EFFECT OF INTEREST RATE ON EXCHANGE RATE MANAGEMENT IN NIGERIA

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ABSTRACT

This study examined how a capital account (closed or open) affects the relationship between interest rate policy and exchange rate volatility in Nigeria. It utilized annual time series data sourced from Central Bank of Nigeria (CBN) and the World Development Indicators (WDI) from 1981 to 2017 to estimate an autoregressive distributed lag model (ARDL) using dummies. The findings of the study reveal that an increase in interest rate will depreciate the exchange in the long run (either in an open or a closed capital account setting) and also in the short run if the capital account is open. Therefore, it is recommended that interest rate should be used to manage short-term temporary pressure on exchange rate volatility in addition to enforcement of effective capital controls.

JEL classification: F3, F31, F38

1. Introduction

One of the central economic issues facing the Nigerian economy since the introduction of the Structural Adjustment Programme (SAP) by the International Monetary Fund (IMF) in 1986 is the rapid depreciation of its domestic currency (the naira). Since then, exchange rate policy regimes have been introduced to achieve exchange rate stability. Some of these policies include the introduction of the autonomous foreign exchange market (AFEM) in 1995, the inter-bank foreign exchange market (IFEM) in 1999 and the whole Dutch auction system

(WDAS) in 2006, among others. The rate at which these measures were introduced shows the determined effort of the monetary authority to combat persistent depreciation and instability of the naira. As of May 2016, the exchange rate of the naira had depreciated to about $1/₦197.00 and the Monetary Policy Committee of the Central Bank of Nigeria approved a dual exchange rate system (a more flexible exchange rate system) to curb further depreciation and ensure availability of foreign currencies in the foreign exchange market (CBN, 2016).

Despite the above-mentioned exchange rate policies, a lot of monetary policy changes have also been undertaken by the Central Bank to curb persistent exchange rate instability through additional monetary tightening (see Adamu, & Sanusi, 2016). However, both the exchange rate policies and monetary policies used to combat this instability have not produced the desired results.

The management of exchange rates via interest rate has been attracting attention in international finance literature. Interest rate affects exchange rate fluctuations via capital flow, and one of the theoretical channels through which these capital flows affect the domestic economy is the exchange rate channel. Over the years, interest rate policy has been used to manage capital flow in Nigeria, but the use of this policy has proved ineffective (Agu, 2010 and Okpanachi, 2013).

Although policymakers have put in much effort to use interest rate to manage the exchange rate of the naira, their efforts seem futile when the exchange rate value of the naira is compared with those of its foreign counterparts. This is because the effect of interest rate on exchange rate appears to be contingent on several factors, including for instance, level of capital account openness. This is evident from the fact that changes in interest rate have not led to a reduction in the depreciation of the naira. Exchange rate has kept on depreciating with changes in interest rate, particularly with the introduction of SAP in 1986 and the change to democratic rule in 1999, which came with liberalization of a lot of economic activities. Also, in 2004 economic policies were put in place to further liberalize the capital account (See Okphanachi, 2013).

In addition, Obadan (2004) stated that capital controls are necessary if other policy measures show limited effectiveness in managing an economy with increased capital inflows. In the same vein Okpanachi (2013) and Agu (2010) documented the ineffectiveness of indirect controls such as monetary policy to manage the capital flow.

The literature reviewed in this study show that there is no consensus in the debate on interest rate defence of a currency. While some studies believe that interest rate policy alone can be used to defend a currency, others believe that this is only possible by enforcing capital controls or in the presence of strong macroeconomic fundamentals. Thus, this paper contributes to the literature by using Nigeria as a testing ground to examine how capital account (closed or open) affects the relationship between interest rate policy and exchange rate management. This is because Nigeria has, over the years, passed through numerous types of structural transformation, of which the major was the adoption of SAP in July 1986, which marked the beginning of all major structural as well as economic liberalization. In addition to the nexus between interest rates and exchange rates, despite the fact that the theoretical exchange rate channel assumes that exchange rate will appreciate as a result of capital inflow if the interest rate of the domestic economy is increased, recently, Gudmundsson and Zoega (2016) pointed out that increased interest rate may result in depreciation of the currency through the flow of interest income to foreigners via the current account if capital controls are not effectively enforced.

Thus, the objective of this paper emerged out of this controversy, and the aim is to examine the effect of interest rate on the exchange rate in Nigeria under protected and liberalized capital accounts from 1981 to 2017. The time frame (1981 to 2017) was chosen to reflect the two periods (periods of capital account protectionism and liberalism) as well as data availability at the time this study was conducted. This is based on the fact that ever since the Structural Adjustment Programme (SAP) was introduced in July 1986 and the return to democratic rule in 1999, Nigeria has moved from periods of strict protectionism to liberalization of its capital account.

The rest of the paper is organized as follows: section 2 reviews the theoretical and empirical literature on interest rate management of exchange rate or interest rate defence of a currency. Section 3 presents the empirical framework and develops an autoregressive distributed lag model (ARDL). In section 4, the empirical results are presented and discussed, while Section 5 concludes the paper.

2. Literature Review

2.1 Theoretical framework

Interest rate defence of a currency is generally regarded as additional monetary tightening or use of high interest rate in an economy to defend a currency from speculative attacks and attract investors with the sole aim of appreciating a currency.

The exchange rate literature has shown that interest rate is a key or fundamental determinant of the behaviour of exchange rate (see for example, Copeland, 2005). Despite the abundance of theoretical issues on exchange rate, there is no general consensus on the appropriate monetary policy framework for different exchange rate regimes that will serve the need of countries based on their level of development or openness (see, for instance, Bird and Rowlands, 2009).

Basically, the theoretical model that links monetary policy changes (or interest rate policy changes) and exchange rate with regard to the level of capital mobility in an economy is the Mundell-Fleming (M-F) model (Copeland, 2005). The original references to this model are: Flemming (1962), Mundell (1962), Mundell (1963, 1968). In addition, this theory considers the size of a country (small open economy or large economy) in its policy analysis. By small open economy, we mean a country whose economic policies do not influence equilibrium conditions in the rest of the world economy, and vice versa for large countries. The underlying assumptions of the model are: a flat aggregate supply curve, static exchange rate expectations, and absence of purchasing power parity even in the long run.

In the context of this research paper, we take the assumptions underlying a small open economy (which is peculiar to developing countries) to reflect the dynamics of the Nigerian economy. This theory is at the core of most international macroeconomic models particularly with respect to policy making. The model in its policy (monetary policy changes) sense is explained in the headings below.

Monetary expansion in M-F model with imperfect capital mobility in a small open economy under a floating exchange rate system

A decrease in interest rate, which presupposes monetary expansion, results in capital outflow, exchange rate depreciation, increased exports and increased income, and vice versa for a monetary contraction.

Monetary expansion in M-F model with imperfect capital mobility in a small open economy under a fixed exchange rate system

A decrease in interest rate, which presupposes monetary expansion, results in capital outflow, balance of payments (BOPs) deterioration, decreased exports and increased income in the short run, although this is temporary. In the long run, it will lead to a fall in foreign reserves with no change in interest rate, income and BOPs, and vice versa for a monetary contraction.

Monetary expansion in M-F model with perfect capital mobility in a small open economy under a floating exchange rate system

In the M-F model, perfect capital mobility is considered a special case. Perfect capital mobility implies that domestic interest rate must equal foreign interest rate continuously. A decrease in interest rate (incipient decline), which presupposes monetary expansion, results in capital outflow and exchange rate depreciation. Unless monetary equilibrium is restored at the foreign interest rate, the depreciation will continue. In addition, the rising price of foreign exchange will, via the Marshall-Lerner condition, result in an improved trade balance and have an expansionary effect on income.

Monetary expansion in M-F model with perfect capital mobility in a small open economy under a fixed exchange rate system

A decrease in interest rate, which presupposes monetary expansion, results in capital outflow, which does not, in this case, have any beneficial effect on income since the exchange rate implies that the monetary authorities must be losing reserves.

2.2 Empirical literature

In Nigeria, not much attention has been given to the study of interest rate defence of a currency, particularly in assessing how the level of capital account openness affects exchange rate management through interest rate policy. Nevertheless, Mordi (2006) discusses extensively the challenges of exchange rate volatility in economic management in Nigeria. In the study he mentioned many factors (economic fundamentals) that determine exchange rate, some of which are: inflation, gross domestic product (GDP) growth rate, external reserves, interest rate movements, and external debt position. In addition, several previous studies concentrated on the relationship between monetary policy and exchange rate volatility in Nigeria. Some of these studies are outlined below.

Adamu and Sanusi (2016), using GARCH (1, 1) model, examined the effect of additional monetary tightening (AMT) on exchange rate volatility in Nigeria from 2007 to 2016. The findings of the study show that AMT is effective in reducing exchange rate volatility. They recommend that AMT should be used as a complementary tool and only to stabilize short-term temporary pressure on the foreign exchange market.

Yinusa and Akinlo (2008) analysed the implication of currency substitution and exchange rate volatility for monetary policy in Nigeria using VECM, and found that exchange rate volatility and currency substitution respond to monetary policy with some lags.

Ditimi, Nwosa and Olaiya (2011) used the OLS technique to examine the effect of monetary policy on macroeconomic variables in Nigeria. The findings of the study show that monetary policy had a significant positive effect on exchange rate and negative significant effect on money supply.

Hassan, Abubakar and Dantama (2017) estimated ARCH and ARDL models to investigate the sources of exchange rate volatility in Nigeria from 1989Q1 to 2015Q4. They found that net foreign asset and interest rate have a statistically positive impact, while fiscal balance, economic openness and oil price have a statistically insignificant impact on exchange rate volatility in Nigeria.

From the reviewed studies above, it is established that changes in monetary policy (or interest rate policy) constitute a channel through which changes can be effected on exchange rate. However, changes in interest rate also affect movement of capital across nations, which directly affects the exchange rate. Thus, the extent of control over movement of capital is another channel via which exchange rate volatility is affected. Due to this direct linkage between capital movement and exchange rate volatility, we reviewed some relevant studies to obtain documented findings with regard to capital flow and the nexus between capital controls/flow, interest rate and exchange rate.

In Nigeria, studies exist that argue for the use of direct controls to manage capital flow. For instance, Agu (2010) used a multi-sectoral general equilibrium model to examine the place of risk in capital movement and the effectiveness of fiscal and monetary policy in combating capital flight in Nigeria. He found that risk and volatility influence outflow of capital. Also, capital flight does not respond to indirect controls such as monetary policy but rather direct controls. In the same vein, Okpanachi (2013) examined the occurrence and intensity of sterilization over time on capital flow in Nigeria and found high sterilization intensity even though there was no indication of sterilization in banks. He therefore did not recommend the use of monetary policy to manage capital flow.

From the foreign scene, there are also studies that have argued in support of using interest rate (monetary policy) to defend a currency in the event of speculative attack or massive depreciation. In this regard, Lahiri and Végh (2007) modelled the trade-off between higher interest rates, output contraction as well as credit crunch in an optimizing first generation model. The results show that higher interest rates can delay a crisis if not raised beyond a certain point deemed optimal because of the large negative output effect. The optimal interest rate defence involves setting high interest rates both before and at the moment of the crisis.

Caporale, Cipollini and Demetriades (2005) used bivariate vector error correction mechanism (VECM) to examine monetary policy tightening effect on exchange rates during the Asian crisis in four Asian countries (Thailand, South Korea, The Philippines, and Indonesia). The findings show that while monetary policy tightening helped defend exchange rate during periods of tranquillity, it showed reverse effect during the Asian crisis. This result shows the impossibility of interest defence of a currency in the presence of a speculative attack.

Gudmundsson and Zoega (2016) analysed the effect of interest rate on exchange rate in a capital control regime using Iceland as testing ground. Using VECM the results show that cutting interest rates from a very high level is not likely to make a currency depreciate in an effective capital control regime. But it highlights the importance of effective enforcement of the controls.

Saborowski, Sanya, Weisfeld, and Yepez (2014) examined whether capital outflow restrictions are effective in reducing net capital outflow using panel vector autogression (VAR) in a sample of 37 emerging market economies from 1995 to 2010 and found that it is effective in places with strong macroeconomic fundamentals and institutions.

Moreover, Nigeria has experienced different political regimes, ranging from military dictatorship to democracy, which has been the dominant political system since 1999. It is obvious that style of political leadership is not unconnected to protectionism in capital accounts, higher barriers to international trade, exchange rate regime and exchange rate level. For example, it is true that Nigeria maintained a highly overvalued currency under military dictatorship while China's Communist Party has maintained a highly undervalued exchange rate. These and other instances in countries like Saudi Arabia where monarchy and fixed exchange rates prevail show divergence in economic policy with regard to exchange rate. For example, Steinberg and Malhotra (2014), in the study using a probit regression and standard errors clustered by country on time-series–cross-sectional data set with annual observations on a large sample of developing countries (146 samples) between 1973 and 2006, found that military and monarchic regimes are more likely than democracies and civilian dictatorships to maintain fixed exchange rate regimes.

From the above, it can be seen that there is no consensus in the literature on the use of tight monetary policy to defend a currency or decrease the probability of a successful speculative attack on a currency. That is, both successes and failures have been achieved using interest rate defence. For example, in October 1997, Hong Kong was successful in defending its currency using higher interest rates while Sweden's success was short-lived in September 1992.

3. Method of Research

3.1 Model specification

Following the Mundell-Flemming model with adjustments, we specify a functional model in equation (1) and also incorporate other variables which determine exchange rate as specified by Mordi (2006). Under a floating exchange rate with perfect and imperfect capital mobility, interest rate is expected to be negatively related to the exchange rate (i.e. an increase in interest rate is expected to appreciate[1] the currency). However, under a fixed exchange rate with perfect and imperfect capital mobility, interest rate is expected to have no effect on exchange rate but be positively related to foreign reserves.

$$lnEXR = f(lnMPR, lnINF, lnRGDP, D_{86}, D_{86} * lnMPR, D_{99} \qquad (1)$$

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[1] In a direct quotation system, if the exchange rate of a domestic currency decreases it is regarded as appreciation.

where:

lnEXR	=	log of exchange rate
lnMPR	=	log of monetary policy rate (interest rate)
lnRGDP	=	log of real gross domestic product
D_{86}	=	dummy variable with 0 for periods between 1981 to 1986 (pre-SAP, i.e. periods of a protected capital account) and 1 for periods between 1987 to 2017 (post-SAP, i.e. periods of liberalized capital account)
D_{99}	=	impulse dummy variable which captures the impact of the shift from military to democratic system of governance with 1 for 1999 and 0 for all other years
$lnMPR*D_{86}$	=	interaction dummy variable

D_{99} is expected to be positive and significant to capture the depreciation of the naira as a result of the shift in the type of governance.

3.2 Estimation techniques

This study adopts the autoregressive distributed lag (ARDL) model to cointegration developed by Pesaran et al. (2001). The choice of the model is based on the behaviour of the data. This is because the model allows for testing the existence of a relationship between variables irrespective of whether the variables are purely stationary at first difference I(1) or at level I(0) or a combination of both. However, if any of the variables is found to be I(2), the model would not hold. Also, the model is suitable for both small and large sample size. Following the work of Pesaran et al. (2001) the ARDL model of equation (1) is given as:

$$\Delta logEXR_t = \beta_0 + \sum_{i=1}^{m}\beta_1\Delta logEXR_{t-i} + \sum_{i=1}^{m}\beta_2\Delta logINF_{t-i}$$
$$+ \sum_{i=1}^{m}\beta_3\Delta logMPR_{t-i} + \sum_{i=1}^{m}\beta_4\Delta logRGDP_{t-i} + \delta DM_t + \vartheta_1 logEXR_{t-i}$$
$$+ \vartheta_2 logINF_{t-i} + \vartheta_3 logMPR_{t-i} + \vartheta_4 logRGDP_{t-i} + \mu_t \quad (2)$$

where $\mu \sim iid\ (0;\delta^2)$

where:

m = optimal lag length which is determined using Akaike information criterion (AIC)

Δ = first difference of the variables

t = time

t-1 = lag one (previous year)

log = natural logarithm

β_0 = constant

Σ = summation

β_1 to β_4 & ϑ_1 to ϑ_4 = coefficients of their respective variables

D_t = vector of dummy variables

Thus, in order to test for the long-run relationship in equation (2), we deploy the bound test. In this regard, the null hypothesis of no cointegration, i.e. H_0: $\vartheta_1=\vartheta_2=\vartheta_3=\vartheta_4=0$ is tested against the alternative of H_1: $\vartheta_1\neq\vartheta_2\neq\vartheta_3\neq\vartheta_4\neq0$ which signifies the existence of cointegration. Here, the F-statistic is compared with the critical value of upper and lower bounds as tabulated by Pesaran, Shin and Smith (2001). If the F-statistic is greater than the upper bound critical values, the null hypothesis will be rejected and vice versa. However, if the F-statistic value lies between the upper and lower bounds critical values then the result is inconclusive.

Furthermore, in the presence of cointegration among the variables, we estimate our short-run model in the error correction representation as:

$$\Delta logEXR_t = \beta_0 + \sum_{i=1}^{m}\beta_1\Delta logEXR_{t-i} + \sum_{i=1}^{m}\beta_2\Delta logINF_{t-i}$$

$$+ \sum_{i=1}^{m}\beta_3\Delta logMPR_{t-i} + \sum_{i=1}^{m}\beta_4\Delta logRGDP_{t-i} + \delta DM_t + \vartheta_1 logEXR_{t-i} \quad (3)$$

where:

ECT = error correction term

ϑ = speed of convergence towards long-run equilibrium

And the long run model is represented at the lagged levels as:

$$\Delta \log EXR_t = \beta_0 + \vartheta_1 logEXR_{t-1} + \vartheta_2 logINF_{t-1} + \vartheta_3 logMPR_{t-1} + \vartheta_4 logRGDP_{t-1} + \delta DM_t + \mu_t \quad (4)$$

Finally, before estimating equation (2), we tested for order of integration of the variables using the Augmented Dickey Fuller (ADF) unit root test. Also, to ensure stability and robustness of the model, we performed some diagnostics tests, such as serial correlation, heteroskedasticity and normality test, and stability test using cumulative sum of the recursive residuals (CUSUM test) and cumulative sum of squares of the recursive residuals (CUSUMSQ test) (see Brown, Durbin and Evans, 1975). For the stability test, the null hypotheses of all parameters are stable and cannot be rejected if the plots of the test lie within the critical bounds of 5 per cent level of significance.

3.3 Data and sources

This study utilized annual time series data from 1981 to 2017 sourced from Central Bank of Nigeria (CBN) statistical bulletins and World Development Indicators (WDI). Exchange rate (EXR), monetary policy rate (MPR) and real GDP (RGDP) data were sourced from the CBN while data on inflation (INF) was sourced from the WDI.

4. Empirical Results

This study tested for unit root using the ADF unit root test to ascertain the order of integration of the variables. The order of integration in most instances determine the estimation technique to be used in a cointegration approach. Table 1 presents the results of the ADF unit root test. The results show that the variables used in this study are a mixture of both I(0) and I(1), thus, this warrants the use of the ARDL technique since none of the variables was found to be I(2).

Furthermore, table 2 shows that all the lag selection criteria selected lag 2 as the optimal lag length of the ARDL model to be estimated. In this regard we estimated our ARDL model based on the AIC selection criterion. Also, table 3 shows the results of the bound test, while tables 4 and 5 show the error correction representation and results of the long-run coefficients respectively.

Table 1. ADF Unit Root Test Based on AIC

Variables	Intercept		Trend & Intercept		None		Decision
	Level	First	Level	First	Level	First	
LNEXR	-1.9089	-5.1082*	-1.3385	-5.4107*	1.8823	-4.0641*	I(1)
LNMPR	-3.0352**	-5.1474*	-3.0086	-5.1616*	0.2114	-5.1737*	I(0)&I(1)
LNINF	-2.4957	-6.5676*	-4.2652*	-6.4541*	-0.6585	-6.6670*	I(0)&I(1)
LNRGDP	0.0321	-3.3397**	-1.9386	-3.2593***	2.4507**	-1.8120***	I(0)&I(1)

Source: Authors Computation from Eviews 9.0

Note: * denotes 1% level of significance, ** denotes 5% level of significant and *** denotes 10% level of significance I(0) means that the series is stationary at level and I(1) means the series is stationary at first difference. See appendix I, tables 1-4 for the critical values respectively.

Table 2. Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-6.697724	NA	5.16e-09	0.782727	1.093797	0.890108
1	197.5742	315.1624	7.66e-13	-8.089955	-5.601398	-7.230905
2	305.2759	123.0877*	3.82e-14*	-11.44434*	-6.778293*	-9.833620*

Source: Authors' computation from Eviews 9.0

Note: This is the optimal lag length used for the independent variables and the dependent variable.

Table 3. ARDL Bound Test

Test Statistic	Value	k
F-statistic	7.541860	6
Critical Value Bounds		
Significance	Lower Bound I(0)	Upper Bound I(1)
10%	2.12	3.23
5%	2.45	3.61
1%	3.15	4.43

Source: Authors' computation from Eviews 9.0.

Note: The values of the critical bounds are as generated by Eviews 9.0.

The bound test is a test for cointegration. The F-statistic in the table is greater than the 10%, 5%, and 1% upper bound critical values. Therefore, this means that there is a long-run relationship between the variables under study.

Table 4 presents the short-run relationships between nominal exchange rate (lnEXR) as the dependent variable and interest rate (lnMPR - monetary policy rate), inflation (lnINF) and real GDP(lnRGDP). The results show that most of the variables, as well as the interaction dummies, are significant at 1% and 5% respectively, with the exception of inflation (lnINF) and real GDP (lnRGDP). The results show that MPR is negatively related to exchange rate and statistically significant at 1%. This implies that on average, a 1% increase in interest rate will lead to a 4.19% decrease in exchange rate (appreciation) in the short run. The interaction dummy, MD_{86}, shows that the marginal effect of interest rate on the exchange rate of the naira is 0.009174[2] (i.e. an extra increase in interest rate is associated with 0.009174 increase in exchange rate) for a liberal capital account and only -4.193047 for a closed capital account. This implies that, an increase in interest rate will result in depreciation of the naira as Nigeria operates an open capital account (post-SAP), whereas the value of the naira will appreciate if it were under a closed capital account (pre-SAP).

Though the results of the interest rate and exchange rate relationship under an open capital account (i.e. post-SAP) do not conform to the theoretical exchange rate channel, however it conforms to the realities of the dynamics of the Nigerian economy. This may not be unconnected with the import-dependent nature of the economy. In addition, it emphasizes the importance of capital controls as a complementary tool in managing exchange rate as in the findings of Okpanachi (2013) and Agu (2010).

Also, the dummy variable (D_{99}) which captures the impact of the shift from military to democratic system of governance in 1999 is positive and significant as expected. This shows the depreciation of the naira as a result of the shift to democratic rule. The results in the table indicate that the ECM, that is, the adjustment or loading factor, has the expected sign (negative) and is statistically significant at 1 per cent. The ECM coefficient of -0.155060 shows about 15.5% convergence towards long-run equilibrium following a shock in the economy in a period of one year.

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[2] This is gotten by adding 4.202221 and -4.193047. See appendix II for a brief explanation and Koop, G. (2005, p.118) for details.

Table 4. Error Correction Representation for the Selected ARDL Model ARDL (1, 2, 2, 1, 2, 2, 0) selected based on AIC

1981-2017	*Dependent Variable* LNEXR			
Variables (Regressors)	Coefficient	Std. Error	t-Statistic	Prob.*
(lnMPR)	-4.193047	0.863689	-4.854811	0.0001
(lnMPR(-1))	-2.589109	0.500052	-5.177681	0.0001
(lnINF)	-0.041567	0.044014	-0.944402	0.3575
(lnINF(-1))	0.213254	0.036866	5.784555	0.0000
(lnRGDP)	-1.086486	0.653437	-1.662726	0.1137
(D86)	-9.847081	2.030001	-4.850775	0.0001
(D86(-1))	-6.070872	1.175567	-5.164205	0.0001
lnMPR*D86(MD86)	4.202221	0.866151	4.851603	0.0001
lnMPR*D86 (MD86(-1))	2.466446	0.505596	4.878292	0.0001
(D99)	1.041971	0.106648	9.770159	0.0000
Ecm(-1)	-0.155060	0.029573	-5.243240	0.0001
Cointeq = lnEXR - (1.6806*lnMPR -1.3400*lnINF + 0.9236*lnRGDP + 0.6116*D86 −0.8206*MD86 + 6.7198*D99 -3.6482)				
R-squared	0.999079			
Adjusted R-squared	0.998260			
F-statistic	1219.945			
Prob(F-statistic)	0.000000			
Durbin-Watson stat	1.830598			
Diagnostics test				
Residual Diagnostics Test	F-Statistic (prob. F(2, 16))	Prob. Chi-Square	Decision	
LM Serial Correlation test	0.853555 (0.4444)	0.1850	Do not reject H_0	
BPG Heteroskedasticity test	0.347991 (0.9805)	0.9405	Do not reject H_0	
Jarque-Bera Normality test	1.064681	0.587229	Do not reject H_0	

Source: Authors' computation from Eviews 9.0.

The diagnostics test of the model revealed that the R-squared of the model is more than 60%, implying that there exists goodness of fit in the model. The F-statistic of the model suggests that the overall regression model is significant at 1%. The residual diagnostic tests for the validity of the OLS assumptions suggest the absence of such econometric problems.

In table 5, the ARDL results of the long-run estimates reveal that interest rate (MPR) is positively related to exchange rate and insignificant. It implies that a

1% increase in interest rate will lead to on average to about 1.68% increase (depreciation) in exchange rate in the long run. Also, the interaction dummy, MD_{86}, shows that the marginal effect of interest rate on the exchange rate of the naira is 0.860004 (i.e. an extra increase in interest rate is associated with a 0.860004 increase in exchange rate) for a liberal capital account and only 1.680577 for a closed capital account. This implies that an increase in interest rate will result in more depreciation of the naira in a closed capital account (pre-SAP) than in a liberal capital account (post-SAP). As both the coefficients appear to be insignificant, this implies that interest rate is not a good policy variable that can be used to finetune long-term economic dynamics.

Table 5. Long-run Coefficients using the ARDL approach

ARDL (1, 2, 2, 1, 2, 2, 0) selected based on AIC. *Dependent Variable* LNEXR				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
lnMPR	1.680577	4.392138	0.382633	0.7065
lnINF	-1.340048	0.376058	-3.563408	0.0022
lnRGDP	0.923633	0.428263	2.156697	0.0448
D86	0.611609	10.438707	0.058591	0.9539
lnMPR*D86 (MD86)	-0.820573	4.493701	-0.182605	0.8571
D99	6.719778	1.419961	4.732369	0.0002
C	-3.648215	10.133099	-0.360030	0.7230

Source: Authors' computation from E-views 9.0.

In addition, the results of the interest rate and exchange relationship under a closed capital account (i.e., pre-SAP) and an open capital account (post-SAP) do not conform to the theoretical exchange rate channel, however they conform to the realities of the dynamics of the Nigerian economy. Again, this may not be unconnected with the import-dependent nature of the economy. This is in line with the affirmation by Gudmundsson and Zoega (2016) that increased interest rate may increase the flow of interest income through the current account making the exchange rate to depreciate. Similar to this is the finding of Adamu and Sanusi (2016) that additional monetary tightening should be used as a complementary tool only to stabilize short-term temporary pressures on exchange rate. Hence, the finding by Adamu and Sanusi (2016) explains the reason for the insignificance of the long-run interest rate and interaction dummy coefficients.

Again, the dummy variable (D_{99}) which captures the impact of the shift from military to democratic system of governance in 1999 is positive and significant and reflects the same effect as in table 4, although not the same magnitude.

Finally, the stability of the estimated long-run and error correction model is evaluated using the CUSUM and CUSUMSQ tests for structural stability. Graphical representations of the two tests are provided in figures 1 and 2. The decision is that the model is stable if the CUSUM and CUSUMSQ statistics stay within the 5% critical bound.

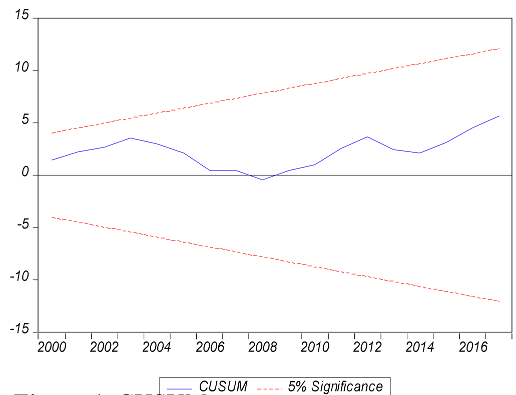

Figure 1. CUSUM test.

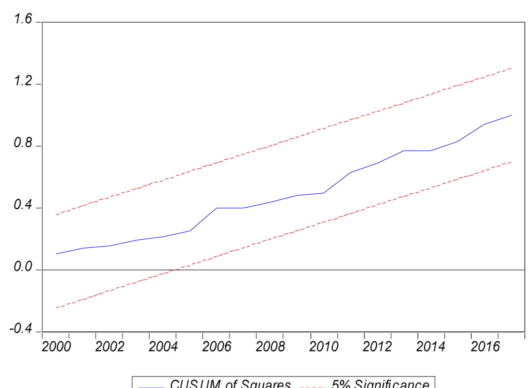

Figure 2. CUSUMSQ test.

5. Conclusion and Policy Implication

This study examined how level of capital account openness affects the relationship between interest rate policy and exchange rate volatility in Nigeria. The findings reveal that an increase in interest rate will depreciate the exchange rate in the long run (either in an open or closed capital account setting) and also in the short run if the capital account is open. Although the findings do not conform with the theoretical exchange rate channel of the relationship between interest rate and exchange rate in the long run (either in an open or closed capital account setting) as well as in the short run under an open capital account system (post-SAP), it however conforms with the theoretical channel in the short run under a closed capital account.

From these findings, it has been shown that the use of interest rate to manage exchange rate is strictly a short-term policy tool as recommended by Adamu and Sanusi (2016). Thus, the major policy recommendation here is that interest rate should be used to manage short-term temporary pressures on exchange rate volatility in addition to enforcement of effective capital controls.

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Appendix I

Table 1. ADF Unit root test critical values for LNEXR

Level of significance	Intercept		Trend & Intercept		None	
	Level	First	Level	First	Level	First
1%	-3.6267	-3.6329	-4.2349	-4.2436	-2.6307	-2.6326
5%	-2.9458	-2.9484	-3.5403	-3.5442	-1.9503	-1.9506
10%	-2.6115	-2.6128	-3.2024	-3.2046	-1.6112	-1.6110

Table 2. ADF Unit root test critical values for LNMPR

Level of significance	Intercept		Trend & Intercept		None	
	Level	First	Level	First	Level	First
1%	-3.6267	-3.6394	-4.2349	-4.2528	-2.6307	-2.6347
5%	-2.9458	-2.9511	-3.5403	-3.5484	-1.9503	-1.9510
10%	-2.6115	-2.6143	-3.2024	-3.2070	-1.6112	-1.6109

Table 3. ADF Unit root test critical values for LNINF

Level of significance	Intercept		Trend & Intercept		None	
	Level	First	Level	First	Level	First
1%	-3.6394	-3.6394	-4.2436	-4.2528	-2.6347	-2.6347
5%	-2.9511	-2.9511	-3.5442	-3.5484	-1.9510	-1.9510
10%	-2.6143	-2.6143	-3.2046	-3.2070	-1.6109	-1.6109

Table 4. ADF Unit root test critical values for LNRGDP

Level of significance	Intercept		Trend & Intercept		None	
	Level	First	Level	First	Level	First
1%	-3.6329	-3.6329	-4.2845	-4.2436	-2.632688	-2.6347
5%	-2.9484	-2.9484	-3.5628	-3.5442	-1.950687	-1.9510
10%	-2.6128	-2.6128	-3.2152	-3.2046	-1.611059	-1.6109

Appendix II

In a regression of $Y = \alpha + \beta_1 D + \beta_2 X + \beta_3 Z + \mu$, where D is a dummy variable, X is continuous variable (non-dummy variable), Z is defined as $Z=DX$ and μ is the error term. In interpreting the results of the regression, Z is 0 for observations with D=0 and X for observations with D=1.

Thus, if D=1 the estimated regression will be $\hat{Y} = \hat{\alpha} + \hat{\beta}_1 + (\hat{\beta}_2 + \hat{\beta}_3)X$ and if $D=0$ the estimated regression will be $\hat{Y} = \hat{\alpha} + \hat{\beta}_2 X$.

This implies that the marginal effect of X on Y is different for D=0 and D=1 because the regression lines corresponding to D=0 and D=1 exist with different slopes and intercept.