Evaluating the Impacts of Major Foreign Currencies on Naira

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Abstract* — This study employed the techniques of Toda-Yamamoto causality tests to examine the causal effects of US Dollar ($), Euro (€) and Pounds Sterling (£) on Naira (₦) using daily exchange rates from the currencies to Naira for the period of about 4,000 days spanning from 2004 to 2014. The data extracted from the Statistical Bulletin of Central Bank of Nigeria and personal daily recordings of exchange rates as announced by the Central Bank of Nigeria were used to obtain the time plots which depicted that the US Dollar to Naira exchange rate series, Euro to Naira exchange rate series and British Pounds to Naira exchange rate series are not stationary at level. The unit root tests conducted using the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests suggested that the maximum order of integration, $d_{max} = 1$. Based on the LR, FPE, AIC and HQ selection criteria, the optimal lag order $p = 6$ was used alongside $d_{max} = 1$ to estimate the augmented VAR($p + d_{max}$) model. From the estimated aforementioned model, Toda-Yamamoto causality tests were carried out and the results from the test showed that neither Euro to Naira nor Pounds Starling to Naira exchange rates granger causes (does not drive) US Dollar to Naira exchange rate. However, both US Dollar to Naira and Pounds Starling to Naira exchange rates granger cause Euro to Naira exchange rate. Also, US Dollar to Naira granger causes Pounds Starling exchange rates, whereas Euro to Naira exchange rate does not granger cause Pounds Starling exchange rates. Based on the findings from this study, it is therefore recommended that the Federal Government of Nigeria should formulate policies that will encourage transactions in local Nigerian currency, and reduce importation of goods from abroad in order to strengthen the value of the Naira against major foreign currencies.

Keywords: *Exchange rate, Toda-Yamamoto Causality, ADF, KPSS, Nigeria.*

I. Introduction

Over the years, the United States of America Dollar has become the vehicle currency which drives all other major foreign currencies in the foreign exchange markets. This is evident from the relative strength of the US economy that supports the US Dollar against other major foreign currencies in the foreign markets. Intuitively, no other global currencies are expected to drive the US Dollar. Apart from the US Dollar, other notable global currencies in the foreign exchange markets include: the British Pounds Sterling, Euro and Japanese Yen. Therefore, understanding the forecasting of foreign exchange behavior is crucial to monetary policy (Simwaka, 2007).

In Nigeria, foreign exchange has become the life-wire of Nigerian economic activities, whose fortune is greatly dependent on the fluctuations of the US dollar owing to her reliance on crude oil for foreign exchange amidst dwindling price of crude oil in the international oil market (Anyanwu *et al*, 2017). Despite various efforts by the Government to maintain a stable rate, the Naira has depreciated from 1980's to date (Augustine; 2015 and Aliyu; 2011). Records has it that Naira has depreciated against the US Dollar, Euro and Pounds Sterling by 58.73%, 61.84% and 48.4% respectively from January 1st 2004 to February 10th 2014 (see Statistical Bulletin of the CBN, 2004-2014).

The inconsistency in policies and lack of continuity in exchange rate policies aggregated unstable nature of the Naira rate (Gbosi, 2005). Therefore, knowledge of the inherent relationships between some major foreign currencies and Naira would assist the Government, policy makers and stakeholders to make efficient business decisions (Garba *et al.,* 2017). To strengthen the Naira against the US dollar and some other major foreign currencies, Aminu (2019) advised the Apex Bank to deepen currency swap pact with China and diversify commodity exports to the US in order to diversify foreign exchange earnings for the country.

In formulating policies that will strengthen the value of Naira against major foreign currencies such as US Dollars, Euro and British Pounds sterling, robust causal analytical technique(s) is/are required. This study employed a robust non-Granger causality technique known as Toda-Yamamoto causality tests to analyze the possible causal effects from US Dollars, Pounds Sterling and Euro to Nigerian Naira.

II. Literature Review

Several studies have been conducted on exchange rates in the recent years. For instance, Garba *et al.* (2017) modeled the structural relationships of exchange rates of Naira to foreign currencies such as Euro, Pounds Sterling and US Dollars using the unrestricted Vector Autoregressive (VAR) technique. They discovered that uni-directional causalities existed between exchange rates of Naira to US Dollars and exchange rates of Naira to Pounds Starling, as well as between Naira to Euro exchange rates and Naira to Pounds Starling exchange rates.

While bi-directional causality existed between the exchange rates of Naira to US Dollars and exchange rates of Naira to Euro. Oyenuga *et al*. (2019) forecasted the exchange rates series of Naira to US Dollars, British Pounds Sterling, Euro and Swiss France currencies using ARIMA models in order to assess the relationships among the aforementioned exchange rates.

Taiwo and Adesola (2013) investigated exchange rate volatility and bank performance in Nigeria while Etuk (2013) fitted SARIMA model to monthly Naira to Euro exchange rates. Musa *et al*. (2014) forecasted exchange rate volatility between Naira and US Dollar using GARCH models. Kadilar *et al. (*2009) forecasted the exchange rate series of Turkey using Artificial Neural Network (ANN) technique.

Chi et al. (2015) forecasted Renminbi (RMB) exchange rate based on a Nonlinear Combination Model of ARFIMA, SVM and BPNN. This study, however, focused on examining the direction of causality between Naira and some major foreign currencies such as US Dollar, British Pound Sterling and Euro.

III. Materials and Methods

For this study, a daily time series data on exchange rates of US Dollar, Pounds Sterling and Euro to Naira covering January 1st 2004 to February 10th 2014 was extracted from the Statistical Bulletin of Central Bank of Nigeria (CBN) and personal daily recordings of exchange rates as announced by the CBN. The technique of Toda-Yamamoto (TY) causality developed by Toda and Yamamoto (1995) was adopted to analyse the causal effects of exchange rates of Naira to the three currencies considered. Toda and Yamamoto (1995) proposed a method used to estimate unrestricted VAR whose order is $\boldsymbol{p} + \boldsymbol{d_{max}}$, where $\boldsymbol{p}$ is the true order and d_{max} is the highest degree of integration in the system. In order to achieve the goal of the study, the following three basic steps of VAR(p+ d_{max}) were followed:

3.1 Determination of the maximum order of integration

The first step involves examining the stationarity of the series and to determine the maximum order of integration ($\boldsymbol{d_{max}}$) of the variables in the system using the Augmented Dickey-Fuller (ADF) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. For the ADF, the null hypothesis states that the series is non-stationary while for the KPSS, the null hypothesis states that the series is stationary.

3.1.1 Determination of the optimal lag length (p)

The $\boldsymbol{p}$ is always unknown and has to be obtained from the VAR estimation of the variables in their levels. The $\boldsymbol{p}$ can be determined using different lag length criteria such as the Akaike's Information Criterion (AIC), Schwarz Information Criterion (SC), Final Prediction Error (FPE) and the Hannan Quinn (HQ) Information Criterion.

3.1.2 Testing for causality

This is done by using the Modified Wald (MWALD) Procedure to test for the VAR (k). The optimal lag length is equal to $\boldsymbol{k = (p+d_{max})}$. The Modified WALD test has an asymptotic chi-square distribution with p degrees of freedom in the limit when a VAR(p+d_{max}) is estimated.
In order to test for TY causality among the LUN, LEN and LPN series, the following tri-variate VAR(k) model is constructed as follows:

$$\mathrm{LUN}_t = \alpha_{11} + \sum_{i=1}^{k} \phi_{1i}\mathrm{LUN}_{t-i} + \sum_{i=1}^{k} \beta_{1i}\mathrm{LEN}_{t-i} + \sum_{i=1}^{k} \delta_{1i}\mathrm{LPN}_{t-i} + e_{1t} \quad (1)$$

$$\mathrm{LEN}_t = \alpha_{21} + \sum_{i=1}^{k} \phi_{2i}\mathrm{LUN}_{t-i} + \sum_{i=1}^{k} \beta_{2i}\mathrm{LEN}_{t-i} + \sum_{i=1}^{k} \delta_{2i}\mathrm{LPN}_{t-i} + e_{2t} \quad (2)$$

$$\mathrm{LPN}_t = \alpha_{31} + \sum_{i=1}^{k} \phi_{3i}\mathrm{LUN}_{t-i} + \sum_{i=1}^{k} \beta_{3i}\mathrm{LEN}_{t-i} + \sum_{i=1}^{k} \delta_{3i}\mathrm{LPN}_{t-i} + e_{3t} \quad (3)$$

where LUN_t= US Dollar/Naira Exchange Rate, LEN_t= Euro/Naira Exchange Rate, LPN_t= Pound Sterling/Naira Exchange Rate, e_{1t}, e_{2t} and e_{3t} are uncorrelated error terms in the equations and $k = p + d_{max}$
The following hypotheses have been formulated with respect to equations (1), (2) and (3):

Hypotheses for equation (1)

$H_{01}: \beta_{11} = \beta_{12} = \beta_{13} = \cdots = \beta_{1k} = 0$ (LEN does not Granger cause LUN)

$H_{02}: \delta_{11} = \delta_{12} = \delta_{13} = \cdots = \delta_{1k} = 0$ (LPN does not Granger cause LUN)

Hypotheses for equation (2)

$H_{03}: \phi_{21} = \phi_{22} = \phi_{23} = \cdots = \phi_{2k} = 0$ (LUN does not Granger cause LEN)

$H_{04}: \delta_{21} = \delta_{22} = \delta_{23} = \cdots = \delta_{2K} = 0$ (LPN does not Granger cause LEN)

Hypotheses for equation (3)

$H_{05}: \phi_{31} = \phi_{32} = \phi_{33} = \cdots = \phi_{3k} = 0$ (LUN does not Granger cause LPN)

$H_{06}: \beta_{31} = \beta_{32} = \beta_{33} = \cdots = \beta_{3k} = 0$ (LEN does not Granger cause LPN)

The decision rule is to reject the null hypothesis if the p-value is less than the 5% level of significance. Otherwise, the null hypothesis will not be rejected.

IV. Results and Discussion

The analyses of the time series data for UN, EN and PN were carried out using Eviews 9.0 Statistical Package and the results are presented as follows.

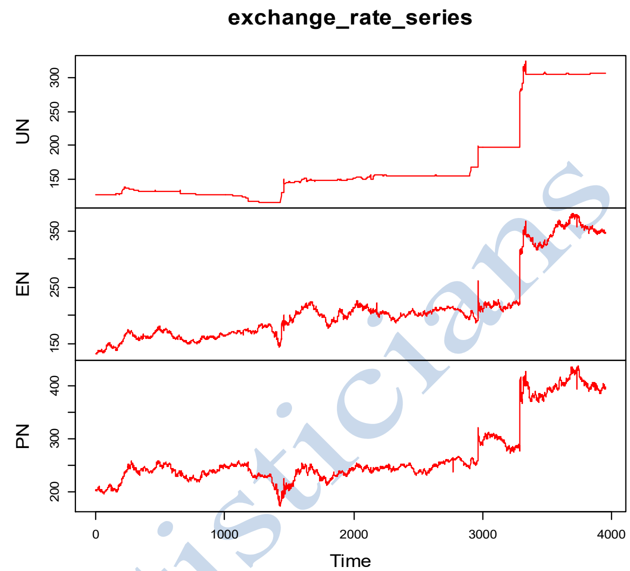

Figure 1: Time plots of US-Naira (UN), Euro-Naira (EN) and UK-Naira (PN) exchange rates

Figure 1 shows that UN, EN and PN series exhibit upward trends albeit with fluctuations. That is, these three series are not level stationary series. Further unit root analyses tests such as the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Scmidt-Shin (KPSS) tests were used to confirm the maximum order of integration (d_{max}) in the system of which Table 1 presents the results of the unit root tests conducted on UN, EN and PN series.

Table 1: Summary of ADF and KPSS Results for LUN, LEN and LPN Series

ADF				
Variable	**ADF-statistic**	**Critical values**	**P-value**	**Order of Integration**
LUN	-61.37841	-2.862075	0.0001	I(1)
LEN	-32.94625	-2.862076	< 0.0001	I(1)
LPN	-31.85703	-2.862076	< 0.0001	I(1)
KPSS				
Variable	**KPSS-statistics**	**Asymptotic critical values***		**d_{max}**
LUN	0.310694	0.347000		I(1)
LEN	0.052503	0.347000		I(1)
LPN	0.075974	0.347000		I(1)

Table 2: VAR Lag Order Selection Criteria for LUN, LEN and LPN Series

Lag	LogL	LR	FPE	AIC	SC	HQ
0	8835.826	NA	2.27e-06	-4.480257	-4.475479	-4.478562
1	42070.25	66401.41	1.09e-13	-21.33312	-21.31401	-21.32634
2	42205.06	269.1391	1.02e-13	-21.39693	-21.36349	-21.38507
3	42214.15	18.13395	1.02e-13	-21.39698	-21.34920	-21.38003
4	42267.31	105.9719	1.00e-13	-21.41938	-21.35727	-21.39735
5	42327.43	119.7547	9.75e-14	-21.44531	**-21.36886***	-21.41819
6	42351.43	**47.77389***	**9.68e-14***	**-21.45292***	-21.36214	**-21.42072***
7	42355.18	7.448176	9.70e-14	-21.45025	-21.34514	-21.41297
8	42357.30	4.223998	9.74e-14	-21.44677	-21.32732	-21.40440

Note: ** denotes lag order selected by the criterion*

Table 3: Estimates of Augmented VAR($p+d_{max}$)

	LEN	LPN	LUN
LEN(-1)	0.77752 (0.02585) [30.0832]	0.014683 (0.02619) [0.56071]	-0.007960 (0.01724) [-0.46168]
LEN(-2)	0.211408 (0.02807) [7.53095]	0.000177 (0.02844) [0.00623]	-0.004327 (0.01873) [-0.23108]
LPN(-1)	0.065600 (0.02655) [2.47087]	0.860921 (0.02690) [32.0049]	0.019576 (0.01771) [1.10527]
LPN(-2)	-0.085043 (0.02856) [-2.97721]	0.095278 (0.02894) [3.29207]	-0.021218 (0.01906) [-1.11347]
LUN(-1)	0.152008 (0.03471) [4.37962]	0.136494 (0.03517) [3.88143]	1.007125 (0.02315) [43.4969]
LUN(-2)	-0.117006 (0.03834) [-3.05165]	-0.138810 (0.03885) [-3.57319]	0.011404 (0.02558) [0.44585]
C	0.021904 (0.00668) [3.27934]	0.024262 (0.00677) [3.58502]	0.012441 (0.00446) [2.79216]
LEN(-7)	0.005138 (0.01451) [0.35397]	-0.018136 (0.01471) [-1.23327]	0.010858 (0.00968) [1.12146]
LPN(-7)	0.013045 (0.01445) [0.90252]	0.034771 (0.01464) [2.37438]	-0.003205 (0.00964) [-0.33237]
LUN(-7)	-0.026055 (0.01674) [-1.55653]	0.010886 (0.01696) [0.64187]	-0.014135 (0.01117) [-1.26575]
R^2	0.998501	0.997428	0.999505

Table 4: Results of Toda-Yamamoto Causality Tests for LUN, LEN and LPN series

Null hypothesis	χ^2 value	df	P-value	Direction of causality
LEN does not Granger cause LUN	1.690920	2	0.4294	No causation
LPN does not Granger cause LUN	1.319465	2	0.5170	No causation
LUN does not Granger cause LEN	23.42929	2	0.0000	LUN→ LEN
LPN does not Granger cause LEN	8.909427	2	0.0116	LPN → LEN
LUN does not Granger cause LPN	15.09628	2	0.0005	LUN → LPN
LEN does not Granger cause LPN	1.205681	2	0.5473	No causation

From Table 1, the ADF test results for LUN, LEN and LPN series showed that these three series are difference stationary series of order one. That is, the null hypothesis of non-stationarity was rejected for each series after first difference.

From the same Table 1, the KPSS test results also showed that the null hypothesis of stationarity was accepted for each series after first difference. Hence, the maximum order of integration (d_{max}) in the system is one.

From Table 2, the least values of LR, FPE, AIC and HQ selection criteria occur at Lag 6. Hence, the optimal lag-order is 6 for the augmented tri-variate VAR ($p+d_{max}$) model. Based on the maximum order of integration ($d_{max}=1$) and the optimal lag order ($p=6$), the VAR ($p+d_{max}$) model was estimated and its estimates are presented in Table 4 below.

From Table 3, the estimates of the augmented VAR (6+1) model were used to conduct the Toda-Yamamoto causality (TY) tests on the LUN, LEN and LPN series. Table 4 presents the results of the TY tests conducted on LUN, LEN and LPN series.

4.1 Interpretation of equations in the tri-variate unrestricted augmented VAR (6+1) system.

From Table 4, the null hypotheses H_{01} and H_{02} were accepted. This means that the coefficients on the lagged LPN and LUN in equation (1) are not statistically different from zero. Hence, LEN does not Granger cause (does not drive) LUN and LPN does not Granger cause (does not drive) LUN.

Also from the same Table 4, the null hypotheses H_{03} and H_{04} were rejected. This simply means that the coefficients of the lagged LUN and LPN in equation 2 are statistically different from zero. Therefore, LUN Granger causes (drives) LEN and LPN Granger causes (drives) LEN.
Also, from the same Table 4, the null hypothesis H_{05} was rejected while H_{06} was accepted. This means that the coefficients of the lagged LUN in equation (3) are statistically different from zero. On the other hand, the coefficients of the lagged LEN in equation (3) are not statistically different from zero. Hence, only LUN Granger causes (drives) LPN while LEN does not Granger cause LPN.

V. Summary of Findings

This study employed non-Granger causality test known as Toda-Yamamoto (TY) causality test to investigate the impacts of exchange rates of US Dollar, Euro and Pounds Sterling on Naira using daily time series data from January 1st, 2004 to February 10th, 2014. The three basic steps of unrestricted augmented VAR ($p+d_{max}$) model were carefully considered and were fulfilled in this study.

In order to properly determine the maximum order of integration of the series in the system of equations, each of the series was subjected to unit root analysis using both the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) techniques. Results of the ADF and KPSS tests stated in Table 1 showed that the three time series are truly difference stationary series of order one (i.e. I(1)). Based on the KPSS results, the maximum order of integration (d_{max}) in the system is one. Results from the VAR optimal lag order in Table 2 showed that the least value of the selection criteria LR, FPE, AIC and HQ occurred at lag 6 indicating that VAR(6+1) model was the appropriate model for analysing the LUN, LEN and LPN series. Results of the TY causality test in Table 4 showed that LEN does not Granger cause (does not drive) LUN and LPN does not Granger cause (does not drive) LUN. Also from the same Table 4, results of the TY showed that LUN Granger causes (drives) LEN and LPN Granger causes (drives) LEN. Finally, from the same Table 4, results of the TY showed that only LUN Granger causes (drives) LPN while LEN does not Granger cause (does not drive) LPN.

VI. Conclusion

Based on the sequence of statistical analyses carried out on the data on US Dollar–Naira exchange rates (LUN), Euro–Naira exchange rates (LEN) and Pounds Sterling–Naira exchange rates (LPN) from January 1st, 2004 to February 10th, 2014, it can be concluded that LEN does not Granger cause LUN and LPN does not Granger cause LUN. However, LUN Granger causes (drives) LEN and LPN Granger causes LEN. Also, LUN Granger causes LPN while LEN does not Granger cause LPN. This implies that Pounds Sterling–Naira exchange rates and Euro–Naira exchange rates can be predicted by US Dollar–Naira exchange rates in the foreign exchange markets.

It is recommended that the Federal Government of Nigeria should formulate policies that will encourage transactions in local Nigerian currency and reduce imports of goods from abroad in order to strengthen the value of the Naira against US dollar in particular and other foreign currencies in general.

References

Aliyu, S. R. (2011). Impact of Oil Price Shock and Exchange Rate Volatility on Economic growth in Nigeria: An Empirical Investigation. *Research Journal of International Studies*. 11:103-120.

Aminu, G. (2019). Statement from President Association of the Association of Bureau De Change Operators of Nigeria. Retrieved from http://www.xinhuanet.com/english/2019-05/21/c_138077809.htm (accessed on 28/01/2020)

Anyanwu, F. A., Ananwude, C. and Okoye, N. T. (2017). Exchange rate policy and Nigeria's economic growth: a Granger causality impact accessment. *International Journal of Applied Economics, Finance and Accounting. Vol.1, No. 1, pp.1-13*

Augustine, C. O. (2015). Exchange Rate Fluctuation, Oil prices and Economic Performance: Empirical Evidence from Nigeria. *International Journal of Energy Economy and Policy*. *5(2): pp.502-506.*

Chi, X., Zhou, M and Wang, G. (2015). Forecasting RMB exchange rate based on a Nonlinear Combination Model of ARFIMA, SVM and BPNN, *Hindawi Publishing Corporation – Mathematical Problems in Engineering*, 2015 (635345): pp. 1 – 10.

Etuk, E. H. (2013). The fitting of a SARIMA model to monthly Naira – Euro exchange rates, *Mathematical Theory and Modeling, 3 (1): pp. 17 – 26.*

Garba, M. K., Yahya, W. B., Babaita, H. T., Banjoko, A. W., Amobi, A. Q. (2017). Modeling structural relationships of exchange rates, of naira to foreign currencies. *Nigerian Statistical Society Conference.Vol.1, pp.41-47.*

Gbosi, A. N. (2005). Money, monetary policy and economy, Port Harcourt: Sodek.

Kadilar, C., Simsek, M. and Aladag, A. (2009). Forecasting the exchange rate series with ANN: the case of Turkey, *Econometri ve Istatistik Sayi, 9 (2009): pp. 17 – 29.*

Musa, Y., Tasiu, M. and Abubakar, B. (2014). Forecasting exchange rate volatility between Naira and US dollar using GARCH models, *International Journal of Academic Research in Business and Social Sciences*, 4 (7): 369 – 381.

Oyenuga, I. F., Oyekunle, J. O., Agbona, A. A. (2019). Modeling exchange rate of the Nigeria to some other major currencies. *International Journal of Statistics and Applications, 9(3): pp. 67-73*

Simwaka, K. (2007). Modeling and forecasting the Malawi Kwacha – US dollar nominal exchange rate, *Munich Personal RePEc Archive (MPRA)*, Paper No.3327.https://mpra.ub.uni-muenchen.de/3327/

Statistical Bulletin of the Central Bank of Nigeria (2004 to 2014*). Data on Euro-to-Naira, Pound-to-Naira and Dollar-to-Naira exchange rates*. Retrieved from daily recordings of exchange rates announced by the Central Bank of Nigeria.

Taiwo, O. and Adesola. O. A. (2013). Exchange rate volatility and bank performance in Nigeria. *Asian Economic and Financial Review, 3(2):pp. 178-185*

Toda, H. Y. and Yamamoto, T. (1995). Statistical inference in Vector Autoregressions with possibly integrated processes. *Journal of Econometrics*, 66, 225–250.