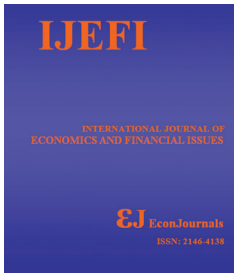

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# Effectiveness of Foreign Exchange Market Intervention in Nigeria (1970-2013)

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**ABSTRACT**

The instability in the value of naira have made the Central Bank of Nigeria (CBN) a regular actor in the foreign exchange market (FEM) in its efforts to stabilize the value of Naira and counter the disorderly behavior of the market. This paper examines the effectiveness of the CBN's intervention operations in the FEM using annual secondary time series data of four variables. The variables are the exchange rate, money supply, net foreign asset (a proxy for intervention variable), and lending rate ranging from 1970 to 2013. The result from the Johansen Juselius cointegration test shows that the naira exchange rate, intervention variable and monetary aggregates are cointegrated. The result from the error correction model also indicates that the naira exchange rate will adjust and re-establish itself at the speed of 12% annually. Moreover, the result of the Granger causality test the CBN intervention is non-sterilized. Therefore, the CBN should provide an effective way through which its FEM intervention could be efficient and sterilized so as to ensure stability in the exchange rate and the price level.

**Keywords:** Foreign Exchange Market, Nigeria, Exchange Rate
**JEL Classifications:** E50, E52, E58, F31

## 1. INTRODUCTION

Macroeconomic policies frequently have a significant impact on the overall economic performance of an economy. These policies are used to achieve several macroeconomic objectives such as sustainable economic growth, price and exchange rate stability, full employment level and a satisfactory balance of payments position (Moreno, 2005). Achieving these objectives is important for any reasonable economy to prosper, even though one objective may sometimes conflict with another. Both monetary and exchange rates policies are used alongside with other macroeconomic policies, such as fiscal policy, to attain these ultimate macroeconomic objectives (Mohamad, 2009).

Over two decades ago, the Central Bank of Nigeria (CBN) have been intervening in the foreign exchange market (FEM) to support and stabilize the value of the Naira, although the supportive efforts remain temporarily and short-lived (Sanusi, 2004; Adebiyi, 2007). For instance, Nigeria had been one of the most active countries in the FEM between 1993 and 1995 (Adebiyi, 2007; Omojolaibi and Gbadebo, 2014). In the month of December 2014 alone, the CBN spent about $2.3 billion to defend the Naira from losing its value (Nweze, 2015). Also, in another effort to strengthen and stabilize the value of the Naira, the CBN conducted another intervention operation in the first quarter of 2015. The process worth the CBN $4.7 billion (Komolafe, 2015).

Basu and Varoudakis (2013) argued that the main objectives of the central bank interventions in the FEM, especially in countries with floating exchange rates are to: (i) Prevent exchange rate misalignment; (ii) counter disorderly FEM; (iii) manage foreign reserve; and (iv) "lean against the wind."

In most emerging market-oriented economies like Nigeria, preserving a realistic value for the domestic currency is of paramount important considering the structure of the economy

and the desire to balance domestic production and consumption, create and improve the sources of foreign exchange earnings and attracts foreign capitals from multi-national corporations. It will also address the prolonged epidemics bedeviling Nigerian economy among which include capital flights, massive importation of consumable commodities, brain drain and absence of linkages between production processes (Sanusi, 2004).

Although many studies have been conducted on the effectiveness of central bank's intervention operations, most of them focused on the developed economies in America, Asia and Europe. Such studies are much scant in Africa and Nigeria in particular. For instance, in Nigeria, only two studies (i.e., Adebiyi, 2007; Omojolaibi and Gbadebo, 2014) are known to the authors. In line with this, the paper evaluates the efficacy of the FEM interventions on the Naira/US Dollar exchange rate.

The proceeded explanation in section one was the introduction. Section two is the brief overview of the foreign exchange management in Nigeria. In section three, theoretical and empirical evidences are presented and evaluated. In section four, method of data analysis is presented and evaluated. Discussions follow in section five and in the concluding section (i.e. section six), the summary of the findings, and conclusion of the entire work are presented. Also, recommendations follow based on the results findings.

## 2. BRIEF OVERVIEW OF EXCHANGE RATE MANAGEMENT IN NIGERIA

Nigeria had experienced a windfall in 1970s that was succeeded by years of budget deficit. This led to the emergence and implementation of Structural Adjustment Programme (SAP) in 1986 as recommended by the International Monetary Fund (IMF) and World Bank as a means of restoring and boosting the growth and development of a given economy (Oyinbo and Rekwot, 2014). Among the conditions of SAP was that naira must be devalued and allowed to float freely in the FEM (deregulated); its value was to be determined by the market forces. Since then, as opined by Adebiyi (2007), CBN has been intervening in the foreign exchange purchases.

Although the value of the Naira was relatively stable before 1986, the adoption of second-tier FEM (SFEM) in July, 1986 as one of the conditions of IMF, naira has continued to depreciate: For instance, in 1985, naira was traded at ₦0.99=$1. But with the Introduction of SFEM in 1986, the merger of First and SFEM in 1987, and the introduction of Interbank Rate in 1988 forced the value of the Nigerian Naira to depreciate to ₦1.75=$1.00, ₦4.54=$1.00, and ₦7.36=$1.00 respectively (CBN, 2014). In her efforts to stabilize the Naira exchange rate, Nigerian government came up with Guided Deregulation Policy that pegged Naira to US Dollar at ₦21.886 in 1994. The re-introduction of the interbank autonomous FEM in 1999 led Naira to depreciate further to ₦86.46=$1.00. Another policy, Whole Dutch Auction System was introduced in 2006; consequently, Naira depreciated further ₦117.97=$1.00 in December, 2007. Concurrently, in 2008, there was financial crisis worldwide which is popularly known as "World Economic Meltdown." The outcome revealed that Naira value was depreciated further to ₦131.5=$1.00. By February 2009, Naira/Dollar exchange rate stood at ₦142.00=$1.00 (Aliyu, 2009). In another effort to ensure a stable value of the Naira, policy makers in Nigeria came up with Retail Dutch Auction in 2013. Unfortunately, the policy also forced Naira to depreciate further to ₦157.31=$1.00 (CBN, 2014).

The continuous depreciation in the value of Naira/US Dollar exchange rate is having strong correlation with the domestic price of goods and services. This relationship between the exchange rate depreciation and inflation has been discussed in detailed in the literature (Laflechel, 1996; Adebiyi, 2007; Mohamad, 2009; Aliyu et al., 2009). As such, any research that aims at stabilizing the domestic exchange rate in Nigeria is of paramount important considering the effect of exchange rate on the domestic price of goods and services.

From Figure 1, it can be seen how the exchange rate, expressed in Naira/US Dollar keep rising (depreciation) constantly in a higher and persistent rate from 1986 when SAP was introduced up till the time of this research.

## 3. LITERATURE REVIEW

### 3.1. Conceptual and Theoretical Framework

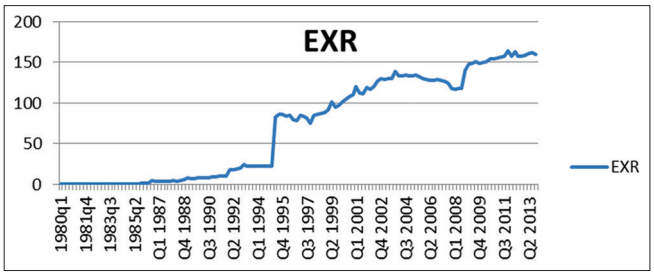
#### *3.1.1. The concept of exchange rate*

Exchange rate is seen as the relative value of the domestic currency in terms of foreign exchange (Mussa, 1984; Ahmed, 2001). The exchange rate of a Naira per US dollar is the amount of Naira necessary required to obtain one unit of US dollar (Jhingan, 2005; Campbell, 2010; Omojolaibi and Gbadebi, 2014). The exchange rate is also defined as an asset price that value depends on the relative supply of and domestic and foreign financial assets and the domestic and foreign income (Ardalan, 2004).

#### *3.1.2. The concept of FEM intervention*

FEM interventions are also known as Central Bank Interventions (Dominguez, 1998) or Official Intervention (Simwaka and Mkandawire, 2006) or Foreign Exchange Intervention as used by Waheed (2010). Official intervention refers to any official announcement, sales or purchases by a given governmental owned monetary authority that aimed at influencing the domestic currency (Simatele, 2003). It has been apparently established that

**Figure 1:** Naira exchange rate from 1986Q1 to 2013Q4




Source: Central Bank of Nigeria Statistical Bulletin (various years)

higher valuation of currency affects the external competitiveness of domestically produced commodities (Jhingan, 2005). This is because currencies with higher values tend to attract less foreign markets and vice versa. That is to say, countries with low-valued currency have higher external competitiveness advantages over their counterparts.

As argued by Sarno and Taylor (2001) and Simatele (2003), the issue whether FEM interventions affect the value of a domestic currency or not is still a controversial issue in the field of financial economics. In addition, to understand the precise way through which central bank intervention influence the exchange rate one has to distinguish and clearly understand two types of FEM interventions. These are the sterilized and non-sterilized FEM interventions.

## 3.2. Theories of FEM Interventions

Schmidt and Wollmerschauser (2004) ascertained that the effectiveness of central bank intervention relies on the three fundamentals intervention channels as follows:

### *3.2.1. Monetary approach to exchange rate determination*

It is the only channel of intervention influencing exchange rate under non-sterilized FEM intervention. The transformation of macroeconomic perception which occur in the early 1970s due to the revolution from the Monetarists and Rational Expectationists have led the "exchange rate" to be regarded as an asset price which value is determined by relative supply of and demand for domestic and foreign financial assets. Foreign financial assets include monies, bonds and relative domestic and foreign income (Ardalan, 2004).

Monetary Approach to exchange rate determination seeks to highlight how the value of domestic currency is directly or indirectly affected due to the changes in the foreign and domestic supply of and demand for money. One important assumption of this approach is that, in the short run, prices are flexible (Spolander, 1999).

Dominguez (1998) argued that monetary approach to exchange rate determination indicates a situation through which non-sterilized FEM intervention affect the value of domestic currency exchange rate equal to the changes in the relative amount of supplies of domestic and foreign exchanges.

### *3.2.2. Portfolio approach of exchange rate determination*

This is an exchange rate determination mechanism through which asset markets, rate of asset accumulation, current account balance and prices are working hand in hand with one another to affect the exchange rates. The essential feature of this approach is that investors are assumed to be rational and risk-averse (Simatele, 2003). This compels them to balance their portfolios between domestic and foreign assets on the basis of their expected returns and risks associated with these returns (Sarno and Taylor, 2001). Therefore, the major feature of this model is that investors strive to invest their portfolio either in the foreign or domestic assets considering the expected returns and relative riskiness of the both assets.

After the central banks or monetary authorities have intervened in the FEM, the amount of currency used during intervention operations is offset by domestic open market purchases. This is what is known as "sterilization." This means that the intervention will have no or little effect on the quantity of money in circulation. What happened were just changes in the composition of portfolios from foreign to domestic assets, and vice-versa. As a result, market participants rebalance their portfolios through continues buying and selling of domestic and foreign assets. For instance, an increase in the supply of domestic currency (example, Nigerian naira denominated assets) in the Nigerian FEM relative to the supply of foreign currency (example, US Dollar denominated assets) will lead to the depreciation in the value of naira in the FEM. This is how the portfolio balance model of exchange rate determination affects the value of the domestic currency.

### *3.2.3. Signaling/expectations approach of exchange rate determination*

In both developed and emerging market economies FEM, market participants are in close watch about the future actions of central banks and they consider these actions as the signals to future monetary policy. In most cases, press reports about the future action of central banks play an important role in changing the value of the domestic currency. It has been established in the literature that monetary authorities often sterilize the amount of currency used in the intervention operations through domestic open market purchases (Kaminsky and Lewis, 1996). On the other hand, central banks rarely provide information with regards to their intervention activities; even if they make the information available, they do so with a lag (Adebiyi, 2007). The major aspect of this theory is that the central bank is the major actor and has superior information about the market than any other individual participant. As a result, other participants rely on press reports as a major source of information. In addition, even though central banks regularly sterilize their interventions, yet, it conveys significant information to the market participant with regard to the future monetary policy (Akıncı et al., 2005b).

Signaling theory of exchange determination posits that central bank intervention operations signals changes in the future monetary policy and affects the behavior of other market participants (Simatele, 2003). As argued by Kaminsky and Lewis (1996), if market participants expect future contractionary monetary policy, it leads to the appreciation in the value of domestic currency although no single transaction took place actually. This is the case even though the central banks offset the amount used in the intervention operations. The reverse is the case when the press reports claim that the intervention operations are going to be expansionary monetary policy (Bonser-Neal et al., 1998).

## 3.3. Empirical Evidences

The practices, uses and effectiveness of official intervention in the FEM as a policy toolkit for the attainment of price and exchange rate stability is a matter of controversial disputes (Schmidt and Wollmerschauser, 2004). This is due to the inconclusive findings from the previously conducted researches (Edison, 1993; Sarno and Taylor, 2001; Dominguez, 2003).

Dominguez (1998) using GARCH (1, 1) Model found that the secret foreign market intervention by the Federal Reserve of America increase the volatility of the US Dollar while the broadcasted intervention lead to the uncertainty and disorder in the FEM. This result did not corroborate with the study of Bonser-Neal et al. (1998) although the later used different approach. Meanwhile, Bonser-Neal et al. (1998) applied Event-Study Model and found that Federal Reserve intervention operation in the FEM is significant and effective in stabilizing the value of US Dollar.

In Japan, Kurihara (2011), Reitz and Taylor (2012), Seerattan (2012) and Hillebrand and Schnabl (2008) argued that the foreign market intervention by the Bank of Japan is effective and significance in stabilizing the value of Japanese Yen. However, their finding did not corroborate with that of Frenkel el al., (2005).

In a another research carried out with the help of GARCH (1, 1), Simwaka and Mkwandawire (2006) found that official intervention in the FEM by Reserve Bank of Malawi (RBM) had an impact on Kwacha, thou very negligible, but, still significant in reducing the undesired volatility of their currency. They concluded that net sales of dollars by RBM depreciated rather than appreciate the value of Kwacha.

In his effort to evaluate the intensity of foreign exchange intervention on monetary aggregates using autoregressive distributed lag (ARDL) approach, Adebiyi (2007) testified that there was no strong relationship between intervention variables and exchange rates. As a result, CBN's intervention in the Nigerian FEM is sterilized. This is due to the inadequate funding of interventions due to lower reserve accumulation of the economy, the inconsistency of intervention policy with the macroeconomic policies as well as frequent interference of politicians in the process of policy implementation.

Looking at the works of Dominguez (1998), Hillebrand and Schnabl (2008), Guimaraes and Karadacag (2005), Domaç and Mendoza (2004), Simwaka and Mkwandawire (2006), Kurihara (2011) and Reitz and Taylor (2012) critically, they all use GARCH (1, 1) model in their researches, but, for the model to be statistically significant, it requires several years of daily data. But, due to the inadequate data of interventions in the countries understudies coupled with the absence of real intervention data in some countries, their findings from the GARCH (1, 1) model is less reliable. Another weakness of GARCH (1, 1) is that it findings are based on the size of the movements between the variables under study not the direction of causality.

Lahura and Marco (2013) investigated the relationship between undisclosed intra-daily data; inter-bank exchange rate and the amount of dollar purchased and sold using structural vector autoregressive (VAR) Model. They found that foreign exchange intervention in Peru was significant and effective in influencing exchange rate in the right direction, but sales interventions were found to be more effective than purchase interventions.

Omojolaibi and Gbadebo (2014) investigate the effect of FEM intervention on the stability of naira exchange rate. They applied ARDL technique on four annual time series data ranging from 1970 to 2006. The data include the money supply, the cumulative net foreign asset, the cumulative foreign private inflow, the real gross domestic product and the structural break. The results have confirmed that there is longrun equilibrium relationship between the central bank intervention in the FEM and the money supply variables. As a result, the CBN intervention operation is regarded as non-sterilized. Despite the fact that this work is among the earliest empirical work in Nigeria, (second to Adebiyi, 2007), however, the researchers failed to include the exchange rate variable which is the main target of foreign exchange intervention. In addition, the method they applied (i.e., ARDL) have been criticized for it have low degree of freedom when it comes to estimating an equation with the large number of regressors. This means that ARDL cannot show more than one equilibrium relationship in a model (Mehdi, 2011).

Base on the above empirical evidence, it shows that there is no conclusion regarding the effectiveness of foreign exchange interventions in the FEM. However, previous studies argued that most frequent, predominant and concurrent interventions tend to be more effective than large one-off interventions Seerattan (2012); sales intervention were found more effective that purchased interventions Lahura and Marco (2013); political interference and concurrence of policies tend to affect the effectiveness of interventions policies Adebiyi, (2007); Hillebrand and Schnabl (2008) and most of the literatures which found the effectiveness foreign exchange interventions in reducing exchange rate volatility and disorderly market used structured VAR (SVAR) and VAR Markov-Switching Models (Seerattan, 2012).

## 4. METHODOLOGY

### 4.1. Data

The research empirically investigates the effectiveness of FEM interventions on exchange rate instability using Nigerian Naira/US dollar exchange rate. The study employed annual secondary times series data spanning from 1970 to 2013. The data were mainly sourced from the United Nation Statistical Bulletin (2015) and CBN Quarterly Statistical Bulletin (2012 and 2014).

### 4.2. Method of Data Analysis

For the purpose of this research, SVAR model base on the multivariate vector error correction model (VECM) is applied to examine the linear interdependence between the intervention variables, monetary aggregates and Naira/US Dollar variable to trace the effect of shocks emanating from the endogenous variable to other variables, and shade more light about the relative importance of each random foreign exchange policy in affecting the exchange rate in the model.

### 4.3. Model Specification

The model used four variables that hypothesized exchange rate variable as the function of net foreign asset, money supply and interest rate respectively.

$$\overset{+}{} \quad \overset{-}{} \quad \overset{+}{}$$

$$EXR_t = F\,(CNFA_t, M2_t, LR_t) \qquad (1)$$

Where *EXR* represents the annual naira exchange rate per US Dollar, C*NFA* stands for annual cumulative net foreign assets (the proxy of FEM intervention variable), *M2* represents the annual growth of money in Nigerian economy (proxy as the money supply variable), and *LR* is the lending rate representing the interest rate variable. The t-sign denotes the time trend. The variables are converted into natural logarithms and composed in an econometric form in the Equation (2) below. Thus, the variables are separated from hetroskedasticity and their values can be presented as elasticity.

$$lnEXR_t = \alpha_0 + \varphi_1 lnCNFA_{t-1} + \varphi_2 lnM2_{t-1} + \varphi_3 lnLR_{t-1} + \mu_t \quad (2)$$

From the Equation (2) above, $\alpha_0$ is the constant term, $\emptyset_1$, $\emptyset_2$ and $\emptyset_3$ are the slope coefficients and $\mu_t$ is the error term respectively.

## 4.4. Unit Root Test

The first stage in estimating the VECM begins by evaluating unit root tests. This is carried out to ensure the order of integration of the series and to avoid the incidence of spurious regression estimates. There are many ways of conducting unit root test, but this study uses the Augmented Dickey-Fuller (ADF) and Phillips-Perron unit root test of stationarity. These tests are performed by letting the exogenous variables be the regressors of the endogenous variables at level I (0) and at the first difference I (1). These involve the estimation of the Equations (3) and (4) below:

$$\Delta Y_t = \alpha_0 + \beta T + \delta Y_{t-1} + \sum \lambda_t \Delta Y_{t-1} + \varepsilon_t \quad (3)$$

$$Yt = \phi_0 + \beta Yt - 1 + \delta t + Ut \quad (4)$$

Equation (3) above is the equation of ADF unit root test of stationarity. From the equation, $\Delta$ is the first difference lag operator, Y is the variables under study, $\Delta Y_t = Y_t - Y_{t-1}$ that are the first difference of $Y_t$. $\alpha_0$ is the constant, $\beta$ is the coefficient on a trend series T, $\delta$ is the coefficient of $Y_{t-1}$, and, the null hypothesis $H_0$: $\delta = 0$ which means that $Y_t$ has a unit root, against the alternative hypothesis $H_1 \neq 0$ indicating that there is the absence of unit root. $\varepsilon_t$ is the white noise error term, mean zero sequence.

On the other hand, Equation (4) is the Phillips-Perron equation of unit root test. From the equation, $Y_t$ represents the variables under study. $\emptyset_0$ is constant; $\beta$ is the coefficient of trend series$Y_{t-1}$. The t-sign denotes the time trend.

## 4.5. Cointegration Test

The next test that follows the unit root test is the co-integration test. The purpose of conducting cointegration analysis is to trace empirically the presence of long-run equilibrium relationships among the time series data in our model. In essence, the test is for the correlation between non-stationary time series variables. If two of the time series or more are themselves non-stationary, but a linear combination of them are stationary, then these time series are said to be co-integrated. A lot of economic series behaves that way and theory often predicted this. The statistical formulation of this example is what is called the co-integration model.

There are many ways for testing cointegration. The most previously used cointegration test is the Engel and Granger (1987). This test involves the running of a static regression (after first conducting unit root test). Unfortunately, Engel and Granger (1987) test of cointegration can only accommodate two variables. As a result, the most appropriate test for cointegration applied for this cointegration test is the Multivariate Johansen and Juselius test of cointegration as discussed by Johansen (1988; 1991), and Johansen and Juselius (1990). The main reason is because it permits the identification of multiple cointegration relationships. Hendry and Juselius (2001) argued that Johansen method indicates two separate maximum eigenvalue tests (i.e. the trace statistics and the maximum eigenvalue statistics). Both tests are used to examine the presence of cointegration relations the results from the two tests pave the way for applying the VECM. The trace statistics and maximum eigenvalue are represented in the equation below:

$$\emptyset_{trace} = -T \sum_{j=r+1}^{\rho} In\left(1 - \hat{\emptyset}_i\right) \quad (5)$$

$$\emptyset_{max} = -TIn\left(1 - \hat{\emptyset}_{r+1}\right) \quad (6)$$

From the Equations (5) and (6) above, r is the number of cointegration relations, $\hat{\emptyset}$ is the eigenvalues, and T is the total number of observations respectively. The trace statistic tests the null hypothesis $H_0$ that the number of divergent cointegrating equation is $\leq$ "*r*" against the alternative hypothesis $H_1$ of *n* cointegrating vectors where *n* represents the number of variables within the model. On the other hand, the maximum eigenvalue tests the null hypothesis $H_0$ of "*r*" the cointegrating vectors against the alternative hypothesis $H_1$ of *r+1* cointegrating vectors.

## 4.6. Granger Causality Test

Specifically, Granger causality test implies a correlation between the current value of one variable and the past values of other variables. It does not shows that changes in one variable cause changes in another variable. The use of the F-test to jointly test for the significance of the lags on the explanatory variables is the effective way to tests for "Granger Causality" between these variables. It is possible to have causality running from variable X to Y, but not Y to X; from Y to X, but not X to Y and from both Y to X and X to Y, although in this case interpretation of the relationship is difficult. The "Granger Causality" test can also be used as a test for whether a variable is exogenous i.e. if no variables in a model affect a particular variable. We test the absence of Granger Causality by estimating the following VAR model:

$$Y_t = \emptyset_1 + \sum_{i=1}^{n} \delta_1 X_{t-1} + \sum_{i=1}^{n} \delta_2 Y_{t-1} + \varepsilon_{t1} \quad (7)$$

$$X_t = \emptyset_2 + \sum_{i=1}^{n} \theta_1 Y_{t-1} + \sum_{i=1}^{n} \theta_2 X_{t-1} + \varepsilon_{t2} \quad (8)$$

From the Equations (7) and (8) above, the parameters $\delta_1$, $\delta 2$ and $\theta_1$, $\theta_2$ and are the predicted coefficients lag of deterministic variables. From the equation (7), the hypothesis $H_0$: $\delta_1 = \delta_2 = \delta\rho = 0$ implies the rejection of the null hypothesis. It shows the existence

of Granger causality between the deterministic variables under study (i.e., F-test X Granger causes Y). This is the same with the Equation (8) above. The null hypothesis is rejected when the calculated F-statistics is greater than the critical value at the significant level.

Specifically, the causal relationship of the model can be expressed as the VECM equation that capture both the long-run causality (i.e., ECT) and the short run ECM as in the equation below:

$$\Delta lnEXR_t = \varnothing_0 + \alpha_{11} ECT_{t-1} + \sum_{i=1}^{n} \beta_{11i} \Delta lnEXR_{t-1}$$
$$+ \sum_{I=1}^{n} \beta_{12i} \Delta lnCNFA_{t-1} + \sum_{i=1}^{n} \beta_{13i} \Delta lnM2_{t-1} + \sum_{i=1}^{n} \beta_{14i} \Delta lnLR_{t-1} + \varepsilon_{1t} \quad (9)$$

From the Equation (9) above, $\alpha_{11}$ is the coefficient of the error correction term, $ECT_{t-1}$, $\Delta$ is the lag difference of the variables, $\phi_0$ is the constant term, $\beta_{11i}$, $\beta_{12i}$, $\beta_{13i}$ and $\beta_{14i}$ are the slopes of the coefficients, and $\varepsilon_{1t}$ is the stochastic error term respectively.

## 5. EMPIRICAL RESULTS

### 5.1. Descriptive Statistics and Correlation Matrix

Most of the economic time series data are highly characterized as skewed (non-normal). The main reason is due to the presence of many outliers along the trend. From the Table 1 below, Jarque-Bera test is applied to test the normality of the series. The study uses the mean based coefficients of skewness and kurtosis to check the normality of the variables within our model. Skewness refers to the tilt in the distribution and should lie within the range of 0 and +3 for the series to be normally distributed. On the other hand, Kurtosis refers to the peakedness of the distribution and is also expected to lie within the range of 0 and +3 for the series to be normally distributed.

The null hypothesis used in the normality test assumes that the series are normally distributed against the alternative hypothesis of non-normality. If the probability value is below the Jarque-Bera normality test at 5% level of significance, then the series are not normally distributed. From the Table 1 below, it is clearly seen that the series are far from been normal. The mean coefficients of Jarque-Bera show that the series are not normally distributed. On the other hand, the standard deviation of the frequency distributions insisted that the variables are far from being normal. The values of the standard deviation in the Table 1 below show that net foreign asset (a proxy for intervention variable), money supply, exchange rates and imports are highly volatile compared to the interest rate.

Moreover, Table 1 also portrays the results of Pearson correlation matrix for the series. The coefficients from the correlation matrix show that there is evident of having higher multicollinearity problems.

### 5.2. Lag Selection Criteria

Table 2 indicates the output of the lag selection criteria based on VAR framework. Lag selection is selection is one of the important aspects in time series analysis. This research chooses Akaike Information Criterion due to the nature of the small sample characterise by the research as recommended by Liew (2004).

### 5.3. Unit Root Test

Table 3 shows the ADF and Phillips-Perron test of stationarity at levels (i.e., I (0). The data show mixed results and, as a result, it is non-stationary at levels I (0). Table 3 below shows the existence of stationarity in the data at first difference I (1). This indicates that we have achieved the precondition for applying the structured VAR Model since the variables are stationary at first difference I (1).

### 5.4. Multivariate Johansen and Juselius Cointegration Test

Having confirmed that the variables are integrated at first difference, the next test that follows the unit root test is the co-integration test. The null hypothesis in the Table 4 state that the variables are not cointegrated at 5% level of significance. In addition, while the trace statistics depicts the existence of cointegration equations, on the other hand, the Maximum-Eigen statistics indicates the

**Table 1: Descriptive statistics**

| Variables | *lnEXR* | *lnCNFA* | *lnM2* | *lnLR* |
|---|---|---|---|---|
| Mean | 2.34 | 11.357 | 25.606 | 2.624 |
| Median | 2.572 | 11.266 | 25.339 | 2.824 |
| Maximum | 5.059 | 16.597 | 30.341 | 3.455 |
| Minimum | −0.604 | 5.981 | 20.764 | 1.792 |
| SD | 2.35 | 3.315 | 2.848 | 0.481 |
| Skewness | −0.125 | 0.166 | 0.085 | −0.377 |
| Kurtosis | 1.251 | 1.718 | 1.849 | 1.742 |
| Jarque-Bera | 5.461 | 3.069 | 2.37 | 3.765 |
| Probability | 0.065 | 0.216 | 0.306 | 0.152 |
| Sum | 98.275 | 476.992 | 1075.447 | 110.21 |
| Sum Sq. Dev. | 226.432 | 450.679 | 332.592 | 9.484 |
| Correlation matrix | | | | |
| *lnEXR* | 1 | | | |
| *lnCNFA* | 0.928 | 1 | | |
| *lnM2* | 0.941 | 0.934 | 1 | |
| *lnLR* | 0.837 | 0.727 | 0.745 | 1 |

SD: Standard deviation

**Table 2: Lag selection criteria**

| Lag | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|
| 0 | NA | 0.009 | 9.514 | 9.727 | 9.59 |
| 1 | 397.715 | 0.00E+00 | −1.256 | 0.023* | −0.797 |
| 2 | 47.715* | 0.00E+00 | −1.678 | 0.668 | −0.836 |
| 3 | 37.108 | 1.19e-07* | −2.009* | 1.403 | −0.785 |

*The lag order selected by each criteria. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion

**Table 3: Unit root test of stationarity**

| Variables | ADF | | Phillips-Perron | | Order of integration I (d) |
|---|---|---|---|---|---|
| | At level | At first difference | At level | At first difference | |
| *lnEXR* | −1.904 | −3.646** | −1.57 | −3.651** | I (1) |
| *lnCNFA* | −1.655 | −5.014* | −0.636 | −5.017* | I (1) |
| *lnM2* | −2.39 | −3.982** | −1.753 | −4.040** | I (1) |
| *lnLR* | −1.055 | −4.801* | −1.249 | −6.275* | I (1) |

*.**Rejection of the null hypothesis at the 1% and 5% probability level respectively, ADF: Augmented Dickey-Fuller

presence of 1 cointegration equations. Thus, there is the existence of a long-run relationship between naira exchange rate, monetary aggregates and the CBN's FEM interventions.

Table 4 above shows the multivariate Johansen cointegration test, the test is carried out based on the null hypothesis that the variables are not cointegrated. However, the study rejects the null hypothesis at 1% significant level. Thus, both the trace and the Maximum Eigen statistics show that one cointegrating vector exists. As such, there is a long run relationship between the naira exchange rate, CBN's foreign market intervention and the monetary aggregates. The cointegration equation is shown in the equation (10) below:

Cointegration equation:

$$lnEXR_t = -39.88 - 0.70lnCNFA_{t-1} + 1.48lnM2_{t-1} + 1.37lnLR_{t-1} \quad (10)$$

From the equation (10) above, the long run coefficients of *lnM2* and *lnLR* show positive value while that of *lnCNFA* indicates the negative of their parameters. From the equation, only interest rate is not signed correctly. The negative relationship between the CBN's foreign market operation and the naira exchange rate shows that 1% increase in the fund the CBN's used to intervene in the FEM will leads to 1.10% decrease (appreciation) in the value of Naira-US Dollar exchange rate. The relationship is also statistically significance at 5% significance level. The reason here is that the CBN's FEM intervention appreciates rather than depreciates the value of the Naira-US Dollar exchange rate. This clearly shows that CBN's foreign market intervention is consistent with its objectives since the purpose is to save naira-us Dollar exchange rate from continuous depreciations (Komolafe, 2015; Nweze, 2015).

Also, the positive long run relationship is found to exist between the volume of money supply (*lnM2*) and the Naira-US Dollar exchange rate and is statistically significant at 5%.The interpretation goes 1% increase in the volume of money supply (due to non-sterilization) will lead to increase (depreciation) in the value of Naira-US Dollar exchange rate by approximately 1.9%. Increase in the volume of Naira in circulation in the currency market, all things being equal, will lead to the depreciation in its value. Looking it again from another angle, increase in the money in circulation increase the level of consumption. This will lead to "too much money chases too few goods" in the product market. The outcome is the general increase in the price of consumable goods and services. A country with domestic inflation tends to attracts fewer foreign markets. This affects the value of its domestic currency negatively. This shows that the CBN's is non-sterilized. The finding is also consistence with findings of Simatele (2003), Simwaka and Mkandawire (2006), Adebiyi (2007) and Omojolaibi and Gbadebo, (2014).

In addition, positive significant long run relationship is also found between the Naira-US Dollar exchange rate and the interest rate variable. The results show that 1% increase in the level of interest rate will lead to 1.65% increase (depreciation) in the value of Naira-US Dollar exchange rate. This is rather contrary to the theoretical underpinnings between the exchange rate and the interest rate. But, the justification in Nigeria is that due to high rate of political instability coupled with the inadequate social amenities, increase in the level of interest rate will not attracts foreign investors. It will only increase the cost of production and discourage exportation. This eventually have negative effects on the Naira-US Dollar exchange rate.

Furthermore, the short run speed of adjustment based on the ECM is presented in the Table 5.

It is significant at 1% and it shows that naira exchange rate respond significantly to the CBN's foreign market intervention to re-establish the equilibrium relationship at the speed of 12.6% annually.

## 5.5. Diagnostic Tests

Table 6 portrays the diagnostics statistics of the model. From the table, the adjusted R-square shows that 81 percent of the behavior of the Naira/US Dollar exchange rate is explained by the variables within the model. Also, it is shown that the model is normally distributed, free from serial correlation and hetrokedasticity. For this reason, the model is efficient and suitable.

## 5.6. VECM Pairwise Granger Causality

Even though the results from the cointegration test confirm the existence of the long-run causality between the exchange rate and interventions operations, it fails to show the direction of the causality. Engle and Granger, (1987) argued that the result of the co-integration tests above indicates that causality exists by definition in at least one direction. Therefore, the next task is to show the direction of causality between the variables in the model. As a result, Table 7 shows the existence and direction of the long-

**Table 4: Multivariate Johansen and Juselius cointegration test**

| $H_0$ | Eigen-value | Trace statistics | 5% critical value | Max-eigen statistics | 5% critical value |
|---|---|---|---|---|---|
| r=0 | 0.635 | 71.287 | 54.079* | 40.337 | 28.588* |
| r≤1 | 0.360 | 30.949 | 35.192 | 17.874 | 22.299 |
| r≤2 | 0.204 | 13.074 | 20.261 | 9.150 | 15.892 |
| r≤3 | 0.093 | 3.924 | 9.164 | 3.924 | 9.164 |

r indicates the number of cointegration vector. *Rejection of the null hypothesis at the 1%, probability level respectively

**Table 5: Result of ECM**

| Variables | Coefficients | Standard error | t-value | P-value |
|---|---|---|---|---|
| c | 32.882 | 5.661 | 5.807 | 0.000* |
| *ΔlnCNFA* | 0.046 | 0.182 | 0.235 | 0.400 |
| *ΔlnM2* | 0.076 | 0.024 | 3.071 | 0.002** |
| *ΔlnLR* | 0.013 | 0.029 | 0.478 | 0.314 |
| ECM(−1) | −0.126 | 0.029 | −4.244 | 0.000* |

*.**Indicate 1%, 5% significance level respectively, ECM: Error correction model

**Table 6: Diagnostic tests**

| Tests | Statistics | P-value |
|---|---|---|
| $R^2$ | 0.812 | |
| Adjusted $R^2$ | 0.669 | |
| Jarque-Bera | 3.321 | 0.189 |
| Serial correlation | 0.559 | 0.333 |
| Heteroskedasticity | 0.103 | 0.163 |

**Table 7: VECM granger causality analyses**

| Dependent variables | Direction of causality | | | | | |
|---|---|---|---|---|---|---|
| | F-statistics | | | | Long run causality | |
| | *ΔlnEXR* | *lnCNFA* | *ΔlnM2* | *ΔlnLR* | $ECM_{t-1}$ | t-statistics |
| *ΔlnEXR* | - | 0.274 | 0.63 | 7.326* | −0.126* | [−4.244] |
| *ΔlnCNFA* | 3.325** | - | 0.275 | 1.249 | 0.046 | [0.235] |
| *ΔlnM2* | 3.646** | 2.964** | - | 0.886 | 0.076* | [3.071] |
| *ΔlnLR* | 3.129** | 0.520 | 0.218 | - | −0.013** | [0.478] |

The Asterisks * and ** show significance at 1% and 5% level of significance respectively. The *Δ shows the variables are in the first difference*. Also, the the values in the [ ] are the t-values.

run and short-run causality amongst the variables in the model. From the table, there is, in the long-run unidirectional causality between money supply and Naira USD exchange rate; money supply and FEM interventions variable. Likewise, unidirectional long-run causality is also found between interest rate and Naira/US Dollar exchange rate.

Base on the pairwise Granger causality, it reveals that there is, in the short-run, unidirectional causality running from the naira exchange rate to the money supply at 5% level of significance. Also, interest rate was found to Granger-cause Naira exchange rate at one percent level of significance. Surprisingly, no causality exists from exchange rate to FEM interventions. This shows that the intervention operation by the CBN is "leaning against the wind". Furthermore, unidirectional causality exists from the interventions variable to exchange rate at five percent level of significance. This clearly shows that the FEM intervention in Nigeria is not sterilized both in the long-run and short-run respectively. For this reason, the high rate of the increase in the price of goods and services in Nigeria is associated with the large amount of fund use in the foreign exchange intervention. This also corroborates with the findings of Simatele (2003), Adebiyi (2007), Simwaka and Mkandawire (2006), Omojolaibi and Gbadebo, (2014).

## 6. SUMMARY AND CONCLUSION

The paper evaluates the efficacy of the FEM interventions in the FEM using Nigeria as a case study. The paper further uses VECM to trace the relationship and nature of causality between the exchange rate and the intervention variables. The results show the presence of the long-run relationship between the intervention operation of CBN and Naira exchange. Moreover, the results from the famous Pairwise Granger Causality test emphasize the presence of unidirectional causality running from intervention variables to the money supply. This has a severe effect on the price stability. As a result, the paper concluded that intervention operations in the FEM embark upon by CBN is non-sterilized.

The CBN have been active in the FEM since 1986 (Sanusi, 2004; Adebiyi, 2007). But Naira has also been losing its value in the FEM woefully. That is to say, the CBN has little or no effect in stabilizing the value of naira. The main reason is the incapability of the CBN to sterilize the amount of money used during intervention operation. These have led to the persistent increase in the price of domestic goods and services. However, for intervention operation to be successful and effective, CBN must accumulate and maintain a reasonable amount of foreign reserve. Foreign reserves are in most countries used to intervene in the FEM. In addition, countries with high rate of foreign reserve tend to attract foreign investors than otherwise.

The Central Bank Management Board, its policy formulation and implementations should be free from any political influences. That is to say, policy formulation in the central bank should be free for political interference. This will enable the management board to have professional personnel who will formulate and implement relevant policies that will restore and maintain a valuable and stable naira.

CBN should make sure that all the amount of currency used during intervention operations are sterilized. It is well-known that non-sterilized interventions are associated with the increase in the volume of money in circulation. As a result, it leads to inflation, and it also affects the economic performance negatively.

There must be a harmony between the monetary and fiscal and intervention policies. This will increase the effectiveness of all the policies because they are targeting and aiming at achieving the same goals. Consequently, a stable and relatively valuable naira can be guaranteed.

CBN should create exchange rate parity band beyond which naira will not be allowed to depreciate of appreciate as the case may be.

Bureau de change and parallel markets should be monitored and controlled properly. The main reason here is the wide gap between the naira official exchange rate and the naira exchange rate in the Bureau de Change and black marketers.

The deregulation of the FEM should be monitored extensively and with utmost care. This can be done by embarking on strategic interventions operations (for example, manage pegging) that will stabilize and restore the value of the Naira.

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