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Modeling the Asymmetric Effects External Reserve Accumulation on Exchange Rate Stability in Nigeria

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Abstract
This paper investigates the asymmetric effects of external reserve accumulation on exchange rate stability in Nigeria between 1980 and 2019. A nonlinear autoregressive distributed lag (NARDL) method is applied to examine how partial sums of positive and negative changes in external reserves affect exchange rate stability. The empirical model is augmented to incorporate the asymmetric effects of trade and financial openness based on exchange rate stability based on theoretical predictions. The bounds cointegration test result shows evidence of asymmetric long run relationship among the variables. The estimated dynamic NARDL model reveals that exchange rate responds positively to positive changes in external reserves in both short and long run. This evidence suggests that increase in external reserve is important for achieving meaning stability in exchange rate in Nigeria. The results further reveal that exchange rate responds positively to positive changes in trade openness in the long run, but negatively to one period lag of negative changes in trade openness in the short run. The implication of this finding is that increase in cross-border trade transactions promotes foreign exchange earnings, which in turn support the goal of exchange rate stability. Additionally, the partial sums of positive and negative changes in financial openness have mixed effects on exchange rate. While exchange rate responds negatively to positive changes in financial openness in the short run, its response to negative changes in financial openness is significantly positive in both short and long run. Based on the findings, this paper recommends that the CBN should ensure prudent management of external reserves to optimize the associated benefits in terms of exchange rate stability while minimizing the associated costs.

Keywords*: Exchange rate, external reserve, trade openness, financial openness and Nigeria*

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I. Introduction

Foreign reserve accumulation has remained essential precondition for exchange rate management in developing economies. Generally, countries build-up foreign reserve to effectively manage the exchange rate of their domestic currencies and mitigate adjustment costs associated with international payments fluctuations (Elhiraika & Ndikumana, 2007). It is also important for building resilience to external shocks and more active conduct of sterilized interventions by monetary authorities (Ito & Kawai, 2014). This helps to stabilize the value of domestic currency. Additionally, large amounts of foreign reserves boost the credit worthiness of a country to borrow from the rest of the world and hedge against instability in external capital flows. According to Lee & Yoon (2020), stockpiling of foreign reserves is an official policy tool for intervention in foreign exchange markets. This is necessitated by the growing practice of 'managed float' exchange rate regime and the need to overcome the challenge of currency depreciation. Obsfield, Shambaugh & Taylor (2009) observe that countries with larger foreign reserves experienced minor currency depreciation during the 2008 global financial crisis.

Another motivation for foreign reserves holding is to maintain price stability. With large amounts of external reserves, monetary authorities can control inflation by lowering exchange rate (Arslan & Cantú, 2019). This helps to reduce exchange rate pass-through to inflation. Despite numerous and potential large benefits of foreign reserves accumulation, it is also associated with high economic and social costs. For instance, it is argued that holding of reserves tends to expose countries to valuation risk (Arslan & Cantú, 2019). Additionally, countries tend to suffer losses due to depreciation of the reserve currency. Other losses countries encounter from accumulating international reserves include forgone gains from infrastructure investments and social investment that could be financed by the reserves (Elhiraika, A., & Ndikumana, 2007). More so, Mohanty & Turner (2006) argue that large amounts of reserves could lead to inflationary risk, overheated credit and asset markets and distorted financial system. Therefore, it is important for countries to have a good understanding of the optimal reserves that offer them the necessary financial security at the least possible cost.

Like other oil exporting countries, Nigeria has continued to accumulate foreign reserves. The reasons behind this development were documented by Irefin & Yaaba (2011); Oyeniran & Alamu (2020); Nwafor (2018) and Nathaniel & Oladiran 2018) among others. As the apex monetary authority, the central Bank of

Nigeria (CBN) is mandated to manage external reserves in line with the provisions of section 2(c) of the CBN Act of 2007. The Act is intended to enable CBN maintain exchange rate stability through interventions in the foreign exchange market. However, over dependence of Nigeria's foreign reserves holding on crude oil earnings makes it vulnerable to volatilities that characterize crude oil price at the global market. This has posed a great challenge to proper prediction and management of external reserves. Thus, there has been growing controversy regarding the effectiveness of foreign reserve in supporting investments in critical infrastructure and maintaining a stable exchange rate in Nigeria. Based on the foregoing, this paper examines the response of exchange rate to the asymmetric changes in foreign reserves holding in Nigeria.

II. Literature Review

2.1 Theoretical Review

The theoretical background for international reserve accumulation has varied overtime. The modern mercantilist theory assumes that reserve accumulation is an intentional development initiative employed by countries to stabilize the value of their domestic currency. Large build-up in foreign exchange reserves is believed to foster growth by maintaining an undervalued real exchange rate to maintain a country's export competitiveness (Aizenman & Lee (2007; Delatte & Fouquau, 2012). The optimal reserve model credited to Heller (1966) assumes that optimal reserve is attained at that which optimizes the gap between cost and benefit derived from holding reserve. Greenspan (1999) describes reserve adequacy as the level of reserve capable of maintaining short-term external debt obligation. On the other hand, Wijnholds & Kapteyn (2001) view reserve adequacy as the ratio of foreign reserve to broad money supply. It therefore, follows that growth in external reserves is closely linked to the growth in monetary aggregates.

Furthermore, Frenkel & Jovanovic (1981) proposed the Buffer Stock model of external reserves demand. The basic assumption of this theory is that policy makers, especially monetary authorities select the stock of reserves which balances the potential macroeconomic costs due to the lack of reserves with the opportunity cost of reserve accumulation. In most instances, monetary authorities engage in the sale of foreign exchange reserves to reduce the volatility of exchange rates affecting international trade, international financial flows, and foreign investment. This makes reserve holding an integral aspect of macroeconomic management. Additionally, Jeanne & Svensson (2007) advocate for countries, especially small open economies to focus on welfare driven model as it is considered helpful in reducing their vulnerability to external crisis. It therefore, follows that the holding of foreign reserves by an economy is key to containing core macroeconomic shocks such as exchange rate volatility given that every economy is linked to the rest of the world.

2.2 Empirical Literature Review

Using a combination of ordinary least square (OLS) and vector error correction (VEC) methods, Abdullateef & Waheed (2010) examined the impact of change in external reserve positions of Nigeria on domestic investment, inflation rate and exchange rate. The study revealed that change in external reserves in the country influences foreign direct investment (FDI) and exchange rates. However, it was found that external reserve does not influence domestic investment and inflation rates. Based on the findings, the study recommended for broader reserve management strategies that will aim at maximizing the gains from oil export revenue by utilizing more of these resources to boost domestic investment. In a similarly study, Wang, Le & Park (2020) employed a threshold vector autoregression (TVAR) model in parallel with its generalized impulse response functions (GIRFs) to explore the asymmetric effects of foreign exchange intervention in Korea. The results showed show that there are asymmetric effects of the Bank of Korea (BOK)-led interventions regardless of the volatility regimes.

Onwuka & Igwezea (2014) investigated the effect of foreign reserve and external debt on USD/Naira exchange rate. The study applied multiple regressions to time series data sourced from secondary sources including CBN Statistical Bulletin. The results consistently show that external reserve and foreign debt have significant contributions to the USD/Naira exchange rate. A direct relationship exists between USD/Naira exchange rate and external reserve and foreign debt respectively. It is therefore recommended that contributions to foreign reserve should be diversified to other major currencies of the world so as to reduce the exchange rate demand on the United States dollar. Again, the study recommended that foreign borrowing should be reduced as low as possible so as to reduce the demand on foreign exchange.

Employing the Autoregressive Distributed Lag (ARDL) bound test approach, Mahidud, Amin & Ahmed (2021) investigated the nexus among foreign exchange reserve, remittance, exchange rate, and trade balance in Bangladesh for the period of 1986 to 2019. It was evident from the results that there is significant positive impact of remittance inflow and trade balance on foreign exchange reserves in the long run. Granger causality test has revealed the presence of unidirectional causality from the remittance inflow to foreign exchange reserve and remittance inflow to exchange rate. Bidirectional causality has observed between trade

openness and exchange rate. To this end, the study suggested for consistent policy directions to cope with post-pandemic variations in the observed level of reserve accumulation.

Padhan, Sahu & Dash (2021) used time series data from 1970 to 2017 to explore the nexus among trilemma policy, foreign reserves and trade openness for in India. The study followed ARDL bound test method and established long-run relationship among the trilemma policy, foreign reserves and trade openness. The study further showed from a non-linear threshold model that low foreign reserve level increases the policy dispersion in the trilemma. This suggests that it could be more difficult for the India authorities to achieve a stable exchange rate, independence of monetary policy and open economy concurrently. On the basis of the findings, the study recommended for proper and prudent reserve management in order to facilitate trilemma effectiveness.

Using time series for Nigeria, Ume & Ndubuaku (2019) applied ARDL bound test approach to estimate the link between foreign reserve and the real exchange. The study established long run equilibrium relationship between the variables. The study further showed that a positive significant relationship exists between real exchange rate and reserves with nominal exchange rate sharing a positive but non-significant relationship with foreign reserves. Consequently, the study recommended for proper policy direction in the management of exchange rate in a manner that produces the best economic results for the Nigerian economy. Similarly, Osigwe & Uzonwanne (2015) explored the causal links among foreign reserves, exchange rate and foreign direct investment in Nigeria. The results of the Granger causality test indicated unidirectional causality from exchange rate to foreign reserves. Consistently, unidirectional causality flowed from FDI to foreign reserves. Based on the findings, it is recommended that the policy makers should establish the optimum exchange rate level to promote foreign reserves and FDI.

III. Methodology And Variable Discription

3.1 Model Specification

This paper follows a dynamic non-linear autoregressive distributed lag (NARDL) model to capture the asymmetric response of exchange rate to external reserve holding. In this case, the empirical model distinguishes the effect of increasing and decreasing external reserve holding and control variables on exchange rate stability. In addition to external reserve, trade and financial openness were introduced into the model as control variables. The introduction of trade openness into the model followed the prediction of optimal currency area (OCA) that openness to international trade enhances greater exchange rate stability. Accordingly, Hagen & Zhou (2007) offer empirical evidence to support the claim that greater trade openness leads to the adoption of a more stable or fixed exchange rate regime. On the other hand, financial openness is included into the model following the growing assumption that it expands opportunities for capital inflows, which in turn promotes exchange rate stability. Similarly, Hagen & Zhou (2007) argue that broader and deeper financial markets create opportunities for countries to stabilize their exchange rates. Generally, the standard econometric form of the model based on the underlying regressors is provided as:

$EXRS_t = \pi_0 + \pi_1 ERVH_t + \pi_2 TROP_t + \pi_3 FION_t + U_t$ (1)

Where: EXRS = exchange rate stability, ERVH = external reserve holding, TROP = trade openness, π_0 and $\pi_1 - \alpha_3$ are intercept and regressors' coefficients respectively.

Following Shin, Yu & Greenwood-Nimmo (2014), the NARDL model for this paper which involves the decomposition of the regressors in equation (1) into partial sums of positive and negative changes in external reserve, trade openness and financial openness in addition to lagged value of the dependent variable (exchange rate) is provided as:

$$\Delta EXRS_t = \lambda_0 + \lambda_1 EXRS_{t-1} + \theta_1^+ ERVH_{t-1}^+ + \theta_2^- ERVH_{t-1}^- + \theta_1^+ TROP_{t-1}^+ + \theta_2^- TROP_{t-1}^- + \theta_1^+ FION_{t-1}^+ + \theta_2^- FION_{t-1}^- + \sum_{j=1}^{p} \beta_1 \Delta EXRS_{t-j} + \sum_{j=1}^{q} \left(\Omega_1^+ \Delta ERVH_{t-j}^+ + \Omega_1^- \Delta ERVH_{t-j}^-\right) + \sum_{j-1}^{q} \left(\Omega_1^+ \Delta TROP_{t-j}^+ + \Omega_2^- \Delta TROP_{t-j}^-\right) + \sum_{j=1}^{q} \left(\Omega_1^+ \Delta FION_{t-i}^+ + \Omega_2^- \Delta FION_{t-i}^-\right) + e_t \quad (2)$$

Where: $ERVH^+$ and $ERVH^-$ = partial sums of positive and negative changes in external reserve, $TROP^+$ and $TROP^-$ = partial sums of positive and negative changes in trade openness, $FION^+$ and $FION^-$ = partial sums of positive and negative changes in financial openness, θ_1^+ *and* θ_2^- = Long run multipliers linked to the partial sums of positive and negative changes in the regressors, Ω_1^+ *and* Ω_2^- = short run parameters, P and q denote optimal lag lengths, Δ = first difference operator and e_t = white noise error process.

3.2 Variable Description

The description of variables and sources of data are provided in table 3.1.

Table 3.1: Summary of variable description

Variable	Description/Measurement	Data source
Exchange rate stability	This defines year-end standard deviations of the monthly exchange rate between the naira and the United States dollars. It is measured between 0 and 1. High value indicates more stable exchange rate.	Aizenman, Chinn & Ito (2013)
External reserve holding	This is foreign exchange reserve held by the central bank for sterilized interventions, improved international credit worthiness and building resilience to external shocks. The percent of external reserve to GDP is used in this paper. .	IMF International Financial Statistics
Trade openness	This defines the degree of trade integration also known as trade intensity index. It is measured by the sum of exports and imports divided by GDP (export + import/gross domestic product).	Word Bank WDI
Financial openness	This refers to index of capital account openness which depends on information regarding restrictions in the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).	Chinn & Ito (2010)

Source: Author's compilation

3.3 Techniques for Data Analysis

This paper follows a dynamic econometric approach, anchored on Shin, Yu & Greenwood-Nimmo (2014) NARDL method to estimate the asymmetric response of exchange rate stability to external reserve build-up. The choice of this method follows its extension of the standard Pesaran, Shin, & Smith (2001) ARDL method as it captures asymmetries in the explanatory variables through partial sums decompositions of their positive and negative changes, and how they affect the forecast variable. Olowofeso, *et. al.* (2017) describe NARDL as important for capturing both the short-run and long-run asymmetries. In other words, the model set up allows for integrating both short and long term asymmetric effects in a single equation. The applicability of NARDL requires that all variables for investigation must be integrated into an order less than two. In addition to NARDL, descriptive statistics, unit root and bounds cointegration as well as post-estimation tests form basis for the analysis.

IV. Results And Discusion

4.1 Descriptive Statistics

The summary of the descriptive statistics for the series is reported in table 4.1.

Table 4.1: Summary of descriptive statistics

	EXRS	ERVH	TROP	FION
Mean	0.484	8.362	32.700	0.202
Median	0.375	8.280	34.110	0.252
Maximum	1.000	18.624	53.280	0.300
Minimum	0.025	1.019	9.140	0.000
Std. Dev.	0.342	5.193	12.523	0.117
Jarque-Bera	3.899	2.243	2.002	5.888
Probability	0.142	0.326	0.367	0.052
Observations	40	40	40	40

Source: Author's computation using E-views software

The statistics in table 4.1 reveal that exchange rate stability averaged 0.484. This shows moderate level of stability in exchange rate. As a percentage of GDP, external reserve averaged 8.362 percent during the study sample. The mean values of trade and financial openness are 32.7 and 0.202 respectively. It is evident from the standard deviations that the observations for each of the series converged around their respective mean values. More so, the Jarque-Bera statistics reveal that all the variables except financial openness are normally distributed. This is evidence from the corresponding probability values which are greater than 0.05.

4.2 Stationary Test Results

The time series properties of each of the variables was ascertained using Phillips-Perron stationary test method. The results are summarized in table 4.2.

Table 4.2: Summary of stationary test results

Series	PP test statistic	Probability value	Order of Integration
EXRS	-3.234	0.0928	
D(EXRS)	-10.369	0.000	I(1)
ERVH	-3.817	0.026	I(0)
TROP	-3.554	0.047	I(0)
FION	-2.116	0.521	
D(FION)	-5.588	0.000	I(1)

Source: Author's computation using E-views software

As observed from the results, exchange rate stability and trade integration are stationary at levels. This indicates that their mean and variance are time invariant. Thus, the null hypothesis of unit root is rejected for the two variables as they are integrated of order zero [I(0)]. The results further revealed that external reserve accumulation and financial openness are stationary at first difference. In other words, they are integrated of order one [I(1)]. The outcome of the stationary reveals that the variables are mixed integrated. This satisfies the empirical precondition for the application of NARDL.

4.3 Bounds Cointegration Test

In furtherance to the pre-estimation test, bounds cointegration test was followed to determine if asymmetric long run relationship exists among variables. The result is reported in table 4.3.

Table 4.3: Bounds cointegration result

Series: EXRS ERVH_POS ERVH_NEG TROP_POS TROP_NEG FION_POS FION_NEG		
Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	K
F-statistic	5.702	6
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10 percent	2.12	3.23
5 percent	2.45	3.61
1 perccent	3.15	4.43

Source: Author's computation using E-views software
NB: K denotes number of regressors in the model

The bounds cointegration test was performed at 5 percent level of significance. It was found that the computed F-statistic is greater than the upper bound critical value. This implies that there is asymmetric long run relationship among the variables. This finding is very impressive as it provides the precondition for estimating the NARDL model.

4.4 Asymmetric Short and Long run Estimates

The response of exchange rate to partial sums of positive and negative changes in external reserve and other regressors is captured by the asymmetric short and long run estimates reported in table 4.4.

Table 6: Summary of asymmetric results

Dependent Variable: EXRS				
Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXRS(-1))	0.219	0.174	1.259	0.227
D(EXRS(-2))	0.263	0.156	1.687	0.112
D(ERVH_POS)	0.079**	0.022	3.699	0.002
D(ERVH_NEG)	0.041	0.028	1.494	0.156
D(TROP_POS)	0.024**	0.008	2.856	0.012
D(TROP_POS(-1))	0.013	0.009	1.428	0.174
D(TROP_NEG)	-0.020	0.012	-1.727	0.105
D(TROP_NEG(-1))	-0.027**	0.009	-2.819	0.013
D(FION_POS)	-0.364	1.077	-0.338	0.740
D(FION_NEG)	2.097**	0.967	2.167	0.047
CointEq(-1)	-0.941***	0.247	-5.296	0.000
Long run Coefficients				
Variable	Coefficient	Std. Error	t-statistic	Prob.
ERVH_POS	0.061***	0.019	3.270	0.005
ERVH_NEG	-0.025	0.028	-0.887	0.389
TROP_POS	0.026**	0.009	2.669	0.018
TROP_NEG	0.012	0.011	1.096	0.290
FION_POS	-3.004***	0.656	-4.577	0.000
FION_NEG	1.599**	0.634	2.524	0.023
C	0.838**	0.309	2.702	0.016

Source: Author's computation using E-views software
NB: ** and * denote significant at 1 and 5 percent level respectively**

As observed from the asymmetric regression results, exchange rate responds positively to positive changes in external reserves in both short and long run. This implies that increase in external reserve promotes exchange rate stability. This finding aligns with the results of Abdullateef & Waheed (2010); Wang, Le & Park (2020); Onwuka & Igwezea (2014), indicating that growth in foreign reserves provides opportunity for the CBN to achieve some stability in dollar/naira exchange rate. On the other hand, the response of exchange rate to negative changes in external reserve is insignificantly positive in the short run and negative in the long run. This suggests that decrease in external reserve holding tends to undermine the practice of sterilized inventions by the CBN under the 'managed float' exchange rate regime. The results further revealed that exchange rate responds positively to positive changes in trade openness in the long run, but negatively to one period lag of negative changes in trade openness in the short run. The asymmetric positive effect of trade openness on exchange rate stability is consistent with the OCA theory predictions and findings of Bernhard & Leblang (1999) as well as Hagen & Zhou (2007). The implication of this finding is that increase in cross-border trade transactions promotes foreign exchange earnings, which in turn support the goal of exchange rate stability. The partial sums of positive and negative changes in financial openness have mixed effects on exchange rate. While exchange rate responds negatively to positive changes in financial openness in the short run, its response to negative changes in financial openness is significantly positive in both short and long run. The negative effect of financial openness on exchange rate stability explains the adverse consequences associated with openness of financial markets in less developed economies like Nigeria with underdeveloped financial sector. The error correction coefficient (-0.941) is negative and significant, indicating that the adjustment towards long run equilibrium per year is 94.1 percent.

V. Conclusion And Recommendations

This paper deepens understanding on the contributions of external reserves to exchange rate stability in Nigeria. It follows a nonlinear approach to explore how partial sums of positive and negative changes in external reserve, trade and financial openness affect exchange rate stability. The findings reveal that growth in external reserve promotes exchange rate stability in Nigeria. This substantiates the theoretical predictions of external reserves' ability to foster financial stability in Nigeria through stable exchange rate. Similarly, increase in trade openness impact positively on exchange rate stability. This implies that trade integration has the potential of driving stability in exchange rate. Contrarily, increase in financial openness generated adverse effects on the stability of exchange rate. This evidence suggests that more financial openness poses a threat to the stability of the naira. Based on the findings, this paper concludes that international reserve holding is an important policy initiative in Nigeria for achieving meaningful stability in exchange rate. Therefore, it is recommended for the CBN to ensure prudent management of external reserves to optimize the associated benefits in terms of exchange rate stability while minimizing the associated costs. More so, policy makers should ensure that Nigeria takes advantage of trade integration to boost export competitiveness and achieve meaningful stability in exchange rate.

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