Demand For Foreign Exchange Reserves In Nigeria: A Cointegration Approach

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Abstract

There have been significant accretions to foreign exchange reserves over the last decade in Nigeria, especially since the return to democratic governance in 1999. The study tries to find out the underlying factors driving the demand for reserves by the monetary authority. To estimate the demand for foreign exchange reserves in Nigeria, Jahansen cointegration and error correction methodology was utilized for the period 1985:Q1-2010:Q4. The results show that the long-run demand for foreign exchange reserves in Nigeria is driven by economic size, capital account vulnerability, exchange rate flexibility and opportunity cost. In the short-run, the major determinant of demand for foreign exchange reserves in Nigeria is current account vulnerability. This implies that foreign exchange reserves should be held as a precaution against current account vulnerability since Nigeria is a high import-dependent country. The study recommended recommends that policy should be tailored towards accumulating reserves during oil boom to serve as a buffer against external shocks and that trade policy should discourage heavy importation of consumption goods in favour of domestic locally produced consumption of locally produced goods.

Key words: Foreign exchange reserves, cointegration, error correction model

JEL Classification: F31, C32

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I. Introduction

There have been significant and rapid increases in the accumulation or stock of foreign exchange reserves over the last decade in both developing and emerging economies. This phenomenal growth is reflective of the importance these countries attach to holding optimal level of foreign exchange reserves in recent times. According to Elhiraika and Ndikumana (2007), apart from the high oil prices, three factors have been identified as reasons for the build-up in foreign exchange reserves. First, is the need for insurance against future crisis. Second, is the need to support a strong export-led growth in Asia following large exchange rate depreciation as a result of the 1997 financial crisis.

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Third, is the weak domestic financial institutions of these countries and integration of the domestic markets into the global financial market.

In the same vein, Nigeria has experienced significant accretions to foreign exchange reserves over the last decade, especially since the return to democratic governance in 1999. This development can be attributed to a host of factors such as the boost in export earnings from crude oil sales exports and the precautionary motive to absorb external shocks or attack on the local currency. The increase in the build-up of foreign exchange reserves in recent times can also be attributed to the macroeconomic reforms embarked upon by the country since 2003.

The question is why would a country's monetary authority want to hold foreign exchange reserves? From a survey of the literature, a country would want to hold certain levels of reserves for the following reasons: to maintain confidence in monetary and exchange rate policies; to intervene in the foreign exchange market by the monetary authorities; to provide a buffer against external shocks in the face of economic crises or emergencies; to boost a country's credit worthiness; and to safeguard the value of the domestic currency. Therefore, an understanding of the determinants of the demand for foreign exchange reserves would help the monetary authorities and policymakers to design optimal foreign exchange reserves management strategies to minimize the associated cost of holding reserves and maximize the gains from the inflow of reserves.

The objective of the study is to investigate the demand for foreign exchange reserves in Nigeria. Basically, it tries to find out the underlying factors that would make the monetary authorities to hold high levels of reserves. To estimate the demand for foreign exchange reserves in Nigeria, the Johansen method of cointegration is utilized because it is better suited to estimate the long-run relationship between foreign exchange reserves and its determinants. Since the variables of interest are cointegrated, the vector error correction methodology (VECM) is employed to verify the short-run dynamics.

The paper is divided into 5 five sections. Following the introduction is section 2, which discusses the reasons for holding foreign exchange reserves, the approaches that influences the accumulation of foreign exchange reserves and the empirical framework of the study. In section 3, the data and econometric methodology adopted for to estimating estimate the long-run demand for foreign exchange reserves are discussed. Section 4 analyzes the results and findings from the estimations, while section 5 concludes with an attempt to proffer some policy recommendations arising from the findings of the study.

II. Review of Empirical Literature

II.1 Review of Relevant Literature

Just like the demand for money, the motives for holding foreign exchange reserves can be classified into three–transaction, speculative and precautionary (Reddy, 2002). Trade across country borders requires the flow of currency that is assumed to be handled by the deposit money banks, which is driven by the transaction motive. In the same vein, the speculative motive for holding foreign exchange reserves is taken care of by individuals or the private sector. The central bank keeps a large stock of foreign exchange reserves in the form of a buffer stock as precaution for unpredictable flows, which is consistent with the precautionary motive for holding foreign assets. The precautionary motive for holding foreign currency, like the demand for money, can be positively related to wealth and the cost of covering unplanned deficit and negatively related to the return from alternative assets.

Foreign exchange reserves are instruments to maintain or manage the exchange rate, while enabling orderly absorption of international money and capital flows. Therefore, foreign exchange reserves are held for precautionary and transaction motives, keeping in view the aggregate for national interests to achieve a balance between demand for and supply of foreign currencies, for intervention and to preserve confidence in the country's ability to carry out international transactions (Reddy, 2002).

From the literature, there are two approaches that drive the accumulation of foreign exchange reserves – the traditional or precautionary and the contemporary or mercantilist approach. The traditional model of the demand for foreign exchange reserves, or the buffer stock approach was proposed by Heller (1966). According to the model, a country holds foreign exchange reserves as a buffer stock to smoothen unexpected and temporary imbalances in international payments, which is known as the precautionary motive of holding reserves (Heller, 1966; Mendoza, 2004; Gosselin and Parent, 2005; Elhiraika and Ndikumana, 2007; and Prabheesh et al, 2009). Where reserves are inadequate, the monetary authority is forced to implement expenditure- dampening policies to rebuild reserves, resulting in loss of output, which is known as macroeconomic adjustment. The rise in adjustment cost may result to in a rise in the demand for foreign exchange reserves. According to Heller (1966), the authorities are looking for an optimal level of foreign exchange reserves that would be a balance between the macroeconomic cost of depleting its reserves and the opportunity cost of holding reserves. This cost is measured as the difference between what the reserves could have earned and what they actually earn. Therefore, the demand for reserves increases with a fall in the opportunity cost. In this situation,

the level of reserves will increase along with a country's risk aversion and volatility (Gosselin and Parent, 2005).

The contemporary approach is the alternative explanation for the accumulation of reserves, which is also known as the mercantilist approach. The approach which is also known as the new Bretton Woods system argues that reserves accumulation is the by-product of the undervalued exchange rate policies being adopted by the Asian economies to promote their exports and channel domestic and foreign direct investment to the export industries. The logic is that the emerging economies are deliberately keeping their currencies undervalued by foreign exchange purchases so as to promote export-led growth. This phenomenon resulted in persistent current account surpluses and reserves accumulation with the central banks of the Asian economies. China is a typical example as it had undervalued its exchange rate to maintain its export competitiveness with trading partners and emerged as the top reserve holding country in the world (Prabheesh, et al., 2009). In sum, the contemporary or mercantilist approach views reserves accumulation as the outcome of exchange rate and export policies of the country, while the traditional or precautionary approach views reserves as a sudden stop, capital flight and its volatility.

Probing into the possible reasons why most central banks hold foreign reserves under the floating exchange rate regime in early eighties, Batten (1982) modeled two central banks' reaction functions, namely, intervention model and asset-choice model. The result of the intervention model indicated that central banks hold foreign exchange reserves purposely to intervene in the foreign exchange market. The findings of the asset model were insightful and showed that different factors influence foreign exchange demand of central banks. It showed that foreign exchange demand is sensitive to relative changes in the yields of central banks' asset portfolio. The result also showed that foreign exchange reserves serve as a substitute to other assets in the central bank's portfolio. Besides, it was found that a decrease in the percentage of uncommitted portfolio composed of foreign reserves, which accounted for the usual over prediction of the reserves demand by the intervention model under the floating exchange rate regime.

In examining the issue of reserves accumulation by central banks in emerging Asia, Gosselin and Parent (2005) estimated a reserve-demand function in a panel of eight Asian emerging market economies. In consonance with the literature, they found that the level of reserves holding can be explained by some key macroeconomic factors. Most importantly, they found evidence of a positive structural break in the demand for international reserves by Asian central banks in the aftermath of the Asian financial crisis of 1997-98, indicating that the actual

level of reserves accumulated in 2003-2004 was in excess relative to that predicted by the model.

Using cointegration and error correction approach, Prabheesh, et al (2007) estimated India's demand for foreign exchange reserves in the period 1983:1 to 2005:1. They established that the ratio of imports to GDP, the ratio of broad money to GDP, exchange rate flexibility and interest rate differential determine India's long-run reserves demand function. They found that foreign exchange reserves accumulation in India was highly sensitive to capital account vulnerability and less sensitive to its opportunity cost. More so, the speed of adjustment coefficient of the vector error correction model suggested that the monetary authorities in India had to engage in more active reserve management practices.

Elhiraika and Ndikumana (2007) investigated the recent increase in foreign exchange reserves accumulation in African countries. By employing panel data from 21 African countries, the study investigated the motivations, sources and impact of reserves accumulation with a focus on the impact of key macroeconomic variables–public and private investment, exchange rate and inflation rate. They found that reserves hoarding cannot be justified by the returns to asset considerations, given the low world interest rates and the high rates of returns to domestic assets in African countries. This implies that reserves accumulation carries a high opportunity cost for African countries and cheap financing of the deficits for reserve assets countries.

Jalil and Bokhari (2008) employed a buffer stock model to estimate optimum demand for foreign exchange reserves for Pakistan using monthly data from June 1995 to June 2005. The result of the model indicated that opportunity cost of holding reserves play a much more significant role than volatility of reserves in determining the level of reserves in Pakistan. The result further showed that structural shift in reserves in the year 2000 occasioned by the surge in remittance and other exogenous capital flows influenced the rise in foreign reserves holdings.

Prabheesh, et al (2009) also investigated the importance of precautionary and mercantilist approaches to international reserves in India using monthly data for the period 1993:06 to 2007:03. They used the autoregressive distributed lag (ARDL) approach and cointegration to estimate the long-run relationship between reserves and its determinants. The results showed that the impact of the volatility of Foreign Institutional Investment which captures the precautionary motive and the undervalued real exchange rate, which was associated with the mercantilist view on reserves were statistically significant in the long-run. They concluded that

both the precautionary and mercantilist motives explain reserve accumulation in India during the period of investigation.

There is a dearth of studies on estimating the long-run demand for foreign exchange reserves in Nigeria. At the time of writing this paper and to the best of our knowledge there have been no documented study carried out to empirically investigate the determinants of foreign exchange reserves in Nigeria. However, there exists a couple of studies that explore other aspects of foreign reserves in Nigeria. Such studies include Oputa (1997), Nda (2006), Abeng (2007), Onwioduokit (2008), Migap (2010) and Oputa and Ogunleye (2010). For example, Oputa (1997) focused on the determination of currency composition of external reserves, while Abeng (2007) dealt with non-empirical aspect of foreign exchange reserves accumulation. The subsequent study by Oputa and Ogunleye (2010) addressed empirical aspect of external reserves accumulation and its adequacy level, which Abeng (2007) failed to address in his study. Other studies such as Nda (2006) and Onwioduokit (2008) focused on issues and challenges of effective reserve management in Nigeria and challenges in investing Africa's external reserves, respectively.

Since none of these studies addressed the demand for foreign reserves in Nigeria, this study finds it expedient to fill the gap by providing an insight to understanding the underlying factors driving the long-run demand for foreign exchange reserves in Nigeria.

II.2 Empirical Framework

From literature, the determinants of foreign exchange reserves are classified into five categories: economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility and opportunity cost (IMF, 2003 and Gosselin and Parent, 2005). Therefore, the long-run demand for foreign exchange demand function depends on these five categories of explanatory variables.

Table 1: Empirical Determinants of Reserve Holdings

Determinants	Explanatory Variables
Economic size	GDP, GDP per capita
Current Account Vulnerability	Ratio of imports to GDP, ratio of trade to GDP and ratio of current account deficit to GDP
Capital Account Vulnerability	Ratio of capital account deficit to GDP, ratio of short-term external debt to GDP and ratio of broad money supply to GDP
Exchange Rate Flexibility	Nominal exchange rate, volatility of the exchange rate
Opportunity Cost	Interest rate differential

The potential explanatory variables that can determine the demand for foreign exchange reserves according to literature are presented in table 1. Following the studies by the IMF (2003) and Gosselin and Parent (2005), the long-run demand for foreign exchange reserves can simply be specified thus:

$$RES_t = \beta_0 + \beta_1 ES_t + \beta_2 CAAV_t + \beta_3 CPAV_t + \beta_4 ER_t + \beta_5 OC_t + \varepsilon_t \quad (1)$$

RES is foreign exchange reserves, ES is economic size, CAAV is current account vulnerability, CPAV is capital account vulnerability, ER is exchange rate flexibility and OC is the opportunity cost of holding foreign exchange reserves.

The demand for foreign exchange reserves and the volume of international transactions are expected to increase as the economic size of a country increases. In view of the nature of production and exports in Nigeria, the level and growth rate of output is expected to influence significantly the level of foreign exchange reserves. Increases in current and capital account vulnerability would induce the central bank to hold more reserves. A higher flexibility of exchange rate would reduce the demand for foreign exchange reserves because central banks no longer need a large stock of reserves to manage a pegged exchange rate. Similarly, there would be a lower demand for foreign reserves if there is a higher opportunity cost of holding reserves because alternative investments become comparatively attractive.

III. Data and Methodology

III.1 Data

The study utilizes quarterly data series of foreign exchange reserves, nominal GDP, imports, money supply, exchange rate flexibility and interest rate differential to examine the determinants of foreign exchange demand in Nigeria during the period 1985:1 – 2010:4. The data were sourced from two main sources namely the World Bank database and the Central Bank of Nigeria's Statistical Bulletin. The rationale for choosing the study period was premised on the argument that the period of deregulation should have reduced central bank intervention and demand for foreign exchange reserves, because of exchange rate flexibility. However, the period was characterized with by a guided deregulation regime which requires the monetary authority to intervene in the foreign exchange market. Therefore, an examination of the determinants of foreign exchange reserves for this period becomes paramount. All the variables are used in their logarithm form except interest rate differential. The variables are defined as follows:

Foreign Exchange Reserves (RES) – Foreign exchange reserves is the total reserves minus gold. These are external assets that are readily available to and controlled by the monetary authority for direct financing of external payments imbalances, for indirectly regulating the magnitudes of such imbalances through intervention in the exchange markets (Balance of Payments Manual, BPM 6IMF, 2009).

Nominal GDP– Nominal GDP is a proxy for economy size. It is expected that an increase in GDP will induce demand for foreign exchange reserves.

Imports (IM) – import is a proxy for current account vulnerability. It is the ratio of imports to GDP. We assume that high imports ratio to GDP leads to increasing current account vulnerability and may lead to a rise in the demand for foreign exchange reserves.

Money Supply (RMS) – Money supply represents capital account vulnerability, it is proxied by the ratio of money supply to GDP. High ratio of M2 to GDP could lead to capital account vulnerability and is associated with high foreign exchange reserves holding.

Exchange Rate flexibility (ERF) – The logarithm of nominal exchange rate would serve as a proxy for exchange rate flexibility. It is assumed that a more flexible exchange rate would require no monetary authority's intervention in the foreign exchange market and thereby reduce the demand for foreign exchange reserves.

Interest Rate Differential (IRD) – Interest rate differential is the difference between the US prime lending rate and Nigeria prime lending rate. It is a proxy for the opportunity cost of holding foreign exchange reserves. We assume that higher opportunity cost of foreign exchange reserves could lead to divestment and thereby reduce foreign exchange reserves holdings.

III.2 Methodology

The paper follows the study of the IMF (2003), where the determinants of the demand for foreign exchange reserves were classified into five categories: economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility and opportunity cost. A study of this nature requires appropriate model that captures the dynamic feedbacks between foreign exchange reserves and its determinants both in the short- and long-run. We, therefore, find it appropriate to utilize the Johansen (1988) and Johansen and Juselius (1992) method of cointegratian to estimate the demand far foreign exchange reserves in Nigeria. The choice of using this methadology is predicated on the grounds that it is better suited to estimate the long-run relationship between foreign exchange reserves and its determinants and/or to find out whether there exists a common stochastic trends among the variables of interest. To verify the short-run dynamics, the vector error correction methodology (VECM) is employed, if the variables of interest are cointegrated. The empirical investigation of the relationship between foreign exchange reserves and its macroeconomic determinants were carried out in three steps.

In the first step, the properties of the variables of interest are investigated to ascertain that they are stationary in order to determine the appropriate specification for the vector autoregression (VAR) estimation. It is important to test for the presence of unit root and determine the order of integration of the variables to avoid the problem of spurious regression. The order of integration of the variables is determined by applying the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests for unit roots in the variables under the null hypothesis that the series is non-stationary and integrated of order one or I(1). A variable is non-stationary if it contains a unit root and co-integration can exist if it combines with other non-stationary variables of the same order of integration to form a stationary co-integration relationship, which imply the existence of a meaningful economic relationship. In sum, co-integration presupposes that the variables in the system are non-stationary and integrated of the same order.

In the second step, we commence by constructing an unrestricted vector autoregressive (VAR) process as advacated by Sims (1980) involving up to *k* lags

as in equation (4). This type of model is used to estimate dynamic relationships among jointly endogenous variables without imposing strong a priori restrictions.

$$X_t = \mu + A_1 X_{t-1} + \cdots + A_t X_{t-k} + \varepsilon_{1t} \qquad \varepsilon_{1t} \sim \mathrm{IN}(0, \Sigma) \tag{2}$$

Where X_t is $(n \times 1)$ vector of endogenous variables consisting of foreign exchange reserves and other dependent variables and each of the A_i is an $(n \times n)$ matrix of parameters, k is the minimum lag length that reduces serial correlation in the residuals of each equation in the VAR to zero statistically, based on the Ljung-Box (L-B) Q-Statistics and ε_{1t} is a vector of white noise processes with non-diagonal covariance matrix.

The model in equation (2) is in reduced form with each variable in X_t regressed on only lagged values of both itself and all the other variables in the system. An efficient way to estimate equation (2) is by using OLS because the right-hand side of each equation in the system comprises a common set of regressors. Equation (2) is then re-formulated to get the vector error correction model (VECM) form as:

$$\Delta X_t = \psi + \Gamma_1 \Delta X_{t-1} + \cdots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \varepsilon_{2t} \tag{3}$$

where $\Gamma_i = -(1 - A_1 - \cdots - A_i); i = 1, \cdots, k-1$

and $\Pi = -(1 - A_1 - \cdots - A_k)$.

Specifying (2) in the error correction model form of (3) helps to uncover the information contained in both the short- and long-run adjustments to changes in X_t, through the parameter estimates of Γ_i and Π, respectively. Besides, we know that $\Pi = \alpha\beta'$, where β is a matrix of long-run coefficients such that the term $\beta' X_{t-k}$ embedded in equation (3) represents up to $(n-1)$ cointegration relationships in the multivariate model, which ensures that X_t converges with to their long-run steady state solutions; while α is the matrix containing error correction coefficients that measures the extent to which each variable in the system respond to deviations from the long-run equilibrium. The component part ΠX_{t-k} of equation (3) is the stationary long-run error correction relation(s), which must be stationary for $\varepsilon_{2t} \approx 1(0)$ to be white noise.

To choose the optimal lag length for estimating the VAR, the Akaike Information Criteria (AIC) and Schwartz Information Criteria (SIC) selection procedures were utilised because they tend to find a balance between a good approximation of the data generating process and an efficient use of the sample information.

The third step considers the test for co-integration, which is the reduced rank test for r non-zero eigenvalues (λ_i). There are two types of tests for co-integration, which are the trace and maximum max-eigenvalue tests. The null hypothesis of the test statistics of at most r cointegrating vectors against the alternative of n cointegrating vectors is the λ_{trace} statistics as stated inas:

$$\lambda_{trace} = -T\sum_{i=r+1}^{n} \ln(1-\lambda_i) \qquad r = 0,1,2,\ldots,n-2,n-1 \qquad (4)$$

Another test of the significance of the largest λ_r is the so-called maximum eigenvalue of or λ_{max} statistic, which tests for the null hypothesis of r against the alternative of $r+1$ cointegrating vectors as in:

$$\lambda_{max} = -\mathrm{T}ln(1-\lambda_{r+1}) \qquad r = 0,1,2,\ldots,n-2,n-1 \qquad (5)$$

IV. Analysis of Results and Findings

IV.1 Result of the Unit Root Tests

To establish cointegration or long-run equilibrium among the six variables, we begin by examining the statistical properties of the data. We test to ascertain the stochastic trends in the autoregressive representation using both augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. For the null hypothesis of non-stationarity of the data, the ADF and PP test statistics were presented and carried out in levels and in differences including a constant and trend. We then compared the critical value of -4.0496 at one per cent with the computed ADF and PP test statistics. In levels, we reject the null hypothesis of non-stationarity if the computed values of the test statistics are smaller than -4.0496 in absolute terms. The results is are presented in table 1.

Table 2: ADF and PP Unit Root Test Results

VARIABLES	Levels				First Difference			
	ADF 1	PP 1	ADF 2	PP 2	ADF 1	PP 1	ADF 2	PP 2
LRES	-1.1070	-0.9787	-3.2229	-3.0958	-12.2255*	-12.2423*	-12.1657*	-12.1817*
LIM	-3.5470	-3.3113	-3.7493	-3.5295	-13.5173*	-13.5654*	-13.4554*	-13.5023*
LMS	-2.3527	-2.2498	-2.4156	-2.3046	-11.6297*	-11.6489*	-11.6955*	-11.7204*
LIRD	-2.6830	-2.7566	-2.4334	-2.5437	-8.5585*	-8.5521*	-8.6054*	-8.6005*
LERF	-2.5688	-2.5288	-2.0750	-2.1244	-9.1093*	-9.1098*	-9.3965*	-9.3968*

Notes: ADF 1 and PP 1 represent= Unit root tests with constant, while ADF 2 and PP 2 = Unit root tests with constant and trend. *, ** and *** indicate statistical significance at the 1%, 5% and 10% level respectively. With constant and trend: McKinnon (1991) critical values are -4.0496(1%), -3.4540 (5%) and -3.1527 (10%).

The results of the unit root test from table 2 permits us to reject the null hypothesis of non-stationarity for all the variables, implying that all variables included in the model are integrated of order one or I(1). This is indicative of the possibility of the existence of cointegration among the variables of interest.

IV.2 Optimal Lag Length Selection

The estimation of a VAR model requires the choice of an appropriate lag length. A maximum lag of 4 was allowed in the selection given the number of observations and variables. The LR, FPE and AIC indicate lag length of 4, while SC and HQ indicate lag length of 1. Based on SC and HQ selection criterion, we choose a lag length of 1 (see table 3).

Table 3. VAR Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-634.4032	NA	0.01471	12.80806	12.96437	12.87133
1	41.01698	1256.281	4.11E-08	0.01966	1.113832*	0.462491*
2	77.05937	62.71376	4.14E-08	0.018813	2.050845	0.841213
3	122.1439	73.03688	3.52E-08	-0.162877	2.807017	1.039092
4	162.0318	59.83189*	3.38e-08*	-0.240636*	3.66712	1.340903

Notes: The following acronyms: LR, FPE, AIC, SC and HQ connotes sequential modified LR test statistic (each test at 5% level), Final prediction error, Akaike information criterion, Schworz information criterion and Hanna-Quinn information criterion, respectively. The asterisk * indicates lag order selected by the criterion.

IV.3 Stability Test

To ensure the reliability of the coefficients of the normalized cointegrating model for the long-run and vector error correction model for the short-run, we employed an autoregressive (AR) root stability test. The estimated VAR is stable if all roots have modulus less than one and lie inside the unit circle. The result of the AR root stability test satisfies the stability condition of the modelas shown in table 4.

Table 4. Stability Test

Root	Modulus
0.992125	0.992125
0.931639	0.931639
0.856616 - 0.109240i	0.863553
0.856616 + .109240i	0.863553
0.798663	0.798663
0.370094	0.370094

No root lies outside the unit circle. VAR satisfies the stability condition

IV.4 Johansen Cointegrating Test

Having carried out the stationarity tests and established that the variables are non-stationary at levels. We proceed to test for long-run relationship among the variables using the Johansen cointegration test.

Table 5. Unrestricted Cointegration Rank Test

Trace

H0	H1	Eigenvalue	Statistic	Critical Value	Prob.**
r = 0	r = 1	0.307458	100.4434*	95.75366	0.0228
r ≤ 1	r = 2	0.201243	62.97	69.81889	0.1557
r ≤ 2	r = 3	0.149184	40.05073	47.85613	0.2207
r ≤ 3	r = 4	0.110428	23.57162	29.79707	0.2191
r ≤ 4	r = 5	0.089291	11.63615	15.49471	0.1752
r ≤ 5	r = 6	0.020338	2.095899	3.841466	0.1477

Maximum Eingenvalue

H0	H1	Eigenvalue	Max-Eigen Statistic	Critical Value	Prob.**
r = 0	r > 1	0.307458	37.47345	40.07757	0.0955
r ≤ 1	r > 2	0.201243	22.91927	33.87687	0.5366
r ≤ 2	r > 3	0.149184	16.47911	27.58434	0.6248
r ≤ 3	r > 4	0.110428	11.93547	21.13162	0.5541
r ≤ 4	r > 5	0.089291	9.540251	14.2646	0.2439
r ≤ 5	r > 6	0.020338	2.095899	3.841466	0.1477

Notes: A linear time trend was included in the specification to compute the cointegration statistic.

From table 5 above, the eigenvalue of the trace test statistic point to the existence of one cointegrating vector with plausible normalized coefficients at the 5.0 per cent level of significance. This implies that among the six variables, there exists one set of cointegrating relationship. Based on this result, we proceed to estimate normalized cointegrating coefficients with respect to reserves (RES).

IV.5 Normalized Cointegrating Result

The coefficient of foreign exchange reserves has been normalized to 1 and the coefficients of the normalized cointegrating equation are according to theoretical expectations, except exchange rate flexibility (ERF) and capital account vulnerability (LMS). Therefore the long-run cointegrating equation of foreign exchange reserves demand and the independent variables is specified thus:

RES = 0.34ERF + 3.18LIM – 1.84LMS +1.19NGDP – 0.12IRD – 3.01

The long-run model indicated that all variables in the model are statistically significant with the exception of the variable for current account vulnerability at the 5.0 per cent level of significance. The result showed that exchange rate flexibility, current account vulnerability and economic growth are positively related to the demand for foreign exchange reserves, while capital account vulnerability and interest rate differential ore negatively related. It implies that a one per cent rise in current account vulnerability and economic growth leads to a 3.18 and 1.19 per cent increase in demand for foreign exchange reserves, respectively. Capital account vulnerability should have been positively associated with foreign exchange reserves holding, but the reverse holds in Nigeria. The negative coefficient of capital account vulnerability implies that variation in capital account has little effect on reserves holdings in Nigeria because the major source of foreign exchange is not from capital account, such as foreign direct and port-folio investments but rather from current account (crude oil exports). This connotes that the variability in capital account for Nigeria does not necessarily lead to reduction in demand for foreign exchange reserves capital account vulnerability constrains or reduces the ability of the centrak bank to accumulate foreign exchange reserves in the long-run. The interest rate differential, which is a proxy for opportunity cost of holding foreign exchange reserves, is in consonance with theoretical expectation. The increase in the opportunity cost of foreign exchange reserves holdings would lead to divestment to other productive ventures and reduce the demand for foreign exchange reserves in Nigeria.

Table 6. Normalised Cointegrating Coefficients

Error Correction:	LRES	LERF	LIM	LMS	LNGDP	IRD
Normalized β	1	-0.34	-3.18	1.84	-1.19	0.12
		(-2.10)	-0.55	(-2.86)	(-3.79)	-3.97
Error Correction						
CointEq1	-0.10	-0.58	-0.34	-0.27	-0.52	0.004
	[-2.28]	[-0.96]	[-2.39]	[-0.51]	[-0.85]	[-0.22]

Figures in parenthesis are the t-statistics of the parameters

IV.6 Short-run Model (Vector Error Correction Model)

From the second panel in table 6, the speed of adjustment which is the coefficient of the error correction model (ECM) is -0.10, implying that about 10.0 per cent of the deviation from equilibrium is corrected every quarter. The ECM is negative and significant; indicating that foreign exchange reserves have to decline in order to adjust to the long-run equilibrium since when it is above its long-run average position. Moreover, 0.10 per cent coefficient of ECM is an indication of a low speed of adjustment to the long-run equilibrium. Clark (1970) and Prabheesh, et al. (2009) states that "a *country with low speed of adjustment would require high level of foreign exchange reserves to finance its balance of payments*". In the short-run only current account vulnerability is significant in explaining demand for foreign exchange reserves, other factors such as capital account vulnerability, exchange rate flexibility; opportunity cost and economic growth are not significant in explaining the demand for foreign exchange reserves in Nigeria. This implies that shocks to the price of crude oil would impact on the current account balance, given that oil export is a major component of Nigeria's current account.

V. Conclusion and Policy Recommendation

This study has empirically examined the determinants of foreign exchange reserves in Nigeria using quarterly data from 1985:1 to 2010:4. Basically, the study sought to find out the underlying factors driving the monetary authorities' desire to hold high levels of reserves. To establish the empirical premises for the study, the empirical findings of similar studies were surveyed with the empirical framework. We then estimate the demand for foreign exchange reserves in Nigeria using the Johansen and Juselius (1992) method of cointegration, because it is better suited to estimate the long-run relationship between foreign exchange reserves and its determinants. Also, the statistical properties of the series were examined using unit root tests and some other relevant tests. Since the variables

of interest are cointegrated, the vector error correction methodology (VECM) was implored employed to verify the short-run dynamics.

The results from the long-run Johansen cointegrating model show that the demand for foreign exchange reserves is driven by economic size, capital account vulnerability, exchange rate flexibility and opportunity cost in the long-run. However, in the short-run, current account vulnerability acts as the major determinant of the demand for foreign exchange reserves in Nigeria. The results corroborate the findings of Jalil and Bokhari (2008) for India and Prabheesh et al (2007) for India and Pakistan, respectively. Their findings showed that reserves holding in India was driven by capital account vulnerability while that of Pakistan was influenced by exogenous capital flows such as remittances and other current account items. In view of our findings, we recommend that Nigeria should hold reserves as a precaution against current account vulnerability. Since Nigeria's current account is majorly driven by the developments in the international oil market; policy should be tailored to accumulate foreign exchange reserves during oil boom as a buffer against external shocks. Also, to reduce the demand for foreign exchange reserves and current account vulnerability, Nigeria's trade policy should discourage importation of foreign consumption goods in favour of locally produced goods. This result also indicates that exchange rate depreciation might not be a good policy option to affect foreign exchange reserves holding in Nigeria, its flexibility might not necessarily lead to increase in foreign exchange reserves both in the long and short-run.

Holding high level of reserves is desirable for Nigeria to stem external shocks and vulnerability; however, the possible effect of high reserves holding on the domestic liquidity management calls for further research. Ascertaining the optimum level of reserves and the cost of holding reserves will shed light on an optimum level of reserves for Nigeria.

References

Abeng, M. O. (2007), "Foreign Exchange Reserves Accumulation: Implications for the Nigerian Economy." *Central Bank of Nigeria, Bullion*, Volume 31, 3.

Batten, D.S. (1982), "Central Banks' Demand for Foreign Reserves Under Fixed and Floating Exchange Rates". *Federal Reserve Bank of St. Louis*, Available at: http://research.stlouisfed.org/publications/review/82/03/Central_Mar1982.pdf

BPM 6 (2009), Balance of Payments and International Investment Position Manual. International Monetary fund Multimedia Service Division: Washington DC.

CBN (2009): Annual Report and Statement of Account.

Clark, P. B. (1970), "Optimum International Reserves and Speed of Adjustment', *Journal of Political Economy*, 78: 356-376

Elhiraika, A. and L. Ndikumana (2007), "Reserves Accumulation in African Countries: Sources, Motivations and Effects". Paper presented at the African Economic Conference, organized by AfDB and ECA, November 15-17 at in Addis Ababa, Ethiopia.

Gosselin, M. and N. Parent (2005), "An Empirical Analysis of Foreign Exchange Reserves in Emerging Asia". Bank of Canada Working Paper 2005-38, Ontario, Canada.

Heller, H. R. (1966), "Optimal International Reserves", *Economic Journal* 76: 296-311.

Huang, G. (1995), "Modelling China's Demand for International Reserves". *Applied Financial Economics*, Vol.5, No.5, pp.357-366

IMF (2009), Balance of Payments and International Investment Position Manual 6. International Monetary Fund Multimedia Service Division: Washington DC.

IMF (2003), "Are Foreign Exchange Reserves in Asia Too High?" *World Economic Outlook* (September): 64-77.

Jalil, A. and S. Bokhari, S. (2008), "The Optimal Demand for Foreign Exchange Reserves in Pakistan". *International Journal of Applied Econometrics and Quantitative Studies*, Vol. 5, No.1, pp.33-48

Johansen, S. (1988), "Statistical Ananlysis of Cointegrated Vectors." *Journal of Economic Dynamics and Control* 12 (213), 231-254.

Johansen, S. and K. Juselius (1992), "Testing Structural Hypothesis in a Multivariate Cointegration Analysis of the PPP and the UPI for UK." *Journal of Econometrics* 53, 211-244.

Migap, J. P. (2010), "The Decline of the Dollar: Implications for Nigeria's Foreign Reserves". *International Journal of Economic Development Reserch and Investment,* Volume 1, 2 & 3.

Mendoza, R. U. (2004), "International Reserves-holding in the Developing World: Self Insurance in a Crisis-prone Era?" *Emerging Markets Review* 5: 61-82.

Nda, M. (2006), "Effective Reserve Management in Nigeria: Issues, Challenges and Prospects". *Central Bank of Nigeria, Bullion,* Volume 30, 3.

Onwioduokit, E. A. (2008), "Investing Africa's External Reserves in Africa: Issues, Challenges and Prospects". *Central Bank of Nigeria, Bullion*. Volume 32, 4.

Oputa, N. C. (1997), "Determinants of Currency Composition of External Reserves in Nigeria: An Empirical Exploration". *CBN, Economic and Financial Review,* 35, 1, March.

Prabheesh, K. P.; D. Malathy and R. Madhumathi (2009), "Precautionary and Mercantilist Approaches to Demand for International Reserves: An Empirical Investigation in the Indian Context". *Macroeconomics and Finance in Emerging Market Economies* Vol. 2, No.2, 279-291

Prabheesh, K.P; D. Malathy and R. Madhumathi (2007), "Demand for Foreign Exchange Reserves in India: A Co-integration Approach" *South Asian Journal of Management.* Vol. 14, No. 2:36-46

Reddy, Y. V. (2002), "India's Foreign Exchange reserves: Policy, Status and Issues", Special Lecture at the National Council of Applied Economic Research, New Delhi.

Sims, C. A. (1980), "Macroeconomics and Reality", *Econometrica*, Vol. 48:1-48