The Implication of Exchange Rate Volatility on Nigeria's External Reserves: 1980-2020

Garbobiya Tuwe Soro*, Osman Nuri Aras**

**Central Bank of Nigeria (CBN), Nigeria*

***Nile University of Nigeria, Nigeria*

Abstract

Given the volatile nature of the exchange rate in Nigeria and the dynamics in the external reserves of the nation which are kept in foreign currency (dollar), this paper examined the impact of exchange rate shocks on the Nigerian external reserves using annual data from 1980 to 2019. Employing the Autoregressive Distributed Lag model, the results of the study indicates that exchange rate has an asymmetric impact on reserves, suggesting that the partial sum of exchange rate differ in magnitude and size relative to reserves in both positive and negative direction. The impact of a positive shock in exchange rate on reserves is statistically significant while the effect of a negative shock in exchange on reserve is statistically insignificant in the long-run. The same relationship holds for the short-run effect, although, both the positive and the negative short-run effects are statistically insignificant. The study therefore recommends that monetary authority should strengthens the exchange rate by adopting a flexible exchange floating and making it to thrives in order to boost reserves. Some of these policies could include allowing the market forces to determine the exchange rate and harmonizing the exchange rate position of the country.

Key Words: Exchange *Rate, External Reserves, Non-Linear Autoregressive Distributed Lag Model, Nigeria.*

corresponding author:
garbobiya@yahoo.com

1. Introduction

International trade in the modern world economy has been greatly facilitated using foreign exchange, comprising the convertible currencies of a few developed countries. In the context of world trade and payments, foreign exchange is the monetary instruments for settlement of international transactions and financing imbalances in a country external payment position vi-a-vis other countries (Ojo, 1990). Foreign exchange according to the International Monetary Fund (IMF), forms a major component of a country's external reserves which is used to offset balance of payment imbalances, stabilization of the exchange rate and for other transactions purposes by the monetary authorities. Thus, for many countries, Nigeria included, whose currencies are not convertible or serve as international currencies, they must necessarily earn foreign exchange through export of goods and services or receipt of foreign loans or investments in order to import of goods and services aimed at promoting growth and development of their economies and enhancing the welfare of the citizens. For such countries, foreign exchange is not only crucial to their development aspirations, but also a scarce resource that needs to be efficiently manage if they are to achieve macroeconomic stability and avoid chronic balance of payments and external reserves problem. Importantly, the conservation and control and implementation of measures to ensure adequate foreign exchange supply.

Against the backdrop of the ineffective of the fixed exchange rate regime and the associated exchange control system, there was the compelling need for radical reform of the economic management strategies and policies. Accordingly, the structural adjustment programme was introduced in July 1986. A crucial element of it was the introduction of the second tier-foreign exchange market on September 26, 1986 as a major institutional framework for foreign exchange allocation and exchange rate determination. Under this, the determination of the exchange rate was to reflect the market forces of demand and supply and the exchange rate becomes an active tool of economic management. The rate derived from the market was to serve as the means for allocating foreign exchange and equilibrating the balance of payments. The strategies, methods and frameworks applied at different times for the determination of exchange rates and foreign allocation were applied in the context of an exchange rate management system, which could be categorized as managed float', in which the Central Bank of Nigeria (CBN) embarked and on a delicate corresponding act of regulatory quantity of foreign exchange and its price (Osako, Masha & Adamgbe, 2003).

So far, the developments in the foreign exchange market do not indicate that the objective of having a stable and realistic exchange rate has been achieved. Despite the numerous changes to the foreign exchanges market frameworks since 1986, the naira exchange rate continued to

depreciation and had become unstable in most of the years. The continued depreciation of the Nigerian currency over the years had have negative consequences on the economy particularly a decline in peoples standard of living, real value of output and assets as a result of the naira's loss of value and the inflationary implications of its depreciation; planning and projections have been made much more difficult tasks (Obadan, 1993 & 2006). According to the Central Bank of Nigeria (CBN), the external reserves position had remained critical such that the reserves that were enough to cover 7.2 months of imports in 1986 could finance only 1.2 months of imports in 1992. As at the end of 2005, the external reserve level was US$28.3 billion in that (equivalent to 19.7 months imports). And by 2007, external reserves which stood at US$51.3 billion could finance 16.1 months of imports, consequent upon favourable developments in the world oil markets. However, in the last seven years, the country has witnessed continued decline in foreign exchange reserves, from about US$42.8 billion in January 2014 to about US26.7 billion as of 10th June 2016, representing only about five months imports equivalent. Currently the Nigeria external reserves position stood N35.4 USD billion as at the end December 2020.

It was for this instability in the exchange rate and the associated impact on the external reserves that brings about this study. This objective is to examine the determinants of demand and supply of the exchange rate and their overall effect on the Nigeria external reserves. Immediately after the introduction is the review of literature in section two follow by methodology in section three and the analysis in section four and conclusion in section five.

2. Literature Review

The foreign exchange rate and external reserve dilemma has attracted serious interests globally, as different economies continue to explore for alternative strategies that will guard their economies against financial instability and stimulate economic growth. Therefore, several scholars have undergone some studies on the effect of exchange rate shocks on external reserves management in recent years. Models have been developed and used to measure the nexus between exchange rate and foreign reserves. The Frenkel and Jovanovic (1981) "buffer stock model" (see Aizenman & Marion, 2004; Flood & Marion, 2002; Heller, 1966; IMF, 2003; Ramachandran, 2005) upon which this work on is anchored are more frequently used.

Tariq et al (2014) examined the relationship between foreign exchange reserves and the real exchange rate for Pakistan using the mercantilist approach during 1973–2008. Their study shows that the depreciation of the exchange rate as result of export led strategies improves the reserves holdings in Pakistan. Ajibola et al (2015) examined the long-run relationship between external reserves and exchange rate in Nigeria between 1990Q1-2012Q4 by examining two regimes applying threshold vector error correction model (TVECM) through maximum likelihood method.

Their findings revealed that not statistically significant between the two regimes and the existence of cointegration among the variables, indicating that exchange rate does not adjust to equilibrium while external reserves respond to restore past divergence. They concluded that measures by central bank of Nigeria to stabilize the exchange rate would help to reposition external reserves to preserve the external value of the currency.

Imarhiagbe (2015) use monthly external reserves and crude oil price from January 1995 to December 2013 and the GARCH-M and EGARCH-M to analyze the impact of crude oil price on external reserves in Nigeria. Persistence to volatility was confirmed through the GARCH estimate, and further findings show the mean is not constant but respond to volatility.

Nwachukwu, Ali, Abdullahi, Shettima, Zirra, Falade, and Alenyi (2016) applied Threshold Vector Error Correction Model (TVECM) framework to examine the long-run nexus among Bureau De Change (BDC) exchange rate and external reserves in Nigeria for the period 2014 to 2015 utilizing daily data. The result shows that bureau de change rate does not significantly impact exchange rate in one regime while external reserves is found to be statistically significant with the error correction coefficients, suggesting that the possibility of adjustment mechanism between BDC rate and external reserves in the second regime.

Ndubuaku and Ifeanyi (2019) conducted a study on exchange rate and foreign reserves interface in Nigeria using time series data from 1996 to 2016. Applying the Auto Regressive Distributed Lag Model (ARDL), the paper found a positive but non-significant relationship between nominal exchange rate and foreign reserves in Nigeria. The results are considered useful for economies in the shape of Nigeria for generalization and policy direction in the management of foreign reserve.

Shaibu and Izedonmi (2020) use an Autoregressive Distributed-Lag Modeling Approach to examine the short and long run influence of key macroeconomic variables on Nigeria external reserves between the period of 1986 to 2018. Interestingly, the result of the analysis in the short run does not showed any relationship between the foreign reserves dynamics and the explanatory variables mainly GDP, inflation rate. Likewise, the past value of foreign reserves significant in explaining the dynamics in foreign reserves within same period in Nigeria. The literatures had revealed that few studies have examined the relationship between exchange rate and external reserves in Nigeria. With no specific attempt on exchange rate shocks on Nigeria's external reserves. This paper also intends to apply different methodology to examine the implication of external shocks on Nigerian external reserves which previous could not covered.

3. Research Methodology

The model specification is based on Shin et al. (2014) ARDL model and modified by Van Hoang et al. (2016) as shown below in equation (1).

$$\Delta Res = \beta_0 + \beta_1 Res + \beta_2 inf_{t-1} + \beta_3 op_{t-1} + \beta_4 exr_{t-1} + \beta_5 imp_{t-1} + \beta_6 exp_{t-1} \sum_{i-1}^{N1} \delta_i \Delta Resi_{t-i} + \sum_{j=0}^{N2} \alpha_j \Delta inf + \sum_{h=0}^{N3} \lambda_h op_{t-h} + \sum_{k=0}^{N4} \varphi_k \, ir_{t-k} + \sum_{k=0}^{N5} \varphi_k \, imp_{t-k} + \sum_{k=0}^{N6} \varphi_k \, exp + \varepsilon_t \quad (1)$$

Where β0, β1, β2, β3, β4 β5 and β6 represents the intercept and coefficients.

To account for error correction term, equation (1) is modified into equation (2) below:

$$\Delta Reserve = \eta v_{t-1} + \sum_{i-1}^{N1} \delta_i \Delta Resi_{t-i} + \sum_{j=0}^{N2} \alpha_j \Delta inf + \sum_{h=0}^{N3} \lambda_h op_{t-h} + \sum_{k=0}^{N4} \varphi_k \, exr_{t-k} + \sum_{k=0}^{N5} \varphi_k \, imp_{t-k} + \sum_{k=0}^{N6} \varphi_k \, exp + \varepsilon_t \quad (2)$$

From the equation above, vt-1 and η are linear error correction and speed of adjustment, respectively. The decompositions of oil price into positive and negative shocks was not done under the symmetric behaviour assumptions. Equation (3) represents the asymmetric behaviour of exchange rate on reserves.

$$\Delta reserve = \psi \chi_{t-1} + A + \sum_{h=0}^{N4} (\lambda_h^+ exr_{t-h}^+ + \lambda_h^- exr_{t-h}^-) + + \varepsilon_t \quad (3)$$

The long run equilibrium in the NARDL model is captures in equation 3), while its related parameter ($^{\psi}$) conveys the speed of adjustment.

4. Results and Discussion

Table 1: Unit Root Test

Philp-Perron's (PP Test)			
Variable	Levels	First diff	Order
Reserves	3.222	-7.23312[A]	*I(1)*
Exchange Rate	-1.4556	-4.5121[A]	*I(1)*
Inflation	3.1887	-2.0021[A]	*I(1)*
Oil	-1.9820	-7.1433[A]	*I(1)*
Exports	-0.8771	-5.8286[A]	*I(1)*
Imports	-4.1242	-4.8291[A]	*I(1)*

Since I(2) variables was not presence in the unit root test, then cointegration test among variables is conducted in Table 2 below.

Table 2: Bounds Test for Cointegration

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	6.122819	10%	1.99	2.94
k	6	5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99
			Finite	
Actual Sample Size	31		Sample: n=35	
		10%	2.254	3.388
		5%	2.685	3.96
		1%	3.713	5.326
			Finite	
			Sample: n=30	
		10%	2.334	3.515
		5%	2.794	4.148
		1%	3.976	5.691

The bounds test in Table 2 above show cointegration amongst the variables. This enable us to reject the null hypothesis of no-long run relationship at 1% level. Therefore, the study employs the Non-linear Autoregressive Distributed Lag (NARL) model to investigate both the long-run and the short-run relationships, and the results are presented in Tables 3 and 4 respectively.

Table 3: Long-Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OIL	0.300057	0.363613	0.825211	0.4201
INFLATION	-0.315153	0.119013	-2.648042	0.0164
IMPORTS	0.203613	0.282916	0.719697	0.4810
EXPORTS	0.207901	0.298025	0.697597	0.4943
EXCHNAGE_RATE_POS	0.298980	0.095939	3.116362	0.0060
EXCHNAGE_RATE_NEG	-2.223664	2.610120	-0.851940	0.4054
C	11.88175	6.066987	1.958426	0.0659

EC = RESERVES - (0.3001*OIL -0.3152*INFLATION + 0.2036*IMPORTS +
0.2079*EXPORTS + 0.2990*EXCHNAGE_RATE_POS -2.2237
*EXCHNAGE_RATE_NEG + 11.8817)

Table 4: Error-Correction Estimates

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RESERVES(-1))	0.418261	0.123454	3.387998	0.0033
D(IMPORTS)	-0.087949	0.168518	-0.521897	0.6081
D(EXCHNAGE_RATE_POS)	0.016721	0.151046	0.110704	0.9131
D(EXCHNAGE_RATE_NEG)	-7.944379	4.319595	-1.839149	0.0824
D(EXCHNAGE_RATE_NEG(-1))	-10.34836	4.449130	-2.325928	0.0319
CointEq(-1)*	-1.189897	0.144263	-8.248110	0.0000

R-squared	0.727988	Mean dependent var	0.119863
Adjusted R-squared	0.673586	S.D. dependent var	0.445868
S.E. of regression	0.254736	Akaike info criterion	0.274809
Sum squared resid	1.622264	Schwarz criterion	0.552355
Log likelihood	1.740456	Hannan-Quinn criter.	0.365282
Durbin-Watson stat	2.093297		

* p-value incompatible with t-Bounds distribution.

The NARDL model is estimated, and the results is shown in Tables 3 and 4 for long-run and short-run relationships, respectively. The models estimated presents reserves changes in response to both a positive and negative change in the exchange rate. From the findings in Table 3, the results of the study indicates that exchange rate has an asymmetric impact on reserves, suggesting that the positive and negative partial sum of exchange rate changes differ in magnitude and size relative to reserves. The results of the long-run effect indicate that positive shocks in exchange rate results into positive change in reserves (0.298980 increase) and is statistically significant at 5% level. Conversely, the long-run estimates indicate that a negative shock in exchanges results into a negative change on reserves (-2.223664 decrease) and the effect is statistically insignificant in the long-run. Consequently, supporting the expectation effects of exchange rate changes on the demand for money, should the naira appreciate, the reserves would increase, Conversely, supporting the wealth effects as the Naira deprecates the reserves would decrease. Our results are in line with Nwachukwu, Ali, Abdullahi, Shettima, Zirra, Falade, and Alenyi (2016), Shaibu and Izedonmi (2020) and Ajibola et al (2015). Furthermore, the results show that oil, exports, and imports have positive effect on reserves while the effect of inflation on reserves is negative.

Regarding the short-run relationship, the results also reveal that positive shocks in exchange rate results into positive change in reserves (0.016721increase) and is statistically insignificant at 5% level, while a negative shock in exchanges results into a negative change on reserves (-7.944379

decrease) and the effect is also statistically insignificant. The coefficient of the error correction mechanism captures the disequilibrium in reserves, which is captured in the next period and is presented in table (4). Stability checks are carried out on the models using (Brown, et al. 1975) model of stability verification. The cumulative sum (CUSSUM) and cumulative sum of square (CUSSUMSQ) are called out on recursive regression residual in Figures 1 and 2 respectively. From the results of the CUSUM, all models stable since they lie within the 5% critical bounds.

Table 5: Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.312932	Prob. F(2,16)	0.7357
Obs*R-squared	1.166963	Prob. Chi-Square(2)	0.5580

Table 6: Heteroskedasticity Test

Heteroskedasticity Test: ARCH

F-statistic	0.066268	Prob. F(2,26)	0.9360
Obs*R-squared	0.147080	Prob. Chi-Square(2)	0.9291

Table 7: Model Specification Test

Ramsey RESET Test
Equation: NARDL
Omitted Variables: Squares of fitted values
Specification: RESERVES RESERVES(-1) RESERVES(-2) OIL INFLATION IMPORTS IMPORTS(-1) EXPORTS EXCHNAGE_RATE_POS EXCHNAGE_RATE_POS(-1) EXCHNAGE_RATE_NEG EXCHNAGE_RATE_NEG(-1) EXCHNAGE_RATE_NEG(-2) C

	Value	df	Probability
t-statistic	0.198814	17	0.8448
F-statistic	0.039527	(1, 17)	0.8448
Likelihood ratio	0.071995	1	0.7885

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.003763	1	0.003763
Restricted SSR	1.622264	18	0.090126
Unrestricted SSR	1.618501	17	0.095206

LR test summary:

	Value
Restricted LogL	1.740456
Unrestricted LogL	1.776453

Figure 1: CUSUM Test

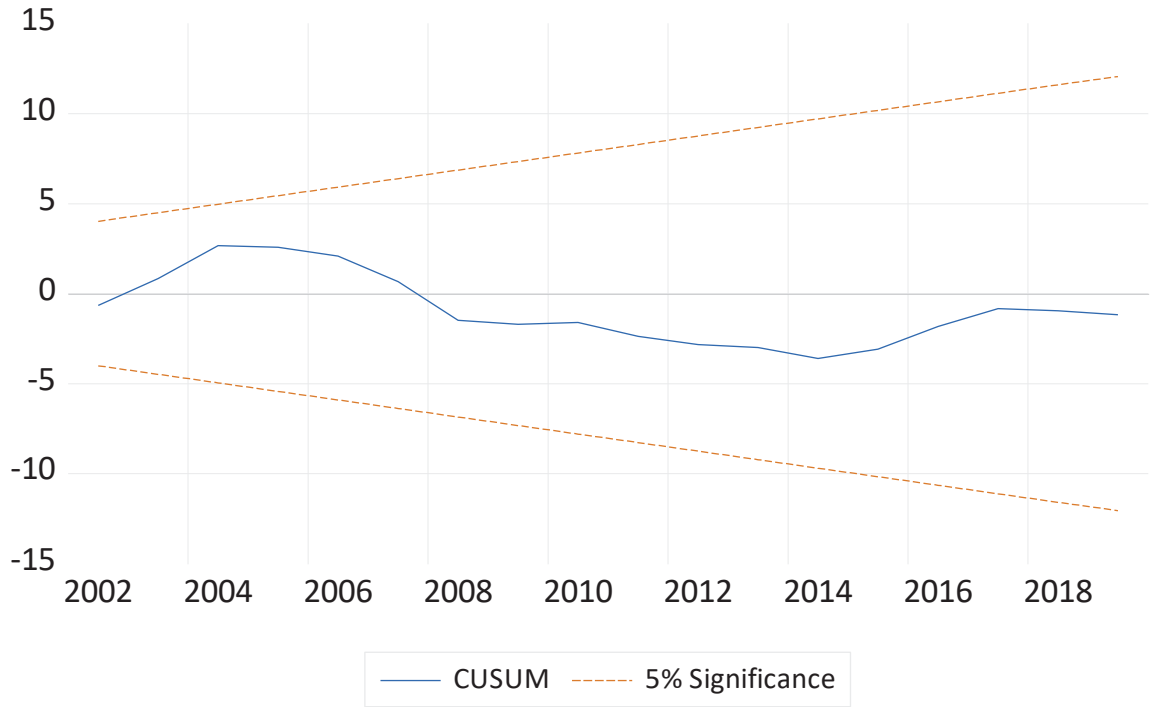
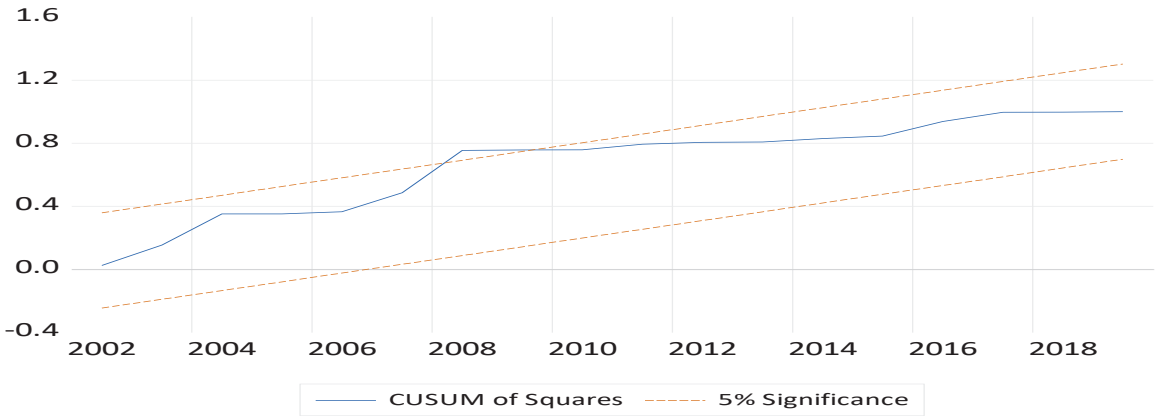


Figure 2: CUSUMSQ Test



5. Conclusion and Recommendations

The study investigated the implication of exchange rate volatility on the Nigeria external reserves using annual data from 1980 to 2020. Employing the Autoregressive Distributed Lag Model, the estimated results shows that exchange rate have an asymmetric impact on reserves, indicating that the partial sum of exchange rate changes positive and negative differ in magnitude and size relative to reserves.

The effect of a positive shock in exchange rate on reserves is statistically significant while the effect of a negative shock in exchange on reserve is statistically insignificant in the long run. The same relationship holds for the short-run effect, although, both the positive and the negative short-run effects are statistically insignificant.

The study therefore recommends that monetary authority should strengthens exchange rate by adopting a flexible exchange floating and making it to thrives in order to boost reserves. These can be achieved by allowing the market forces to determine the exchange rate and harmonizing the exchange rate position of the country.

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