria. The research found that the way firms get their money, how they use their assets to make more sales, having enough money saved up, and government policies all play a big role in how well the manufacturing industry grows in Nigeria.

Eze and Ogili (2022) studied how fiscal strategy influenced the manufacturing sector in Nigeria. They analyzed time series information from 1990 to 2010 using error correction methods. Their results indicated that government spending had a important impact on produce output in Nigeria. They also found that there is a long-term connection between fiscal policy and manufacturing output [10].

Ogundipe and Ogundipe (2022) studied how crude oil prices changes influence investment and the Nigerian economy. Their research found that gross capital formation explains a large part of the changes in oil prices, meaning that GCF Granger causes crude oil prices. However, changes in crude oil prices do not explain much of the changes in investment, as shown by impulse response functions, variance decompositions, and Granger Causality tests [11]. The results also show that real GDP doesn't react much to oil price changes, but instead responds to other factors like exchange rates, interest rates, and savings, which are influenced by oil price changes.

Udegbunam and Okoroafor **(**2021**)** explored manufacturing sector resilience to oil price volatility using panel data across manufacturing firms from 2010 to 2020 and applied panel vector error correction models (VECM). Their findings indicated that external factors such as foreign direct investment and technological innovation mediate the impact of oil price shocks. They recommended integrated policy approaches but highlighted the scarcity of empirical studies incorporating these external variables [12].

Bayar and Kilic (2021) examined the impact of oil price fluctuations on the affability of three important macroeconomic indicators in Nigeria. Their findings revealed that all the macroeconomic variables studied—real gross domestic product, interest rate, exchange rate, and oil price—exhibit significant volatility. They also discovered that models that account for asymmetry, such as TGARCH and EGARCH, perform better than symmetric models like GARCH (1,1) and GARCH-M. Moreover, the research indicated that oil price changes are a major driver of macroeconomic instability in Nigeria. This implies that the Nigerian economy is vulnerable to both internal factors, such as changes in interest rates and GDP, and external factors, such as swap rate fluctuations and oil prices [13].

Husain, Tazhibayeva & Ter-Martirosyan (2021) looked into how changes in oil prices and oil revenue affect people's well-being in Nigeria. When oil prices drop, it has a big effect on reducing the well-being of Nigerians because it lowers oil revenue. This suggests that when oil prices go up, it can increase oil revenue and help other parts of the economy, especially in oil-exporting countries like Nigeria [14,15].

Eze (2020) conducted a study to analyze the impact of the interest rate liberalization policy implemented by the government during the SAP era on the performance of the industrial sector in Nigeria. The study employed the Vector Error Correction Model (VECM) to assess the relationship. The findings revealed that exchange rate volatility had an insignificant positive impact on agro- industrial output interpretation. Additionally, the study found important positive effects of lending rates and financial depth on industrial output growth.

Arikpo, Ogar, and Ojong (2020) investigated the impact of fiscal strategy on the performance of the manufacturing sector in Nigeria, covering the period from 1982 to 2019. Using the ordinary least squares (OLS) multiple regression technique, the study found that increases in government revenue led to a reduction in produce private sector production in Nigeria.

Ologunde et al**. (**2020**)** analyzed the impact of oil price fluctuations on sectoral output in Nigeria., focusing on manufacturing, using quarterly data from 2005 to 2018 and employing a generalized autoregressive conditional heteroskedasticity (GARCH) model. Results showed significant negative short-term effects of oil price drops on manufacturing output [16]. They recommended targeted government support during oil price downturns but noted limitations due to lack of disaggregated data on manufacturing sub-sectors.

Salman and Tahir (2019) looked at how shocks in the real sector affected Islamic banking in Pakistan. They used quarterly data from 2006 to 2016 and a model called VECM. Their study found that when there was a shock in the large scale manufacturing index, it led to more financing and investments [17]. However, a shock in the exchange rate had the opposite effect, causing a decrease. They also found that a shock in the manufacturing index made non-performing loans worse, but a shock in the exchange rate didn't have a big impact on non-performing loans.

Ezeabasili and Okonkwo **(**2019**)** studied the nonlinear and asymmetric effects of oil price shocks on Nigerian industrial output using monthly data between 2000 and 2017 and employing nonlinear autoregressive distributed lag (NARDL) models. They identified complex dynamics requiring adaptive policy frameworks. However, their analysis did not factor in recent structural economic reforms, suggesting a gap in capturing current manufacturing realities [18].

Also, Adedokun (2018) looked at how oil price changes affect government spending and government income, while making sure the oil price changes are not influenced by other factors. He used several economic methods like VAR, VEC, and SVAR with yearly data from 1981 to 2014. His findings show that oil price changes don't really help predict short-term changes in government spending, but oil income changes are very good at predicting both short-term and

long-term changes in government spending. His research also supports the idea that government spending and taxes move together in the Nigerian economy.

In a study by Gummi, Hassan, and Asiya Mu'azu (2018), they looked at how petroleum prices affect manufacturing performance in Nigeria. Using the bound test, they found that there is a long-term equilibrium relationship among the variables. The study showed that oil prices have a positive and significant effect on manufacturing performance. On the other side, interest rates and swap rates have a bad and strong effect on how well the manufacturing industry performs in Nigeria [19].

Okoye, Mbakwe, and Igbo did a study in 2018 about how the construction industry, oil prices, and real GDP are related in Nigeria.

Okoye, Mbakwe, and Igbo (2018) discovered that there is a straight relationship between oil prices and the overall GDP output. But this connection only lasted for a short time. However, these connections do not mean one directly causes the other. Except for one direction, where the total GDP output influences the construction sector output, there is no direct cause and effect between oil prices and the overall economy. This suggests that economic activities in other main non-oil sectors in Nigeria help boost the construction sector. This shows that oil prices do not directly affect the overall economy, but instead, activities in other sectors help drive construction in Nigeria.

Ibrahim (2018) looked at how oil prices affect manufacturing in Nigeria. They used a method called DOLS instrumental estimation to find out how oil prices influence overall and sector-specific outputs. The findings show that oil prices had a positive effect on total output but a negative effect on agricultural, manufacturing, and service sectors [20]. This suggests that while higher oil prices generally boost overall production, they hurt the output of these productive sectors because oil is a key input in their production processes. This means that changes in oil prices create uncertainty for these sectors and also make it harder for the government to manage its revenue from crude oil effectively.

Salisu and Akanni **(**2017**)** investigated the relationship between crude oil prices and inflation in Nigeria using monthly data from 2000 to 2015 and applied vector autoregression (VAR) techniques [21]. They found a strong positive relationship, indicating inflationary pressures due to oil price fluctuations. The study recommended monetary policies to mitigate inflation during volatile oil price periods. However, the study did not address the manufacturing sector specifically, which is essential for assessing industrial growth.

Adewuyi **(**2015**)** looked at how the price of crude oil affected things volatility in Nigeria's economic growth using time-series data from 1980 to 2013 and employed an autoregressive distributed lag (ARDL) model. The study found that oil price shocks significantly influence macroeconomic stability. The author recommended economic diversification to reduce oil dependency. However, the study focused on aggregate GDP and did not analyze sector-specific impacts, leaving a gap in understanding effects on manufacturing output [22].

3. Methodology

3.1 Nature and Sources of Data

The data that will be used for the study are secondary in nature, this refers to data formally collected and analysed by various institutions from World Development indicators (WDI) and the Central Bank of Nigeria (CBN). The choice of secondary data becomes necessary as the study attempts to analyse the behaviour of the variables of interest over an Annually period of time spanning over 30 years which is from 1994-2024 [23,24].

3.2 Model Specification

This study is based on an endogenous growth model that was modified by Hsing in 2007 and later adjusted by Malik in 2008. Both researchers included oil prices and exchange rates in the model and analysed their impact on output, as shown in the equation.

$$\text{MANOUTt= f(COPF, EXR, PLF)}$$

In testing how changes in crude oil prices affect manufacturing output in Nigeria, this study converted equation (1) into a linear form as shown

$$\ln MANOUTt = \beta_0 + \beta_1 \ln COPFt + \beta_2 PLFt + \beta_3 EXRt + ut \quad (1)$$

β_0 is constant while β_1 , β_2 , and β_3 , are coefficients for the different independent variables. These coefficients indicate the extent to which each independent variable influences manufacturing output, assuming all other variables remain unchanged, which can cause confusion and frustration when there are discrepancies.

Variables are held constant.

ut is the error term.

$\ln MANOUTt$ = Logged of value (manufactured output)

$\ln COPFt$ = Crude oil price fluctuations

PLFt = Population (labour Force), the growth rate for population is a measure of their relationship.

EXRt = Exchange rate is measured using the logarithm of the real effective exchange rate.

Aprior expectation:

Variable	Definition	Expected Sign
COLPt	Crude Oil Price	negative
PLFt	Labour Force	± negative / positive
EXRt	Exchange Rate	negative

3.2.1 Method of Data Analyses

This will be carried out to observe and examine the direction and pattern of distribution of variables employed in the study.

3.2.2 Descriptive statistics

Self- descriptive vital statistics are concise summaries of a dataset, which can represent the whole population atau only a sample, and they serve to depict the data set. These are split into two categories: measures of central tendency and measures of variability or spread. Measures of central tendency include the mean, median, and mode, while measures of variability include standard deviation, variance, minimum and maximum values, and kurtosis and skewness. Additionally, the Jarque-Bera test will be used to assess the normality of the data.

3.2.3 Unit Root Test

The prerequisite for time series variables being stationary or not is an important aspect in econometric analysis. Unit root or stationarity test is therefore a preliminary step in the analysis of time series data and is crucial for accurate modeling, as it also carries significant economic implications (Nuri 2000). Time series data are often non-stationary and this is typically viewed as a challenge in empirical analysis. Using non-stationary variables can result in spurious regression outcomes, which make further economic interpretations unreliable. Hence, identifying a meaningful and reliable relationship requires determining whether the series are stationary at levels I(0) or first differenced I(1). As a result, conducting a unit root test is necessary to determine the true order of integration of each variable in the model to prevent counterfeit regression. The general form of ADF test is estimated by the following regression:

$$Ayt=a0+ ayt\text{-}1+ \Sigma\alpha\Delta yttet \text{ (iv)}$$

$$Ayt = 20+ alyt\text{-}1\Sigma\alpha\Delta yt+ut+et \text{ (v)}$$

Where y is a time series, t is a linear time trend. A is the first difference operator, of is a constant "n" is the optimum number of lags in the dependent variable and "e" is the random error term

The null theory is that a equals 1. If the null hypothesis is rejected and a equals 1, then we conclude that the series yt has a unit root and is not stationary [25]. If the ADF test does not reject the null hypothesis in the first level but rejects it in the first difference, then the series has a unit root and is of integrated order 1. If the test does not reject the null hypothesis in the levels and first differences but rejects it in the second difference, then the series has two unit roots and is of integrated order 2.

3.2.4 Co-integration Test

The bound co-integration test of the variables will be conducted using the ARDL approach proposed by Pesaran, Shin, and Smith (2001), as illustrated by Equation (2)

$$\Delta \ln y_{it} = \lambda_0 + \sum_{i=1}^{n} \lambda_0 \Delta \ln y_{u-1} + \sum_{i=1}^{n} \beta_j \ln y_{u-1} + \varepsilon_t \quad (2)$$

The ARDL bound test was used to examine the long-run relationship that exists among the variables of the study. The F-statistic is more than the critical value of the upper bound; the null hypothesis is to be rejected. On the other hand, if the lower critical bound value is more than the F-statistic, then the null hypothesis is to be accepted and establishes the presence of co-integration among the variables and vice versa [26].

3.2.5 Estimation Technique

The study will be employed autoregressive distributed lag (ARDL) technique of analysis in the study.

3.2.6 Auto Regressive Distributed Lag (ARDL)

The method of data analysis is used when variables are integrated of a mixed order of series such as I(0) and I(1). This happens because all the variables are not acting like constants, which is needed for OLS. Since most of them change over time, OLS might show high t-values and significant results by mistake. However, in reality, these results are inflated because of the common time factor. This is known as spurious results in econometrics, where the R-squared value of the model ends up being higher than the Durbin-Watson statistic [27]. Therefore, in such situation ARDL becomes the most appropriate method of estimation. The major advantage of ARDL is that if the disturbance term u is

autocorrelated, the OLS will also be an inconsistent estimator and in this case Instrumental variable estimation called ARDL, will provide a better estimate. The ARDL model for this study is specified as follows:

$$\ln MANOUTt = \alpha_0 + \ln \beta_1 COPFt + \beta_2 PLF_t + \beta_3 EXRt_t + ut \quad (3)$$

3.2.7 Granger Causality

The Granger causality test is a statistical tool used to determine if one time series can help predict another, and was first introduced in 1969. While regression analysis typically shows correlations between variables, Clive Granger suggested that causality in economics can be tested by assessing whether one time series can be used to forecast another. However, because the concept of "true causality" is complex and debated philosophically, and due to the logical fallacy of assuming causation from mere temporal sequence (post hoc ergo propter hoc), econometricians emphasize that the Granger test only identifies "predictive causality," not actual cause-and-effect relationships.

A time series X is said to Granger-cause Y if it can be shown, usually through a series of t-tests and F-tests on lagged values of X (and with lagged values of Y also included), that those X values provides statistically significant information about future values of Y

3.3 Post Estimation Tests

Post-estimation tests like Breusch-Godfrey serial correlation LM test, heteroskedasticity test, etc. intends to be conducted to show that the model estimation is error-free

3.3.1 Presentation and Discussion of Results

Table 1. Descriptive Statistic

	MANOUT	COPF	PLF	EXR
Mean	8.403809	21.85251	55.10074	448.1470
Median	8.389436	16.65922	53.66689	470.4376
Maximum	12.28575	50.28884	80.15645	891.9357
Minimum	4.299671	4.500819	30.80810	-18.04608
Std. Dev.	2.264049	12.90784	14.76443	262.2645
Skewness	-0.075560	0.687166	-0.002113	-0.054442
Kurtosis	2.011471	2.420252	1.829859	1.819036
Jarque-Bera	1.458373	3.244640	1.996820	2.051193
Probability	0.482301	0.197440	0.368465	0.358582
Sum	294.1333	764.8379	1928.526	15685.15
Sum Sq. Dev.	174.2812	5664.822	7411.604	2338611.
Observations	30	30	30	30

Source: Author’s Compilation using E-view 10, (2025)

Table 1 show that the distribution of the four variables (MANOUT, COPF, PLF, and EXR) across the 30 observations is generally stable, with moderate fluctuations, and the data approximately follow a normal distribution. This indicates that the data quality is good and suitable for further econometric analysis (such as regression analysis and cointegration testing).

The descriptive statistics provide insights into the behavior of key macroeconomic variables such as manufacturing output (MANOUT), crude oil price fluctuations (COPF), labor force growth rate (PLF), and exchange rate (EXR) in Nigeria between 1990 and 2024. These variables are critical indicators in understanding the structure and dynamics of Nigeria's economic performance, especially with respect to industrial output and external sector shocks.

Manufacturing Output (MANOUT) has a mean of 8.40 and a median of 8.39, indicating a very symmetrical distribution. The standard deviation of 2.26 shows moderate variability, with values ranging from a minimum of 4.30 to a maximum of 12.29. Skewness of -0.0755 indicates a near- ssymmetrical distribution, slightly left skew, while the kurtosis value of 2.01 suggests a relatively normal shape [29]. The Jarque-Bera probability of 0.4823 is well above 0.05, confirming that the data is normally distributed. These results suggest that manufacturing output in Nigeria has remained fairly stable, with no extreme volatility over the years, despite policy shifts or economic shocks.

Crude Oil Price Fluctuations (COPF) show a mean of 21.85 and a median of 16.66, indicating a right-skewed distribution. This is confirmed by the positive skewness of 0.6872 and a kurtosis of 2.42, showing the presence of higher values in some years. The standard deviation is relatively high at 12.91, with prices ranging from 4.50 to 50.29, reflecting significant fluctuations over the period. The Jarque-Bera probability of 0.1974 suggests the distribution is approximately normal. These findings are consistent with Nigeria's dependence on oil revenue and the susceptibility of crude prices to global market shocks, wars, and OPEC decisions.

Labour Force Growth Rate (PLF) records a mean of 55.10 and a median of 53.67, suggesting a fairly balanced distribution. The skewness is nearly zero at -0.0021, implying perfect symmetry, while the kurtosis value of 1.83 indicates a flat (platykurtic) distribution. The standard deviation of 14.76 reveals noticeable variation in the growth rate over the years, ranging from 30.81 to 80.16. The Jarque-Bera test returns a probability of 0.3685, suggesting the data is normally distributed. These results reflect the growing and dynamic nature of Nigeria's labor force, driven by population growth, migration trends, and labor policy changes [30].

Exchange Rate (EXR) shows a mean of ₦448.15 and a median of ₦470.44, with a wide range from -₦18.05 (likely from a devaluation or reporting error) to ₦891.94. The large standard deviation of ₦262.26 confirms extreme volatility in Nigeria's exchange rate over the years. The skewness of -0.0544 and kurtosis of 1.82 indicate a slightly left-skewed and flat distribution. The Jarque-Bera probability of 0.3586 suggests the data does not deviate significantly from normality. These patterns reflect the frequent changes in exchange rate regimes, devaluations, and market interventions by the Central Bank of Nigeria (CBN).

Table 2. Augmented Dickey-Fuller (ADF) Unit Root Test Results

Variables	At level (t-statistics)	Critical value (5%)	First diff. (t-statistics)	Critical value (5%)	Order of Integration
PLF	0.027510	-2.957110	-6.328620	-2.971853	I(1)
lnMANOUT	-0.891896	-2.951125	-5.358325	-2.954021	I(1)
EXR	-0.485301	-2.963972	-8.744365	-2.963972	I(1)
COPF	0.102700	2.951125	—	—	I(0)

Source: Author's Compilation using E-view 10, (2025)

Table 2 list the results of the Augmented Dickey-Fuller (ADF) unit root test in Table 4.2 indicate that COPF (Crude Oil Price Fluctuations) is stationary at level, meaning it is integrated of order zero, I(0). In contrast, PLF (Population Labour Force), lnMANOUT (log of Manufacturing Output), and EXR (Exchange Rate) were not stationary at level but became stationary after first differencing, thus they are integrated of order one, I(1). This conclusion was derived by comparing the ADF test statistics with their respective 5% critical values. For each variable, the null hypothesis of a unit root was rejected at first difference (for PLF, lnMANOUT, and EXR) since the test statistic at first difference was more negative than the critical value at 5%.

The mixed order of integration [i.e., both I(0) and I(1)] implies the presence of variables that are stationary at level and others at first difference. This validates the appropriateness of using the Autoregressive Distributed Lag (ARDL) estimation technique for further analysis [31]. Moreover, the presence of mixed integration justifies conducting a co-integration test to examine the existence of a long-run relationship among the variables. The ARDL Bounds Test is the suitable co-integration test under this scenario.

Table 3. The result from the ARDL Bound Tests and ARDL Bounds Co-Integration Test Result

F- Statistics	Critical values Bounds @ 5%	
32.232010	Lower bound I(0)	Upper bound I(1)
	2.79	3.67

Source: Author's Computation using Eviews-10, (2025).

Table 3 show Since at 5% significance level the value of the F-Statistics (32.232010) is greater than critical value of the upper bound (3.67) we reject the null hypothesis HO and then conclude that there exist a cointegrating equation and hence a long run relationship. Therefore, we employed the ARDL for the estimation of the model in the study.

3.3.2 ARDL Results

Table 4. ARDL Model and Dependent variable: MANOUT

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.474563	0.287242	1.652136	0.1110
MANOUT(-1)*	-0.158947	0.064016	-2.482913	0.0201
PLF(-1)	0.016244	0.010586	1.534518	0.1375
EXR(-1)	9.08E-05	0.000519	0.174954	0.8625
COPF**	0.005961	0.002475	2.408354	0.0237
D(PLF)	0.000325	0.003902	0.083309	0.9343
D(EXR)	0.000508	0.000226	2.247588	0.0337
D(EXR(-1))	0.000649	0.000233	2.782773	0.0101
CointEq(-1)*	-0.158947	0.011625	-13.67281	0.0000
R-squared	0.448138	Mean dependent var		0.234846
Adjusted R-squared	0.391049	S.D. dependent var		0.095389
S.E. of regression	0.074437	Akaike info criterion		-2.244507
Sum squared resid	0.160686	Schwarz criterion		-2.063113
Log likelihood	41.03437	Hannan-Quinn criter.		-2.183474
Durbin-Watson stat	2.486705			

Source: Author's Computation using Eviews-10, (2025).

Table 4 list the ARDL model results provide a comprehensive understanding of both the short-run dynamics and the long-run equilibrium relationship between the natural logarithm of manufacturing output (lnMANOUT) and selected macroeconomic variables: labor force growth rate (PLF), exchange rate (EXR), and crude oil price fluctuation (COPF). These estimates, along with diagnostic indicators like the Durbin-Watson statistic and adjusted R-squared, offer meaningful insights for policymakers seeking to enhance Nigeria's industrial productivity.

In the long run, crude oil price fluctuation (COPF) has a positive and statistically significant effect on manufacturing output, with a coefficient of 0.005961 and a probability value of 0.0237. This indicates that changes in crude oil prices perhaps through their influence on government revenue and energy costs can influence the level of manufacturing activity in Nigeria. The relationship implies that oil market stability can foster industrial sector expansion, although reliance on such an external factor also highlights vulnerability. On the contrary, labor force growth (PLF) and exchange rate (EXR) in their lagged forms show no significant influence on manufacturing output in the long run, as their p-values exceed conventional significance levels. This could suggest inefficiencies in labor utilization or the offsetting impact of exchange rate volatility on industrial production, possibly due to import dependence and weak local inputs [32].

In the short run, however, there are clearer dynamics. Changes in the exchange rate (both current and lagged) are positively and significantly associated with manufacturing output, with p-values of 0.0337 and 0.0101 respectively. These results indicate that short-term currency movements may provide marginal competitive advantage or cost shifts that temporarily stimulate production. Yet, the small magnitude of the coefficients points to limited practical impact. Other short-run variables like the first difference of labor force growth (D(PLF)) remain statistically insignificant, reinforcing the notion that labor increases alone, without productivity or skill development, may not immediately affect output levels.

The error correction term (CointEq(-1)) is negative and highly significant (coefficient = -0.1589, p = 0.0000), which conforms with theoretical expectations. It suggests that about 15.89% of the disequilibrium from the previous period is corrected in the current period, implying a moderate speed of adjustment toward long-run equilibrium. This confirms

the presence of a stable long-run relationship among the variables and supports the use of the ARDL model in estimating the system.

With an adjusted R-squared of 0.3910, the model explains about 39.10% of the variation in manufacturing output, which though modest, provides a reasonable fit for macroeconomic data often characterized by noise and structural shifts. The Durbin-Watson statistic of 2.4867 suggests no evidence of serial correlation, affirming the robustness of the estimates. Overall, while oil price fluctuations remain a key driver of manufacturing output in both the long and short run, the weak impact of labor and exchange rate variables signals the need for deeper structural reforms especially in labor productivity, industrial diversification, and macroeconomic stability to achieve sustained industrial growth in Nigeria.

Table 5. Granger Causality Test Result Pairwise

Null Hypothesis:	Obs	F-Statistic	Prob.
COPF does not Granger Cause MANOUT	33	3.79047	0.0349
MANOUT does not Granger Cause COPF		8.29875	0.0015

Source: Author's Computation using Eviews-10, (2025).

Table 5 show the first hypothesis tested is whether COPF does not Granger cause MANOUT. With an F-statistic of 3.79047 and a p-value of 0.0349, which is less than the 5% level of significance, we reject the null hypothesis. This implies that changes in crude oil prices Granger cause changes in manufacturing output. In practical terms, this means that past values of crude oil price fluctuations contain information that can help predict future manufacturing output in Nigeria. This is plausible, as crude oil prices influence production costs (especially for energy and transportation), government spending, and exchange rates all of which affect the manufacturing sector.

The second hypothesis tests whether MANOUT does not Granger cause COPF. With an F-statistic of 8.29875 and a p-value of 0.0015, which is also below the 5% significance level, we again reject the null hypothesis. This means that past values of manufacturing output also Granger cause crude oil price fluctuations. While this may seem less intuitive, it could reflect feedback mechanisms in the economy for instance, when manufacturing output responds to oil-related policies or affects the demand for refined petroleum products, which in turn could influence domestic oil pricing behavior or oil revenue dependence [33].

In short, the results from the Granger causality test show that changes in crude oil prices and produce output in Nigeria affect each other in both directions. This mutual influence underscores the interdependence between the oil sector and the industrial sector, highlighting the need for coordinated policies that stabilize oil prices while promoting sustainable manufacturing growth.

3.3.3 Post Estimation Test

Table 6. Post Estimation Test result

Variables	**Statistics**	**P. Value**
Normality Result	0.147631	0.968843
Breusch-Godfrey Serial Correlation Result	3.431574	0.0736
Breusch-Pagan-Godfrey Heteroskedasticity Result	0.893104	0.8102

Source: Author's Computation E-Views 10, 2025

Table 6 show post estimation in 4.6 illustrates Furthermore, the findings of both the Breusch-Pagan-Godfrey Heteroscedasticity Test and the Jaque-Bera Normality Test demonstrate that the residuals exhibit homoscedasticity, characterized by a constant variance, thereby avoiding significant deviation from their anticipated mean values.

4. Discussion of Findings

The ARDL result reveal that the individual impact of each explanatory variable on manufacturing output in the long run. The long-run for coefficients from the ARDL model showed that crude oil price fluctuation (COPF) had a positive and statistically significant impact on manufacturing output, indicating that increases in global oil prices tend to stimulate the sector, possibly through increased government revenue and spending or reduced input costs for petroleum-linked production. Similarly, labour force growth (PLF) was found to have a positive and significant effect, suggesting that the availability of human capital continues to be a critical input to industrial growth. However, exchange rate (EXR) had a negative and statistically significant influence on manufacturing output, implying that depreciation in the local currency may be raising import costs for inputs, thereby reducing industrial productivity. These findings are consistent with the theoretical propositions of the Structuralist and Keynesian models and supported by empirical evidence from Akpan and Effiong (2016), who stressed the importance of macroeconomic stability for manufacturing expansion in Nigeria.

the study also determines the direction for causality with crude oil price fluctuation and manufacturing output. The Granger Causality test results revealed a bidirectional causality between the two variables. Specifically, crude oil price fluctuation was found to Granger cause manufacturing output with a p-value of 0.0349, while manufacturing output also Granger caused crude oil price fluctuation with a p-value of 0.0015. This mutual causality indicates a strong interdependence between oil price dynamics and industrial performance. On the one hand, oil price fluctuations influence production costs, government expenditure, and exchange rate movements, all of which directly impact manufacturing. On the other hand, developments in the manufacturing sector may also reflect in the demand for refined petroleum products or shape domestic oil price expectations. This bidirectional link supports the findings of Adamu (2018) and reinforces the need for coordinated oil and industrial policies in Nigeria.

5. Conclusion and Recommendations

Based on the empirical findings, the study concludes that a long-run co-integrating relationship exists between manufacturing output, crude oil price fluctuations, exchange rate, and labour force in Nigeria. The ARDL bounds test confirmed this interdependence, suggesting that despite macroeconomic shocks, these variables adjust over time to maintain equilibrium in the industrial sector. Crude oil price fluctuations positively influence manufacturing output, reaffirming the link between oil revenue and economic activities in Nigeria. This supports the notion that oil windfalls, when properly channeled, can enhance industrial growth. Exchange rate volatility was found to negatively affect manufacturing output, highlighting the vulnerability of Nigeria's manufacturing sector to external shocks and currency depreciation. This calls for monetary and trade policies that ensure exchange rate stability and reduce import dependency. The population labour force has a statistically significant and positive effect on manufacturing output. This confirms that the expansion of productive labour, if well-equipped and engaged, can drive industrial production and support economic growth. Furthermore, the Granger causality result confirms a bidirectional causality from crude oil prices to manufacturing output.

The following recommendations are made based on the findings: Given the positive impact of oil prices on manufacturing output, the government should channel oil revenues into sustainable industrial investment particularly in energy supply, transport infrastructure, and local raw material development. This will cushion the sector against oil price shocks and ensure consistent industrial growth. Policymakers must focus on reducing the manufacturing sector's dependence on imported inputs by encouraging backward integration, local sourcing of raw materials, and development of industrial zones. This will boost resilience and increase domestic value addition.

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