



Exchange Rate and Output in Nigeria (1986-2021)

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Abstract

Exchange rate as a major macroeconomic indicator was examined alongside output within the period (1986-2021) in Nigeria. With the ever rising exchange rate, indications are that certain drivers of the economy that should help create some balance are lacking. Secondary data were sourced from the CBN statistical bulletin for the said period and subjected to statistical inferential analysis using the Vector Autoregression (VAR) model. The major objective was to ascertain the relationship between exchange rate and output following coefficients like the unit root test, difference-stationary process, lag length criteria, stability condition check, Engel and Granger test as well as autocorrelation test. Results indicate that exchange rate indirectly affects output as a unit increase in it results in a corresponding unit decrease in output where at lag 2, there is a positive relationship affecting output directly, where any unit increase in exchange rate at those lags leads to a unit increase in output. Exchange rate based on the other VAR variables may not be used in predicting output as prob. of the χ^2 coefficient for all were less than 0.05 hence output is adversely affected as various macroeconomic variables are at risk. The study discourages heavy reliance on mono-economy (oil exports) while diversification in the areas of agriculture and manufacturing will help cushion the effects of rising exchange rates and inflation in the country.

Key words: Exchange Rate, Economy, Output, Macroeconomics, Nigeria.

1. Introduction

Economic indices like exchange rate, interest rate and other macro-economic indicators are on the front burner of discussions that affect international finance including developing nations as Nigeria (Adediran, 2014). Exchange rates relate a transmission mechanism in policy-evaluation models, serving as arbitrage equation relating the interest rate in one country to the interest rates in other countries (Taylor, 2001). On the other hand, exchange rates are non-stationary economic concepts where the price of one country's currency is expressed in terms of some other countries' currencies. It is a major determination of relative prices of domestic and foreign goods and the strength of external sector participation in international trade. Exchange rate as a major macroeconomic

indicator has great effect on their macroeconomic aggregates like GDP, inflation rate, money supply and interest rate (Jhingan, 2009). Since exchange rates are seen as volatile, economists devote much of their attention on monitoring them and how they affect various countries' economies. In developing economics, exchange rates and economic growth in especially sub-Saharan Africa had been problematic. Therefore, Rapetti *et al*, (2012) had noted that decrease in overvaluation of real exchange rate boosts economic growth, but all these facts are established on the developing countries only, while Ghura (1991) observed that foreign credit among other factors have contributed significantly to slow growth rate in sub-Saharan Africa.

In Nigeria as in other developing countries that are endowed with enormous natural resources, there is the heavy reliance on one particular sector (mono-economy). This tradable booming sector (crude oil) contributes about 72.93 percent while the non-oil exports contribute about 27.07 percent of the country's foreign exchange earnings (National Bureau of Statistics, 2015). This reliance on crude oil and non-oil exports affects exchange rates considerably including other macroeconomic indicators. This situation also gives rise to the neglect of tradable lagging sectors and the non-tradable sectors which would have contributed in no small measure in creating a sustainable robust economy for the developing economies. Therefore, the dependence on a mono economy with full exportation of mainly crude oil implies that the local currencies begin to slide to affect other aspects of the economy, whereas suggestions from various economists are that economies should specialize in industries in which they have co-operative advantages (Jhingan, 2009). This is because most natural resources especially crude oil, natural gas and solid minerals are non-renewable and once depleted, there would be volatility in pricing.

Exchange rates in Nigeria have undergone considerable changes in the post-independence era. This followed a fixed exchange rate of 1960 to the pegged exchange regime of the early 1970s and mid-1980s. In 1995, the Central Bank of Nigeria (CBN) enhanced the sale of foreign exchange to end-users through the Autonomous Foreign Exchange Market. Central to the reform is the launching of Bureau De change market as authorized dealers. To further enhance access to foreign exchange market, the Nigerian government introduced the interbank foreign exchange marketing in 1999. According to CBN (2020), a relative stability in the exchange rate put an average rate of ₦1.75 per US dollar. The movement of the foreign exchange experienced mostly depreciation since the liberalization of the 1986 until 1993 when it was again fixed at ₦22/USD. Later, the fixed exchange rate could not be sustained leading to further depreciation to ₦92/USD by 1999. Subsequent reforms led to unceasing depreciation between 1999 and 2004 when it reached ₦132/USD. However, there was slight respite for the economy when it appreciated between 2004 and 2008 and since then the depreciation has been steady reaching ₦192/USD in 2015 and ₦253/USD on the average in 2016. Between June and September 2016 it officially stood at ₦305/USD till July 2018 when the CBN devalued the naira currency twice in 2020; trading within a band of 380 and 381 naira per USD.

When oil price tumbled, the naira came under severe pressure from rising demand for the USD as foreign investors pulled out of the country during the global pandemic crisis. The exchange rate of the naira to the USD has worsened as it was ₦428/USD in 2021 while it is worse off between 2022 and 2023 with over ₦750/USD and ₦1000/USD respectively (Raff, 2022).

As earlier noted, one major export commodity has dominated Nigeria's exports in the recent decades. Contrary to economic developments in the millennium, primary agricultural products were exported in large quantities in the 1960s up to mid-1970s when Nigeria experienced a positive crude oil stock. But the proportion of crude oil export in total export had increased greatly, making it a major export commodity. Between 1999 and 2004, the share of crude oil export averaged 97.5 percent. In terms of real money value, crude oil and natural gas exports averaged N45.33 billion between 1986 and 1990 and increased to N307.66 billion during 1991 to 1995 due to favorable crude oil price at the international market. Later it increased to ₦1, 183, 8.7 billion; ₦ 3,622.51 billion, and N 8,794.38 billion between 1996 and 2000; 2001 and 2005; 2006 and 2010 respectively, which are favorable indices in the international market. Crude oil and gas kept an upward trend of ₦13, 688.11 billion during 2011 to 2014 but depreciated to ₦8, 339.55 billion and further to ₦8,093.4 billion during 2011 to 2014 but depreciated to N8, 339.55 billion and further N8, 093.41 billion in 2015 and 2016 when oil price slumped in the international market and reduction in domestic production during the period.

Non-oil exports contribution to total exports remained non-encouraging throughout the review period in spite of the government effort to diversify the export base of the country's economy. The value of non- exports especially agricultural products averaged N0.02 billion between 1986 and 1990 but increased to N0.07 billion and N0.8 billion between 1995 and 2005 in that order. Between 2006 and 2010, 2011 and 2014 the value of agricultural exports rose to N0.22 billion and N0.97 billion respectively due to government's effort towards value addition for exports. This rising trend began to slide in 2016 when the export value came to N0.8 billion with increased local demand as restrictions were placed on some Nigeria's agricultural products from entering European markets due to non-compliance with international standards as well as high production costs (Aliyu, 2010).

In essence, literature is buoyant with exchange rate trends over so many periods but an assessment of exchange rates influence on the performance of manufacturing output in Nigeria between the periods under review (1985-2021) is lacking hence this study.

2. Materials and Methods

Secondary data sets were sourced from the CBN statistical bulletin within the period (1986-2021). The analyses were done using the VAR Model as discussed below;

Vector Autoregression (VAR) as a stochastic process model, is a statistical model used to measure and analyze the relationship between multiple variables over time. This means that, VAR models randomness in the form of data points that can be observed at different moments in time. Where there are multiple variables to consider when making decisions or predictions, VAR has been widely used. It generalizes univariate autoregressive by allowing multivariate time series. A univariate regression is a one single equation model where its current values are explained by its lagged values. A VAR is a n-variables, n-equation model which expresses each variable as a linear function of its own past values, the past values of all other variables being considered and a serially uncorrelated error term. Popularity of VAR models was made by Christopher (1980). VAR model provides a coherent and credible approach to data description, forecasting, structural inference and policy analysis Stock and Watson (2001).

The study, therefore, reviewed government responses to output with the ever changing the exchange rate over the years. It sought to examine if output increases, exchange rate (Ex), will decrease the rate to activate the economy. To do so, the bivariate VAR model was set up.

Variables: Output (Ou) and Exchange rate (Ex)

Frequency: yearly data 1986 – 2021

VAR Model Representation.

$$Ou_t = \alpha_{10} + a_{11}Ou_{t-1} + a_{12}Ex_{t-1} + b_{11}Ou_{t-2} + b_{12}Ex_{t-2} + \dots + u_t \quad (1)$$

$$Ex_t = \alpha_{20} + a_{21}Ou_{t-1} + a_{22}Ex_{t-1} + b_{21}Ou_{t-2} + b_{22}Ex_{t-2} + \dots + u_t \quad (2)$$

Unit Root Test

A unit root test was conducted to test for stationary (or non-stationarity) of the data set. The unit root (stochastic) process used is given as:

$$y_t = \rho y_{t-1} + u_t \quad -1 \leq \rho \leq 1 \quad (3)$$

where u_t is a white noise error term. If $\rho = 1$ equation (6) becomes a random walk model without drift which is a nonstationary stochastic process which would no longer be estimated using Ordinary Least Squares method (OLS). By subtracting y_{t-1} from both sides of equation (6) to obtain

$$y_t - y_{t-1} = \rho y_{t-1} - y_{t-1} + u_t \quad (4)$$

$$\Delta y_t = (\rho - 1) y_{t-1} + u_t \quad (5)$$

$$\Delta y_t = \delta y_{t-1} + u_t \quad (6)$$

where $\delta = (\rho - 1)$ and Δ is the first difference operation

A stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between the time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed Gujarati and Porter (2009).

The hypothesis is

H₀: the variables do not have unit roots (are stationary).

Decision Rule: Reject H₀ if the *p*-value > 0.05, otherwise do not reject

Difference – Stationary Process

If a time series data has a unit root, the first differences of such time series are stationary, therefore the solution is to take the first differences of the time series. When a time series is *I*(2), it will contain two unit roots, in which case it will have to difference it twice. If it is *I*(d), it has to be differenced d times where d is any integer.

Lag Length Criteria

Once a VAR model is estimated, it is important to check for the lag length criteria. The lag length defines the number of lags that will be included as explanatory variables in the

model and has a substantial impact on its performance. The choice of an appropriate lag-length is not always straightforward and requires careful consideration by the user. If the lag length is too small, the model is miss-specified and if the lag length is too large, then the degrees of freedom are wasted. The test uses Akaike, Schwartz and Hannan-Quinn criteria. The lower the values of these criteria, the more appropriate the lag length which ensures that there should be no autocorrelation at the selected lags.

Stability Condition Check

In literature, stability condition of the VAR model is also referred to as stationarity conditions. If all inverse roots of the characteristic Autoregressive polynomial have modulus less than one and lie inside the unit, the estimated VAR is stable that is, if $-1 < \rho < 1$ /. If the VAR is not stable, diverse test conducted on the VAR model may be invalid.

Engle and Granger Test

The Granger test shows the relationship between variables. If one variable causes the other one, it means that it helps to predict future values of the other variable Granger (1969). The Granger causality test is stated thus;

$$Ou_t = \sum a_i Ou_{t-i} + \sum a_j Ex_{t-j} + u_t \quad (7)$$

H₀: the independent variable (Ex) does not granger cause Ou

Decision Rule: if p-value < 0.05, the independent variable (Ex) granger causes Output otherwise the independent variables (Ex) do not granger cause Output at 5% significance level.

Test of Autocorrelation

To work with VAR model, it must be ensured that the variables are stationary; that is they do not have unit root.

3. Results and Discussion

Test of Unit Root

The variables were tested for unit roots using Dickey fuller Test and the results are presented in tables 1 to 5

Table 8: VAR Estimation

. var dOUTPUT dexchangerate

Vector autoregression

Sample: 1990 - 2021	Number of obs	=	32
Log likelihood = -387.0127	AIC	=	24.8133
FPE = 2.06e+08	HQIC	=	24.96512
Det(Sigma_ml) = 1.10e+08	SBIC	=	25.27134

Equation	Parms	RMSE	R-sq	chi2	P>chi2
dOUTPUT	5	411.424	0.7958	124.675	0.0000
dexchangerate	5	30.8917	0.0795	2.7639	0.5981

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
dOUTPUT						
dOUTPUT						
L1.	-.0052381	.1218902	-0.04	0.966	-.2441385	.2336623
L2.	.0860401	.1342703	0.64	0.522	-.1771249	.3492051
dexchanger~e						
L1.	-7.327684	2.362658	-3.10	0.002	-11.95841	-2.69696
L2.	23.73383	2.467084	9.62	0.000	18.89844	28.56923
_cons	-63.58623	83.09779	-0.77	0.444	-226.4549	99.28243
dexchanger~e						
dOUTPUT						
L1.	.0052921	.0091521	0.58	0.563	-.0126457	.0232299
L2.	-.0022994	.0100817	-0.23	0.820	-.0220591	.0174603
dexchanger~e						
L1.	-.023699	.1773998	-0.13	0.894	-.3713962	.3239982
L2.	.3031844	.1852406	1.64	0.102	-.0598806	.6662493
_cons	10.52549	6.239383	1.69	0.092	-1.70348	22.75445

Source: *Authors' regression results*

The table revealed the result of the VAR model of output as explained by lags of Output and Exchange rate at lag 2. From the result of the table, it was showed that the coefficients of lag 1 of Output and lag 1 of Exchange rate were all negatively explained; that is, they indirectly affect Output. Hence any unit increase on these variables at those lags 1, leads to decrease in Output. However, lag 2 of Output and Exchange rate were all positively explained. Output thus; they affect Output directly. Hence any unit increase on these variables at those lags leads to increase in Output as well.

. summarize error

Variable	Obs	Mean	Std. Dev.	Min	Max
error	32	9.98e-07	383.9643	-1290.29	597.8546

Figure 1: Summary Table

Figure 1 shows the summary of the error from the estimated model. It revealed that the values of the error mean with a value of 0.000000998 and standard deviation with a value of 383.9643.

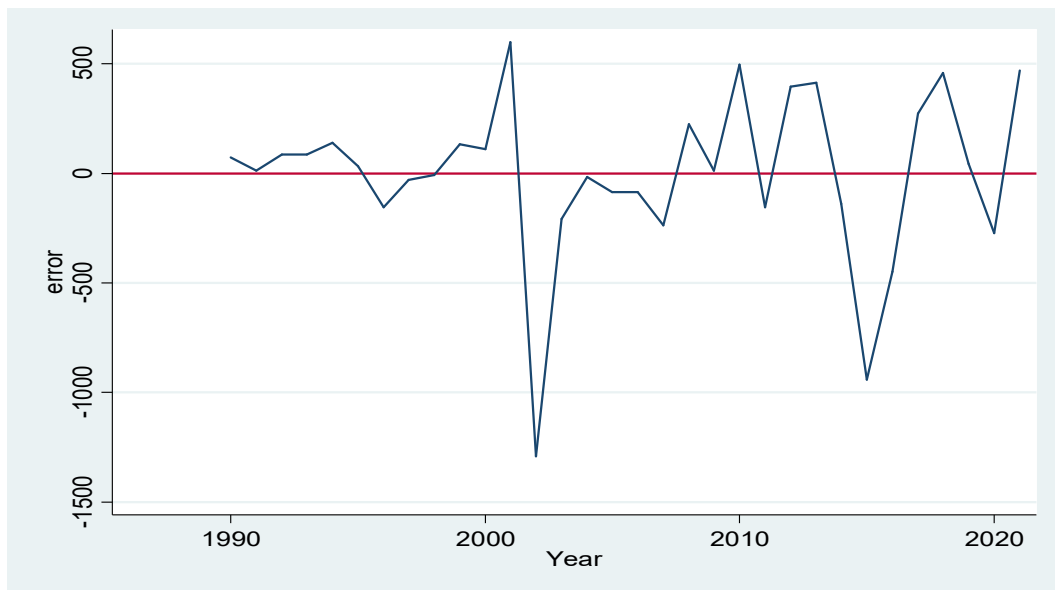


Figure 2: Graph of fitted VAR model

Figure 2 shows the graph of the residual of the fitted model. From the graph, the residual fluctuates around the mean error which is 0.000000998 as indicated by the red horizontal line in the graph. This fluctuation around the mean shows a good behavior of the VAR model fitted.

Table 11: Autocorrelation Test

. varlmar

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	49.4834	25	0.00247
2	42.4617	25	0.01602

H0: no autocorrelation at lag order

Source: *Authors' regression results*

Table 11 shows the test of autocorrelation or the lagrange-multiplier test for the estimated VAR model. The H_0 that there is no autocorrelation at lag order was not rejected. This is because the values prob > chi of 0.00247 and 0.01602 were all less than 0.05. Therefore, there is no autocorrelation among the variables included in the model.

Table: 12 Granger Causality Test

. vargranger

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
dOUTPUT	dexchangerate	97.05	2	0.000
dOUTPUT	ALL	97.05	2	0.000
dexchangerate	dOUTPUT	.3503	2	0.839
dexchangerate	ALL	.3503	2	0.839

Source: *Authors' results of regression*

Table 12 shows the causality test using granger. It revealed that Output causes the Exchange rate which implied that there is relationship between Output and Exchange rate and can be used in predicting the future values of Exchange rate as the prob>chi² at the 2 lags were 0.000 < 0.05 or 5% level of significance.

However, Exchange rate does not help to cause Output which implied there is no relationship between Exchange rate and Output. However, Exchange rate cannot be used in predicting Output as the prob>chi² of the coefficient for all 0.839 > 0.05.

4. Summary and Discussion

Vector AutoRegression (VAR) as a Statistical model, is used to measure and analyze the relationship between multiple variables over time. To measure and analyze

the relationship between Output and Exchange rate using VAR model, the variables were first tested for unit roots using Dickey-fuller Test. The results of the test are that the variables were not stationary as they contained unit roots. In order to make the data sets stationary, second order differencing $I(2)$ was conducted which made series stationary using Dickey-fuller test again.

VAR model was then fitted. The result of the fitted model is that the coefficients of lag 1 of Output and lag 1 of Exchange rate were all negatively explained which is an indication that they are indirectly affecting Output. This suggests that any unit increase in the variable at those lags leads to a decrease in Output. At lag 2, Output and Exchange rate were all positively explained; thus they affect Output directly. Hence any unit increase on these variables at those lags leads to an increase in Output as well.

A check on the appropriate lag length was conducted so that the model should not be mis-specified if the lag length is too small, and if the lag length is too large, then the degrees of freedom are wasted. The result of the check is that the appropriate lag length according to the selection criteria is lag 2. This is because the value 24.8133 of the selection criteria (Akaike) at lag 2 was less than the values of the selection criteria (Akaike and Hannan Quinn) for other lag lengths. This implies that lag 2 is the appropriate lag length for the estimated VAR model.

However, a stability condition test for our estimated model was performed. The result of the test is that all the inverse roots of the characteristic (AR) Autoregressive polynomial have modulus all less than and lie inside the unit. Hence the estimated VAR model was stable and may be used for future predictions. A graph was also plotted which showed the mean of the residual of the fitted model. However, the graph revealed that the residual fluctuates around the mean error with a value of 0.000000998 which is approximately 0 as indicated by the red horizontal line in the graph. This fluctuation around the mean shows a good behavior of the VAR model fitted.

Furthermore, the test of autocorrelation or the lagrnger-multiplier test for the estimated VAR model was performed. From the test, H_0 , that there is no autocorrelation at lag order was not rejected. This is because the values $\text{prob}>\chi^2$ of 0.00247 and 0.01602 were all less than 0.05, which therefore implied that there is no autocorrelation between the variables included in the model.

Finally, the causality test using granger was conducted. The results of the test are that Output causes the Exchange rate which implied that there is a relationship between Output and Exchange rate and can be used in predicting the future values of Exchange rate as the $\text{prob}>\chi^2$ at the 2 lags were $0.000 < 0.05$ at 5% level of significance.

5. Conclusion and Recommendations

Exchange rate does not help to cause Output which implied that there is no relationship between Exchange rate and output. However, Exchange rate cannot be used in predicting output as the $\text{prob}>\chi^2$ of the coefficient for all $0.839 > 0.05$. Therefore, with the ever unrelenting increase on exchange rates in Nigeria, output is adversely affected as various macroeconomic variables stand at risk. These changes ultimately affect the economy where prices of commodities continue to skyrocket causing more and more economic hardship. Since some relationships were recorded from the results of the various indices used in the VAR model, it then implies that to a reasonable extent, increase in Output will likely impact some cushioning effect of this rising trend in exchange rate in Nigeria and other developing nations of the world. Heavy reliance on

one sector (mono-economy) will always relegate the others and hasten the rates at which inflation hits the economy as the Exchange rate continues in this upward trend.

The work among others recommends increased Output from non-oil products-agriculture and manufacturing since the country is awash with resources of great economic value and vast fertile arable land that can guarantee the desired results. Also insecurity which has become a thriving norm in the Nigerian social and political system must be tackled head on if agriculture and other sectors must thrive.

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