Effect of Monetary Policy on Exchange Rate in Nigeria: Examining the Pre-and-Post Global Financial Crisis

Mathew B. Ogunniyi and Darlington Akam
University of Lagos

Abstract
The authors investigated how monetary policy has affected the exchange rate in Nigeria before and after the global financial crisis, using Autoregressive Distributed Lag (ARDL) and Granger causality test. It is evident from the empirical results that a decrease (increase) in the supply of money and increase (decrease) in interest rates of Nigeria have led to the appreciation (depreciation) of the national currency before Global Financial Crisis (GFC). However, this has led to the depreciation (appreciation) of the domestic currency after GFC. In summary, the Central Bank of Nigeria had a better control on the exchange rate before the GFC. Also, the causality test revealed that Nigeria's exchange rate drives money supply before the GFC, while money supply and interest rate drive the exchange rate after the GFC. Therefore, policies that are conducive to stabilising monetary variables are essential in attaining exchange rate stability. Besides, the government should ensure optimal control of liquidity surplus in the banking system in order to strengthen the stability of the financial sector.

***Keywords**: Monetary Policy, Exchange Rate, Interest Rate, Global Finance Crisis*

***JEL Classifications**: E52, F31, E44, G01*

Introduction

Nigeria's monetary authority has sailed through many uncertainties vis-à-vis an unpredictable corridor since the 2000s in an effort to achieve macroeconomic objectives. Global Financial Crisis (GFC) especially was a shock that hurt many economies, Nigeria inclusive, and many monetary policies were sought to return those economies to normal. Monetary policy is the measures taken by the

monetary authorities to influence the variations of credit and money in the economy to achieve the macroeconomic objectives such as the stability on price levels, economic growth, and accomplishment of desirable balance of payments. Meanwhile, Precious and Palesa (2014) opine that an economy in pursuit of price stability will indirectly pursue other goals such as economic growth and stability of financial market. They also posited that economic growth is influenced by monetary policy through aggregate spending. That is, change in interest rate and supply of money affect consumer spending as well as investment decision.

According to Ndubuisi, Uma and Obidike (2017), monetary policy is designed specifically to regulate the availability, cost, and direction of credit to attain stated economic objectives including exchange rate stability. In a developing country like Nigeria, the Central Bank plays an indispensable role by using the monetary policy techniques to improve liquidity situations in the financial sectors to control the market activities and ensure price and financial stability. However, since 2008 the central bank of Nigeria (CBN) has placed emphasis on regulation of the country's money supply (CBN, 2008). Over the years, CBN has employed different effective monetary policy regimes intending to limit the pressure on exchange rates and, at the same time, maintain financial stability in the economy. The various instruments used to achieve the stated objective include: monetary policy rate (MPR), Open Market Operation (OMO), Cash Reserve Ratio (CRR) on private and public sector deposit, Foreign Exchange Net Open Position (NOP), interest rate, money supply and Liquidity Ratio (LR). Among these instruments, MPR got introduced on the 4th of December 2006 as a reference rate for a transaction in the inter-bank money market to achieve a stable domestic currency through the stability of interest rate (CBN, 2007). The MPR replaced the Minimum Rediscounted Rate (MRR) as the benchmark interest rate and a nominal anchor rate for all other rates in the economy which banks can borrow from the CBN (Komolafe, 2006; Fadun, 2011; Joseph and Thaddeaus, 2013). Monetary control authorities play a crucial role by influencing MPR to inform the investors of what will happen to the interest rate in the future. According to Joseph and Thaddeaus (2013), the lower the interest rate on loan at which the Central bank lends to its client, the more loses its control over the growth of money supply. In other words, a reduction in the MPR is to increase the money supply and trigger capital outflow. By implication, an increase in money supply and a decrease in interest rate

encourage lending and investment spending (Njimanted, 2009). However, in the long run, Nigeria's money growth seems to translate only into proportional higher inflation (Ufoeze, Okuma, Nwakoby, and Alajekwu (2018) and the nation's health can best be maintained by eliminating monetary expansion which dampens its economic growth.

Exchange rate stability, on the other hand, has been one of the major concerns of the monetary authorities in any economy (Akhter and Faruqui, 2015). However, Umoru (2013) opines that the national economy whose money supply rises at a quicker rate than those of her trading partner would experience deterioration in her external balance. Moreover, the key domestic vulnerabilities in the economy has sometimes called for tight monetary policy stance (CBN, 2007). The apex banks have had to regulate and pay attention to the financial system since the appreciation and depreciation in the value of their currencies against exchange rates fluctuation which affects the performance of other macroeconomic variables. Thus, a strong (weak) exchange rate is a reflection of how strong and viable (weak and vulnerable) an economy performs (Ojo & Temitayo, 2018).

Moreover, Curkierman (2013) posits that the GFC has raised concerns about country's financial stability and the roles of central banks. The evolving crisis affected Nigeria by causing unrest in the banking sectors and the stock market, thereby leading to liquidity squeeze resulting from an increase in interest rate (Olatunji & Weilang, 2017). Based on this, one cannot argue against the fact that the crisis led to a distressed capital market, which was already unstable as a result of the withdrawal of foreign portfolio investors, thereby posing pressure on the nation's foreign exchange incomes. However, the reduction in foreign exchange earnings due to fall in the crude oil prices affected the budget of the nation (Nwoba, et al., 2017). Also, the demand pressure mounted on the foreign exchange market led to the capital outflow and depreciation of the Naira (Ozsoz, et al., 2017). This scenario required the CBN to raise the MPR to stabilise the exchange rate but it was observed that inflation and interest exhibit an upward trend. With the depreciation of the currency, high unemployment, withdrawal of foreign investors, low inflow of capital, and recession in the economy globally, the need for influence and significance of monetary policy on the exchange rate received fabulous attention from researchers all over the world. Therefore, this paper investigates and compares the effect of monetary policy on the exchange rate before and after the GFC. The study also

distinguishes itself from previous studies in Nigeria by comparing causal inference between monetary policy and exchange rate before and after the GFC. Following this introductory part, section 2 presents a review of the literature on monetary policy and exchange rate while section 3 sheds light on the methodology employed. Section 4 contains the empirical analysis and discussions on them while in part 5, conclusion and recommendations are drawn.

Review of Literature

Theoretical Review

Purchasing Power Parity (PPP) and Quantity Theory of Money

According to Cassel (1918), PPP is the exchange rate between two national currencies overtime which is caused by the changes in the prices of goods of the two countries. Essentially, the PPP is seen as the open economy extension of quantity theory of money (Officer, 1976). An essential part of the augment given by these theories is that in PPP, exchange rate is measured by the ratio of a country's price of goods to that of the other country whereas in the monetary theory, exchange rate can be said to be measured in terms of the ratio of prices due to ratio of money supply of a country to that of the other (Levich, 1983). Therefore, PPP theory links exchange rate to prices while quantity theory of money links prices to monetary conditions. Put it all together, the monetary approach to exchange rates says that given a rise in real money balance due to an increase in real income, the exchange rate would appreciate proportionately.

Mundell-Fleming Model

Refocusing on Meade (1951) analysis, Marcus Fleming (1962) argued that monetary policy was more effective under floating exchange rates compared to fiscal designs. On the other hand, Robert Mundell (1963), using a large-scale model to link real and nominal variables, argued that the direction of monetary policy whether internal or external balance depends on either a fixed or floating exchange rate. Internal balance (domestic balance) implies full employment with price stability while external balance implies equilibrium in the balance of payments (Isedu, 2013). According to the theory, the relationship among interest rate, income and exchange rate policy, which is also known as the IS-LM balance of payments (BOP) model, highlights the difference between

floating and fixed exchange rate. However, the restraint of the model is that it fails to explicate exchange rate fluctuations in the inflationary environment adequately. As cited by Boughton (2002), the Mundell-Fleming model is essentially the combination of Fleming's equations and Mundell's policy analysis.

Balance of Payments Theory of Exchange Rate

As propounded by Whiteman (1975), Frenkel and Johnson (1976), and Mussa (1976), the BOP theory presumes that under floating exchange rate system, a country's exchange rate depends on its BOP. The value of exchange rate rises as a result of a favourable BOP and falls as a result of unfavaourable BOP. The monetary approach implies that the determination of the exchange rate is by demand and supply of foreign exchange -forex (Iganiga, 2012). An adverse BOP arises when the payments to foreign countries exceed the incomes from foreign countries (demand for forex exceeds its supply). Thus, the resulting value of exchange rate falls concerning the fall in the external value of the domestic currency. Conversely, the favourable BOP occurs when the returns to foreign countries exceed their payments. There is equilibrium BOP when the payments of a country to foreign countries equate returns from foreign countries. Consequently, the resulting exchange rate rises in relation to the rises in external worth of the local currency.

Empirical Review

There are many studies on the effect of monetary policy on exchange rate. Starting with the study by Dilmaghani and Tehranchian (2015), they found that lag of exchange rate and money supply have significant positive effect on the exchange rate. However, inflation, GDP, and exports have significant negative effects on the exchange rate. Similarly, Samour and Resatoglu (2018) examined the nexus between monetary policy and exchange rates in Turkey over pre-and-post global financial crisis periods spanning 2001:12- 2007:12 and 2010:1-2016:1, employing Autoregressive Distributed Lag (ARDL) model. They also carried out FMOLS, DOLS, and CCR tests to achieve the objective of robustness in the estimation results. The results show that there is a significant impact of monetary policy on exchange rates before and after the GFC. The finding also suggests that the central bank of Turkey had a stronger effect on exchange rates after the GFC than before the GFC.

Inoue and Rossi (2018) examined the effects of conventional and unconventional monetary policy on exchange rates in the US for the period 1995-2016. The authors used daily data and employed vector autoregressive (VAR). The result showed that monetary policy easing results to a depreciation of the nominal exchange rate in periods under investigation. West (2004) also applied the simple linear models and examined the effect of monetary policy on exchange rates in New Zealand using quarterly data from 1986:2-2003:1. The results revealed that an increase in the monetary policy proxy with interest rate and price level leads to a fall in the real exchange rate.

Hoffmann and MacDonald (2009) re-investigated the study of Baxter (1994) on U.S real exchange rate and real interest rate (RERI) nexus in relation to other G7 countries (Germany, Japan, Italy, France, Canada and the United Kingdom), using a quarterly time series data spanning 1978 to 2007. The study used a VAR-based approach and found a positive RERI relationship. In contrast to Baxter (1994), the results showed that the robust RERI link has a significant economic relationship and that the real interest rate differential is vastly associated with measures of the expected rate of depreciation. Furthermore, studies by Chinn and Meridith (2004), Chinn and Meridith (2005), Hacker et al. (2010), and Andrieș et al. (2017) were found to show a negative relationship between the twin variables when dealing with the shorter periods. In contrast, a positive relationship often appears when dealing with longer periods. However, Saraç and Karagöz (2015) determined the efficient level of short-range interest rates on the exchange rate during the post-2001 crisis in Turkey, using monthly data over 2003:02 – 2015:08. The study employed the frequency-domain causality test and showed no evidence of higher interest rates causing the depreciation of the exchange rate. Based on the study, the authors question the presumption that increasing interest rates is an effective mechanism for defending the exchange rate, and concluded that this remains a theoretical discourse. However, the study by Akçağlayan (2008) on the subject matter revealed the existence of a one-way causality relationship running from interest rate to the exchange rate. The author also established that the depreciation in domestic currency is a result of a rise in the rate of interest. Contrarily, Tarı and Abasız (2009), using the frequency domain approach and Granger causality test on the case of Turkey and, Kayhan *et al.* (2013) using a non-linear causality test and a frequency domain causality test on BRIC-T countries, evaluated the causal association between rate of interest and exchange rate and found

evidence of a one-way causal nexus that runs from exchange rate to interest rates.

The study by De Grauwe (2000) found a strong connection between money supply and nominal exchange rate in the long-run. The result, however, showed an insignificant relationship in the short-run. Zamanian et al. (2013) investigated the causal association between money stock and exchange in Iran under three exchange rate regimes, using quarterly time series data over 1974: 1- 1992: 4, 1993: 1- 2001: 4, and 2002: 1- 2008:4. The study applied the Toda-Yamamoto test and, it showed that bi-directional causality between money stock and exchange rate in fixed and floating regimes. However, in the absence of fixed exchange regime, the result showed no significant connection between the variables.

As discovered in recent studies from Africa, Ozsoz et al. (2017) found the impact of ECOWAS central banks interventions on their exchange rate as negative and insignificant in terms of its rebound effects. The result also showed that the monetary policy rate influences the exchange rate positively. Kwakye (2015) using the ARDL approach showed that the money supply has a significant positive effect on exchange rate in Ghana while interest rate does not significantly cause exchange rate. The study by Ndubuisi et al. (2017) showed a long-run relationship between / impact of monetary policy on the exchange rate. The result also revealed that the ECM showed the extent of reverting to stability when deviated from a stable path. They recommended that the CBN should intensify its efforts in monitoring or regulating foreign exchange demand to discourage speculative demand. Adeoye and Saibu (2014) analysed the association between exchange volatility and monetary policy shock in Nigeria over 1980-2009. The study applied the classical ordinary least squares to examine the effect of short-run monetary policy on the exchange rate and employed the Engle-Granger approach to incorporate the long-run interaction among the variables. The result showed that the nominal and real exchange rate connection is unstable during the period under review. The authors also showed that there is a causal relationship between past values of monetary policy and exchange rate. They concluded that money supply, inflation, reserve and interest depreciate and cause nominal exchange rate volatility.

There have been a few studies on the effect of monetary policy on the exchange rate before and after the global financial crisis. However, majority of the studies conclude that, on the one hand, money supply causes and has significant effect on exchange rate. On the other hand, the interest rate does not have significant impact nor cause the exchange rate. This present study bridges the gap on monetary policy and exchange rate nexus in Nigeria before and after the global financial crisis.

Methodology

Theoretical Framework

Several monetary theories have been used to explicate exchange rate determination. The focus of the study is given to the purchasing power parity, quantity theory of money, balance of payments theory, and the Mundell-Fleming model adopted by Dornbusch (1979). The models were constructed as:

$$EXR = F\ (Y, Y^f, r, r^f, \frac{P}{}) - - - - - - - - - (1)$$

Where Y is local income, Y^* represents foreign income, r, and r^f represents local and foreign interest rate, $\frac{P}{}$ represents relative price levels. This framework readily shows that the exchange rate depends on both home and foreign income, both home and foreign interest rates, and relative price levels.

From equation 4,

$$Y = \frac{M}{P} V(r, Y) \quad - - - - - - - - - (2)$$

Assuming V is constant; $Y = \frac{M}{P}$ or $GDP = \frac{M}{P}$

The theory implies that an equilibrium exchange rate becomes:

$$EXR = F\ (\frac{M}{P}, (\frac{M}{P})^f, r, r^f, \frac{P}{}) - - - - - - - - - (3)$$

So that in reduced form

$$EXR = F\ (M, r, ...) \quad - - - - - - - - - (4)$$

In the final form, equation (4) shows that a rise in money stock or a decrease in interest rate would lead to depreciation in the exchange rate, and the dots denote fiscal policy variables and other exogenous determinants.

Model Specification

Drawing from the Mundell-Fleming model adopted by Dornbusch (1979) as explained in the preceding section, we specify the following equations:

$$EXR_t = F(MP\ ,P,) \qquad ----------\ (5)$$

Where EXR represents the exchange rate, MP represents monetary policy proxy with money supply (M) and interest rate (R), while P stands for price level which represents the control variable. Equation (5) is further specified as:

$$EXR_t = F(M, R_t,\ P) \qquad ----------\ (6)$$

The data span is from 1995:1 to 2007:11and 2010:1 to 2019:03, and all indicators are obtained from the CBN Statistical bulletin (2019). Money Supply (M) is proxied by broad money (current LCU), Exchange Rate (EXR) is the official exchange rate, interest rate (R) is proxied by lending interest rate, and price level is proxied by the consumer price index. On a priori expectations, money supply and price level are positively related to exchange rate depreciation while the interest rate is negatively related to exchange rate depreciation.

The equation is stated in empirical form as follows

$$prEXR_t = \emptyset_0 + \emptyset_1 prM + \emptyset_2\ prR_t + \emptyset_3\, prP + U_{1t} \quad (7)$$
$$psEXR_t = \gamma_0 + \gamma_1 psM + \gamma_2\ psR_t + \gamma_3\, psP + U_{2t} \quad (8)$$

Where

Pr represents pre-variables from year 1995m01 to 2007m11

Ps represents post-variables from year 2010m01 to 2019m03

The ARDL-ECM is specified into pre-and-post equations:

$$\Delta prEXR_t = \gamma_0 + a_1 \sum^{p}_{i=1} \Delta prEXR_{t-1} + b_1 \sum^{q}_{i=0} \Delta prM_{-1} + b_2 \sum^{q}_{i=0} \Delta\, prR_{t-1} + b_3 \sum^{q}_{i=0} \Delta prP_{-1} + \lambda \mathrm{ECT}_{-1} + U \quad (9)$$

$$\Delta psEXR_t = \gamma_0 + a_1 \sum^{p}_{i=1} \Delta psEXR_{t-1} + b_1 \sum^{q}_{i=0} \Delta psM_{-1} + b_2 \sum^{q}_{i=0} \Delta\, psR_{t-1} + b_3 \sum^{q}_{i=0} \Delta psP_{-1} + \lambda \mathrm{ECT}_{-1} + U \quad (10)$$

Analysis and Interpretation

Descriptive Statistics

Table 1: Descriptive Statistics and Correlation Matrix

Variables	EXR	M	R	P
Mean	-3.94E-16	2.72E-16	-2.76E-16	-1.47E-16
Median	-0.292537	-0.442784	-0.333083	-0.309755
Maximum	3.661654	2.260822	3.274087	2.591286
Minimum	-1.002260	-0.984293	-1.596005	-1.164702
SEXR	1			
SM2	0.856811	1		
SINTR	-0.311926	-0.567297	1	
SINFL	0.896068	0.926001	-0.542895	1

Source: *Author computation from the CBN statistical bulletin, (CBN) 2019*

Table 1 shows the summary statistics of each variable and their correlation matrix. Validating the correlation matrix results with the argument in Iyoha and Ekanem (2004) that multicollinearity is present when the coefficient is greater than 0.95; the reflection of the relationships among variables revealed that there is no exact linear relationship among them. However, the association among the variables does not show the exact causal association.

Unit Root Test

Graphical analysis of the series variable under study is plotted to reveal if the integrating nature of the series exist or not, and also to see their cyclical pattern. The graphical representations of the series are examined below.

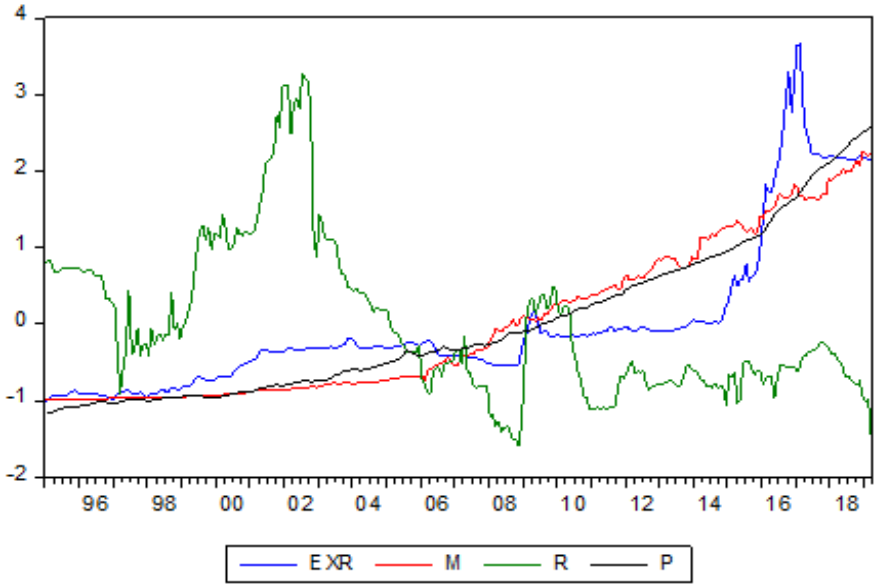

Figure 1: Exchange rate (EXG), Money supply (M), Interest rate (R) and Price level (P)

Figure 1 depicts the movements of money supply, exchange rate, interest rate, and price level from 1995:m1 to 2019:m3. The data were sourced from the CBN annual statistical bulletin (2018). It is seen that the variables possess upward and downward trends and this implies that their means and variances change over time. Hence, they are not stationary at level. Moreover, the figure revealed that there is a need for differencing in order to achieve stationarity.

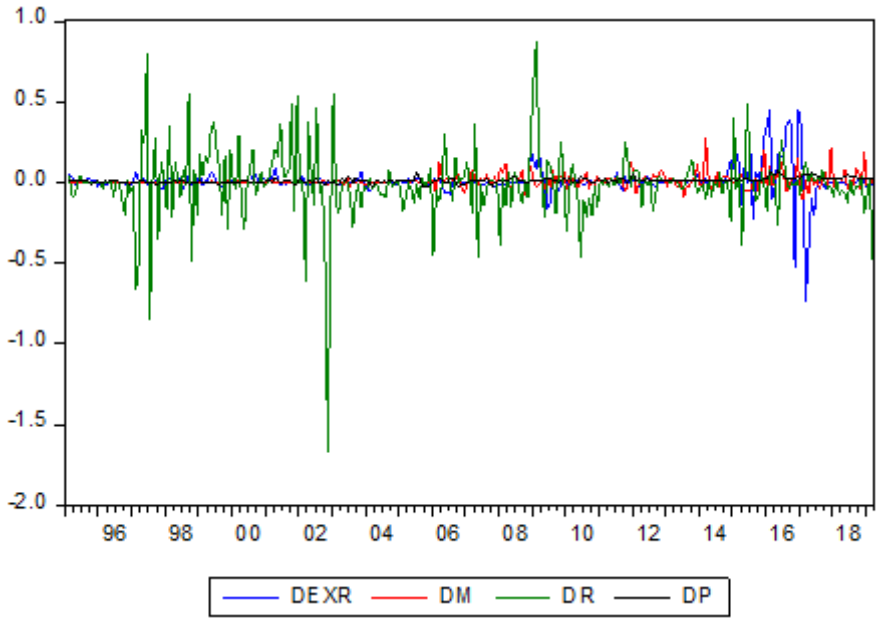

Figure 2: Difference of Exchange rate d(EXG), Difference of Money supply d(M), Difference of interest rate d(R) and Difference of Price level d(P)

Figure 2 depicts the difference of exchange rate, difference of real money supply, difference of interest rate, and difference of price level from 1995:m1 to 2019:m03. It showed that visible trends were filtered out, and this in turn suggested that they are stationary at first differencing.

Table 2: Unit Root Test

Variables	ADF at level		PP at level		KPSS at level		Order of Integration
	@ level	@ First difference	@ level	@ First difference	@ level	@ First difference	
EXG	-2.2243	-4.8130[abc]	-1.6800	-12.7125[abc]	0.2843	0.05134[abc]	*I*(1)
M	-1.2867	-19.5015[abc]	-1.2184	-19.6527[abc]	0.50068	0.01831[abc]	*I*(1)
R	-2.2559	-16.1804[abc]	-2.4228	-16.1670[abc]	0.01831[a]	0.04861[abc]	*I*(1)
P	2.9251	-11.08496[abc]	4.1474	-11.1370[abc]	0.4536	0.2880	*I*(1)

Note: [a], [b] and [c] denote the rejection of the null hypothesis at 10 %, 5 %and 1 %, respectively. The optimal lag order for the ADF test is determined by SIC, while the bandwidths for PP and KPSS tests are determined by using the Newey-West Bartlett kernel.

Source: *Author's computation*

We applied the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests to examine the stationarity of the variables. The results in Table 2 show that money supply, exchange rate, interest rate, and price level are all I (1) at 10%, 5% and 1% level of significance. The results of ADF, PP, and KPSS unit root tests fit into the graphical illustration (Figures 1 and 2), where the series would become stationary at first difference. The PP and KPSS unit root tests are to check the robustness of the estimation results of the ADF test.

Autoregressive Distributed Lag (ARDL) Test

Table 3: ARDL Bounds test result

Period	Model	Lag	F statistics	Decision
Before GFC	EXR,M,R,P	8, 6, 0, 11	8.133967[abc]	Co-integration exist
After GFC	EXR,M,R,P	5, 7, 7, 8	7.008095[abc]	Co-integration exist

Critical Value

level	I(0) Bound	I(1) Bound
10%	3.47	4.45
5%	4.01	5.07
2.5%	4.52	5.62
1%	5.17	6.36

Note: [a], [b] and [c] denote the rejection of null hypothesis at 10 %, 5 %and 1 % respectively

Source: *Author's computation*

The results from the ARDL bounds test of cointegration are reported in Table 3. The results show that the *F*-statistics exceeds the Upper Bound table value at all conventional levels of significance provided by Pesaran et al. (2001). The

study rejects the null hypothesis of no long-term association. This result implies that there is cointegration among the variables before and after the GFC.

Table 4: Pre-GFC long-run and short-run result of EXR

Variables	Coefficient	Standard error	T-Statistics	Prob.
M_t	-0.594131	0.261821	-2.269228	0.0251[ab]
R_t	0.041487	0.021880	1.896107	0.0605[a]
P_t	-1.132147	0.598047	-1.893075	0.0609[a]
ΔEXR_{t-1}	0.321009	0.081163	3.955127	0.0001[abc]
ΔR_{t-1}	0.321009	0.081163	3.955127	0.0001[abc]
ΔP_{t-1}	0.453159	0.140260	3.230844	0.0016[abc]
ECM_{t-1}	-0.146564	0.025363	-5.778588	0.0000[abc]

[a], [b] and [c] denote significance at 10 %, 5 %and 1 % respectively

Source: *Author's computation*

Table 4 shows the estimated long-run and short-run effect of monetary policy on the exchange rate in Nigeria before the GFC. The results in the short-run reflect a positive and significant association between interest rates and exchange rates before the GFC, while the money supply does not have an impact on the exchange rate before the GFC.

Table 5: Post-GFC long-run and short-run result of EXR

Variables	Coefficient	Standard error	T-Statistics	Prob.
M_t	3.468014	1.371017	2.529520	0.0135[ab]
R_t	0.052561	0.269886	0.194753	0.8461
P_t	-0.615061	0.847031	-0.726138	0.4700
ΔEXR_{t-1}	0.328334	0.082194	3.994596	0.0001[abc]
ΔM_{t-1}	0.635672	0.188614	3.370223	0.0012[abc]
ΔR_{t-1}	0.061187	0.092929	0.658432	0.5122
ΔP_{t-1}	1.204094	1.192254	1.009931	0.3157
ECM_{t-1}	-0.171060	0.031697	-5.396717	0.0000[abc]

[a], [b] and [c] denote significance at 10 %, 5 %and 1 % respectively

Source: *Author's computation*

This implies that if an interest rate rises by one standard deviation, the average value of the exchange rate will go up by 0.32 standard deviation units in the short-run. The outcome of the long-run coefficients shows that the exchange rate will rise in reaction to a fall in the money supply and a rise in interest rate. Table 5 shows the estimated long-run and short-run effect of monetary policy on the exchange rate in Nigeria after the GFC. The results in the short-run reflect a positive and significant association between money supply and exchange rates after the GFC, likewise a positive but insignificant association between the interest rate and exchange rate after the GFC. This implies that if the money supply and interest rate rise by one standard deviation, the average value of the exchange rate will go up by 0.64 and 0.06 standard deviation units in the short-run. The outcome of the long-run coefficients shows that the exchange rate will rise in reaction to a rise in money supply and interest rates respectively. The result obtained is in support of the findings of West (2004) and Ozsoz et al. (2017).

Table 6: Comparison ARDL-ECM of Pre-GFC and ARDL-ECM of Post-GFC

Model	ECM(-1)	Probability value	Akaike Criteria
ARDL-ECM of Pre-GFC	-0.146564	0.0000[abc]	-4.954076
ARDL-ECM of Post-GFC	-0.171060	0.0000[abc]	-1.367785

[a], [b] and [c] denote significance at 10 %, 5 %and 1 % respectively

Source: *Author's computation*

In Table 6, the pre-GFC ARDL result shows that the speed of adjustment about 15% of the disequilibrium in the exchange rate of previous period's shock adjust back to the long-run equilibrium in the current period while the post-GFC ARDL result showed that about 17% of the disequilibrium in the exchange rate of previous period's shock adjust back to the long-run equilibrium in the current period**.** This result is in contrast with the ones obtained for the speed of adjustment of the exchange rate in Turkey by Samour and Resatoglu (2018) involving the higher speed of adjustment before the GFC.

4.4 Multivariate Granger Causality

To examine the direction of causality among the variables before and after the GFC, this study employs a pairwise Granger causality test advanced by Granger (1969).

Table 7: Pre-GFC Causality Test

Variables	EXR	M	R	P
EXR	NA	0.0028[abc]	0.5235	0.3321
M	0.8084	NA	0.8954	0.2207
R	0.2784	0.0543[a]	NA	0.1554
P	0.5337	0.0018[abc]	0.1340	NA

[a], [b] and [c] denote significance at 10 %, 5 %and 1 % respectively

Source: *Author's computation*

Table 7 depicts the pairwise Granger causality test result before the GFC in Nigeria. The values in the table represent the probability value for the test. Table 7 also shows that all the variables fail to granger cause each other hypothetically except for a unidirectional causality running from both the exchange rate and price level to money supply at all conventional level of significance. However, the interest rate also has a causal inference on the money supply but at a 10% significance level.

Table 8: Post-GFC Causality Test

Variables	EXR	M	R	P
EXR	NA	0.5256	0.7685	0.2489
M	0.0840[a]	NA	0.9819	0.6901
R	0.0144[ab]	0.0091[abc]	NA	0.5001
P	0.5416	0.5105	0.2038	NA

[a], [b] and [c] denote significance at 10 %, 5 %and 1 % respectively

Source: *Author's computation*

Table 8 depicts the pairwise Granger causality test result after the GFC in Nigeria. The values in the table represent the probability value for the test. It could be seen in the table that there exists a unidirectional causality running from both the money supply and interest rate to the exchange rate. The result implies that the past occurrence of monetary policy after the GFC drives the

current value of exchange in Nigeria. This study supports the findings of Adeoye and Saibu (2014) and Kwakye (2015) whose studies reveal that that money supply Granger cause exchange rate and the findings Akçağlayan (2008) and Saraç and Karagöz (2015)whose result revealed the existence of a one-way causality association running from interest rate to the exchange rate.

Diagnostics tests

Table 9: Diagnostics tests results

Pre-GFC (A)		**Post-GFC (B)**	
Normality	30.716[0.000]	Normality	17.052[0.000]
Serial correlation (LM)	0.960 [0.543]	Serial correlation (LM)	0.967[0.558]
Heteroscedasticity	0.800 [0.752]	Heteroscedasticity	0.616[0.938]
ARCH	0.880 [0.658]	ARCH	0.616[0.938]

Source: *Author's computation*

Table 9 above shows four test statistics adopted to verify the viability of the estimated model of Pre-GFC and Post-GFC. The null hypothesis is that there is no autocorrelation in the residual, and homoscedasticity of error terms. Since we use monthly data in this study, we carried out an ARCH test of heteroscedasticity, and the LM test the presence of autocorrelation. Based on the computed statistics and their insignificant probabilities (in the square bracket), the null hypothesis of no autocorrelation and homoscedasticity in an estimated model of pre-and-post GFC may be accepted. However, the model suffers from non-normality, this is because the probability value is significant. Thus, the findings of this study can be used for policy analysis.

Conclusion and Policy Recommendations

This study has investigated the effect of monetary policy on exchange rate in Nigeria before and after the GFC. It determined which monetary policy tool had a better influence on the exchange rate in Nigeria either before or after GFC. It also calculated the causal connection between monetary policy and exchange rate in Nigeria. It is evident from the study that effect of money supply and interest rate on exchange rate manifests in a different season (pre GFC and post GFC). Further, the results suggest that decrease (increase) in the money supply

and increase (decrease) in interest rates of Nigeria led to the appreciation (depreciation) of the domestic currency before GFC. Also, the increase (decrease) in the money supply of Nigeria led to the depreciation (appreciation) of the national currency after GFC. Thus, the CBN had a better influence on the exchange rate before the GFC than after the GFC. In addition, it is revealed that exchange rate in Nigeria drives money supply before the GFC, while money supply and interest rate drive exchange rate in the country after the GFC.

Based on the findings, policies that are conducive to stabilise monetary variables are essential in order to achieve exchange rate stability. Also, government must ensure optimal control of liquidity surplus in the banking system in order to strengthen the country's financial stability. CBN should be more autonomous of government control to achieve monetary independence and ensure periodic discrepancy in inflation is minimised for achieving stability in the exchange rate. Finally, the monetary authority in harmony with government fiscal policy should maintain exchange rate stability by improving the business environment and building up the confidence of consumers and investors. This in turn would fast track increase in economic activities in the country.

References

Adeoye, B. W., and Saibu, O. M. (2014). Monetary policy shocks and exchange rate volatility in Nigeria. *Asian Economic and Financial Review*, 4(4), 544-562.

Akçağlayan, A. (2008). The effects of interest rate policy on exchange rates during 2001 currency crises. *AbantIzzetBaysal University Journal of Social Sciences*, 9 (1), 1-20. (in Turkish).

Akhter, F. and Faruqui, N. (2015).Effects of macroeconomic variables on exchange rates in Bangladesh.*International Journal of Scientific & Engineering Research*, 6(2), 1028-1034.

Andrieș, A. M., Ihnatov, L., Căpraru, B., and Tiwari, A. K. (2017).The relationship between exchange rates and interest rates in a small open emerging economy: The case of Romania. *Economic Modelling*, 6(c), 153-172

Baxter, M (1994). Real exchange rates and real interest rate differentials: Have we missed the business cycle relationship? *Journal of Monetary Economics*.(33)1 pp. 5-37

Boughton, J. M. (2002). On origins of the Flaming-Mundell model.*Policy Development and Review Department, Working Paper* No. 107.

Cassel, G. (1918). The present situation of the foreign exchanges. *Economic Journal*, 26, 62-65.

CBN (2007).The Conduct of monetary policy. Retrieved from https://www.Cbn.gov.ng/conduct/2007.asp.Accessed on 5th May 2019.

CBN (2008).The Conduct of monetary policy. Retrieved from https://www.Cbn.gov.ng/conduct/2007.asp.

Chinn, Menzie D., and Meredith, Guy (2004). Monetary policy and long horizon uncovered interest parity. *IMF Staff Papers*. 51(3) pp. 409-430.

Chinn, Menzie D., and Meredith, Guy (2005) Testing uncovered interest parity at short and long horizons during the post-Bretton Woods era. *National Bureau of Economic Research, Working Paper* No. 1107.

Curkierman, A. (2013). Monetary policy and institutions before, during, and after the global financial crises.*Journal of Financial Stability,* 9, 373-384.

De Grauwe, P. (2000). Exchange rate in search of fundamental variable. *Centre for Economic Policy Research, Discussion Paper* No.1073.

Dilmaghani, A. K. and Tehranchian, A. M. (2015).The impact of monetary policies on the exchange rate: a GMM approach. *Iran. Econ. Rev*., 19 (2), 177-191.

Dornbusch, R. (1979). Monetary policy under exchange-rate flexibility. *National Bureau of Economic Research, Working Paper* No, 311. Doi:10.3386/w0311.

Fadun, S. O. (2011). Nigeria's new monetary policy framework in line @ http:/www.jidefadun.netfmoneyartpolicy.htm

Fleming, J.M. (1962). Domestic financial policies under fixed and floating exchange rates. *Staff papers, international monetary fund*, 9, 369-379.

Frenkel, J. A., and Johnson, H. G. (1976).The monetary approach to balance of payment. *Allen& Unwin, London, and University of Toronto Press, Toronto.*

Granger, C.W.J. (1969).Investigating causal relations by econometric model and cross-spectral model method. *Econometrica* .37: 424-35.

Hoffmann, M. and MacDonald, R. (2009).Real exchange rates and real interest rate differentials: a present value interpretation. *Institute for Empirical Research in Economics, Working Paper* No. 404.

Iganiga, B. O. (2012). Macroeconomics: concept, theory and application. Lagos, Nigeria: Amfitop Books.

Inoue, A. and Rossi, B (2018).The effects of conventional and unconventional monetary policy on exchange rates. *National Bureau of Economic Research Working Paper* No. 25021.

Isedu, M. (2013).Effect of monetary policy on economic performance: the case of Nigeria. Unpublished Ph.D. thesis from the department of economics, University of Greenwich, United Kindom.

Iyoha, M. A., and Ekanem, O. T. (2004).*Introduction to Econometrics*. Benin City: March Publishers.

Joseph, T. B. and Thaddeaus, L. D. (2013). The relationship between monetary policy (MPR) and bank rates: Evidence from regression and multivariate causality analysis. *AFREVIJAH: An International Journal of Arts and Humanities*, 2(1), 234-256

Kayhan, S., Bayat, T. &Uğur, A. (2013).Interest rates and exchange rate relationship in BRIC-T countries. *Ege Academic Review*, 13 (2), 227- 236.

Komolafe, B. (2006, December 5). CBN new monetary policy replaces MRR with MPR. Vanguard (Lagos).Retrieved from https://www.allafrica.com.

Kwakye, K. (2015). An examination of the relationship between exchange rate and key macroeconomic variables in Ghana: an autoregressive distributed lag (ARDL) approach. Unpublished Masters Dissertation from the department of Business administration, Kwame Nkrumah University, Ghana.

Levich, R. M. (1983).Empirical studies of exchange rates: Price behavior, rate determination and market efficiency. *National Bureau of Economic Research Working Paper No. 1112*.

Meade, J. E. (1951). The balance of payments. *The Theory of International Economic Policy*, 1, 1-11.

Mundell, R. (1963). Capital mobility and stabilization policy under fixed and flexible exchange rates. *Canadian Journal of economics and political science*, 29, 475-485.

Mussa, M. (1976). The exchange rate, the balance of payments, and monetary and fiscal policy under a regime of controlled floating. *Scandinavian Journal of Economics*, 78(2), 229-248.

Ndubuisi, P., Uma, K. E., &Obidike, P.C.(2017). Monetary policy and exchange rate stability in Nigeria: An Empirical Investigation. *International Journal of Humanities, Arts, Medicine and Sciences*, 5(4), 15-26.

Njimanted, G. F. (2009). Money supply, interest rate, economic growth in Cameroon. *Journal of the Cameroon Academy of Sciences*, 8(2), 123-130.

Nwoba, M. O., Nwonu, C., and Agbaeze, E. (2017).Impact of fallen oil prices on the Nigerian economy. *Journal of Poverty, Investment and Development* 33, 2017

Officer, L. (1976).The purchasing-power-parity theory of exchange rates: a review article. *International Monetary Fund*, 23 (1), 1-60.

Ojo, O.M and Temitayo, A.T. (2018). An empirical determinants of the exchange rate in Nigeria. *International Journal of Scientific Research and Management*, 6(5), 412-423. Doi.org/10.18535/ijsrm/v6i5.em07.

Olatunji, J. and Weilang, H. (2017).The effect and policy analysis of global financial crisis on Nigeria economy. *International Journal of Management Science and Business Administration*, 3(4), 58- 64.Doi: 10.18775/ijmsba.1849-5664-5419.2014.34.1007.

Ozsoz, E., Akinkunmi, M., Ay, I. C., and Bamidele, A. (2017). How CBN confronted the meltdown: The global financial crisis and the central bank of Nigeria ʾs response. *The Singapore Economic Review*, 62 (1), 147–161.

Pesaran, M.H., Shin, Y., and Smith, R. J. (2001). Bound testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16, pp.* 289- 326.

Precious, C. and Palesa, M. (2014). Impact of monetary policy on economic growth: A Case Study of South Africa. *Mediterranean Journal of Social Sciences*, 5(15), 76-84.

Samour, A. and Resatoglu, N. G. (2018). Monetary policy and exchange rates pre-and post-global financial crisis: the case of Turkey. *Journal of History Culture and Art Research*, 7(5), 83-91. doi:http://dx.doi.org/10.7596/taksad.v7i5.1615.

Saraç, T.B., and Karagöz, K. (2015). Impact of Short-term Interest Rate on Exchange Rate: The Case of Turkey. *Procedia Economics and Finance*, 38, 195 – 202.

Tarı, R. &Abasız, T. (2009). Frequency domain approach and short run and long run causality test: Evidence from Turkey for interest rate and exchange rate relationship. *METU Studies in Development*, 36, 405-421.

Ufoeze, L.O., Okuma, N.C., Nwakoby, C., and Alajekwu, U.B. (2018).Effect of Foreign Exchange Rate Fluctuations on Nigerian Economy. *Annual of SpiruHaret University, Economic Series*...Doi: 10.26458/1814

Umoru, D. (2013). Monetary models and exchange rate determination: The Nigerian Evidence. *International Journal of Development and Management Review*, 8(1), 172-197.

West, K. D. (2004). Monetary policy and the volatility of real exchange rates in New Zealand.*National Bureau of Economic Research, Working Paper no. 10280.*

Whiteman, M. V. N. (1975). Global monetarism and monetary approach to the balance of payments. *Brookings Papers on Economic Activity*, 2, 491-536.

Zamanian, G., Pahlavanl, M., and Ranjbarouri, F. (2013).Causal relationship between money stock and exchange rate under the fixed and floating regime. *International Journal of Academic Research in Progressive Education and Development,* 2(1), 75- 82.