

## **Econometric Analysis of Foreign Reserves and Some Macroeconomic Variables in Nigeria (1970–2007)\***

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**Abstract:** Countries are showing interest in accumulating foreign reserves to ensure macroeconomic stability. There has been some debate whether to beef up the level of nations' foreign reserves or make it lower, especially in developing countries like Nigeria. Whereas some argue that the foreign reserve determines the country's rating in the global market, others hold opposing views. In this light, this paper examined the interactive influence of foreign reserve (FRS) on some macroeconomic variables such as: economic size (GDP); trade; level of capital inflows (KFL); exchange rate (EXR); and inflation. Analyzing secondary data from CBN statistical bulletins (1970–2007), the econometric results obtained from cointegration test, vector error correction (VEC) within the framework of autoregressive distributed lags (ARDL) revealed the following: (1) existence of a long-run relationship between the variables and two cointegrating equations; (2) possibility of convergence of the variables from the short run to the long run with slow speed of adjustment. It is thus the conclusion of this paper that accumulation of large foreign reserves is not very productive in Nigeria due to its inability to induce some of the macroeconomic variables.

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## 1. Introduction

Countries usually hold foreign reserves to have a favourable level of exchange rate—especially with a view to stabilizing it. In this regard, there has been a debate whether there is a need to beef up the level of nations' foreign reserves or trim them back, and this debate is becoming more interesting especially in developing countries like Nigeria. Some individuals—scholars and non-scholars alike—are of the opinion that keeping scarce resources in reserve when there is a series of issues to be attended to domestically, such as education and health among others, may not be a very wise decision (Osabuohien and Egwakhe, 2008). Nonetheless, some others have argued that the foreign reserve position determines the country's rating in the global market. In other words, these proponents hold the view that a robust level of foreign reserves will make the country appear financially responsible and creditworthy in the eyes of other countries, creditors and donors (Ford and Huang, 1994).

In making the case for a robust level of foreign reserve in Nigeria, the Central Bank of Nigeria (CBN) argued that China has over one billion dollars in her foreign reserves even though her population is very large (Soludo, 2006). For example, China's foreign reserves position was estimated at US\$822 billion in 2004, while the value for Nigeria in the same year was about US\$17 billion, which has increased to about US\$51.33 billion in 2007 (CBN, 2007a; Russell and Torgerson, 2007). One of the major reasons for foreign reserves accumulation put forward by the CBN is the need to make Nigeria more creditworthy; this is believed to be essential for attracting foreign capital. However, it has been noted that other issues such as a country's institutional structure play key roles in attracting foreign capital (Hassan *et al.*, 2009).

From the foregoing, the main research question of this study is stated thus: is accumulation of foreign reserves, its depletion or an ad-mixture of the two a better choice for Nigeria? It is the quest of providing an answer to the question posed above and giving further clarification with empirical evidence on the issue that primarily initiated this study. Thus, the paper is focused on providing empirical findings on the issue of foreign reserves in relation to some macroeconomic variables such as gross domestic product (GDP); trade; level of capital inflows (KFL); exchange rate (EXHR); and inflation. The paper has five sections. Sections 1 and 2 are the introduction and literature review, respectively. Theoretical foundation, estimation technique and the empirical model are provided in Section 3. Section 4 covers the results from the estimation process and discussion, while the last section is the conclusion.

## 2. Literature Review

Countries usually hold foreign reserves to have a favourable level of exchange rate—especially with a view to stabilizing it and removing possible volatility. It is essentially held in terms of marketable securities, among others. According to Archer and Halliday (1998), the reasons for holding foreign reserves include: exchange rate stability, exchange rate targeting, exchange market stability, creditworthy consciousness, provision of emergency fund, and having transactions safeguard. Heller (1966) concludes that emerging-market economies hold reserves as a buffer stock to smooth unexpected and temporary imbalances in international payments. In determining the optimal level of reserves, the monetary authority will seek 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.

Further empirical research works on foreign reserves (e.g. Landell-Mills, 1989; Lane and Burke, 2001) established a relatively stable long-run demand for reserves based on a limited set of explanatory variables such as gross domestic products (GDP). Gosselin and Nicolas (2005) grouped the determinants of reserve holdings in five categories: economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility, and opportunity cost. In theory, the volume of international financial transactions and foreign reserve holdings are expected to increase with economic size. Also, GDP and GDP per capita have been used as indicators of economic size in the literature. The vulnerability of the current account can be captured by some measures as trade openness and export volatility. In the long run, central banks will increase their reserves in response to a greater exposure to external shocks. Thus, the level of foreign reserves could be positively correlated with an increase in both exports and imports. Capital account vulnerability increases with financial openness and potential for resident-based capital flight from the domestic currency. Consequently, reserves could be positively correlated with some variables like the ratio of capital flows to GDP. Exchange rate flexibility is usually important: it reduces the demand for reserves, since central banks no longer need a large stockpile of reserves to manage a pegged exchange rate.

There could be an opportunity cost of holding reserves, because the monetary authority swaps high-yield domestic assets for low-yield foreign ones. Iyoha (1976) had observed the factors that determined the demand for foreign reserves in 29 LDCs—Nigeria included—and established that a rise in the opportunity cost of holding reserves would result in a decrease

in the level of foreign reserves holding. Furthermore, Osabuohien and Egwakhe (2008) noted that holding of foreign reserves promotes exchange rate stability and the existence of positive relationship between reserves and exports; however, the relationship was not significant for Nigeria between 1994 and 2005, hence suggesting that export was not induced significantly by the nation's foreign reserves.

India Economic Survey (2004) identified three main factors that predicated the nation's reserve holding (the sixth largest in the world with US\$113 billion in 2003 and rose to US\$132 billion in 2005) which include: import adequacy—the number of months of imports that it can finance; its ability to cover external payment obligations—captured by the ratio of reserve to external and short-term debt; and monetary adequacy—measured by ratio of reserve to broad money and reserve money.

A nation's external debt and reserves values are important indicators of external vulnerability, which include current account indicators; debt indicators; liquidity indicators; and other indicators such as the ratio of foreign reserves to money supply, nominal and real effective exchange rate (Vojtisek, 2002). Countries can also keep foreign reserves to meet their daily transactions, such as purchase of foreign goods or payment of obligations to international bodies (Ford and Huang, 1994). Moderate reserve holding may be adequate for these sources of demand outside a currency crisis, while non-currency crisis reserve demand will not exceed demand for reserves to protect against a currency crisis. On the other hand, countries may be interested in reserve acquisition as against shocks. Intervention to respond to terms of trade shocks, to fight deflation, or to support export-led growth may result in reserves stocks. However, resources kept in reserves have limited use beyond precautionary purposes.

In determining the optimal level of external reserves, the monetary authority of the country could balance the macroeconomic adjustment costs incurred if reserves are exhausted with the opportunity cost of holding the external reserves. This means that a country can decide to accumulate reserves to get rid of all or some of its consumption unpredictability. Thus, the level of foreign reserves would move in the same direction with a country's risk aversion and output volatility. Country circumstances vary, and there may not be a precise level of reserves universally considered either sufficient or optimal. Advanced economies with highly liquid, floating currencies and stable financial market access in domestic currency are unlikely to derive any significant value from large precautionary reserve holdings, while developing countries may hold reserves equal to all external debt coming due within the next year.

Some countries have acquired such high levels of reserves that the conventional benchmarks for reserves adequacy have been met with the

largest absolute holdings of total gross reserves minus gold, as measured by the International Monetary Fund (IMF). At the end of 2005 major oil exporters held eight of the largest reserves. Japan tops the list, but by 2006, China had become the largest reserve holder. Both hold levels of reserves far greater than the rest (Russell and Torgerson, 2007). Foreign reserves normally kept in the form of high quality, marketable securities issued, usually have attendant cost, especially the opportunity cost (Gosselin and Nicolas, 2005). This implies that holding foreign reserve may or may not rub off on the economy directly but depending on whether the benefits (attracting investment, providing buffer against shocks and volatility etc.) are over and above the costs that are associated with it.

### **3. Theoretical Foundation and Model Formulation**

#### ***3.1 Theoretical Foundation of Foreign Reserves***

According to the International Monetary Fund (IMF, 2004) guidelines for foreign reserve management, official foreign reserves are held in support of a range of objectives such as:

- support and maintain confidence in monetary and exchange rate policy, including the capacity to conduct foreign exchange interventions;
- limit external vulnerability by maintaining foreign currency liquidity to absorb shocks during times of crises or when access to borrowing is curtailed;
- provide a level of confidence to markets that a country can meet its external obligations.

Building on these guidelines, three theoretical foundations for reserve accumulation especially by developing countries are appraised. They include:

##### *a) Self-insurance Theoretical Model*

Wijnbergen's (1990) pioneer work on Self-insurance Theory examined the cash/debt buy-backs in the context of missing terms of trade contingent instruments in international capital markets coupled with differences in risk aversion between commercial creditors and developing countries' borrowers. The author argued that the price of debt in secondary markets does not adequately reflect the insurance value of reserves to debtors. In the 'bad

state' (i.e. a debt default) the debt buy-back is of little use as no debt can be serviced. Hence, the Self-insurance Theory demonstrates how foreign reserves ensure that policymakers have some additional options during the bad state.

A study by IMF (2003) suggested that a ratio of reserves to short-term external debts above one reflects an important reduction in crisis vulnerability, as long as the current account is not out of line and the exchange rate is not misaligned. Mendoza (2004) equally investigated a possible self-insurance motivation for increased reserve-holding in 65 developing countries after the Asian financial crisis. An empirical verification of the hypothesis, that a self-insurance framework is a reasonable explanation for the recent increase in reserve accumulation, provided evidence that several countries could indeed be self-insuring. The recent accumulation of reserves in developing countries has thus been largely interpreted as a form of self-insurance precipitated by the high level of global economic and financial instability and the absence of an adequate international system for crisis management (Stiglitz, 2006; Elhiraika and Ndikumana, 2007).

#### *b) Mercantilist Theoretical Model*

The Mercantilist model posits that many countries accumulate foreign reserves as a means for effective exchange rate management and as a tool for maintaining low exchange rates in order to promote trade and international competitiveness (Durdu *et al.*, 2007). On this model, Yeyati (2008) also noted that one reason for the recent surge in the stock of foreign reserves in developing countries is to prevent real exchange rate appreciation as a result of capital inflows, either due to the 'mercantilist' objective of preserving competitiveness or to avoid a potential overvaluation that may eventually create downside risks.

#### *c) Macroeconomic Stabilization Theoretical Model*

Macroeconomic stabilization remains at the fore of national economic policymaking in order to aid conditionality in developing countries especially in Africa. This has induced African countries to hold reserves to allow monetary authorities to intervene in markets to influence the exchange rate and inflation (Lapavitsas, 2007; Elhiraika and Ndikumana, 2007). Many African countries including Nigeria argued that adequate foreign reserves may allow them to borrow abroad, attract foreign capital and promote domestic private investment as a result of strengthened external position and reduced vulnerability to external shocks. Thus, it is believed that maintaining

adequate reserves can boost investors' confidence and enhance investment and growth (Elhiraika and Ndikumana, 2007).

### **3.2 Recent Macroeconomic Perspective on Reserve Accumulation**

The literature suggests that reserves are held for both transaction and precautionary motives (Mendoza, 2004). In principle, countries hold reserves in order to meet unexpected and temporary fluctuations in international payments. Thus, a country's demand for reserves will increase with its risk aversion and output volatility (Gosselin and Nicolas, 2005). There is a relatively stable long-run reserve demand function that depends on five categories of explanatory variables: economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility and the opportunity cost of holding reserve (Gosselin and Nicolas, 2005).

Reserve-holding is expected to increase with economic size and the volume of international transactions. Thus, in view of the nature of commodity-based production and exports in Nigeria, both the level and growth rate of output are expected to influence reserve accumulation. Increased current and capital account vulnerability should motivate central banks to hold more reserves while exchange rate flexibility reduces the demand for reserves. The higher the opportunity cost of holding reserves, *ceteris paribus*, the lower should be the demand for reserves (Osabuohien and Egwakhe, 2008). Aizenman and Marion (2003) established that countries with high discount rates, political instability and political corruption find it optimal to hold smaller precautionary balances. These three factors are predominant in Nigeria. Hence, this study becomes relevant because the findings would serve as a check (or otherwise) for accumulating foreign reserves and reconcile with the CBN's advocacy.

In a more recent study, Aizenman *et al.* (2007) interpreted the recent hoarding of international reserves by East Asian countries as precautionary demands. The study suggested that precautionary demand depends positively on the ability of international reserves to mitigate the probability of output collapse induced by sovereign partial default, and the ability of international reserves to alleviate shortages of fiscal resources in bad states of nature. They however stated that the present level of international reserves observed in East Asia may not be optimal. In spite of these motives for reserve accumulation, empirical literature provides evidence that, today, the level of foreign reserves in some emerging economies appear excessive with respect to the level inferred by two rules—(1) rule of thumb (the three months of imports) rule and (2) the Greensan-Guidotti-IMF rule, which recommends that reserves should enable full coverage of total short-term external debt in

order to pay back the debt in the event of sudden stops (Jeanne and Ranciere, 2006; Jeanne, 2007; Osabuohien and Egwakhe, 2008).

Current reserves holding do not seem to correspond to the optimal behaviour of a sovereign that can both choose the levels of debt and hold reserves. Some form of transaction costs could rationalize countries holding some small amount of reserves (Alfaro and Kanczuk, 2009). Stiglitz (2006) established that the total opportunity cost of reserves is roughly equal to the amount of funds needed by developing countries to finance necessary investments to meet the Millennium Development Goals (MDGs). To Stiglitz (2006), developing countries earn 1 to 2 per cent in real return on their \$3 trillion reserves whereas they could invest these reserves locally with returns up to 10 to 15 per cent. Thus, assuming a difference of 10 per cent between domestic and foreign returns, the opportunity cost of holding reserves is quite high, well in excess of \$300 billion per year, i.e. more than 2 per cent of GDP.

A European Central Bank (ECB, 2006) report showed that the build-up of foreign reserves creates new risks. As the bulk of foreign exchange reserves is held in US assets and used to finance current account deficits in developed countries, reserve holding countries become susceptible to risks and costs emanating from adjustments in reserve currency countries. These risks and costs include inflationary pressures, over-investments, asset bubbles, complications in the management of monetary policies, potentially sizeable capital losses on monetary authorities' balance sheets, sterilization costs, segmentation of the public debt market, and misallocation of domestic bank lending. ECB (2006) therefore counsels that developing countries should exercise active reserve management and diversification to mitigate these risks and costs. Elhiraika and Ndikumana (2007) however stated that this is a major challenge in Africa especially for resource-rich countries including Nigeria.

### **3.3 Model Specification and Estimation Technique**

The model for the paper assumes an underlying relationship between some macroeconomic variables that can influence the level of foreign reserves (*FRS*). This is informed by information gained in literature and the theoretical foundation on foreign reserves, which were discussed in previous subsections. Given the macroeconomic nature of GDP, other macroeconomic variables can be brought in. To examine this, the paper employs an autoregressive-distributed lag (ARDL) test approach to co-integration analysis.

The ARDL modelling method has numerous merits, which include its application regardless of the stationary properties of the variables (series) in

the sample. Also the ARDL model takes sufficient numbers of lags to capture the data generating process in a general-to-specific modelling structure (Hall and Wickens, 1993; Pesaran *et al.*, 2000). In addition, a dynamic Error Correction Model (ECM) can be obtained from ARDL through a simple linear transformation, which allows for inferences on long-run estimates (Banerjee *et al.*, 1993; Frimpong and Oteng-Abayie, 2008). This is not possible under alternative co-integration procedures, for example that of Engle and Granger (Toda and Phillips, 1993).

More so, the ARDL method has another merit of yielding consistent estimates of the long-run parameters that are asymptotically normal irrespective of the order of integration, i.e. whether variables are  $I(0)$ ,  $I(1)$  or mutually integrated since there is no need for unit root pretesting. However, it is still essential to complement the estimation process with a unit root test in order to be sure that none of the variables are integrated of higher order like  $I(2)$  (Hall and Milne, 1994; Luintel and Khan, 1999). Additionally, the stationarity tests can yield different conclusions due to their different power. Thus, the appropriate lags in the ARDL are corrected for both residual correlation and endogeneity. Provided the ARDL model is free of residual correlation, endogeneity is less of a problem (Pesaran *et al.*, 2000).

The core merit of ARDL against the single equation co-integration analysis such as Engle and Granger (1987) is that the latter suffers from problems of endogeneity, while the ARDL method can distinguish between dependent and explanatory variables. Therefore, when using the ARDL method it is possible to estimate even when the explanatory variables are endogenous (Alam and Quazi, 2003). In this wise, ARDL provides robust results in small sample size such as less than 80 observations (Narayan, 2005).

From the fall out above and with regards to the merits of the ARDL modelling method, this paper represents a model below relating *FRS* to some macroeconomic variables.

$$FRS = f(GDP, TRAD, EXHR, KFL, INFR, U) \quad (1)$$

The explicit form of Equation 1 is represented as follows:

$$FRS = \varphi_0 + \varphi_1 GDP + \varphi_2 TRAD + \varphi_3 EXHR + \varphi_4 KFL + \varphi_5 INFR + \varepsilon \quad (2)$$

where *FRS* is foreign reserves; *GDP* is gross domestic product; *TRAD* is the level of trade captured by the sum of import and export as a ratio of GDP; *KFL* is foreign capital flows to the economy; *EXR* is the exchange rate (naira to US dollar);  $\varphi_i$  are parameters, while  $\varepsilon$  is an error term.

The *a priori* is such that  $\varphi_i > 0$ ,  $i = 1-4$  and  $\varphi_5 < 0$ .

From Equation 2, an error correction (ECM) type of ARDL model can be expressed as:

$$\begin{aligned}
 \Delta FRS_t = & \varphi_0 + \varphi_1 FRS_{t-1} + \varphi_2 GDP_{t-1} + \varphi_3 TRAD_{t-1} + \varphi_4 EXHR_{t-1} \\
 & + \varphi_5 FKL_{t-1} + \varphi_6 INFR_{t-1} + \sum_{i=1}^m \varphi_7 \Delta FRS_{t-i} + \sum_{i=0}^m \varphi_8 \Delta GDP_{t-i} \\
 & + \sum_{i=0}^m \varphi_9 \Delta TRAD_{t-i} + \sum_{i=0}^m \varphi_{10} \Delta EXHR_{t-i} + \sum_{i=0}^m \varphi_{11} \Delta FKL_{t-i} \\
 & + \sum_{i=0}^m \varphi_{12} \Delta INFR_{t-i} + e_t
 \end{aligned} \tag{3}$$

The first part of Equation 3 shows the long-run dynamics of the model while the second component represents the short-run relationship. The sign  $\Delta$  is the first difference operator;  $e_t$  is a white noise disturbance term. The equation points out that foreign reserve tends to be influenced and explained by its previous level, thus it involves other disturbances or shocks.

The ARDL method involves two stages for the estimation of the long-run relationship. First stage involves the examination of the existence of a long-run relationship among all variables in the equation. The second stage involves the estimation of the long-run and the short-run coefficients of the same equation. However, the second stage is mainly essential only when a long-run relationship in the first stage has been established (Pesaran *et al.*, 2000; Narayan, 2005).

To test the existence of a long-run relationship, Equation 3 can be conducted by placing some restrictions on estimated long-run coefficients of the variables. Thus, the null and alternative hypotheses are stated as follows:

$$\begin{aligned}
 H_0: & \varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = \varphi_5 = \varphi_6 = 0 \\
 & \text{(No long-run relationship—no co-integration).} \\
 H_1: & \varphi_1 \neq \varphi_2 \neq \varphi_3 \neq \varphi_4 \neq \varphi_5 \neq \varphi_6 \neq 0 \\
 & \text{(There is long-run relationship—co-integration exists).}
 \end{aligned}$$

The test has a non-standard distribution that relies on whether the series included in the model are I(0) or I(1), the number of regressors and whether the model contains an intercept and/or a trend. This study used the Johansen and Juselius (1990) approach to test for the cointegration before the ECM. If the calculated trace and maximum Eigen values are larger than the critical values, then the null hypothesis of no co-integration is rejected and it is concluded that there is evidence of a long-run relationship between the variables at that level.

If there is evidence of long-run relationship (co-integration) of the variable, the following long-run models are estimated as follows:

$$\begin{aligned}
 FRS(P) = & \omega_1 + \sum_{i=1}^p \omega_2 (FRS(P))_{t-1} + \sum_{i=0}^p \omega_3 GDP_{t-1} + \sum_{i=0}^p \omega_4 TRAD_{t-1} \\
 & + \sum_{i=0}^p \omega_5 EXHR_{t-1} + \sum_{i=0}^p \omega_6 FKL_{t-1} + \sum_{i=0}^p \omega_7 INFR_{t-1} + e_t
 \end{aligned} \tag{4}$$

The ARDL approach estimates  $(p + 1)^k$  number of regressions in order to obtain optimal lag length for each variable, where  $p$  is the maximum number of lag to be used and  $k$  is the number of variables in the equation. The optimal lag length can be selected using the model selection criteria like Akaike's Information Criteria (AIC) and Schwartz-Bayesian Criteria (SBC). The SBC is known as the parsimonious model because it selects the smallest possible lag length, while the AIC selects the maximum relevant lag length.

## 4. Estimation and Discussion

The paper employed the use of econometric tools in the analyses of the variables shown in the model. The data used in the estimation for the paper were sourced from CBN Statistical Bulletin for the period 1970–2007. The E-views package was used in the estimation process and results are presented in tables. The variables were taken in their log form to bring them to a comparative level.

### 4.1 Test of Stationarity and Cointegration of Variables

It is usually conventional to examine stationarity of the chosen variables in econometric studies to obtain a reliable result. In taking cognizance of this, the paper carried a stationarity test of the variables using both Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP)<sup>1</sup> tests at both intercept with and without trend, which is presented in Table 1.

It is apparent from Table 1 that all the variables were stationary at first difference, i.e. I(1) series, except *LINFR* that was I(0) using ADF but with PP it was I(1). When variables that are known to be I(1) produce a stationary series, then there is possibility of cointegration among them: existence of a long-run relationship between them. To establish the existence (or otherwise) of a long-run relationship among the variables (series), a cointegration test was performed using Johansen's multivariate approach. This is reported in Table 2.<sup>2</sup>

**Table 1: Test of stationarity using Augmented Dickey–Fuller (ADF) Phillips–Perron (PP)**

Series	ADF		PP		Remarks
	Intercept no trend	Intercept and trend	Intercept no trend	Intercept and trend	
LLFRS	-0.4576	-2.2066	-0.3495	-2.3079	
ΔLFRS	-5.1489	-5.0828	-6.4698	-6.3733	I(1)
LGDP	1.5633	-2.1317	1.7515	-2.0327	
ΔLGDP	-3.7484	-4.3975	-5.5361	-6.2349	I(1)
LTRAD	-2.2021	-2.7386	-2.4571	-2.9162	
ΔLRAD	-3.5159	-3.8488	-6.7652	-7.1661	I(1)
LEXHR	-0.1548	-2.3715	-0.0099	-2.2708	
ΔLEXHR	-3.5794	-3.5672	-4.8109	-4.7727	I(1)
LFKL	-0.6244	-2.3084	-1.4388	-2.3261	
ΔLFKL	-7.5882	-7.4729	-14.7946	-14.5696	I(1)
LINFR	-3.5970	-3.9489	-2.3997	-3.3143	
ΔLINFR	-6.6525	-6.6925	-6.4315	-6.3705	I(0)/I(1)
Critical values (CV) at 5% significant level					
Level	-2.9446	-3.5386	-2.9422	-3.5348	
1 <sup>st</sup> Diff	-2.9472	-3.5426	-2.9446	-3.5386	

Notes: A variable is stationary when ADF and PP values are greater than the CV at a given level.

**Table 2a: Test of cointegration among series**

Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	5% CV	Prob.**	Max-Eigen statistic	5% CV	Prob.**
None*	0.805970	1155.85270	103.8473	0.0000	59.03073	40.95680	0.0002*
At most 1*	0.723638	96.82194	76.97277	0.0007	46.29755	34.80587	0.0014*
At most 2	0.489638	50.52439	54.07904	0.1000	24.21489	28.58808	0.1640
At most 3	0.353850	26.30950	35.19275	0.3249	15.72206	22.29962	0.3184
At most 4	0.177493	10.58745	20.26184	0.5822	7.034331	15.89210	0.6653
At most 5	0.093983	3.553114	9.164546	0.4827	3.553114	9.164546	0.4827

Series: ΔLFRS, ΔLGDP, ΔLTRAD, ΔLEXHR ΔLFKL and ΔLINFR. Trend assumption is no deterministic trend.

Trace test and Max-eigenvalue test indicate 2 cointegrating equations at the 5% level; \*denotes rejection of the hypothesis at 5%. \*\*MacKinnon–Haug–Michelis (1999) *p*-values.

From Table 2a, the trace statistic, Max-eigenvalue and MacKinnon–Haug–Michelis (1999) *p* values, reveal that the null hypotheses of no cointegration and at most one cointegrating equation among the variables were rejected in favour of the alternative hypotheses at 5 per cent. This is because their values exceed the critical values (CV) at the 0.05 level. This connotes that a long-run relationship exists among the variables. It can equally be seen from Table 2b that there are at most two (2) cointegrating equations in the series. Thus, we reported the normalized cointegrating equation, which was at *LFRS* and *LEXHR*.

**Table 2b: Cointegrating Equations (2) on LFRS and LEXHR**

		Log likelihood					
		-66.1549					
Normalized cointegrating coefficients (standard error in parentheses)							
LFRS	LEXHR	LFKL	LGDP	LLINFR	LTRAD	C	
1.0000	0.0000	1.1155*	-1.4918*	0.4899**	-2.1132*	-3.6473	
		(0.2445)	(0.1496)	(0.2572)	(0.3091)	(1.6936)	
0.0000	1.0000	1.7244*	-1.9502*	-2.0533*	0.9699*	17.2735	
		(0.2286)	(0.1391)	(0.2404)	(0.2890)	(1.5835)	

\*and \*\*: statistically significant at 1% and 5%, respectively.

The results from the cointegrating equations in Table 2b suggest that all the variables in the two equations are significant at the 0.05 level. With respect to the sign and magnitude of the variables in the long-run equilibrium, the first equation, which is of interest, reveals that the key factors that influence the level of foreign reserves in Nigeria include: GDP, level of trade openness, foreign capital inflow and inflation. The levels of GDP and trade exert positive impacts on foreign reserves. This implies that in the long run the size of the economy and trade openness would induce the accumulation of foreign reserves. This is in line with the self-insurance theoretical base of foreign reserves. The values indicate that about a €1 billion increase in GDP and trade would bring about a €1.49 billion and €2.11 billion increase in the level of foreign reserves.

On the other hand, the equation points out that the level of foreign capital inflow and inflation had a negative relationship with foreign reserves, while the sign of inflation conforms to the *a priori* expectation implying that an inflationary trend will reduce the level of foreign reserves. This is because as the domestic goods become costly, there would be lower demand for Nigerian exports, which will lower net exports and ultimately reduce the level of foreign reserves. However, the negative sign of foreign capital is unexpected. Basically, the level of foreign capital should induce foreign reserves as foreign currencies come into the domestic economy from the mercantilist point of view. However, the reverse is observed. This may not be unconnected with the fact that most foreign capital in Nigeria goes mainly to the oil and gas sectors which have little multiplier effect in the economy with respect to linkages with other sectors. This tends to contradict the accumulation of reserves agenda of the CBN. Just as it has been noted that there are other factors such as stable macroeconomic environment that stimulate foreign investment than foreign reserves (Osabuohien, 2007; Hassan *et al.*, 2009).

#### 4.2 Causality Tests for Vector Error Correction Model

The study examined the short-run dynamics (i.e. direction of causality) between the variables in the cointegrating equation by estimating the error

correction model (ECM). The estimation also involved the Wald Exogeneity test, which is presented in Table 3. Basically, variable  $y$  is said to be ‘Granger caused’ by variable  $x$  if  $x$  helps in the prediction of  $y$ , that is, if the coefficients on the lagged  $x$ 's are statistically significant at a given level.

The error correction variable in Table 3, which measures the speed of adjustment, i.e. the tendencies of each variable to return to equilibrium shows that the past equilibrium values play a role in determining the current outcomes. This is because they all have the expected negative signs which are significant at either varying levels, which implies the possibility of convergence from the short-run dynamics to the long-run equilibrium. However, the speed of adjustment among the variables is quite slow. This denotes that the past errors of interactions of foreign reserves and the selected macroeconomic variables are corrected in the current period but not very fast.

Still on Table 3, the causality in VEC and Wald tests points out that past values of GDP are significant in explaining the current values of foreign reserves. In other words, GDP Granger causes foreign reserves. However, the value of the joint significance implies that the previous values of foreign reserve are more influential in determining the current values of foreign reserves more than the previous values of the other variables taken together. For GDP, though the individual variables do not Granger cause it, their joint significance is relevant, which implies that jointly the previous values of other variables can exact influence on the current value of GDP. In the trade equation, it is obvious that the joint significance of the variables are relevant at the 1 per cent level. A similar explanation holds for foreign capital and inflation equations, where at 10 per cent there was no joint significance. However, in the former it is observed that the previous values of GDP, level of trade openness and exchange rate influences its current values, while in the latter only exchange rate influences it. This means what drives inflow of foreign capital in Nigeria is the growth of the economy, the level of trade openness and flexibility of exchange rate. This means that policy that would focus on the enhancement of the productive base of the economy would be a better position than a call for foreign reserves accumulation.

The above is further supported by impulse response function and variance decomposition carried<sup>3</sup> out among the variables as plotted in Figures 1 and 2, respectively. The impulse response functions usually trace out how the endogenous variables of the model respond to the shocks in the system at a given period, i.e. it traces out how the changes in one variable impact on the other endogenous variables (Pesaran *et al.*, 2000; Alege, 2009). Figure 1 plots the impulse response functions for the variables. The combined graphs are based on the output of the restricted VAR with analytic response standard error over ten periods and Cholesky degree of freedom adjusted, which show the response to Cholesky one standard deviation innovation. The graphs in

**Table 3: Causality in VEC and Wald exogeneity tests for vector error correction model**

Dependent variables	ECM (t-stat)	$\Delta$ LFRS (t-stat)	$\Delta$ LGDP (t-stat)	$\Delta$ LTRAD (t-stat)	$\Delta$ LEXHR (t-stat)	$\Delta$ LFKL (t-stat)	$\Delta$ LLNFR (t-stat)	Joint Sig. <sup>a</sup> p-value
$\Delta$ LFRS	-0.3074*** (1.8734)	0.1017 (0.4521)	1.5888*** (1.8928)	0.18228 (0.2690)	0.6054 (1.0233)	0.2151 (0.7235)	0.20232 (0.9737)	0.4769
$\Delta$ LGDP	-0.2418*** (1.9601)	0.1741 (1.1567)	0.0688 (0.3564)	0.0812 (0.4888)	0.2252 (1.7249)	0.0641 (1.0617)	0.0582 (1.1428)	0.0000*
$\Delta$ LTRAD	-0.3973* (2.7301)	0.2413 (1.6937)	0.5511 (2.1636)	0.6594 (1.4410)	0.2918 (1.7381)	0.1376 (1.7381)	-0.1382* (2.1636)	0.0000*
$\Delta$ LEXHR	-0.2269* (4.3504)	0.1316 (1.0141)	0.1595 (0.5359)	0.3321 (1.2975)	0.3106 (1.5443)	0.1675 (1.4918)	0.2023 (0.9737)	0.3491
$\Delta$ LFKL	-0.1352* (2.4332)	-0.7318 (1.3991)	1.5506* (2.5543)	1.1767* (2.5767)	1.0179* (2.5532)	0.3973 (1.7831)	0.2708 (1.8162)	0.1544
$\Delta$ LLNFR	-0.1288* (1.9542)***	0.3360 (1.3818)	0.6402 (1.0676)	0.1194 (0.2674)	0.8980* (1.9949)	0.4007 (1.7714)	0.2904 (1.8386)	0.2077

\*, \*\*, and \*\*\* mean significant at 10%, 5% and 1%, respectively. t-statistics are in parentheses.

<sup>a</sup>The joint significance was obtained from Wald Test of exogeneity because the lag value was more than one.

**Figure 1: Impulse response to Cholesky one SD (combined graphs)**

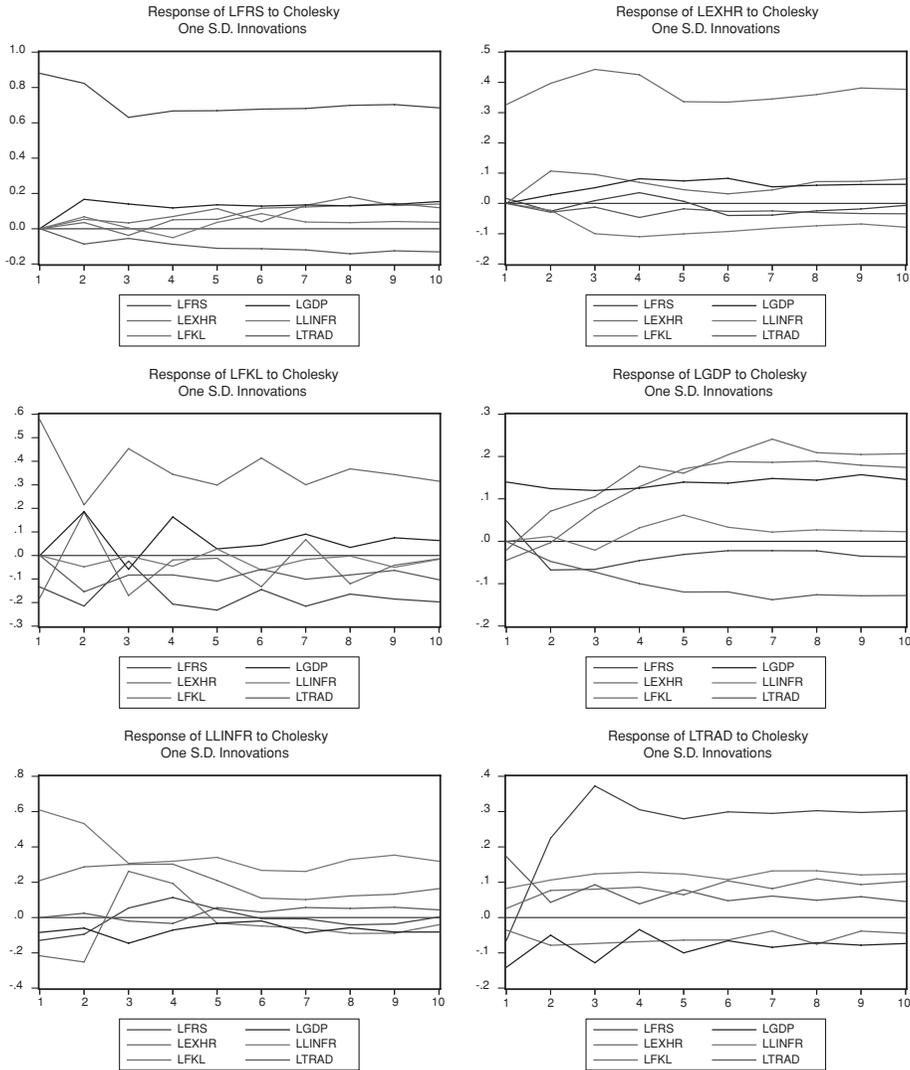
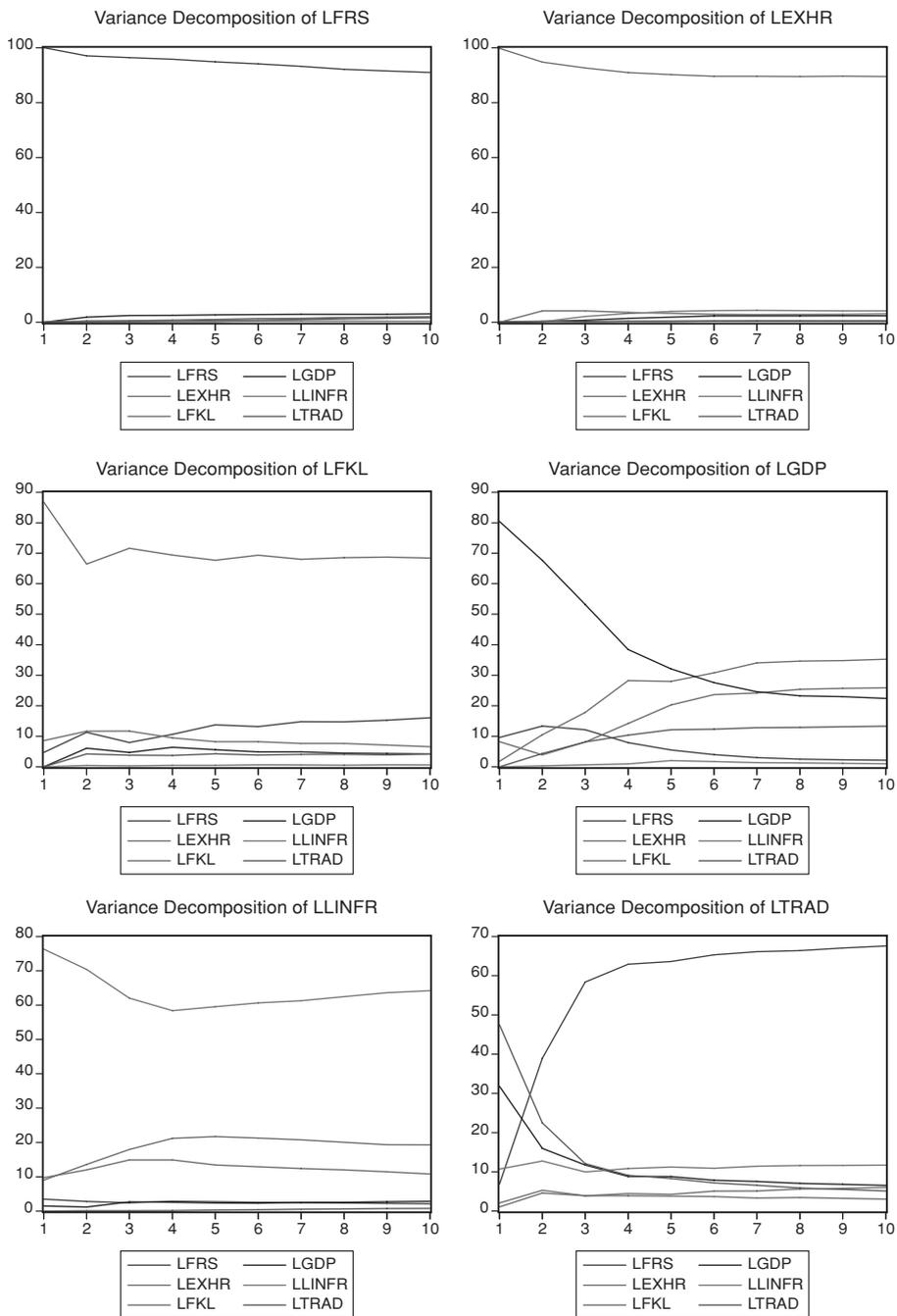


Figure 1 indicates the response of a shock of an endogenous variable on the other endogenous variables, implying the effect of a positive temporary shock on the variables. Hence, the first entry shows a temporary positive shock causes an initial increase and the response at the instance of the shock over the horizon. It also shows that there is little or no effect on the other variables at impact.

The variance decomposition, on the other hand, shows the percentage of error variance in one variable due to one standard deviation shock of the

**Figure 2: Variance decomposition of series (combined graphs)**



variable itself and other variables in the model. It helps in ascertaining the relative importance of various variables in explaining the variations in the variables being considered. It could be observed from Figure 2 that the variation of 'own shock' is high on impact and declines in a non-linear pattern into the horizon.

## **5. Conclusion**

The existence of a variety of debatable discourse regarding the level of Nigeria's foreign reserves motivated this paper. The paper employed econometric tools to analyze time series data sourced from CBN Statistical Bulletin (1970–2007) after reviewing the theoretical background for the reasons why countries keep reserves, which include self-insurance, mercantilist and macroeconomic stabilization maxims.

The results from the econometric analyses show that there is a long-run relationship between foreign reserves and selected macroeconomic variables with some of them accounting for the increasing level of foreign reserves. The results obtained from the cointegration indicate at least two co-integrating equations. The study confirms that in Nigeria, the factors that influence the level of foreign reserves are GDP, level of trade openness, foreign capital inflow and inflation. The levels of GDP and trade openness were found to exhibit positive impacts on foreign reserves, supporting the self-insurance theoretical base of foreign reserves. Whereas the level of foreign capital inflow and inflation had a negative relationship with foreign reserves, which tends to contradict the accumulation of reserves agenda of the CBN.

The error correction model of the study showed the possibility of convergence from the short-run dynamics to the long-run equilibrium between the selected variables; however, the speeds of adjustment among the variables were observed to be slow. In addition, the causality in VEC and Wald tests point out that past values of GDP is significant in explaining the current values of foreign reserves. On the other hand, the value of the joint significance indicates that the previous values of foreign reserve are most influential in determining the current values of foreign reserves more than the previous values of the other variables taken together. It was equally established that the previous values of GDP, level of trade openness and exchange rate influences the current values of foreign capital. This underscores that what drives inflow of foreign capital in Nigeria is the growth of the economy, the level of trade openness and flexibility of exchange rate. Thus, the policy that would focus on the enhancement of the productive base of the economy would be a better position than a call for foreign reserves accumulation. This paper therefore opines that accumulation of foreign reserves does not produce satisfactory returns for Nigeria. It is therefore

recommended that policies, which would focus on the enhancement of the internal economy, especially the stability of the economy, should be pursued instead of a crusade for foreign reserves.

### Notes

1. Both tests are similar but the PP takes into cognizance time series properties in the presence of possible structural change. However, variables that are stationary using ADF are always stationary using PP at a given level (Abdulai and Jaquet, 2002; Osabuohien, 2007).
2. The maximum lag length chosen for the variables in the model was 2. This was derived from AIK procedure, which selects the maximum possible lag length.
3. The study equally carried out diagnostic tests. The tests, which are not reported for the sake of brevity, confirm that no violations of the basic assumptions on them were made.

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