Stochastic Analysis of the Exchange Rate of Naira, YEN, GBP, CFA and FRANC in Relation to US Dollar and Predicting the Naira for the Year 2025

Ledisi G. Kabari, and Believe B. Nwamae

Abstract—In Nigeria today, constant fluctuations of exchange rate or volatility is of great importance in one way or the other to the general public because its fluctuation has an effect on the economy. The objectives of the paper were to investigate the recent changes in the naira currency and other world currencies if there appear to be any relationship. Data was obtained from daily exchange rate of different countries’ currencies from 12/10/2005 and 2/11/2018 with 3,190 observations obtainable from the Data and statistics publication of the Central Bank of Nigeria. The study investigates the past recent changes in the naira and four foreign currencies of the world (Pounds, Yen, Cfa and Swiss Franc) and their relationship plotted as signal using MATLAB 2016a. The four currencies were randomly selected from the list of world currencies. Multiple Linear Regression was used to perform the analysis. The analysis of 3,190 observation resulted in a prediction model that has 97% prediction accuracy, which suggests that under ideal circumstances and barring any natural disaster, total collapse of the economy or major crisis like recession. The results from the model of this study suggest that fluctuation in currency exchange rate of other currencies has significance on the Nigerian exchange rate and as such should be considered when designing exchange rate policies.

Index Terms—MATLAB 2016a, Multiple Linear Regression, Exchange Rate, Prediction, World Currencies.

I. INTRODUCTION

The Exchange rate reflects the ratio at which a countries currency can be exchanged with another currency, that is the ratio of currency prices. It is the value of a foreign nation’s currency in terms of the home nation’s currency. It also shows how much one currency is valued in terms of the other. Exchange rate is a significant important macroeconomic policy instrument.

Changes in exchange rates have powerful effects on tradable and non-tradable of countries concerned through effects of relative prices of goods and services [1]. An appropriate exchange rate has been suggested as one of the most important factors for economic growth in the economies of some of the developed countries [2].

There continues to be an ongoing debate on the appropriate exchange rate policy in developing countries [3]. The debate focuses on the degree of fluctuations in the exchange rate in the face of internal and external shocks. Exchange rate fluctuations are likely, in turn, to determine economic performance [4].

In Nigeria today, constant movement of exchange rate or volatility is of great importance in one way or the other to the general public because its fluctuation has an effect on the economy [2]. Furthermore, Nigeria as a high import dependent country, exchange range volatility is alarming considering macro-economic importance [5].

Despite all of government’s effort to stabilize the exchange rate, there appears to be volatility in the exchange rate. In other words, this research intends to investigate the fluctuations in other foreign currencies and its effect on the naira exchange rate exert on market performance. This is study is important to virtually all the various economic agents; for instance, policy makers will find the answer useful in knowing what policy to pursue when determining appropriate exchange rate policy. Investors (both institutional and private) will also find the result interesting as it will help in determining their expectations as to changes in other country currency and the effect on the naira in terms of market performance and their investment.

The objectives of the paper are hypotheses in their null form such as (i) exchange rate fluctuation in any other country currency exchange rate does not have any significant impact on the naira exchange rate; (ii) In designing exchange rate policies, fluctuation in other countries currency exchange rate does not have any significant impact on the naira exchange rate as such should not be considered.

The rest of the paper is structured as follows: Section 2 deals with literature review; Section three centers on methodology; Section four presents the results and Section five concludes the paper.

II. LITERATURE REVIEW

The volatility of exchange rates under different regimes has been studied extensively in the literature. There are many factors considered for the random changes (volatility) in daily exchange rates, some factors include interest rates, budgetary imbalance and uncertainty about fiscal discipline just to mention but a few [6]. Krugman suggests that the interest rate differential, the inflation rate differential, and the level of foreign reserves have effect on the volatility of exchange rate [7].

Etuk investigated the volatility of the Naira and Dollar using time series. The data of the study was from 2007 – 2011 which were very few observations and had 63%
accuracy. In addition only naira to dollar currency exchange rate was evaluated [8].

From review of literature in this study, there appears to more of the literatures focus on other factors like interest rate, foreign reserves etc. and its relationship on exchange rate and there is little or no relationship between the random changes that affect the different currencies in the world.

With the help of machine learning tools and advancements in computer capability to process large repository of data, it has now become possible to change the focus and instead review available data to discover hidden patterns that exist between the data. This study aims to investigate the using advanced statistical concept the relationship that may exist between different world currencies and the exchange rate volatility.

III. MATERIALS AND METHOD

For this study, data was scoured from daily exchange rate of different countries’ currencies from 12/10/2005 and 2/11/2018 with 3,190 observations obtainable from the Data and statistics publication of the Central Bank of Nigeria retrievable form the website (Central Bank of Nigeria, 2018)[10]. The study investigates the past recent changes in the naira and four foreign currencies of the world (Pounds, Yen, Cfa and Swiss Franc) and their relationship plotted as signal using Matlab 2016a. The four currencies were randomly selected from the list of world currencies. We used Multiple Linear Regression in Microsoft Excel 2016 to perform the analysis.

Multiple Linear Equation

Multiple independent variables contributing to the dependent variable and hence multiple coefficients to determine and complex computation due to the added variables [9](Frost, 2018). The multiple linear regression model has the form

\[
y = mx + b
\]

where

- \( y = (y_1, ..., y_n) \) is the \( n \times 1 \) response vector
- \( X = [1_n, X_1, ..., X_P] \) is the \( n \times (P + 1) \) design matrix
- \( 1_n \) is an \( n \times 1 \) vectors of ones
- \( X_j = (X_{1j}, ..., X_{nj}) \) is \( j \)-th predictive vector (n × 1)
- \( m = (m_0, m_1, ..., m_p)^T \) is \( (P + 1) \times 1 \) vector of coefficients
- \( b = \text{intercept} \)

This can be represented as:

\[
\begin{bmatrix}
  y_1 \\
  y_2 \\
  y_3 \\
  \vdots \\
  y_n
\end{bmatrix} =
\begin{bmatrix}
  1 & X_{11} & X_{12} & \cdots & X_{1P} \\
  1 & X_{21} & X_{22} & \cdots & X_{2P} \\
  1 & X_{31} & X_{32} & \cdots & X_{3P} \\
  \vdots & \vdots & \vdots & \ddots & \vdots \\
  1 & X_{n1} & X_{n2} & \cdots & X_{nP}
\end{bmatrix}
\begin{bmatrix}
  m_0 \\
  m_1 \\
  m_2 \\
  \vdots \\
  m_P
\end{bmatrix} +
\begin{bmatrix}
  b_0 \\
  b_1 \\
  b_2 \\
  \vdots \\
  b_p
\end{bmatrix}
\]

IV. RESULTS AND DISCUSSION

The plot of the data for this study as signal is shown in figure 1. Table 1 gives the result of our analysis and figure 2 presents the residuals against the observation.

Figure 1 - The Exchange Rates against date
TABLE 1: SUMMARY OF OUR REGRESSION RESULT

SUMMARY OUTPUT

<table>
<thead>
<tr>
<th>Regression Statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
<td>0.988</td>
</tr>
<tr>
<td>R Square</td>
<td>0.977</td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td>0.977</td>
</tr>
<tr>
<td>Standard Error</td>
<td>9.49</td>
</tr>
</tbody>
</table>

Observations: 3190

ANOVA

<table>
<thead>
<tr>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Significance F</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>12631646.2</td>
<td>2526329</td>
<td>28039.31</td>
<td>0</td>
</tr>
<tr>
<td>3184</td>
<td>286876.9867</td>
<td>90.0956</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3189</td>
<td>12918523.18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coefficients

<table>
<thead>
<tr>
<th></th>
<th>Standard Error</th>
<th>t Stat</th>
<th>P-value</th>
<th>Lower 95%</th>
<th>Upper 95%</th>
<th>Lower 95.0%</th>
<th>Upper 95.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>14.1177672</td>
<td>15.70259</td>
<td>1.41E-53</td>
<td>194.0046105</td>
<td>249.36629</td>
<td>194.00461</td>
<td>249.366286</td>
</tr>
<tr>
<td>Rate date</td>
<td>-0.00355137</td>
<td>-18.0744</td>
<td>1.36E-69</td>
<td>-0.007115207</td>
<td>-0.005723</td>
<td>-0.0071152</td>
<td>-0.005722565</td>
</tr>
<tr>
<td>yen</td>
<td>0.143030202</td>
<td>0.926671</td>
<td>0.354168</td>
<td>-0.1478987</td>
<td>0.4129826</td>
<td>-0.1478987</td>
<td>0.4129826</td>
</tr>
<tr>
<td>gbp</td>
<td>0.009578921</td>
<td>33.9255</td>
<td>1.2E-215</td>
<td>0.3061882</td>
<td>0.3437511</td>
<td>0.3061882</td>
<td>0.343751122</td>
</tr>
<tr>
<td>cfa</td>
<td>5.4562736</td>
<td>2.827419</td>
<td>0.004722</td>
<td>4.729006511</td>
<td>26.12354</td>
<td>4.7290065</td>
<td>26.12533954</td>
</tr>
<tr>
<td>swissf</td>
<td>0.014801942</td>
<td>47.52141</td>
<td>0</td>
<td>0.674386765</td>
<td>0.7324314</td>
<td>0.6743868</td>
<td>0.732431375</td>
</tr>
</tbody>
</table>

Figure 2: Residuals Chart against Observations

From figure 1, we see that three out of the five currencies exchange rates (Naira, Pounds and Swiss Franc) appears to have similar movement, which suggests that fluctuations in the exchange rates of the different currencies have significant relationship.

In addition, from table 1 above R square of 98% explains that the variance in the Naira Exchange rate is explained by the variance of the other four exchange rate including the exchange rate date. In addition, the Regression significance F which is 0, suggests that there is 0% that our output was obtained by random chance.

Furthermore, from figure 2, we see most of our observation’s residuals are centered around zero with very few outliers as such our regression appears good. From our results we reject our earlier stated null hypothesis and accept that there is a relationship between volatility in exchange rates of other countries and that of Nigerian exchange rate. Finally, we accept that fluctuations in other currency
exchange rate should be considered in designing of exchange rates policy.

**Equation for the Analysis**

From equation (1), the equation for the model is given as:

\[
\hat{y} = 234.4876 - 0.0067x1 + 0.1420x2 + 0.3294x3 + 0.0115x4 + 0.7254x5
\]

where \(x1 = \text{rate date}, x2 = \text{yen}, x3 = \text{gbp}, x4 = \text{cfa}, x5 = \text{swissf}\).

We make the following assumption that there is no natural disaster or financial crises.

**Prediction**

By 1/01/2025, this study’s model predicts that the value of naira would be N 282.54. It is given in the table 1 below:

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>234.4876</td>
</tr>
<tr>
<td>rate date</td>
<td>-0.0067</td>
</tr>
<tr>
<td>Yen(x2)</td>
<td>0.1420</td>
</tr>
<tr>
<td>Gbp(x3)</td>
<td>0.3294</td>
</tr>
<tr>
<td>Cfa (x4)</td>
<td>0.0115</td>
</tr>
<tr>
<td>Swissf (x5)</td>
<td>0.7254</td>
</tr>
</tbody>
</table>

**TABLE 2: PROJECTION OF THE NAIRA EXCHANGE RATE FOR 1/1/2025**

Assumption – We assumed that all the other currency added by one.

V. CONCLUSION

This paper has examined the insights provided by examining the existing relationship of foreign exchange rates using multiple linear regression. The specific data used were from daily exchange rates of four different country currency collected by Central bank of Nigeria, the raw data were from 12/10/2005 – 2/11/2015, which resulted in 3,190 observations. The five currencies exchange rates examined were the Chinese Yen – US dollar, British Pounds – US dollar, Central African CFA – US dollars, Switzerland’s Swiss franc and Nigerian Naira to US Dollar.

The analysis of 3,190 observation resulted in a prediction model that has 97% prediction accuracy, which suggests that under ideal circumstances and barring any natural disaster, total collapse of the economy or major crisis like recession. The results from the model of this study suggest that no single exchange rate of the four other currencies has major influence on the Nigerian naira. However, changes in all the other four currencies jointly have serious impact on the exchange rate of the Naira.

REFERENCES