

# TIME SERIES ANALYSIS OF NIGERIA GROSS DOMESTIC PRODUCT USING US DOLLAR AND BRITISH POUNDS FROM 2000 – 2014

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**Abstract:** Time series analysts have used different technical and fundamental approach in modelling and forecasting exchange rate in both developed and developing countries. These results vary base on the approach applied. In this research work, ) developing country like Nigeria was used to forecast the naira/dollar and the naira/British pound exchange rate for the period 2000-2014. A time domain model (fundamental approach) using Autoregressive Integrated Moving Average (ARIMA) to evaluate the impact of exchange rate on the economy. The result reveals that there is an upward trend but there was break down in the economic growth in 2010 and rose again in 2011 and the first difference of the series was stationary using Phillips-perron test statistics with the aid of econometric view (Eviews).

**Keywords:** Autoregressive regressive, moving average, integrated, rate,

## 1.0 Introduction

Exchange rates have become unfavourable to Nigeria as a result of using the floating foreign exchange determination system. Prior to 1986, Nigeria was on a fixed exchange rate determination system. At that time, naira was very strong in reference to dollar. The exchange rate was one naira to one US dollar i.e. N1=\$1. The increasing demand for foreign exchange and the inability of the exchange control system to evolve an appropriate mechanism for foreign exchange allocation in consonance with the goal of internal balance makes it to be discarded in September 26, 1986 while a new mechanism was introduced under the Structural Adjustment Programmes (SAP). The main objectives of the new exchange rate policy were to preserve the value of the domestic currency, maintain a favourable external balance and the overall goal of macroeconomic stability and to determine a realistic exchange rate for the Naira. Since 1986 when the new exchange rate policy has been adopted, however, exchange rate determination in Nigeria has gone through many changes. Before the establishment of the Central Bank of Nigeria(CBN) in 1958 and the enactment of the Exchange Control Act of 1962, foreign exchange was earned by private sector and held in balances abroad by commercial banks that acted as agents for local exporters. The boom experienced in the 1970s made it necessary to manage foreign exchange rate in order to avoid shortage. However, shortages in the late 1970s and the early 1980's

compelled the government to introduce some adhoc measures to control excessive demand for foreign exchange.

Further reforms such as the formal pegging of the Naira exchange rate, the centralization of foreign exchange in the CBN, the restriction of Bureau de change to buy foreign exchange as an agent of CBN etc. were all introduced in the foreign exchange market in 1994 as a result of the volatility in exchange rates. Still, there was another policy reversal in 1995 to that of “guided deregulation”. This necessitated the institution of the Autonomous Foreign Exchange Market (AFEM) which later metamorphosed into a daily; two ways quote Inter-Bank Foreign Exchange Market (IFEM) in 1999. The Dutch Auction System was reintroduced in 2002 as a result of the intensification of the demand pressure in the foreign exchange market and the persistence in the depletion of the country’s external reserves. Finally, the wholesale Dutch Auction System (W-DAS) was introduced in February 20, 2006. The introduction of the WDAS was also to deepen the foreign exchange market in order to evolve a realistic exchange rate of the Naira

### **1.1 Aim and Objectives**

The aim of this research work is to evaluate the impact of exchange rate of US Dollar and British Pounds on the Nigerian economy with the following objectives:

- ❖ To observe changes that occurs in the Nigerian foreign exchange rate with the two currencies
- ❖ To fit a model to the data
- ❖ Forecast future values of Nigeria GDP

### **2.0 RESEARCH METHODOLOGY**

To realise the objectives of this research, simple time domain techniques (ARIMA model) will be used to forecast the Dollar/Naira and the British pounds/Naira exchange rates from 2000 to 2014. The simple ARIMA model description is covered on Box- Jenkins methodology. The ARIMA encompass three components, AR, MA, and integrated series. AR stands for the autoregressive model i.e. regressing the dependent variable with linear combination of its past values or lagged values, MA stands for moving average model i.e. regressing the dependent errors with linear combination of its past error or lagged error or

innovation and I stands the differencing order, that is number of difference applied on the stochastic process before attaining stationary. The model is given below;

The simplified form of representing ARIMA model algebraically is:

$$GDP = F (GBP/NGN, USD/NGN).$$

Where: GDP = Gross Domestic Product

GBP/NGN = British Pound to Naira

USD/NGN = United States Dollar to Naira.

Hence, the mathematical form of the model with the parameters is:

$$GDP = \beta_0 + \beta_1 GBP + \beta_2 USD.$$

There are two steps we will take to achieve our aims and these are listed below;

1. Model Estimation
2. Model Identification
3. Model Diagnostic and Forecasting Accuracy.

## 2.1 MODEL ESTIMATION

We estimate the parameters of ARIMA model using Statistical Package for social sciences (SPSS).

## 2.2 MODEL IDENTIFICATION

The major thing to do here is to test for stationarity of the series (US Dollar and Naira exchange rate as well as British pound and Naira) using the approach of Phillips-Perron test statistic.

## 2.3 MODEL DIAGNOSIS

if we fit the model, the model diagnosis will aid us to know the forecasting, reliability, accuracy ability which will be judge under the coefficient of determination or through the use of the smallest mean square error or other smallest measurement tools like MAE (Mean Absolute Error), MAPE (Mean Absolute Percentage Error), RMSE (Root Mean Square Error), MSE (Mean Square Error). Box-jenkins model building strategy entails a diagnosis of the adequacy of the model. More importantly, it is necessary to ascertain in what way a model is adequate or inadequate. And this entails being sure that;

- The model converged upon minimum sum of square error
- The sum of square error (residuals) should be quite small so that  $R^2$  of the model could be quite large.

Parameter estimates should be evaluated for significance, magnitude, number, proximity to

**Source: Author’s computation using SPSS**

the boundary of stationarity

**3.0 DATA ANALYSIS AND INTERPRETATION OF RESULTS**

**Table 1: ARIMA MODEL PARAMETERS**

|                 |         |                   |           |       | Estimate | SE      | T      | Sig. |
|-----------------|---------|-------------------|-----------|-------|----------|---------|--------|------|
| GDP-<br>Model_1 | GDP     | No Transformation | Constant  |       | -881.968 | 193.804 | -4.551 | .001 |
|                 | GBP/NGN | No Transformation | Numerator | Lag 0 | 1.047    | 1.212   | .864   | .405 |
|                 | USD/NGN | No Transformation | Numerator | Lag 0 | 6.563    | 2.180   | 3.011  | .011 |

**The ARIMA model**

$$\begin{array}{l}
 \text{GDP} = -881.968 + 1.047 \text{ GBP/NGN} + 6.563 \text{ USD/NGN} \\
 \text{SE} \quad (193.804) \quad (1.212) \quad (2.180) \\
 \text{t} \quad -4.551 \quad 0.864 \quad 3.011 \\
 \text{P-value} \quad 0.001 \quad 0.405 \quad 0.011
 \end{array}$$

**Source: Author’s computation using SPSS**

**3.1 Interpretation of table 1:**

- -881.968: The value shows the level of Gross Domestic Product (GDP) when the exchange rate of British pounds to Naira is zero, holding the exchange rate of US dollar to Naira constant. It is also the value of Gross Domestic Product (GDP) when the exchange rate of US dollar to Naira is zero holding the exchange rate of British pounds to Naira constant.
- 1.047: It shows that a unit increase in the exchange rate of British Pounds to Naira will lead to 1.047 Increase in Gross Domestic Product (GDP).
- 6.563: It shows that a unit increase in the exchange rate of US dollar to Naira leads to 6.563 Increase in Gross Domestic Product (GDP).

**3.2 STANDARD ERROR TEST EXPLAINING THE MODEL.**

**Hypothesis:**

**H<sub>0</sub>:  $\beta_0 = 0$**

**H<sub>1</sub>:  $\beta_1 \neq 0$**

- $1/2 (\beta_0)$  compare it with the  $S_{\beta_0}$

i.e.  $1/2 (881.968) = 440.984$

$S_{\beta_0} = 193.804$

**Decision / conclusion:**

Since  $1/2 (\beta_0) > S_{\beta_0}$  we accept **H<sub>1</sub>:  $\beta_1 \neq 0$** , and conclude that GDP is statistically significant.

**Hypothesis:**

**H<sub>0</sub>:  $\beta_1 = 0$**

**H<sub>1</sub>:  $\beta_1 \neq 0$**

- $1/2 (\beta_1) = 1/2 (1.047) = 0.5235$

$S_{\beta_1} = 1.212$

**Decision / conclusion:**

Since  $S_{\beta_1} > 1/2 (\beta_1)$ , we accept **H<sub>0</sub>:  $\beta_1 = 0$** , and conclude that the GBP/NGN is not statistically significant.

**Hypothesis:**

**H<sub>0</sub>:  $\beta_2 = 0$**

**H<sub>1</sub>:  $\beta_2 \neq 0$**

- $1/2 (\beta_2) = 1/2 (6.563) = 3.2815$

$S_{\beta_2} = 2.180$

**Decision / conclusion:**

Since  $1/2 (\beta_2) > S_{\beta_2}$ , we accept **H<sub>1</sub>:  $\beta_2 \neq 0$**  and conclude that the USD/ NGN is statistically significant

### 3.3 ARIMA MODEL EXPLANATION USING t - TEST

The t-statistic test is carried out by comparing the calculated values of t-test and the tabulated value of t-test.

**Decision:** If  $t_{cal} > t_{tab}$ , we accept  $H_1$  and reject  $H_0$  vice versa. Since the number of observations  $n < 30$ , we use t-test in order to know or to test the significance of the variables.

We obtain t-tab at 5% level of significance to be,  $t_{0.05/2}$ ,  $15-1=2.14$ . Where:  $15-1=14$  represents the degree of freedom. i.e.  $n-1$

- **For  $\beta_0$**   
**H<sub>0</sub>:  $\beta_0 = 0$**   
**H<sub>1</sub> :  $\beta_0 \neq 0$**   
**t-cal= 4.551**  
**t-tab= 2.14**

**Conclusion:**

Since, t-cal (4.551)>2.14, we accept the alternative hypothesis and reject the null hypothesis, and conclude that  $\beta_0$  which represents the value of Gross Domestic Product when the exchange rate of British Pounds to Naira is zero. All things being equal is statistically significant at 5% level of significance.

- **For  $\beta_1$**   
**H<sub>0</sub>:  $\beta_1 = 0$**   
**H<sub>1</sub> :  $\beta_1 \neq 0$**   
**t-cal= 0.864**  
**t-tab= 2.14**

**Conclusion:**

Since, t-cal (0.864)<2.14, we accept the null hypothesis and reject the alternative hypothesis, and conclude that  $\beta_1$  which represents the slope of exchange rate of British Pounds to Naira is not statistically significant at 5% level of significance.

- **For  $\beta_2$**   
**H<sub>0</sub>:  $\beta_2 = 0$**   
**H<sub>1</sub> :  $\beta_2 \neq 0$**   
**t-cal= 3.011**  
**t-tab= 2.14**

**Conclusion:**

Since, t-cal (3.011) >2.14, we accept the alternative hypothesis and reject the null hypothesis, and conclude that  $\beta_2$  which represents the slope of exchange rate of US dollars to Naira is statistically significant at 5% level of significance.

### **3.4 PROBABILITY TEST EXPLAINING THE ARIMA MODEL**

**P- Value [ $\alpha = 0.05$ ]**

**Hypothesis**

**H<sub>0</sub>: β<sub>0</sub> = 0**

**H<sub>1</sub>: β<sub>0</sub> ≠ 0**

- For β<sub>0</sub>: α > p – value (β<sub>0</sub>)

i.e. 0.05 > 0.001

**Decision / conclusion:** since α > p (β<sub>0</sub>), we accept H<sub>0</sub> : β<sub>0</sub> = 0, and conclude that GDP is not statistically significant.

- For β<sub>1</sub>: α < p – value (β<sub>1</sub>), **H<sub>0</sub> : β<sub>1</sub> = 0, H<sub>1</sub> : β<sub>1</sub> ≠ 0**  
 = 0.05 < 0.405

**Decision / conclusion:** since α < p (β<sub>1</sub>), we reject H<sub>0</sub> : β<sub>1</sub> = 0 and conclude that GBP/NGN is statistically significant.

- For β<sub>2</sub>: α > p – value (β<sub>2</sub>), **H<sub>0</sub> : β<sub>2</sub> = 0, H<sub>1</sub> : β<sub>2</sub> ≠ 0**  
 = 0.05 > 0.011

**Decision / conclusion:** since α > p (β<sub>2</sub>), we accept H<sub>0</sub> :β<sub>2</sub> = 0, and conclude that USD/NGN is not statistically significant.

**Model Identification:**

The unit root test is used to test for the Stationarity of the variables. Hence, if a variable has unit root, it means it is not stationary vice versa.

**Formulation of hypotheses:**

H<sub>0</sub>: There is Unit Root

H<sub>1</sub>: There is no Unit Root

If Phillips Perron test statistic < test critical values accept H<sub>0</sub> Vice Versa

**Table 2: PHILLIPS PERRON UNIT ROOT TEST**

| VARIABLES | Phillips Perron Test<br>Statistic values | 5% Mackinnon<br>Critical value | Remark     | Order of<br>integration |
|-----------|------------------------------------------|--------------------------------|------------|-------------------------|
| GDP       | -5.354958                                | -3.119910                      | Stationary | I(1)                    |
| GBP/NGN   | -3.502187                                | -3.119910                      | Stationary | I(1)                    |
| USD/NGN   | -4.196612                                | -3.119910                      | Stationary | I(1)                    |

**SOURCE: AUTHOR’S COMPUTATION USING EVIEWS 7**

**Model Diagnosis**

**Table 3:**

### Model Statistics

| Model       | Number of Predictor s | Model Fit statistics  |           |        |        |        | Ljung-Box Q(18) |    |      | Number of Outliers |
|-------------|-----------------------|-----------------------|-----------|--------|--------|--------|-----------------|----|------|--------------------|
|             |                       | Stationar y R-squared | R-squared | RMS E  | MAP E  | MAE    | Statist ics     | DF | Sig. |                    |
| GDP-Model_1 | 2                     | .750                  | .750      | 93.452 | 43.127 | 66.624 | .               | 0  | .    | 0                  |

SOURCE: AUTHOR’S COMPUTATION USING SPSS

### Interpretation Of Table 3:

- R-squared (0.750) or stationary R-squared (0.750): it shows that 75% total variation in Gross Domestic Product (GDP) is explained by the exchange rate of GBP/NGN and USD/NGN while the remaining 25% is captured within the error term or stochastic variable.
- RMSE (93.452), MAPE (43.127) and MAE (66.624) are used to show the forecasting, reliability and accuracy of the ARIMA model. Hence, the Mean Absolute Percentage Error of 43.127 which is the smallest is suitable for forecasting, as well as knowing the reliability and the accuracy of the ARIMA

### 3.5 FORECASTING USING THE ARIMA MODEL

Forecast Sample: 2000 – 2019

Adjusted Sample: 2000 – 2019

Included Observations 19

Root Mean Squared Error 93.452

Mean Absolute Error 66.624

Mean Absolute Percentage Error 43.127

**Table 4: SUMMARY OF FORECASTING GDP FOR FIVE YEARS**



| <b>YEAR</b> | <b>FORECAST VALUES</b> |
|-------------|------------------------|
|             | <b>GDP</b>             |
| 2015        | 288.6712               |
| 2016        | 263.7034               |
| 2017        | 273.8865               |
| 2018        | 172.6251               |
| 2019        | 342.0034               |

**Source: Author's Computation Using EVIEWS 7**

#### **Interpretation of table 4:**

The summary result of the forecast values of Gross Domestic Product for each year is given respectively in the table above for easy comprehension. For example, from the table above, the value of Gross Domestic Product predict for the year 2015 is 288.6712. The predicted values of Gross Domestic Product are given above in table 4.

## **4.0 SUMMARY AND CONCLUSION**

### **4.1 SUMMARY**

From results analysed above, there is a positive relationship between Gross Domestic Product and the exchange rate of British pounds to naira, which means a rise in the exchange rate of British pounds to naira leads to a rise in Gross Domestic Product. It is also observed that there exist a positive relationship between Gross Domestic Product and the exchange rate of US dollar to naira, which means a rise in the exchange rate of US dollar to naira leads to a rise in Gross Domestic Product. The results obtained showed that the model is a good fit since there exist a high value of R-squared of about 75% which explains the total variation in the Gross Domestic Product while the remaining 25% is explained by other variables which are captured within the error term or the omnibus variable.

### **4.2 CONCLUSION**

Based on my findings, I can conclude that the exchange rate of British pounds to naira has positive effect on the Gross Domestic Product. There were also noticeable increases in the movement of the Gross Domestic Product

Within the years examined or under review. The most important thing was the high percentage of GDP increase in the year 2011 over that of 2010 budget year due to a decline in the level of investment and high level of importation of goods and services in the Nigerian economy in the year 2010. Therefore, we can conclude that exchange rate serves as one of the important determinants of Gross Domestic Product.

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