External Reserves and Economic Growth in Nigeria: An Empirical Investigation

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EXTERNAL RESERVES AND ECONOMIC GROWTH IN NIGERIA: AN EMPIRICAL INVESTIGATION

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ABSTRACT

The paper examines the nexus between Nigeria's foreign reserves and economic growth. Analysis of the data from 2000:Q1 - 2013:Q2, using the modified Wald statistic of Toda and Yamamoto (1995) confirms a unidirectional causality running from external reserves to economic growth. The Gregory and Hansen cointegration test also confirms the existence of a long run relationship between the variables, but with a structural break in 2009Q4. We find that external reserves drive economic growth in Nigeria, both in the short and long term horizons. Results also show that a one per cent increase in external reserves leads to 0.15 per cent increase in economic growth. Since general macroeconomic stability has growth enhancing effects, the paper endorses the CBN routine interventions in the foreign exchange market aimed at ensuring stability of the exchange rate.

JEL Classification: F31, F43, O47

Keywords: Exchange Reserves, Co-integration, Structural Break, Economic Growth, Causality

1.0 Introduction

The debate on the rationale for maintaining high external reserves amidst rising government debt profile, persistent high unemployment, sluggish industrial sector growth, huge infrastructure gap and the urgent need to diversify from oil (for oil producing countries) has been a recurring one among economists, development planners and policy makers in oil producing countries. Meanwhile, there is no consensus in extant literature regarding the exact impact of external reserves accumulation on output performance.

Some studies have shown that reserves accumulation has both economic and social costs, including opportunity cost arising from low returns on reserve assets, losses due to reserve currency depreciation, and forgone gains from investment and social expenditures that could be financed by these reserves. The costs may be so significant that they undermine economic output in which the reserves accumulation becomes inimical to overall growth (Rodrik, 2006; Adam and Léonce, 2007). Other studies have argued that external reserves accumulation have been instrumental to growth performance of nations as such reserves are used to finance transaction needs, intervene in foreign exchange markets, enhance credit worthiness, promote wealth accumulation, create buffer against external shocks and entrench the credibility of monetary policy (Yeyati, 2006; Cave and Jones, 1973; Obaseki and Bello, 1996; Ogwumike, 2001; and Abeng, 2007).

For most natural resource endowed emerging economies, a recurrent macroeconomic policy question relates to the extent to which their external reserves management strategies should aim to promote growth or enhance welfare. Thus, researchers in these countries have attempted to examine the causal relationship between external reserves and economic growth as well as quantify the output cost of holding excess reserves. In Nigeria, the literature is still sparse with the few available ones failing to agree on the existence and direction of causality between external reserves and economic growth (Usman and Ibrahim, 2010; Irefin and Yaaba, 2012).

The broad objective of this study is therefore to empirically examine the nexus between external reserves and economic growth in Nigeria while leveraging on recent advances in econometric methodologies and data set (2000:Q1 to 2013:Q2). Specifically, the paper expects to confirm the existence of long-run relationship between external reserves and output performance in Nigeria and, thereafter, examine the direction of causality between the two variables. This paper is different from earlier related works in a number of ways. First, it considers the possibility of structural breaks in the modelling approach. Second, a causality test that is robust to non-stationary VARs has been used. Lastly, in order to reduce the sensitivity of the model results to the inclusion/exclusion of other covariates, the analysis was restricted by investigating the relationship between external reserves and output performance using a bivariate approach.

The study is divided into six sections. Following this introduction, a review of empirical literature has been undertaken in section two. Section three presents stylized facts on external reserves management in Nigeria. Section four discusses data and methodology while the results of the study are discussed in section five. Section six concludes the paper with some policy implications.

2.0 Review of Empirical Literature

The literature is replete with studies conducted to investigate the determinants of external reserves and the growth implications of external reserves accumulation. For instance, Adam and Léonce (2007), in their study, using panel data from 21 African countries, examined the sources, motivation and economic implications of reserve accumulation with a focus on the impact on exchange rate, inflation, and public and private investment. They argue that countries generally maintain reserves in order to effectively manage their exchange rate and reduce adjustment costs associated with fluctuations in international payments but advised that in any credible reserves management strategy, the benefits of external reserve accumulation should be carefully weighed against its potentially high economic and social costs. Their results showed that excessive accumulation of external reserves resulted in exchange rate appreciation while it yielded little benefits in terms of public and private investment. They concluded that African countries, especially those endowed with natural resources; need to adopt a more pro-growth approach to reserve management.

In an analysis of the benefits of reserves accumulation, Adam and Léone (2007) opined that the costs of maintaining reserves comprise the opportunity cost of foregone domestic consumption and investment as well as financial costs and the strain on monetary policy arising from efforts to sterilize the effects of excessive monetary expansion through higher domestic interest rates. This, according to the duo, can increase fiscal pressure (control of government spending and deficits) and make reserve accumulation inconsistent with fiscal policy objectives.

Aizenman and Lee (2005) compared the relative importance of precautionary and mercantilist motives in explaining the hoarding of international reserves by developing countries. Their empirical results suggest that precautionary motives have played a more prominent role in reserve accumulation. Meanwhile, a study by Rodrik (2006) revealed that reasonable spreads between the yield on reserve assets and the cost of foreign borrowing led to an income loss of nearly one per cent of GDP in developing countries that have rapidly increased foreign exchange reserves. In contrast, Yeyati (2006) pointed out that the costs of foreign exchange reserves may have been considerably overstated in previous studies. He argued that, to the extent that reserves lower the probability of a run-induced default, they reduce the spread paid on the stock of sovereign debt.

IMF (2003) applied a simple empirical model on a large panel that covers 122 emerging-market economies with annual data from 1980 to 1996 to investigate the determinants of reserve holdings. In the study, real GDP per capita, the population level, the ratio of imports to GDP, and the volatility of the exchange rate are found to be statistically significant determinants of real reserves. Predicted values from the model revealed that international reserves in Latin America are not excessive, while those in emerging Asia have increased more than warranted since 2001.

Aizenman and Marion (2002, 2004) investigate the reasons for the relatively high demand for reserves by countries in emerging Asia and the relatively low demand by some other developing countries (e.g., Latin America). In addition to share of imports/exports to output, ratio of capital flows or broad money to GDP, short term external debt, exchange rate and interest rates differential; they examine the role of political uncertainty and corruption as determinants of reserve holdings. Using a theoretical model, they show that sovereign risk, costly tax collection to cover fiscal liabilities, and loss aversion (defined as the tendency of agents in an economy to be more sensitive to reductions in consumption than to increases) lead to a relatively large precautionary demand for international reserves. They further conclude that the recent large build-up of international reserves in emerging Asia is motivated by the experience of the Asian crisis.

Osabuohien and Egwakhe (2008) made an attempt to evaluate the role of external reserve in the Nigerian economy. Their model was structured to determine the relationships between external reserves and three covariates; namely, gross domestic product (GDP), exports and imports. It was assumed that external reserves were held with a view to making the economy more attractive to foreign investment, which would, in turn, improve the economic performance of the nation. Their results however showed that large foreign reserves cannot propel economic growth in Nigeria.

In a more recent paper, Usman and Ibrahim (2010) specified a simple long run external reserves demand equation for the period 1986-2006. Using an error correction model, they found that demand for external reserves in Nigeria is driven mainly by current account variability, real exchange rate and opportunity cost of holding reserves. Two of these variables (current account variability and real exchange rate) have positive and statistically significant coefficients, while the opportunity cost of holding reserves has a negative coefficient. However, GDP was found to be insignificant. Meanwhile, Obaseki and Bello (1996) argued that external reserves accumulated either through a phenomenal rise in oil price or exchange rate promotes Nigeria's domestic output.

Ogwumike (2001) was of the view that reserves are necessary impetus for investors to invest in the critical sectors of an economy - such as agricultural, manufacturing, mining and quarrying, building, and construction and crude petroleum sectors- which will bring about significant growth to the economy. Reserves could also serve as collateral for capital importation which in effect will enhance growth in output.

According to Fapolusi (2006), external reserves, if appropriately managed are expected to enhance economic growth and very essential for the prosperity of a nation and this is why it is a major macroeconomic goal. Even though economic growth is not a sufficient condition for poverty alleviation/elimination it is indeed a necessary condition for the reduction and sustained economic growth in an atmosphere of equitable distribution of income and wealth paves the way for the reduction or elimination of absolute poverty and underdevelopment.

Heller (1966) concludes that emerging market economies hold reserves as a buffer stock to smooth unexpected and temporary imbalances in international payments. This view was supported by Eichengreen (2006) who noted that demand for reserves is partially driven by demand for insurance against financial shocks. However, in determining the optimal level of reserves, the monetary authority needs to balance the macroeconomic adjustment costs incurred if reserves are exhausted (crisis prevention motive) with the opportunity cost of holding reserves. Thus in theory, a country can decide to accumulate foreign reserves to eliminate some of its volatility. Evidence suggests that higher reserves reduce both the likelihood of a crisis and the depth of a crisis, should one occur (IMF 2003).

Jeanne and Ranciere (2006) argue that holding reserves is costly, but without reserves, a sudden stop in capital flows would lead to sharp falls in consumption and output. Osabuohien and Egwakhe (2008) maintained that "the opportunity cost of stock-pilling Nigeria's external reserve in order to cushion financial crisis vulnerability appears as a risk-aversion strategy. Nevertheless, this strategy undermines the marginal benefit if the reserve is pumped into investment to stimulate economic productivity". Alternatively, the duo asserted further that "the elasticity of reserve accumulation to the degree of unlikely financial shocks affects the foregone utilisation-benefits. Nda (2006) noted that, the Nigerian reserve is to some degree exclusively held in government bonds. Hence, yielding low returns, and provide security and liquidity that are highly priced by reserves managers. As a result, the cost-benefit analysis between security and liquidity vis-à-vis the return constitutes a bitter pill for the acceptance by the general public (Osabuohien and Egwakhe, 2008).

In a more methodological paper, Gosselin and Parent (2005) argued that the model estimated by IMF (2003) could be liable to misspecification error, due to issues of structural break. Their argument was based on the fact that the Asian crisis could have led to significant changes in the relationship between the variables. However, after conducting various robustness tests using the IMF's data set; they could not find any statistical evidence of a break in the patterns of the correlations among the variables. This, they concluded, could reflect the fact that the IMF's data set covers a wide array of monetary regimes for which the average coefficients are stable. While also, considering the possibility of structural breaks in external reserves models, Lizondo and Mathieson (1987) find that the debt crisis of the early 1980s in Latin America produced a structural break in the country's demand for reserves.

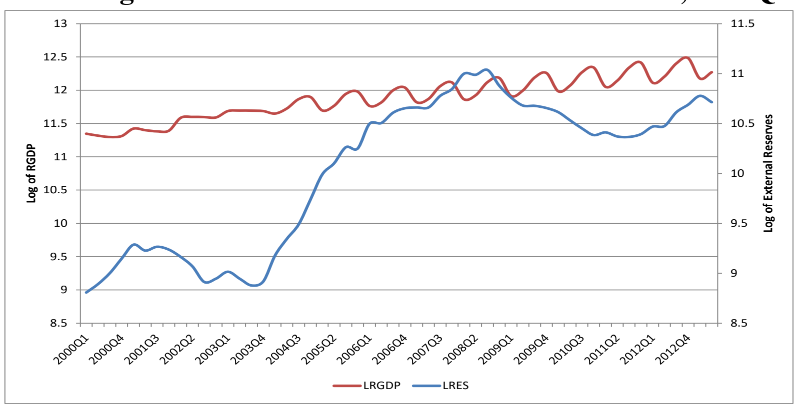
The studies reviewed above indicated that the literature is not unanimous on the exact relationship between external reserves and growth, even though some studies (like IMF, 2003) have highlighted the possibility of threshold effect. Only very few studies accommodated structural break in their modelling approach. Failure to account for structural breaks when they do occur leads to biased parameter estimates.

3.0 Data and Methodology

3.1 Data Source and Description

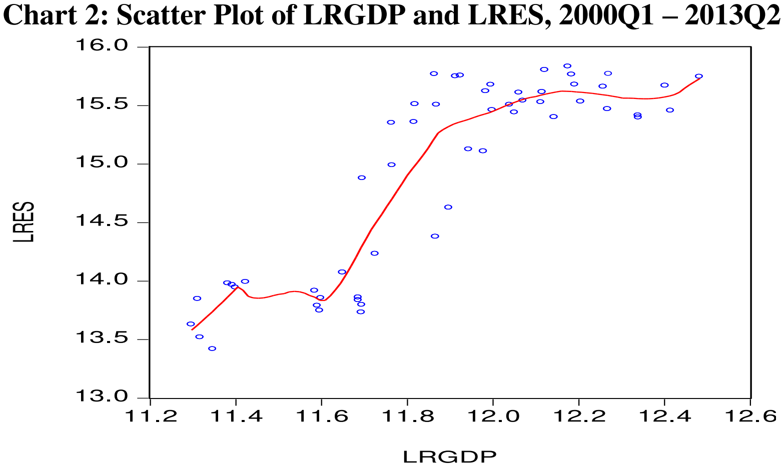
This study uses quarterly data on real gross domestic product (RGDP) and external reserves (RES) covering the period 2000Q1 to 2013Q2. The choice of estimation period is based on data availability and the need to cover current economic developments in the country, especially in the aftermath of the 2008/09 global financial crisis. Time series data on the variables are sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin. In order to take care of the possibility of exponential growth trend in the series and curtail the effect of outliers, the variables are transformed into logarithmic form. The double log transformation enables us to estimate a linear relationship between the two variables with the obtained coefficients interpreted as elasticities.

Chart 1: Plot of Log-transformed RGDP and External Reserves, 2000Q1 – 2013Q2



Furthermore, a scatter plot of the series presented in Chart 2 seems to broadly suggest a positive relationship between the two variables, a relationship that is more pronounced between 2004 and 2007.

Chart 2: Scatter Plot of LRGDP and LRES, 2000Q1 – 2013Q2



However, as shown by the polynomial kernel fit of the scatter plot, the relationship seems to be flat during 2007 – 2012 and there are also pockets of short term negative relationships during the entire sample period. (for instance during 2000 and 2002).Overall, Chart 2 seems so suggest that the exact pattern of relationship between real gross domestic product and external reserves requires further investigation. The observed behaviours in the two charts above are informative and provide a guide in the choice of estimation procedures to be adopted to provide answers to the research questions posed by the study.

3.2 Methodology

3.2.1 Unit Root

A critical step in any time series analysis is the identification of the order of integration for the variables. This is to avoid the spurious regression problem. We employ the Augmented Dickey-Fuller (ADF) unit root test which includes intercept as well as intercept and trend in the test regression. In addition, we employ the Zivot and Andrews (1992) unit root test, which is robust to the presence of structural breaks in our data. The null hypothesis in this case is the presence of unit root with drift that excludes any structural break in the series while the alternative is a trend stationary series process that allows for a one-time break in the trend function (Zivot and Andrews, 1992). Thus, given a time series Y_t, the regression equations specified by Zivot and Andrews to test for unit root under the assumptions of structural break in levels, trend and both trend and intercept are respectively as follows:

$$y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{\lambda}) + \hat{\beta}^A t + \hat{\alpha}^A y_{t-1} + \sum_{j=1}^{k} \hat{C}_j^A \Delta y_{t-j} + \hat{e}_t, \quad (2)$$

$$y_t = \hat{\mu}^B + \hat{\beta}^B t + \hat{\gamma}^B DT_t^*(\hat{\lambda}) + \hat{\alpha}^B y_{t-1} + \sum_{j=1}^{k} \hat{C}_j^B \Delta y_{t-j} + \hat{e}_t, \quad (3)$$

$$y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\hat{\lambda}) + \hat{\beta}^C t + \hat{\gamma}^C DT_t^*(\hat{\lambda}) + \hat{\alpha}^C y_{t-1} + \sum_{j=1}^{k} \hat{C}_j^C \Delta y_{t-j} + \hat{e}_t \quad (4)$$

where $DU_t(\lambda) = 1\ if\ t > T\lambda, 0\ otherwise;\ DT_t^*(\lambda) = t - T\lambda$ if $t > T\lambda, 0\ otherwise$. λ in the three equations corresponds to estimated values of the break fraction, $\theta\ and\ \gamma$ are parameter estimates that endogenously account for the structural break at levels and trend respectively. Δ is first difference operator. The asymptotic distribution of the test statistic is given as $inf_{\lambda\epsilon\Lambda} t_{\hat{\alpha}^i}(\lambda),\quad i = A, B, C$ $(for\ the\ models\ corresponding\ to\ equations\ 2-4)$ with the size α left-tail critical value from the asymptotic distribution being $k_{inf,\alpha}^i$. Thus, the null hypothesis of a unit root is rejected if:

$$\inf_{\lambda\epsilon\Lambda} t_{\hat{\alpha}^i}(\lambda) < k_{inf,\alpha}^i \quad i = A, B, C\ (for\ the\ models\ corresponding\ to\ equations\ 2-4)$$

The overall essence of this step is to ensure that the proper order of integration of the series is identified with a view to ensuring that the included variables enter the model in a non-explosive form.

3.2.2 Causality Test

The idea of causality was formally developed by Granger (1969) who argued that a variable X_t causes another variable Y_t if the former helps to improve the forecast of the latter and if otherwise, X_t is said to be Granger-noncausal for Y_t. Granger's test for causality is based on zero restrictions on the coefficients of a subset of lagged variables included in an estimated simple Vector Autoregression. In line with Granger's suggestion, we test for the absence of Granger causality between LRGDP and LRES by estimating the following bivariate VAR:

$$LRGDP_t = \propto + \sum_{i=1}^{m} \gamma_i LRGDP_{t-i} + \sum_{j=1}^{n} \delta_j LRES_{t-j} + \mu_{yt} \quad (5)$$

$$LRES_t = \propto + \sum_{i=1}^{m} \theta_i LRES_{t-i} + \sum_{j=1}^{n} \varphi_j LRGDP_{t-j} + \mu_{xt} \quad (6)$$

where LRGDP and LRES are real gross domestic product and external reserves in their logarithmic form, m and n are the optimal lag orders selected via information criteria, μ_{yt} and μ_{xt} are the uncorrelated white-noise error terms of the respective equations, γ_i, δ_j, θ_i and φ_j are the coefficients in the VAR.

The investigation of causality between LRGDP and LRES involves investigating the joint significance of the coefficients for the lagged LRES and lagged LRGDP terms (δ_j and φ_j) in equations (5) and (6), respectively. This is based on the calculated *F* statistic for the Wald test on coefficient restrictions. However, the Wald test statistic used in a VAR-based Granger causality test as outlined above has been criticized as following a nonstandard asymptotic distribution and depending on nuisance parameters if the VAR process is non-stationary (Sims et al., 1990; Toda and Phillips, 1993; Toda and Yamamoto, 1995). The consensus in literature is that the results of the simple Granger causality test, as outlined above, are meaningless, even asymptotically when the variables in the model are I(1). The shortcomings of the simple Granger causality test are documented in Shirazi and AbdulManap (2005).

To overcome these shortcomings, Toda and Yamamoto (1995), hereafter referred to as T-Y procedure, proposed a causality test procedure that involves the estimation of levels VAR with augmented lags and the usual restrictions on the parameter matrices irrespective of the order of integration or cointegration of the process. Thus, the T-Y procedure modifies the Wald statistic for testing the significance of the relevant coefficient by estimating a VAR (m+h_{max}) instead of a *VAR (m)* model (where m is the optimal lag length for the system selected on the basis of an appropriate selection criterion and h_{max} is the maximal order of integration in the process). Thus, the inclusion of an additional lag in the VAR allows the testing of non-causality hypothesis by a conventional Wald statistic since the standard asymptotic inference holds. He further showed that that the estimated parameters under this framework have a limiting normal distribution. Consequently, we employed the T-Y procedure to investigate the direction of causality between the two variables of interest, namely *LRGDP* and *LRES*.

3.2.3 Cointegration Test

It has been argued in literature that the Engle and Granger (1987) approach to testing for cointegration tends to under-reject the null of no cointegration if there is a cointegration relationship that has changed at some (unknown) time during the sample period (Harris and Sollis, 2003). This implies that the Engle-Granger procedure has low power in the presence of structural breaks. In view of the possibility of structural breaks in the cointegrating relationship between our variables (see Gosselin and Parent, 2005 and Lizondo and Mathieson 1987), we employ a residual based cointegration tests proposed by Gregory and Hansen (1996) to investigate whether LRGDP and LRES share similar stochastic trends in the long run relationship, which may have changed as certain period. This is an extension of the Engle and Granger (1987) approach and it involves testing the null hypothesis of no cointegration against an alternative of cointegration with a single break in an unknown date based on extensions of the traditional *ADF*-, Z_α and Z_t – test types. Thus, this test is robust to the presence of structural breaks in the cointegrating relationship amongst the variables in the model. Being residual based, it involves testing for unit roots in the residuals from the cointegrating regression. If the null hypothesis is rejected, it implies that the linear combination of the variables exhibits stable properties in the long run, albeit with the presence of structural break. This concept is of importance to this study because it helps define the existence of a long-run equilibrium to which the two variables converge over time.

Gregory and Hansen developed three different models to test for cointegration based on different assumptions about the form of the structural beaks in the cointegrating relationship. These are models that assume a level shift in the cointegrating relationship (C), a level shift with time trend (C/T) and a regime shift (C/S). The third assumption allows the cointegrating relationship not only to shift in a parallel fashion but to also rotate. Thus, given a bivariate model involving Y_t and X_t (which are I(1) variables) and *I(0)* residuals, the specifications for models C, C/T and C/S are respectively given as:

$$y_t = \alpha_1 + \alpha_2 D_t + \delta X_t + \mu_t, \quad t = 1, 2, \ldots, T. \tag{7}$$

$$y_t = \alpha_1 + \alpha_2 D_t + \varphi t + \delta X_t + \mu_t, \quad t = 1, 2, \ldots, T. \tag{8}$$

$$y_t = \alpha_1 + \alpha_2 D_t + \delta_1 X_t + \delta_2 X_t D_t + \mu_t, \quad t = 1, 2, \ldots, T. \tag{9}$$

Where y_t is the dependent variable, x_t is a vector of covariates, t is a time trend, parameters α_1 and α_2 are the respective intercept terms before and after the break, φ is the coefficient for time trend, δ_1 and δ_2 are the respective coefficients of the independent variable before and after the structural break and u_t is the disturbance term. D_t is a dummy variable that takes the form:

$$D_t = \begin{cases} 0, if\ t \leq [T\tau] \\ 1, if\ t > [T\tau] \end{cases} \tag{10}$$

where the unknown parameter $\tau \in (0,1)$ denotes the relative timing of the break and [ ] denotes the integer part operator. Since the change point or its date are unknown, the test for cointegration within this framework involves computing the usual statistics for all possible break points $\tau \in J$ and then selecting the smallest value obtained, since it will potentially present greater evidence against the null hypothesis of no cointegration. Assuming LRES causes LRGDP, the implied Gregory and Hansen (1996) cointegrating equations for our variables are as follows:

$$LRGDP_t = \alpha_1 + \alpha_2 D_t + \delta LRES_t + \mu_t, \quad t = 1, 2, \ldots.., T. \tag{11}$$

$$LRGDP_t = \alpha_1 + \alpha_2 D_t + \varphi t + \delta RES_t + \mu_t, \quad t = 1, 2, \ldots.., T. \tag{12}$$

$$LRGDP_t = \alpha_1 + \alpha_2 D_t + \delta_1 RES_t + \delta_2 RES_t D_t + \mu_t, \quad t = 1, 2, \ldots.., T. \tag{13}$$

where LRGDP and LRES are as earlier defined and ε_t is the random error. The parameters of equations (11) – (13) are estimated via OLS and the residuals from the selected model are tested for stationarity. If the residuals are found stationary, it implies that the linear combination of LRGDP and LRES is stable and the variables are cointegrated.

3.2.4 Error Correction Model

We employ the Engle and Granger (1987) two- stage procedure to examine the short and long run dynamics of the relationship between the two variables. The Granger's representation theorem shows that if there exists cointegration amongst a group of variables, there must also exist an error correction representation. Thus, following the results of the tests for unit roots, structural breaks and cointegration, we estimate an error correction model specified as:

$$\Delta LRGDP_t = \alpha_0 + \sum_{i=0}^{s} \beta_i \, \Delta LRES_{t-i} + \sum_{j=1}^{q} \gamma_j \, \Delta LRGDP_{t-j} + \rho \varepsilon_{t-1} + \mu_t \tag{14}$$

Where Δ denotes the first difference operator, $\mathcal{E}_t$ is the estimated residual from the selected Gregory-Hansen equation, s and q are the number of lag lengths selected on the basis of information criterion. For a stable system, the coefficient ρ is negative and statistically significant. Moreover, the value of ρ measures the speed of adjustment of the LRGDP to the value implied by the long run equilibrium relationship.

4.0 Results

4.1 Unit Root Test Results

The results of the Augmented Dickey-Fuller unit root test are reported in Table 1. At 5 per cent significance level, we cannot reject the null hypothesis of unit roots for the two variables in their levels. However, stationarity was attained after differencing each of the variables once. This implies that the variables are integrated of order one, I(1). The results of the Zivot-Andrews unit root test with endogenously determined structural breaks in the intercept, trend as well as intercept and trend are presented in Table 2.

Table 1: Augmented Dickey-Fuller Unit Root Test

Variable	Levels		First Difference		Integration Order
	ADF^{c}	ADF^{ct}	ADF^{c}	ADF^{ct}	
LRGDP	-2.7337*	-2.7944	-2.9838**	-3.6546**	I(1)
LRES	-1.3996	-1.8675	-2.6372*	-4.1201**	I(1)

ADF^{c} and ADF^{ct} represent unit root test with constant and constant and trend, respectively

*Lags are chosen based on Schwarz Information Criterion (SIC). ** and * indicate significance at 5% and 10% levels, respectively*

The timing of the structural break for each of the variables is determined based on the most significant t-ratio for the respective parameter in equations (2) to (4). For instance, the model with break in trend shows that the two series are stationary at levels, albeit with structural breaks in 2003Q3 and 2008Q2 for LRGDP and LRES, respectively. The timing of the structural break for LRES coincides with the period of the global financial crisis. As shown in Chart 1, an era of substantial decumulation in Nigeria's external reserves began in 2008Q3, which lasted till about the second quarter of 2011.

Table 2: Zivot-Andrews Unit Root Test

Variable	Break in Intercept			Break in Trend			Break in Intercept and Trend		
	Test Statistic	Break Date	I(d)	Test Statistic	Break Date	I(d)	Test Statistic	Break Date	I(d)
LRGDP	-3.4211	2004Q2	I(1)	-11.0567***	2003Q3	I(0)	-4.6209	2003Q3	I(1)
LRES	-5.1982***	2004Q1	I(0)	-6.1722***	2008Q2	I(0)	-5.9595***	2007Q3	I(0)

***Critical values** - **Intercept break:** -5.43 (1%), -4.80 (5%); **trend break:** -4.93(1%), -4.42 (5%); **intercept and trend breaks:** -5.57 (1%), -5.08 (5%) (Zivot and Andrews, 1992). *** indicate significance at 1% level*

This development was not unconnected with pressures from the foreign exchange market as well as the effects of falling crude oil prices in the international market. This did not however translate to a decline in LRGD, at least not in a contemporaneous sense.

4.2 Lag Order Selection

In order to properly identify the underlying dynamics of the VAR model to be used for the causality test, we determine the optimal lag length using the Schwarz Information Criterion (SIC) and the results are presented in Table 3. The SIC criterion suggests a VAR of order six (6). The implication of this is that the dynamics of the interactions between external reserves and output performance in Nigeria persists up to six quarters and this knowledge is factored into our VAR specification.

Table 3: Optimal Lag Length Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-23.5953	NA	0.0116	1.2188	1.3016	1.2492
1	68.9111	171.7976	0.0002	-2.9958	-2.7475	-2.9048
2	74.3418	9.5683	0.0002	-3.0639	-2.6502	-2.9122
3	100.8493	44.1793	5.52e-05	-4.1357	-3.5565	-3.9234
4	144.0726	67.9224	8.58e-06	-6.0035	-5.2587	-5.7305
5	152.4473	12.3627	7.05e-06	-6.2118	-5.3016	-5.8782
6	162.3864	13.7254*	5.40e-06	-6.4946	-5.4189*	-6.1003
7	169.4265	9.0515	4.79e-06	-6.6394	-5.3982	-6.1844
8	175.1740	6.8423	4.55e-06	-6.7226	-5.3159	-6.2070
9	182.3354	7.8434	4.09e-06	-6.8731	-5.3009	-6.2968
10	183.9108	1.5754	4.85e-06	-6.7577	-5.0200	-6.1207
11	193.2935	8.4891	4.04e-06	-7.0140	-5.1108	-6.3164
12	201.2947	6.4771	3.66e-06*	-7.204510*	-5.1359	-6.4463*

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

4.3 Causality Test

As outlined in the previous section, both the simple pairwise Granger causality test and T-Y procedure are employed to test for causality between LRGDP and LRES based on the selected optimal lag. The result of the pairwise Granger causality test is presented in Table 4. At the 5 per cent significance level, the null hypothesis that LRES does not Granger Cause LRGDP cannot be rejected, except at the 10 per cent level. However, at all conventional levels of significance, there is no evidence to reject the null hypothesis that LRGDP does not Granger Cause LRES. Therefore, based on the pairwise Granger Causality test, we can conclude that there is unidirectional causality running from and LRES to LRGDP at the 10 per cent significance level.

Table 4: Pairwise Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
LRES does not Granger Cause LRGDP	48	1.9588	0.0985
LRGDP does not Granger Cause LRES	48	1.9117	0.1064

In order to address the shortcomings of the pairwise Granger Causality test conducted above, the procedure developed by Toda and Yamamoto (1995) is also implemented. Since the optimal lag length selected criteria suggested a lag order of six (6), a VAR of order 7 (i.e. $m+h_{max}$) is estimated based on the results of the ADF unit root test. The results of the test are summarised in Table 5.

The results, which are based on the modified Wald test, suggest that the null hypothesis of Granger no-causality from LRES to LRGDP is rejected at the 5 per cent significance level, affirming the results obtained from the pairwise Granger causality test. However, there is no evidence to reject the null hypothesis of Granger no-causality from LRGDP to LRES. This implies that there is no bidirectional causality between the two variables in Nigeria. These results suggest that movements in Nigeria's real gross domestic product can be explained by variations in the level of the country's external reserves. This may not be unconnected with the active role being played by the CBN (using its external reserves) to ensure exchange rate stability in the country.

Table 5: Toda and Yamamoto No-causality Test Results

Null Hypothesis:	Optimal Lag (m)	Augmented Lag ($m+h_{max}$)	Modified Wald	P-values	Decision
LRES does not Granger Cause LRGDP	6	7	2.6331**	0.0344	Reject H_0
LRGDP does not Granger Cause LRES	6	7	1.7864	0.1335	Fail to Reject H_0

*Notes: ** indicates significance at 5% level. M+hmax refers to the order of the augmented lag VAR suggested by Toda and Yamamoto (1995). The optimal lag of 6 is as per the lag order selection procedure based on SIC*

The result is also suggestive of the fact that foreign exchange supply by the CBN for valid transactions (especially of machineries and equipment) at its regular auctions may have been supportive of the enterprises or sectors that are critical to the output growth of the economy. These are in line with the findings of studies like Yeyati (2006), Cave and Jones (1973), Obaseki and Bello (1996), Ogwumike (2001) as well as Abeng (2007), which argued that robust external reserves are helpful in promoting growth performance of nations as such reserves could be used to finance the country's transaction needs, intervene in foreign exchange markets, enhance credit worthiness, promote wealth accumulation, create buffer against external shocks and entrench the credibility of monetary policy.

4.4 Cointegration Test

The results of the Gregory Hansen residual-based integration test akin to the three test regressions specified in equations (11) - (13) are presented in Table 6. Based on the *ADF** test statistic, the study failed to establish cointegration between external reserves and growth during the estimation period, even though, break dates of 2002Q4 and 2009Q4 were identified. However, results based on the Z_t* statistic showed that cointegration exists between the two variables and identified two break points which occurred in 2002Q1 and 2009Q4. The Z_α* found a cointegrating relationship only for GH-2 and identified a break date of 2002Q1.

Table 6: Gregory-Hansen Cointegration Test with Structural Breaks

Model	ADF*	Break Date	Z_t*	Break Date	Z_α*	Break Date
GH-1 (Level shift)	-3.7793	2009Q4	-5.2098	2009Q4	-38.2129	2009Q4
GH-2 (Level shift with trend)	-4.9455	2002Q4	-7.4664	2002Q1	-55.6343	2002Q1
GH-3 (Regime shift)	-3.7212	2009Q4	-5.1494	2009Q4	-37.6961	2009Q4

The ADF* and Z_t* 5 per cent critical values are -4.61, -4.99 and -4.95 for GH-1, GH-2 and GH-3 models, respectively (Gregory & Hansen, 1996)

The Z_α* 5 per cent critical values are -40.48, -47.96 and -47.04 for GH-1, GH-2 and GH-3 models, respectively (Gregory & Hansen, 1996)

Based on the statistical significance of the coefficients in the estimated variants of the Gregory and Hansen cointegrating regressions, the study chose GH-1 (akin to equation 11) as the static model from which the residuals used for the error correction model is obtained. Thus, based on the Z_t* statistic for GH-1, this study recognises a break date of 2009Q4, which coincides with the period of the last global financial crisis.

4.5 Long Run Elasticity Estimates (With and without Structural Break)

Table 7 reports long run elasticities of the real gross domestic product to external reserves based on the model with and without structural break. Results of model 1a (OLS regression without structural break) reveal a statistically significant and positive relationship between external reserves and RGDP, implying that increasing external reserves was associated with increasing growth during the estimation period.

Table 7: Long Run Elasticity Estimates of RGDP to External Reserves

Dependent Variable: LRGDP

Variable	Model 1a (without break)		Model 1b (with break)	
	Coefficient	P-value	Coefficient	P-value
Intercept	8.4823	0.0000	8.8931	0.0000
Dum*Intercept			0.3035	0.0000
LRES	0.3387	0.0000	0.2928	0.0000
R-squared	0.6312		0.7476	
Adjusted R-squared	0.6241		0.7377	
SIC	-0.3147		-0.6200	
S.E. of regression	0.1956		0.1634	
Log likelihood	12.4871		22.7243	

Even after accounting for structural break, a positive relationship is found. The estimated coefficient of LRES in model 1a is 0.3387, implying that a one per cent increase in reserves leads to about 0.34 per cent increase in real output. However, the incorporation of a structural break dummy leads to lower output elasticity to external reserves (0.2928). Also, the interaction term for the shift in intercept is statistically significant, implying that the break date is correctly identified. Compared to the model without structural break, the model with structural break provided a better fit to the data as it yielded a higher adjusted R-squared is higher (0.7377) and lower Schwarz Information Criterion (-0.6200). Thus, the residuals from the cointegrating regression in Model 1b are used to set up an appropriate error correction model in the next step.

4.6 Error Correction Model

In order to understand the short and long run dynamics of the relationship between external reserves and growth, we set up two bivariate error correction models. The results of the models are presented in Table 8. Model 2a is based on the residuals obtained from the static model (model 1a) presented in Table 7 above while model 2b is set up based on the obtained residuals from the level shift model of Gregory-Hansen procedure (GH-1). Therefore, model 2b incorporated the identified structural break point while model 2a did not.

The LRGDP has strong autoregressive dynamics as its fourth lag confers huge and statistically significant impact on itself. A one per cent increase in RGDP four quarters ago leads to about 0.95 per cent increase in RGDP in the current period (Model 2a). However, after accounting for structural break, the impact wanes to about 0.92 per cent (Model 2b).

In terms of the impact of external reserves on growth, a positive impact is conferred at the second lag. Based on the results of model 2a, a one per cent increase in external reserves two quarters ago, propels output growth by about 0.17 per cent in the current quarter. Similar to the results of the obtained long run elasticities, accounting for structural break in the cointegrating regression leads to a lower external reserves elasticity of output. Thus, model 2b shows that the elasticity of output to a percentage change in external reserves is 0.15 per cent during the estimation period. It is revealing to observe that the sign of the coefficient for DLRES (-2) in models 2a and 2b remains positive. On the other hand, a negative relationship is found between output and the fourth lag of external reserves. A percentage increase in external reserves four quarters ago leads to a 0.26 per cent decline in output in the current quarter (model 2a) while the model with structural break (model 2b) reveals an impact of about 0.25 per cent.

Table 8: Results of the Bivariate Error Correction Model

Dependent Variable: DLRGDP

Variable	Model 2a (without break)		Model 2b (with break)	
	Coefficient	P-value	Coefficient	P-value
C	0.0043	0.5295	0.0066	0.3650
DLRGDP(-1)	0.0843	0.0639		
DLRGDP(-4)	0.9509	0.0000	0.9236	0.0000
DLRGDP(-5)			0.0979	0.0645
DLRES(-2)	0.1672	0.0142	0.1523	0.0355
DLRES(-4)	-0.2635	0.0007	-0.2478	0.0012
ecm(-1)	-0.1188	0.0146	-0.1627	0.0153
R-squared	0.9381		0.9379	
Adjusted R-squared	0.9309		0.9305	
S.E. of regression	0.0390		0.0395	
Log likelihood	92.6102		90.2147	
Durbin-Watson Stat	1.8549		1.8324	

As stated in the previous section, the coefficient of the error term measures the speed of adjustment to long run equilibrium. For a stable system, the coefficient is expected to be negative and statistically significant. The results presented in Table 8 reveal that the two models are stable as the error correction coefficients in the two models are negative and statistically significant. The model without break (model 2a) indicates that 11.8 per cent of the disequilibrium error is corrected within the quarter. However, after accounting for structural break, a faster speed of adjustment is realised. The statistical significance of the error correction coefficient, at the 5 per cent significance level, further provides evidence of a long-run cointegrating relationship among the variables.

Based on the argument in literature on the need to avoid parameter bias by incorporating the effects of structural breaks in modelling economic relationships, model 2b is selected as the preferred model. In view of the mixed results obtained in terms of the sign of the LRES coefficient in model 2b, the impact of external reserves on economic growth remains inconclusive. At 93.1 per cent, the adjusted R^2 obtained is satisfactorily high, implying that 93.1 per cent of the variation in the response variable is explained by the model.

In Table 9, the results of the tests for serial correlation, heteroscedasticity and stability in the residuals of the selected error correction model 2b are presented. It shows that the model is quite adequate for inference purposes. For instance, the Breusch-Godfrey test for serial correlation failed to reject the null hypothesis of no autocorrelation in the errors while the white test for heteroscedasticity also failed to reject the null hypothesis of homoscedasticity in the errors. Furthermore, a test for specification error conducted based on Ramsey reset procedure reveals that the model is correctly specified as the associated p-value is 0.1941.

Table 9: Model Diagnostics

Test	F-statistic	P-value
Breusch-Godfrey (Serial Correlation)	2.0514	0.1419
White Test (Heteroskedasticity)	0.7864	0.3799
Ramsey RESET (Stability)	1.7425	0.1941

6.0 Conclusion and Policy Implications

The paper examines the relationship between external reserves and economic growth in Nigeria. While growing reserves seem to have been used to achieve exchange rate stability in Nigeria, the exact relationship between external reserves and economic growth remains largely unexplored. This study attempts to bridge this gap using time series econometrics and quarterly data spanning 2000:Q1 to 2013:Q2.

The result of the pairwise Granger causality test shows that there is unidirectional causality running from reserves to output at 10 per cent significance level. The results of the modified Wald test of Toda and Yamamoto (1995) suggest that the null hypothesis of Granger no-causality from LRES to LRGDP is rejected at the 5 per cent significance level, affirming the results obtained from the pairwise Granger causality test. Thus, the study concludes that reserve accumulation causes growth and not vice versa.

The existence of a long-run relationship between external reserves and economic growth in Nigeria was investigated. Based on the Gregory Hansen residual-based cointegration test, we found a cointegrating relationship albeit with a structural break date of 2009Q4, which coincides with the period of the last global financial crisis. Thus, there is a long run relationship between the two variables. Results of the long run static models with and without structural break reveal a statistically significant and positive relationship between external reserves and RGDP, implying that increasing external reserves was associated with increasing growth during the estimation period. After accounting for structural break (2009Q4), the external reserves coefficient remained positive but became lower. The results of the bivariate error correction models also show that a one per cent increase in external reserves leads to 0.15 per cent increase in output growth. As in the long run model, lower external reserves elasticity of output is realised when structural breaks are accounted for.

While the investigation of the channel of transmission is beyond the scope of this study, it is important to note that the macroeconomic stabilization effects of reserves accumulation (especially in terms of exchange rate stability) may have been positive on growth. Therefore, this study endorses the routine interventions of the CBN in the foreign exchange market with a view to ensuring stability in the exchange rate.

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