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THE IMPACT OF EXCHANGE RATE ON INDUSTRIAL OUTPUT IN NIGERIA

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Abstract

This study examined the impact of exchange rate on industrial output in Nigeria from 1986 to 2021. Empirical test of stationarity was carried out using Philips-Perron test. The results from the unit root test shows that consumer price index is stationary at levels while exchange rate, interest rate and industrial output are integrated of order one. The Bounds cointegration test shows the existence of long run relationship between exchange rate, consumer price index, interest rate and industrial output. Finally, Autoregressive Distributed Lag (ARDL) analysis indicates that there is a positive and significant link between exchange rate, consumer price index and industrial export in Nigeria both in the short run and in the long-run. The study recommends an attempt by the government to encourage acceptable exchange rate policies in order to fully exploit the benefits of the sector and promote industrial output. To increase the impact of consumer price index on industrial output, a concerted effort should be directed toward price control in the economy to enhance sustainable economic growth through increased industrial output.

Key words: Exchange Rate, Industrial Output, Bounds Test, ARDL

1. Introduction

Industrial sector plays a catalytic role and has dynamic benefits that are significant to economic growth and development of a nation. Apart from having significant linkages across other sectors in terms of contribution to and from these sectors, the industrial sector is an avenue for increasing productivity in relation to import substitution and export expansion, creating foreign exchange earning capacity, raising employment, promoting the growth of investment at a faster rate than any other sector of the economy (Fakiyesi, 2005).

Nigerian economy for decades is considered a mono-economy due to her over reliance on the earnings from the oil sector. The country's budget is always prepared based on forecasted price per barrel of crude oil. The fluctuation in the crude oil price in the international market together with the exportation of raw crude, the economy is always unstable. It suffices to state that the oil and gas sector accounted for over 95% and about 85% of government revenue respectively, while also contributing 14.8% and 13.8% to GDP in 2016 and 2017 respectively (World Bank Development Indicator 2018). In spite of the enormous revenue gotten from the sale of crude oil, the World Bank Development Indicator (2016) has shown that majority of Nigerians live below poverty line, with over 80 million or 64% of the population living on less than two dollars a day. Likewise, Human Development Report (2016) also ranks Nigeria as 158 out of 188 countries, which is a significant decrease in its human development ranking of 153 in 2013; and World Bank Development Indicators (2012) have placed Nigeria within the 47 poorest countries of the world.

An industrial sector that does not contribute at least one-quarter of the country's GDP is widely viewed as a major challenge facing a country's economic growth.

The industrial sector accounted for only 6% to GDP in 2011 (Bennett, Anyanwu & Kalu 2015). Chang and Tan (2008) attributed the poor performance of the industrial sector to poor industrial policies, neglect or even total abandonment of the sector, unfavourable exchange rate policies. As a result, such policies can never promote a holistic growth in the industrial

sector of the economy. Exchange rate is an important endogenous factor that affects economic performance, due to its impact on macroeconomic variables like outputs, imports, export, prices, interest rate and inflation rate. A sound and appropriate exchange rate policy is crucial condition for improving economic performance (Chang and Tan, 2008).

The industrial sector has become increasingly dependent on the external sector for import of non-labour input and as such adversely affected by exchange rate (Okigbo, 1993). Exchange rate reforms according to Bakare (2011) were expected to put the Nigerian economy on the path of macroeconomic stability, recovery and sustainable development. But rather, the country has continued to be at disadvantage in terms of macroeconomic performances.

Several empirical works have been conducted on the impact of exchange rate on industrial output. Some of the studies such as Vo, Dinh, Do, Hoang, and Phan (2000), Terence and Pentecost, (2001) have reported positive effect of devaluation (depreciation) on output. Contrariwise, the works of others such as Sheeley, (1986), Rogers and Michael, (1995) have reported a negative impact of depreciation (devaluation) on output. However, few studies including the works of Edwards (1989) Kamin and Klau, (1998) have argued that real exchange rate may produce negative or positive impact on output.

In an attempt to achieve and sustain an acceptable growth rate, Nigeria as a country have pursued many developmental policies. A critical component of these policies is exchange rate deregulation. This policy allows the ruling exchange rate to be determined by the forces of demand and supply. The exchange rate deregulation is expected to enhance increased access to foreign exchange for industrial production thereby increasing industrial output. Exchange rate deregulation can, in one-dimension increase investors access to foreign exchange thereby, increasing industrial output. Foreign exchange accessibility will enable the investors procure the needed imported raw material and equipment needed for production hence, industrial output can be enhanced. Furthermore, exchange rate depreciation can lead to increased industrial output where domestic firms are exporters. Depreciation of domestic currency makes exports competitive with positive effect on profitability and output. Depreciation of domestic currency can as well have negative impact on industrial output. When domestic firms are raw materials import dependent, depreciation of exchange will lead to increased cost of imported raw materials, which will feed into cost of production and thus higher unit cost which may eventually lead to reduction in industrial output.

The nature of the impact of exchange rate on industrial output remain unresolved. This create a vacuum for researchers to still investigate in to the impact of exchange rate on industrial output especially in developing countries like Nigeria where the country is import dependent and production is carried out largely for local consumption.

This study is therefore, set out to examine both the short run and long run impact of changes in exchange rate on industrial output in Nigeria from 1986 to 2021 using a relatively new estimating technique popularize by Auto Regressive Distributed Lag (ARDL). The rest of the study is structured as follows: literature review is followed in section two, section three deals with methodology of the study, data presentation and analysis is done in section four, while section five concludes the work.

2. Literature Review

2.1. Conceptual Review

Exchange rate implies the price of one currency in terms of another (Oloyede, 2002). It is a reflection of the strength of a currency when measured against another country‘s currency; usually determined in principle by the interplay of supply and demand in a free market environment. In the Nigerian context, it is the units of naira needed to purchase one unit of another country‘s currency for instance, the United States dollar (Campbell, 2010). Ahmed and Zarma (1997) posited that exchange rate is an important decision making variable in every nation, thus making it a crucial issue for any country desirous of economic growth. Fluctuation in exchange rate is an important factor that affects economic performance, due to its impact on macroeconomic variables like outputs, imports, export prices, interest rate and inflation rate (Adeniran, Yusuf & Adeyemi, 2014).

According to Bennett, Anyanwu, and Kalu, (2015) a country is said to have industrialized when at least

one-quarter of its Gross Domestic Product (GDP) is produced in its industrial sector.

2.2. Theoretical Review

2.2.1 Optimal Currency Area (OCA) Theory

The earliest and leading theoretical foundation for the choice of exchange rate regimes rests on Optimal Currency Area (OCA) theory, developed by Mundell (1961) and McKinnon (1963). This theory is concerned with stabilization of the business cycle and trade. It is based on concepts of the symmetry of shocks, the degree of openness, and labor market mobility. According to the theory, a fixed exchange rate regime can increase trade and output growth by reducing exchange rate uncertainty and thus the cost of hedging, and also encourage investment by lowering currency premium from interest rates. However, it can also reduce trade and output growth by stopping, delaying or slowing the necessary relative price adjustment process.

Modern exchange rate theories are based on the monetary and the asset market or portfolio balance approaches to the balance of payments, and views the exchange rate, for the most part, as a purely financial phenomenon. A traditional exchange rate theory, on the other hand, is based on trade flows and contributes to the explanation of exchange rate movement in the long run. With financial flows now dwarfing trade flow, interest has shifted to modern exchange rate theories, but traditional theories remain important in the long run (Lawal, 2016).

2.3. Empirical Review

Jonathan and Kenneth (2016) analyze the link between exchange rate fluctuations and private domestic investment in Nigeria. The descriptive statistics of the variables included in the model show the existence of wide variations in the variables as depicted by the standard deviation of the exchange rate variable that was unusually high. The findings suggest that, the depreciation of the currency and interest rate does not stimulate private domestic investment activities in Nigeria.

Ikechukwu (2016) investigates the effects of volatility clustering in exchange rate on firm's performance in Nigeria, examining cross sectional data for the most active 20 companies listed on the Nigerian Stock Exchange. The results show that exchange rate fluctuation has significant negative impacts on the rate of return on assets, asset turnover ratio and the portfolio activity and resilience, thus, showing the significant negative impact of exchange rate fluctuation on firm performance in Nigeria between 2004 and 2013.

Mensah, Ofori-Abebrese and Pickson (2016) within the ARDL (Autoregressive Distributed Lag) framework ascertaining the relationship between industrial performance and macroeconomic factors in Ghana from 1980-2013. Their findings indicate a cointegrating relationship between industrial output and macroeconomic factors; they opined that the major macroeconomic factors affecting industrial performance in Ghana were lending rate, inflation, employment and government expenditure. Based on the findings, they recommend that the government of Ghana stabilize the macroeconomic environment in order to achieve industrial growth and development.

Bennett, Anyanwu and Kalu (2015) investigated the effect of industrial development on the Nigeria's economic growth from 1973-2013 using OLS (Ordinary Least Square) regression they found that the influence of industrial output on economic growth is not statistically significant. They further recommend that the government and its agencies ensure political stability and also implement strategic policies that will create a fair playing ground for foreign investors which will also improve the establishment of industries especially the manufacturing industries to encourage industrialization of the Nigerian economy as this will facilitate the strengthening of economic growth.

Dhasmana (2015) explored the impact of real exchange rate changes on the performance of Indian manufacturing firms over the period 2000– 2012, using Panel- VAR. The empirical analysis showed that real exchange rate movements have a significant impact on Indian firms'performance but the impact varied across different firm and industry characteristics. Results from Panel- VAR also proved that appreciation and depreciation affect firms'performance differently.

Adelowokan, Adesoye and Osisanwo (2015) examine the effect of exchange rate volatility on investment

and growth in Nigeria over the period of 1986 to 2014. The results confirm the existence of long run relationship between exchange rate, investment, interest rate, inflation and growth. Finally, the results show that exchange rate volatility has a negative effect with investment and growth while exchange rate volatility has a positive relationship with inflation and interest rate in Nigeria.

Omorokunwa and Ikponmwosa (2014) investigate the dynamic relationship between exchange rate volatility and foreign private investment in Nigeria from 1980 to 2011. The finding includes among other things that; exchange rate volatility has a very weak effect on the inflow of Foreign Direct Investment (FDI) to Nigeria, both in the long run and in the short run and that exchange rate volatility has a weak effect on foreign portfolio investment in the short run but a strong positive effect in the long run.

Onyeizugbe and Umeagugesi (2014), examined how Exchange rate, particularly, devaluation of the naira affects the survival of the industrial subsector in Nigeria during the period 1990-2013, using Ordinary Least Square (OLS) regression method. The result showed that manufacturing capacity utilization has positive relationship with exchange rate and export. The study thereby recommended that manufacturing firms should embark on production of quality goods and the Government should encourage the development of local industrial subsector. In his work, Jongbo (2014) evaluated the impact of real exchange rate fluctuation on industrial output of the Nigeria industrial sector using ordinary least square (OLS) and revealed that real exchange rate plays a significant role in determining the industrial output.

Musa and Sanusi (2013) investigated the response of aggregate industrial output to relative change in prices and exchange rate in Nigeria between 1970-2011, using a Vector Error Correction (VEC) model. Their empirical evidence indicated a significant relationship between exchange rate and industrial output; arguing that inflation and exchange rate have the potentials of causing significant changes in industrial output in Nigeria. This study therefore suggested that more policy attention should be given to proper management of the exchange rate and inflation.

Asher (2012) studied the impact of exchange rate fluctuation on the Nigeria real economic growth for the period of 1980 – 2010. The result showed that real exchange rate has a positive effect on the real economic growth.

Eme and Johnson (2012) investigated the effect of exchange rate movements on real output growth in Nigeria for the period 1986 – 2010. The result revealed that there is no evidence of a strong direct relationship between changes in exchange rate and output growth.

Akpan Riman, Duke and Mboto (2012), using the VECM model explored the long-run implications of industrial production and non-oil export on economic growth in Nigeria from 1970-2006, they found that a unidirectional causality runs from industrial sector output to economic growth.

Bakare (2011), conducted an empirical analysis of the consequences of the foreign exchange rate reforms on the performances of private domestic investment in Nigeria using the ordinary least square multiple regression analytical method. The multiple regression results showed a negative but significant relationship between floating foreign exchange rate and private domestic investment in Nigeria.

Akpan and Atan (2011) investigated the effect of exchange rate movements on real output growth in Nigeria for the period 1986 to 2010. Using quarterly series. They employed the simultaneous equations model within a fully specified macroeconomic model and a generalized method of moment's technique. This study found no evidence of a strong direct relationship between changes in exchange rate and output growth; rather, Nigeria's economic growth had been directly affected by monetary variables. The study further concluded that improvements in exchange rate are necessary but not adequate to revive the Nigerian economy.

Opaluwa, Umeh and Abu. (2010), examined the impact of exchange rate fluctuations on the Nigerian manufacturing sector during a twenty (20) year period (1986 – 2005), using Linear Regression tool. The result indicated an adverse but statistically significant effect of exchange rate on manufacturing output.

Adebiyi and Dauda (2009), using error correction model, argued on the contrary that trade liberalization promoted growth in the Nigerian industrial sector and stabilized the exchange rate market between 1970 and 2006. This study maintains that there was a positive and significant relationship between index of industrial production and real export.

3. Methodology

3.1 Model Specification and Techniques of Analysis

The study employed annual time series data, through secondary source, on industrial sector output which is proxied by industry share of real gross domestic product at 2010 constant base prices, exchange rate proxied by annual average exchange rate, annual percentage change in the consumer price index (CPI), and interest rate (INT) proxied by the prime lending rate. The data were sourced from Central Bank of Nigeria Statistical Bulletin and National Bureau of Statistics (NBS).

To examine the impact of exchange rate on industrial output in Nigeria, the study adopted the Solow-Swan production function, an economic model of long-run economic growth, within the framework of neoclassical economics with modification. The functional form of the model is as specified below:

$$\ln INDOT_t = \beta_0 + \beta_1 \ln EXR_t + \beta_2 \ln CPI_t + \beta_3 \ln INT_t + \varepsilon_t \quad - \quad - \quad - \quad (1)$$

Where:

$\ln INDOT_t$ = log of industrial output

$\ln EXR_t$ = log of real exchange rate

$\ln CPI_t$ = log of consumer price index

$\ln INT_t$ = log of interest rate

β_1 *to* β_3 are the parameters to be estimated.

β_0 = Intercept of the entire regression model

ε_t = Stochastic error term

In line with the argument of Khan and Rose (1977) regarding the functional form of the model, all the variables are in their natural logarithm form in a log-linear specification. According to them, a log-linear specification is better than a standard linear one on both empirical and theoretical ground. That is, the log-linear specification allows the dependent variable to react proportionally to an increase or decrease in the regressors and exhibits interaction between elasticities. In addition, the variables are linearized and it leads to a reduction in the scale of measurement.

This research work used a relatively new estimating technique popularized by Auto-Regressive Distributed Lag (ARDL) approach developed by Pesaran and Shin (1999) and Pesaran, Shin and Smith, (2001). It is a general dynamic specification which uses the lags of the dependent variable and the lagged and contemporaneous values of the independent variables, through which the short-run effects can be directly estimated, and the long-run equilibrium relationship can be indirectly estimated (Altinay 2007). Apart from being efficient and consistent in cases involving small samples, the ARDL approach has the ability to handle situations where the variables of interest to the researcher are *I(0), I(1)* or fractionally integrated. However, this technique collapse if any variable is of I*(2)*. ARDL also generates both short-run and long-run coefficient simultaneously. Moreover, this approach can distinguish dependent and independent variables. In addition, different variables can be assigned different lag lengths as they enter the model. The ARDL form of equation 1 is specified as:

$$\Delta \ln INDOT_t = \beta_0 + \sum_{i=1}^{N} \beta_1 \Delta \ln INDOT_{t=i} + \sum_{i=0}^{N} \beta_2 \Delta \ln EXR_{t=i} + \sum_{i=0}^{N} \beta_3 \Delta \ln CPI_{t=i} + \sum_{i=0}^{N} \beta_4 \Delta \ln INT_{t=i}$$

$$+ \lambda_1 \ln INDOT_{t-1} + \lambda_2 \ln EXR_{t-1} + \lambda_3 \ln CPI_{t-1} + \lambda_4 \ln INT_{t-1} + \varepsilon_t \quad - \quad -(2)$$

Where; $\ln INDOT_t$ is natural logarithm of industrial output, $\ln EXR_t$ is natural logarithm of exchange rate, $\ln CPI_t$ is natural logarithm of consumer price index, $\ln INT_t$ is natural logarithm of interest rate. β_0 and ε_t represents constant and Gaussian white noise respectively and $\beta_1, \beta_2, \beta_3, and\ \beta_4$ are the short run parameters (coefficients) of independent variables to be estimated.

Theoretically, the a priori expectation of the model are $\beta_1 > 0$, β_2 can be + or -, $\beta_3 > 0$, $\beta_4 < 0$. The expressions from β_1 to β_4 with the summation signs represents the short-run dynamics of the variables where lag values are included while λ_1 to λ_4 depicts the long-run relationship between the variables (long run coefficients).

The existence of a long-run relationship among industrial output, exchange rate, consumer price index and interest rate is examined by Bounds test. In the first stage, the null hypothesis of no co-integration of equation (2), $H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ is tested against the alternative $H_1 : \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$.
This test is performed on the basis of comparing the computed F-statistic values with bounds on critical values which depend on the number of variables. If the calculated F-statistic is higher than the upper bound critical values *I(1)* for the number of explanatory variables (k) by Pesaran et al (2001), the null hypothesis will be rejected, indicating co-integration. The upper bounds critical value is based on the assumption that all the variables are *I(1).* On the other hand, if the F-statistic is lower than the lower bound crucial value *I(0),* null hypothesis cannot be rejected. This indicates no co-integration. The lower bounds critical value is based on the assumption that all the variables are *I(0).* However, the F-statistic being between *I(0)* and *I(1)* presents an in conclusive result.

In the second step, the parsimonious model i.e the model with minimum information Criteria or the maximum R-square value is determined using the three-lag selection criterion namely, Akaike's Information Criterion (AIC), Schwarz Bayesian criterion (SBC) and R-squared Criterion to obtain appropriate lag length. This exercise is important because only an appropriate lag selection will be able to identify the true dynamics of the model (Akinlo, 2006). The following error correction model is estimated in the third step.

$$\Delta \ln INDOT_t = \beta_0 + \sum_{i=1}^{N} \varpi_i \Delta \ln INDOT_{t-1} + \sum_{i=1}^{N} \varphi_i \Delta \ln EXR_{t-1} + \sum_{i=1}^{N} \Omega_i \Delta \ln CPI_{t-1} + \sum_{i=1}^{N} \Upsilon_i \Delta \ln INT_{t-1}$$

$$+ \Psi ECM_{t-1} + V_t \quad . \quad . \quad . \quad (3)$$

Where $\Delta \ln INDOT_t = INDOT_t - INDOT_{t-1}$, and ditto to all other explanatory variables, β_0 is the constant, $\varpi_i, \varphi_i, \Omega_i, and\ \gamma_i$, are the dynamic adjustment coefficients, ECM_{t-1} is the lag of residual representing short run disequilibrium adjustments of the estimates of the long run equilibrium error, and Ψ is the coefficient of the error correction term, while V_t is the random error term (Gujarati, 2004). The error correction coefficient must be negative and statistically significant which indicates the existence of a short-run relationship. The size of the error correction coefficient determines the speed of adjustment towards equilibrium.

4. Data Presentation and Analysis

4.1 Unit Root Test Result

As stated in the previous section, one of the major short coming of ARDL approach is its inability to handle situations in which variable(s) is/are *I(2)* or higher. To be sure that the variables under study are only of *I(0)* and *I(1),* the popular Philips-Perron stability test is carried out to test for unit root. The result is presented in table 1:

Table 1: Phillips-Perron Unit Root Test Results

Philips-Perron							
	LEVELS			FIRST DIFFERENCED			
Variable	t-statistic	Critical value	p-value	t-statistic	Critical value	p-value	*I(d)*
Log(INDOT)	-0.254210	-2.945842	0.9220	-6.336371	-2.948404	0.0000 **a*****	*I(1)*
Log(EXR)	-2.206131	-2.945842	0.2077	-5.11589	-2.948404	0.0002**a*****	*I(1)*

Log(CPI)	-5.063835	-2.945842	0.0002**a*****	-	-	-	*I(0)*
Log(INT)	-2.704263	-2.1945842	0.00831	-7.950158	-2.948404	0.0000 **a*****	*I(1)*

Source: Researcher's computation (2022) using E-view 9.0

Note: *** and ** imply statistical significance at 1% and 5% levels respectively.
Also, '*a*' denotes model with constant.

The results as presented in table 1 revealed that industrial output (INDOT), exchange rate (EXR) and interest rate (INT) have unit root problem at their levels but are integrated of order one using Philips-Perron tests. While consumer price index (CPI) is stationary at level, *I(0)*. The results of the unit root test has necessitated the co-integration test as well as the choice of ARDL model because consumer price index is *I(0)* while other variables are *I(1)*.

4.4 Bounds Testing Approach for co-integration

Equation 2 is used in testing for co-integration using ARDL bound test. The null hypothesis of no co-integration $H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ is tested against the alternative hypothesis $H_1 : \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$. The result is presented in table 2.

Table 2: Co-integration Test Result:

Test Statistic	Value	K		
F-statistic	5.222612	3		
Critical Value Bounds				
Significance	I0 Bound	I1 Bound		
10%	2.72	3.77		
5%	3.23	4.35		
2.5%	3.69	4.89		

Source: Researcher's computation (2022) using E-view 9.0

The result as presented in table 2 shows that the computed F-statistic of 5.222612 is far above the upper bound critical values of 3.77, 4.35 and 4.89 for 10%, 5% and 2.5% respectively as suggested by Pesaran et al (2001).

This is an evidence of strong long-run relationship between and among exchange rate, consumer price index as well as interest rate and industrial output in Nigeria based on the data and the period used. In order words, there is long-run co-integration between and among the variables. The implication of the existence of cointegration is that any of the regressor variables can be targeted as a policy variable to bring about the desired changes in dependent variable in the system (Asongo, 2019). Therefore, exchange rate, consumer price index and interest rate are long run determinants of industrial output in Nigeria.

4.5: Long- Runs ARDL Estimates

Using the Schwarz Bayesian criterion (SBC) lag selection criterion to obtain appropriate lag length the E-views 9.0 software suggested the model of ARDL (1,1,0,0) as parsimonious. The result of long- run estimates is presented in Table 3.

Table 3: Long- run (ARDL 1, 1, 0, 0) results for industrial output model in Nigeria

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(EXR)	0.108912***	0.025039	4.349701	0.0001
LOG(CPI)	0.068543**	0.034184	2.005108	0.0170
LOG(INT)	0.201171	0.173889	1.156892	0.2564
C	8.414617	0.418531	20.105143	0.0000

Source: Researcher's Computation (2022) Using E-views 9.0

*Note: ***and ** signifies 1% and 5% levels of significance respectively*.

For the fact that a cointegration relationship was detected between the series, ARDL models were established to determine the long- and short-term relationships. According to Pesaran and Shin (1999),

the SBC is generally preferred to other criteria because it tends to define more parsimonious specifications with the limited observation. This study used the SBC to select appropriate lags for the ARDL models, which is found to be the order of ARDL (1, 1, 0, 0).

In terms of direction of relationship, there is a positive relationship between all the regressors (exchange rate, consumer price index and interest rate) and industrial output. This means that increase in any of these variables will result to increase in industrial output. Exchange rate and consumer price index is positive and statistically significant in explaining the variation in industrial output. Interest rate is however positive but statistically insignificance in explaining the variation in industrial output. Precisely, increase in exchange rate/depreciation in naira value by one percent will significantly increase industrial output by about 11 percent and it stands inelastic. Increase in consumer price index by one percent will result to a significant increase in industrial output by about 06 percent in the long-run. It is also inelastic. Increase in interest rate by one percent will insignificantly increase industrial output by about 20 percent in the long run.

4.6 Short-Run ARDL Estimates

Table 4: Short-run (ARDL 1, 1, 0, 0) results for industrial output model in Nigeria

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(EXR)	0.105537**	0.045248	2.332434	0.0266
DLOG(CPI)	0.023918**	0.010844	2.205699	0.0352
DLOG(INT)	0.070197	0.054592	1.285853	0.2083
CointEq(-1)	-0.348943***	0.093270	-3.741226	0.0008
R-squared	0.961348	Mean dependent var		9.121970
Adjusted R-squared	0.954906	S.D. dependent var		0.278920
F-statistic	149.2299	Durbin-Watson stat		1.737085
Prob(F-statistic)	0.000000			

Source: Researchers computation (2022) using E-view 9.0
*Note: ***and ** signifies 1% and 5% levels of significance respectively.*

The results of the short-term dynamic coefficients associated with the ARDL specifications are presented in tables 4. The last line presents the error correction terms (CointEq(-1)) related to the cointegration vector. It indicates that short-term relationships are satisfactory because the error correction term is significant and exhibit the expected negative sign. This coefficient corresponds to the speed of the adjustment to equilibrium level due to short-run shocks. Thus, higher values of that coefficient are associated with more rapid adjustments. The significant and negative magnitude of the ECT, of −0.348943 reflects a rapid speed of adjustment. This implies that about 35% of the disequilibria of the previous year's shock adjusting back to the long run equilibrium in the current year. This industrial output equation revealed that any deviation from the long run equilibrium is recovered in 2.9 months (1/0.34). This support the result of the co-integration test. Consequently, exchange rate, consumer price index and interest rate will play important roles to absorb any negative shock to industrial output in Nigeria. Just like in the case of long run, the variables are positively signed. Again apart from interest rate which have positive but insignificant impact on industrial output and stand inelastic, exchange rate and consumer price index have positive and significant relationship with industrial output and stand inelastic.

The magnitude of the long-run coefficients are larger than those of the short-run revealing that the impact of exchange rate is more in the long-run than in the short-run. This calls for long-run exchange rate policies that will stimulate industrial output.

The adjusted R-squared value of 0.961348 indicates that about 96 percent of the variation in industrial output is explained within the model and only about 4 percent that is explained by the variables outside the model. Durbin-Watson value of approximately 2

confirm the absence of serial correlation. The probability value of F-statistic shows that, as a whole, the model performs well.

4.6: Post-Estimation Tests:

4.6.1: Linearity Test:

Table 5: Ramsey RESET Test

	Value	Df	Probability	
t-statistic	2.208984	29	0.1352	
F-statistic	4.879612	(1, 29)	0.2352	

Source: Researcher's Computation (2022) Using E-view 9.0

Ramsey's RESET statistic is reported to judge misspecification. Given its probability value of 0.1352 and 0.2352 for t-statistic and F- statistic respectively, the RESET statistics are highly insignificant, supporting correct specification of the model.

4.6.2: Serial Correlation Test:

Table 6: Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.268732	Prob. F(2,28)	0.7663
Obs*R-squared	0.678011	Prob. Chi-Square(2)	0.7125

Source: Researcher's Computation (2022) Using E-view 9.0

A key assumption in the bounds testing methodology of Pesaran et al. (2011) is that the errors of equation (2) must be serially independent. To make sure residuals of the optimum model are autocorrelation free, the researcher reported the Breusch-Godfrey Lagrange Multiplier (LM) statistic. The LM statistic is insignificant at 1% since the probability values of 0.7663 and 0.7125 for F-statistic and Obs*R-squared respectively are higher than 0.1. Therefore, there is no evidence of serial correlation.

4.6.3: Heteroskadasticity Test:

Table 7: Heteroskedasticity Test: ARCH			
F-statistic	0.240740	Prob. F(1,33)	0.6269
Obs*R-squared	0.253481	Prob. Chi-Square(1)	0.6146

Source: Researcher's Computation (2022) Using E-view 9.0

Table 7 presents the results of heteroskedasticity test. The P-values of 0.6269 and 0.6146 for F-statistic and Obs*R-squared from Breusch-Pagan-Godfrey ARCH is in support of the null hypothesis of no evidence of heteroskedasticity. That means that the residuals are homoskedastic.

5. Conclusion and Recommendations

This research work empirically examined the impact of exchange rate on industrial output in Nigeria using annual time series data for the period of 1981 to 2021. Unit root tests (PP tests), and co-integration test (Bounds Test) were carried out to ascertain the stationarity and to know the existence of long-run relationships between exchange rate and industrial output respectively. Error correction model was carried out to test the power of adjustment to long run equilibrium due to short run shock. The speed of adjustment of 0.35 is found to be very high. The results of the unit roots test indicated that apart from CPI which is stationary at levels, all other variables are stationary in first differences *I(1).* The co-integration tests results showed that long-run relationships exist between the EXR and industrial output, error correction method estimates the short-run relationship between exchange rate and industrial output.

Exchange rate and consumer price index are individually positive and statistically significant in explaining variation in industrial output both in short-run and long-run. This implies that increased access to exchange rate for production purposes could have significant impact on industrial output both in the short-run and in the long-run.

Interest rate on the other hand reported a positive but insignificant relationship in explaining changes in the industrial output in Nigeria. Battery of diagnostic tests was also applied to the empirical models to

gauge the adequacy of the models' specifications. The Breusch–Godfrey LM test statistic rejects the hypothesis of serial correlation for the equations. The ARCH test confirms that the residuals are homoscedastic in all equations, and the Ramsey Reset test confirms the correct functional form of the equations.

Since exchange rate has potentials of causing significant changes in industrial output in Nigeria, the study recommended the need for more macroeconomic policy attention to the proper management of the exchange rate. This therefore suggests that more foreign exchange should be made available for industrial production. The government should attempt to encourage acceptable exchange rate policies in order to fully exploit the benefits of the sector and promote industrial output. The emphasis should be on moderate exchange rate since the relationship with industrial output is inelastic.

Measures should be in place to strengthen both backward and forward linkages between industrial sector and other sectors of the economy especially the agricultural sector to obtain raw materials thereby reducing the reliance of the sector on import of inputs to a reasonable level. In addition, efforts should be put in place to check the importation of goods that could be locally produced so as to improve the performance and competitiveness of the industrial sector.

To increase the impact of consumer price index on industrial output, a concerted effort should be directed toward price control in the economy to enhance sustainable economic growth through increased industrial output. The impact of consumer price index on industrial output of Nigeria will increase if the government concentrates on acceptable price of goods and services in the economy since the impact of this variable is inelastic to industrial output. Generally, the government of Nigeria should improve resources and development in the industrial sector in order to improve the lives of citizens.

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