

# Demand For International Reserves: A Case For Reserves Accumulation In Nigeria

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## **Abstract**

*This paper examined the determinants of international reserves holding in Nigeria, where a huge amount of foreign reserves is necessary to ensure good macroeconomic policy and international credit worthiness. Adopting a dynamic modeling approach combined with the Mizon-Richard encompassing test, both precautionary and mercantilist motives explain holding of foreign reserves in Nigeria. Specifically, the current account variability and past levels of external reserves drive reserve holding in the short run. In the long run, the former and the money supply are significant determinants. Therefore, enhancement of exports through support for quality and competitiveness of non-oil exports are key to reserves management.*

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## **I. Introduction**

The need to finance current account deficits makes the stability and stockpiling of external reserves imperative. In the absence of foreign reserves, balance of payment deficits would have to be corrected through a reduction in aggregate expenditure, imposing macroeconomic adjustment costs manifested in sharp contractions of investment and consumption, thereby inducing recessionary pressures. According to the Guidotti-Greenspan rule of thumb of the 1990s, countries should hold liquid external reserves equal to their foreign liabilities due within a year. Foreign reserves accumulation has high economic and social costs, including a high opportunity cost of low returns on reserve assets, losses due to domestic currency depreciation, and forgone gains from investment and social expenditure that could be financed by external reserves. Therefore, there is a need for monetary authorities to have a better understanding of the determinants and economic costs of external reserve accumulation and de-accumulation in order to design optimal external reserves management strategies to minimize these costs.

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Nigeria, since 2004, experienced phenomenal growth in foreign exchange reserves partly due to rising crude oil prices in the international market occasioned by instability and regional conflicts and increasing global demand for oil, especially from China<sup>1</sup>. With macroeconomic stabilization at the forefront of national economic policymaking, the need for Nigeria to hold adequate level of foreign reserves is perceptively imperative; at least to retain the flexibility to borrow from abroad and also hedge against the volatility in external capital flows.

This paper seeks to analyze the determinants of international reserves in Nigeria. External sector vulnerability and the need for external and internal balance in a developing economy like Nigeria provoke the need for adequate predictions of foreign reserves behaviour.<sup>2</sup> Adequate knowledge and understanding of the determinants and dynamics of external reserves in a country-specific manner not only ensures sustainable stability and confidence in the economy, it is also essential for more informed successful and efficient macroeconomic policy design and implementation. Most studies on international reserves were focused on panel or cross-country analyses (Ball and Reyes (2006); Cheung and Ito (2007); Elhiriaka and Ndikumana (2007); Parent and Gosselin (2005); Aizenman and Lee (2005); Sehgal and Sharma (2008); Frenkel and Jovanovic (1981); Lane and Burke (2001); Aizenman and Marion (2002); Kenen and Yudin (1965); Kelly (1970); Iyoha (1970)).

Of these, only few accounted for the time series properties of the response of the determinants of international reserves (Sehgal and Sharma (2008); Khan and Ahmed (2005); Ford and Huang (1994); Badinger (2004)). Generally, the models adopted in these studies focused on either the monetary, buffer stock or mercantilist approaches. Also, none of these studies focused on Nigeria and data used for most of the cross-country studies did not include Nigeria's data. This paper modestly attempts to bridge these gaps by specifying a model that incorporates behavioural characteristics embedded in the precautionary, mercantilist and monetary approaches as well as examining the time series characteristics of the data with a view to minimizing spurious regression that

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<sup>1</sup> Over-reliance on crude oil for over 90 per cent of Nigeria's foreign exchange earnings makes its capital account susceptible to international crude oil price fluctuations. This has been further exacerbated by high import bills that have contributed to the level of fluctuations in reserves over the years.

<sup>2</sup> Overall, greater exposures of developing countries like Nigeria to sudden stops and reversals of capital flows, growing trade openness, and the desire to improve competitiveness and to reduce real exchange rate volatility go a long way towards accounting for the observed increase in the rapid and massive stockpiling of international reserves (Aizenman, 2007)

characterize less rigorous econometric techniques. The rest of the paper is organized as follows. Section 2 reviews related theoretical, methodological and empirical literature on factors influencing the demand for international reserves while section 3 presents a brief trend analysis of external reserves and some general causal factors. Modeling issues are addressed in section 4, while in section 5, the results of the time series characteristics of the data, the encompassing tests, and long and short run econometric estimates are presented and discussed. The paper is concluded in section 6.

## **II. Review of Literature**

The determinants of international reserves are implicitly explored in the literature on adequacy of reserves, cost of reserves, optimality of reserves, and demand for international reserves, among others. Theoretically, the Keynesians argue that individuals demand cash to transact daily for purchases of goods and services and as a contingency against unforeseen circumstances/expenditures as well as a store of wealth. In contrast, classical monetary theory in the Cambridge cash balance approach had argued that individuals will need money for transaction purpose only, but modern monetarism is of the view that the demand for money is no longer a function solely of interest and income but also that of the rate of return on a much wider spectrum of physical and financial assets. The basic analytical approach of most studies on international reserves is the equivalence of the transaction, precautionary and speculative motive for holding cash balances either by individuals or countries holding foreign reserves (see Keran (1971) and Landell-Mills (1989)). Moreover, the transaction and speculative motives are important for an individual economic unit but plays no role in the decision of monetary authorities regarding the optimal portfolio. The precautionary motive dominates the latter's decision to hold certain stocks of liquid assets (Heller, 1966). Keran (1971) indeed argued forcefully for the equivalence of the precautionary motive for holding international reserves. In the same vein, the motives for holding reserves appear identical to those of holding money domestically, though there are important distinctions. Whatever the motive for holding reserves, the central bank ultimately wants to earn income from placement of the reserves (Obaseki, 2007).

Over 90 per cent of Nigeria's foreign exchange inflows and outflows are denominated in the United States (US) dollar (Usman, (2005), Tella (2007), Obaseki (2007)) as its crude oil receipts and other non-oil exports are invoiced in the US dollar while most of its obligations such as external debt service and foreign exchange market intervention are carried out with the US dollar and require some level of reserves depletion. This suggests that Nigeria's external reserves act

as a buffer against unforeseen exigencies (See Nda, 2006). This is contrary to another popular explanation for the high level of reserves, that is, export competitiveness, and which draws strongly from the mercantile perspective, as a development strategy. Moreover, Dooley et al(2004) have argued that reserve accumulation reflects the intervention of Asian central banks who want to prevent their currency from appreciating against the U.S. dollar in order to promote export-led growth.

Sehgal and Sharma (2008) suggested that the cost of holding excess reserves in India was quite high and stood at about 4.75 and 3.50 per cent of GDP in 2004-05 and 2005-06, respectively. They analyse a demand function for India reserves holding and in the function include the sensitive part of the capital account and monetary disequilibrium with the traditional determinants of reserves. They made use of cointegration and VECM approach on Indian quarterly data and find evidences for both precautionary as well as mercantile motives behind holding reserves in India.

Frenkel and Jovanovic (1981) applied the inventory theoretic framework which follows from the precautionary motive for holding reserves to model external reserves holding behaviour. Heller (1966) on the other hand theorizes that external reserves demand is essentially an inventory control problem, in which case reserves serve as buffer stocks accumulated in times of abundance and depleted in times of scarcity. Thus, a country's holding of international reserves is negatively related to its marginal propensity to import (MPI). Many theoretical works on international reserves rely on the buffer stock model to guide their specification, Frenkel and Jovanovic (1981), Lizondo and Mathieson (1987), Parent and Gosselin (2005) and Flood and Marion (2002) while the precautionary framework links reserves accumulation directly to exposure to sudden shocks, capital flight, and volatility; the mercantilist approach views foreign reserves accumulation as a residual of an industrial policy, a policy that may impose negative externalities on other trading partners (Aizenman and Lee, 2005). The thrust of the mercantilist motive is to save foreign reserves in a bid to reduce or prevent appreciation of the domestic currency, with the ultimate goal of increasing export-led growth.

An alternative perspective relies on the monetary approach to balance of payments and relates changes in international reserves to changes in money demand. Edward (1984), Elbadawi (1990) and Elhairaika and Ndikumana (2007) used this framework. Aizenman and Lee (2005), compare the importance of precautionary and mercantilist motives in the hoarding of foreign reserves in

developing countries. They provide empirical evidence that shows the superiority of the precautionary motive over the mercantilist motive and argue that theoretically, large precautionary demand for international reserves arises as self-insurance to avoid costly liquidation of long term projects when the economy is vulnerable to sudden shocks.

Empirically, using a cross country regression for 29 less developed countries (LDCs) in 1970, Iyoha (1976) examined the determinants of international reserves holding by the monetary authorities of less developed countries and found that the opportunity cost variable<sup>3</sup> is a vital determinant of foreign reserves holding. Landell-Mills (1989) in an empirical study of the relationship between international reserves and their opportunity cost showed that a country's reserves holding is sensitive to the rates at which they can borrow at the international financial markets. The author also found that international borrowing cost were highly significant determinants of reserves holding particularly before 1982 for the group of countries that were to face debt difficulties. Ben-Bassat and Gottlieb (1992) in an empirical study of the effects of opportunity cost on international reserves holding on Israel during the period 1968–1988 found that if measured correctly, opportunity cost played a pivot role in determining reserves.

A review of Nigeria's foreign reserves management showed that the country's reserves have been managed over the years by correspondent banks abroad as well as reputable international investment companies (Obaseki, 2007). He goes further to conclude that apart from the exchange rate mechanism, other factors influence the design of a framework for reserves management in Nigeria such as the state of the money market and balance of payments. Lane and Burke (2001) examined the cross-country variations in the level of international reserves over the period 1981 – 95 and found that trade openness is the most important of all the variables they considered. The authors also provided evidence that financial deepening is correlated with an increase in reserves ratio and indebted developing economies tended to have small reserves ratios.

Flood and Marion (2002) estimated optimal reserves holdings for countries under various monetary regimes and found that in a world with high capital mobility, interest rates were weakly significant and not robust in explaining reserves holdings. However, Ball and Reyes (2006) argued strongly against such findings, and thus carried out a two stage least square analysis due to the endogeneity of interest rates and international reserves under fixed exchange rate regimes to

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<sup>3</sup> The opportunity cost variable is a measure of the other benefits which could have been accrued if external reserves were not saved and/or used for other purposes.

buttress the importance of interest rates. They showed that interest rate was statistically significant in their specification.

Badinger (2004) estimated Austria's demand for international reserves over the period 1985:1-1997:4, tested for short-run effects of the disequilibrium on the national money market and found that Austria's long-run reserves demand exhibited a stable function of imports, uncertainty and the opportunity cost of holding reserves with strong economies of scale. Aizenman and Marion (2003, 2004) investigated the interpretation of relatively high demand for international reserves in the Far East (emerging Asia) and the relatively low demand by some other developing economies (e.g. Africa and Latin America). They found that reserves holding over the period 1980 – 1996 was a function of some key factors such as the size and volatility of international transactions, exchange rate arrangement, political corruption, and external borrowing. Their model specification showed that sovereign risk, costly tax collection to cover fiscal liabilities and loss aversion led to relatively large build-up of reserves.

Abdullateef and Waheed (2010) examine the implication of investment, inflation and exchange rate for Nigeria's external reserves holding using ordinary least squares (OLS) and vector error correction (VEC) and found that changes in reserves influence foreign direct investments and exchange rates but found no influence on reserves over domestic investments and inflation rates. Choi, et al (2007) examined the interaction between capital flows and international reserves holding within the context of increasing financial integration and found that capital flows had a negative relationship with external reserves for advanced economies while the responsiveness of reserves to capital flows was fuelled by the rapid spate of globalisation for emerging market economies.

Using panel data from 21 African countries, Elhiraika and Ndikumana (2007) examined the causes and economic implications of reserves accumulation with emphasis on the impact of exchange rate, inflation, public and private investment. They empirically showed that accumulation was not just driven by portfolio choice or stabilisation objective, but African countries, especially those endowed with natural resources, needed to adopt a more pro-growth approach to external reserves management. Similarly, Parent and Gosselin (2005) estimated a long-run reserves demand function in a panel of eight Asian emerging-market economies and provided evidence of a positive structural break in the demand for international reserves by Asian central banks in the aftermath of the financial crisis of 1997–98. Their result also showed that the actual level of reserves accumulated in 2003–04 was still in excess relative to that predicted by the model. According to the author, empirical research on international reserves

establishes a relatively stable long-run demand for reserves based on a limited set of explanatory variables. However, the authors opined that the determinants of reserves holdings reported in the literature can be grouped into five categories: economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility, and opportunity cost which form the basis for their empirical specification.

Sehgal and Sharma (2008) analysed the demand function for India's reserves holdings with a large number of variables using time series analysis (co-integration and vector error correction mechanism) on Indian quarterly data and found that most of the variables used in the study had significant impact on reserves demand in India. Similarly using time series techniques, Khan and Ahmed (2005) with quarterly data of Pakistan over the period 1982:1 – 2003:2 sought to determine the long and short run determinants of external reserves holding in Pakistan and found that there existed a stable long run reserves demand. In the short run, reserves responded positively to the variations in the balance of payments and negatively to its own lagged changes and, thus, concluded that variations in balance of payments played an important role both in the short and long run.

Obstfeld, et al (2008) attempted to provide reasons for the rapid accumulation of reserves in emerging market economies in recent times by investigating the empirical determinants of reserves growth in a broad panel of developing, emerging and advanced economies. Their analysis showed that there had been a statistically robust and economically significant correlation of reserve levels (reserve/GDP) with financial openness (a measure of cross-border capital mobility), financial development (proxied by M2/GDP), and exchange rate policy. Trade was statistically significant but foreign debt was not. In all, the explanatory variables in the foreign reserves behaviour/movement models were somewhat similar but differ markedly in the adopted proxies to measure some of the variables, whether cross-sectional or country-specific.

The major methodological techniques used in estimating the reserves equations were ordinary least square (OLS) adopted by Iyoha (1976) with distributed lag; Landell-Mills (1989) with pooled cross-section; Ben-Bassat and Gottlieb (1992) with autoregressive processes; Burke and Lane (2001) with heteroscedastic consistent standard errors. Two stage least square (2SLS) employed by Ball and Reyes (2006), panel data were used by Elhiraika and Ndikumana (2007) and time series analysis using ARIMA were employed by Heller and Khan (1978); Ford and Huang (1994) with ECM; Badinger (2004) with vector error correction method; Jo (2007) with co-

integration and error correction model; Sehgal and Sharma (2008) with co-integration and vector error correction mechanism; and Khan and Ahmed (2005) with vector error correction.

### **III. Trend of Nigeria's External Reserves and its Determinants**

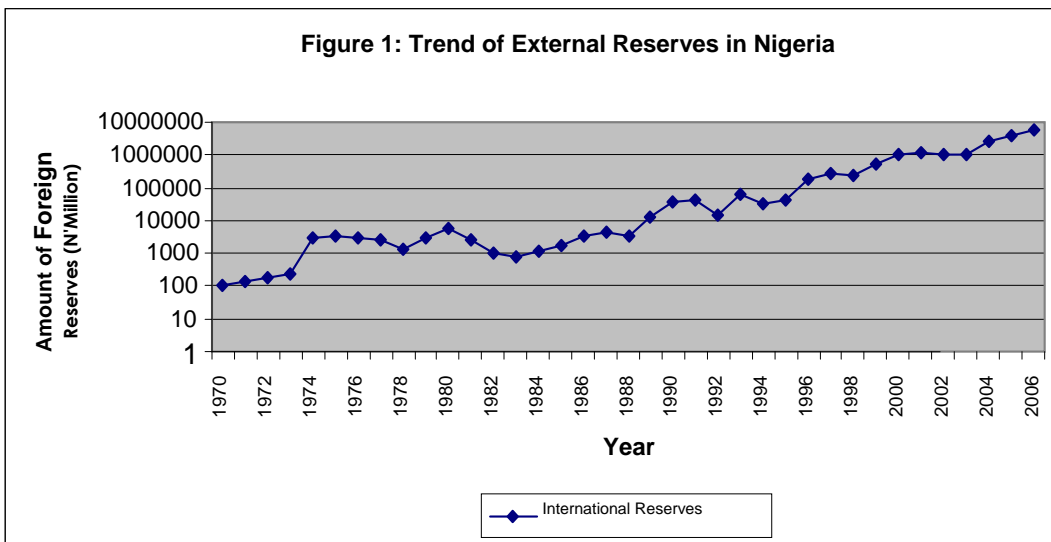
The global economic meltdown of 2008/2009 affected Nigeria's external sector. This was reflected in the substantial depletion of reserves, sudden withdrawal of portfolio capital by investors and a dwindling trade balance induced by the global crude oil price shock. As at the end of 2009, external reserves stood at USD42.4billion which was equivalent to about 18 months of import cover. This was in excess of the stipulated target of 6 months of import cover under the West African Monetary Zone (WAMZ) convergence criteria.

Following weak demand for Nigeria's export, external trade slowed, with the oil sector particularly affected during the period as crude oil exports fell by 32.9 per cent, as the price of Nigeria's reference crude (Bonny Light) fell precipitously from an average of USD101.15 per barrel to USD62.08 per barrel (CBN, 2009). In addition to this, reserves decumulation during the period was also induced by capital outflows even as direct investment remained stagnant between 2008 and 2009. Crude oil export earnings have persistently dominated the revenue-expenditure profile of Nigeria. In addition to increased oil revenue earnings occasioned by rising global crude oil price, higher degree of openness to capital inflows have resulted in the gradual accretion of international reserves. However, prolonged oil glut added to the growing current account deficits and subsequent economic turbulence experienced in the 1980s. There was a dramatic change from 1999 as external reserves took an upward trend occasioned by sustained current account surpluses which continued to subdue the deficit in the capital accounts; positive terms of trade shocks as a result of higher global crude oil prices; fiscal discipline; and resilience of monetary policy actions (CBN, 2009).

The number of months of import equivalent used to assess the adequacy of external reserves holding increased from about 8 months in 1999 to an all-time high of about 23 months in 2006 before moderating to approximately 22 months in 2007. By 2008 and 2009, Nigeria's reserves chest could only finance about 17 months of import mainly due to the global financial crisis which affected exports and disrupted capital inflows. It is pertinent to note that accumulation of reserves also accelerated as foreign debt service obligations fell. For instance, external debt stock which stood at over US\$20 billion as at 2005 fell sharply to about US\$3



billion in 2005. This period coincides with the period during which reserves holding rose by over 80 per cent from US\$28 billion in 2005 to US\$42 billion in 2006. Two phases alternately marked by reserves accumulation and depletion that have occurred contemporaneously with the major oil price shocks and other domestic imbalances over the period of 1970-2007. During 1970 – 71, 1973 – 75, 1979 – 80, the net performance of the external sector resulted in the accumulation of foreign reserves; on the other hand, during the periods 1972, 1976 – 78, and 1981 – 82, Nigeria experienced severe balance of payments crisis culminating in a rapid depletion of external reserves. As a result of the boom-bust cycle, Nigeria's earnings from petroleum exports fell from over US\$25.0 billion in 1980 to US\$6.4 billion in 1986. In recent times Nigeria is envisaged to produce approximately 2,000,000 barrels per day but barely meets its OPEC quota due to the instability and persistent crisis in the Niger-Delta which disrupt crude oil extraction. Also, persistent and unprecedented rise of international crude oil prices in addition to robust domestic indicators like downward trending and/or single digit inflation, stable exchange rate, low fiscal deficits and debt stock, sustained growth in domestic output, positive current account balance due to macroeconomic fundamentals like internal reforms have led to phenomenal growth in external reserves position from a meager US\$0.15 billion in 1970 (equivalent of 1.7 months of import cover) to US\$4.99 billion in May 1999. By 2002, the foreign reserves stood at US\$7.7 billion. The external reserves level rose to US\$43.5 billion in 2006 (equivalent to 28.4 months of import cover). The gross reserve as at end December 2007 stood at over US\$51 billion and increased to over US\$63 billion as at August 2008.



Source: CBN Statistical Bulletin (2006)

Figure 2 shows the months of import cover which is a veritable indicator of measuring reserves adequacy. The trend mirrors that of reserves shown in figure 1. Between 1980 and 1994, only 5 of the 15 year sample met the conventional (and WAMZ minimum requirement) measure of reserves adequacy with respect to its ability to finance 4 to 6 months of import. However, from 1996 to 2006, the government has surpassed the West African Monetary Zone (WAMZ) minimum requirement of six months.

External reserves assumed a sharp rise in the 1973-1974 periods due to the first oil price shock influenced by the oil embargo in October 1973. The 1980s and particularly 1983 represent the period of the oil glut which reduced oil export earnings and thus reserves. The period was also characterized by external indebtedness. Increase in oil exports in the 1990s raised external reserves holdings to levels higher than in the 1970s and 1980s. The trend of external reserves in the 1990s was relatively stable except for 1992 which saw a sharp decline from N44.25 billion in 1991 to a mere N13.99 billion and there from rose sharply to N67.25 billion. Since 1999, external reserves witnessed a relatively stable and gradual pile up attributable to the tight fiscal stance of government and the reduced debt service burden induced by the debt relief.

Figure 3 depicts the trend of oil revenue, global remittances, growing foreign direct and portfolio investments capital inflows, guarantees and grants sources of international reserves accumulation. Oil revenue earnings assumed an upward trend in 2002, debt portfolio dropped from over US\$35bn in 2004 to about US\$3.5 in 2007 while foreign direct investments and portfolio capital inflows induce an increase in foreign reserve accumulation, remittances inwards have also added significantly to external reserves holding especially since year 2004.

Capital inflows into Nigeria have a tremendous effect on reserves accumulation even as foreign direct investment (FDI) dominates the mix. FDI inflows increased from N624.5 billion in 2006 to N759.4 billion and N460.2 billion respectively, in 2007 and 2008 but it rose by 24.4 per cent to N572.5 billion in 2009. As from 2000, the Nigerian economy witnessed a remarkable increase in portfolio investments to an all-time high of N360.3 billion in 2006 but fell by 7.7 per cent to N332.5 billion in 2007. The consolidation of the banking sector in 2004 led to a surge in foreign portfolio investment in the form of bonds and equity as a result of the initial public offerings by the deposit money banks and liberalization of the money markets which permitted foreign investors to invest in treasury bills for at least a year. As at 2009, the banking sector still had the dominant share of imported capital with about 49.5 per cent of the total.

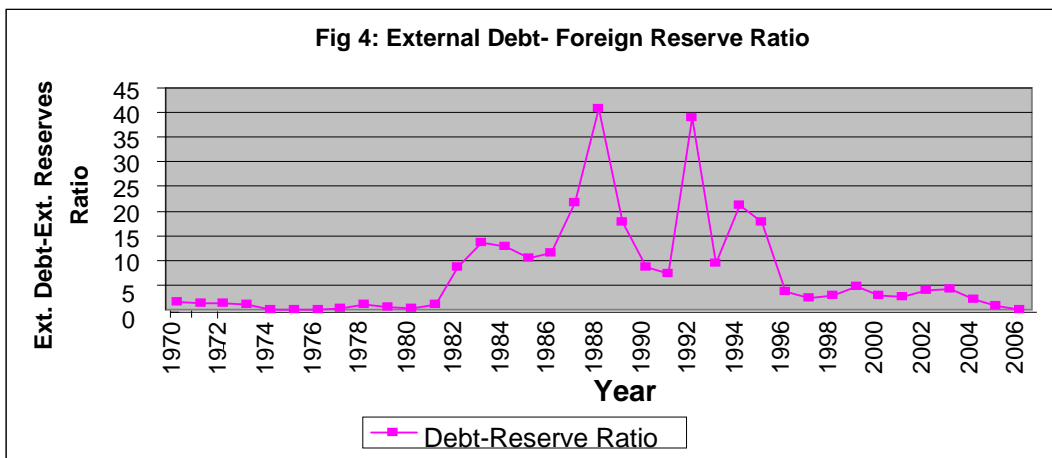
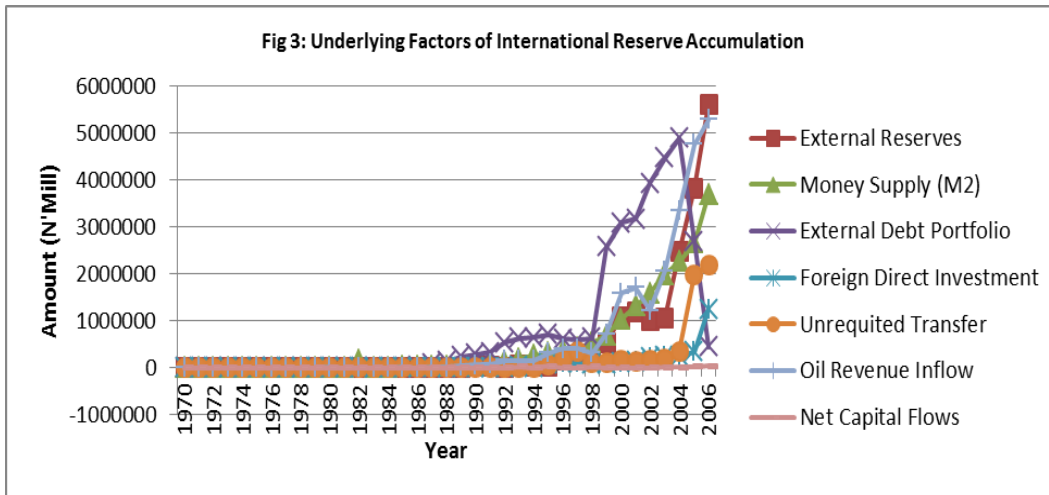


Figure 4 above depicts the external debt to foreign reserves ratio otherwise referred to as the Guidotti-Greenspan rule. The trend shows that between 1982 and 1996 the ratio has increased rapidly due to the loans obtained in the 1980s especially in 1986 to finance the structural adjustment programme (SAP). This led to declining foreign exchange reserves due to debt servicing obligations. With the successful negotiation with the Paris and London club, Nigeria was able to secure debt relief which has reduced the pressure on reserves as observed in the trend of external debt to reserves ratio. Countries may need to hold reserves more than their short-term debt due to many reasons, for example, differences in macroeconomic fundamentals; the structure and quality of private risk management and financial sector supervision; the exchange rate regime; and the size and currency composition of the country's external debt.

#### IV. Analytical Framework

This paper tests three competing models of external reserves holding using encompassing technique to determine which model best explains international reserves holding behaviour of the country's central bank. This is justified by the fact that the three motives enunciated by the models have been applied in Nigeria's reserves holding at different times, which may have spilled the effect of a particular holding motive to another period when that motive may have given way to another. This technique has the advantage of revealing which motive is superior and has the most significant impact on the economy. The final specifications of the buffer, mercantilist and monetary reserves holding models are stated respectively as follows: <sup>4</sup>

$$\text{The Buffer Stock Model: } \ln R^* = \alpha_0 + \alpha_1 \ln \sigma + \alpha_2 \ln r + e \quad (1)$$

$$\text{The Mercantilist Model: } IR = \beta_0 + \beta_1 GRRE + \beta_2 RER + \beta_3 TOT + \mu \quad (2)$$

$$\text{Monetary Model: } R = k_0 + k_1 PL + k_2 RDI + k_3 DBH + k_4 Mss + e \quad (3)$$

where, in equation (1),  $R^*$  is external reserves,  $\sigma$  and  $r$  are the standard deviation of reserve increment, and opportunity costs of holding reserves, respectively. In equation 2,  $IR$  is external reserves,  $GRRE$  is the growth rate of real exports,  $RER$  is the real exchange rate and  $TOT$  is the terms of trade. In equation (3),  $R$  is reserves,  $PL$  is the price level (proxied by CPI),  $RDI$  is real domestic income (proxied by real GDP),  $DBH$  is domestic bond holding, and  $Mss$  is domestic money supply.  $\alpha$ ,  $\beta$ ,  $k$  and  $m$  are parameters of the three international reserve holding models.

The thrust of the encompassing principle pioneered by Mizon (1984) and Mizon and Richard (1986) is to ascertain whether a maintained model can explain the features of its competitors. It is a non-nested test based on the principle that a model should account for the salient features of different and perhaps rival models. The use of this test, unlike the orthodox arbitrary model selection approach, provides an empirical basis for selecting a model from a group of competing models. It also discerns between coefficient variation that is not explained by the model at hand and coefficient that is. In addition, the encompassing test is sensitive to data nuances or distinctions. The encompassing

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<sup>4</sup> See Frenkel and Jovanovic (1981) for the Buffer Stock model, and Lee (2005) and Gab-Je Jo (2007) for the Mercantilist model; and Khan and Ahmed (2005) and Elhairaika and Ndikumana (2007) for the Monetary model.

test is carried out by first estimating the joint model which includes all the regressors from the three models. Accordingly, synchronising these models following Mizon (1984) and Mizon and Richard (1986) gives the following nested model:

$$R = C + \sum_{i=0}^n \alpha_i y_i + \sum_{i=0}^n \beta_i z_i + \sum_{i=0}^n \lambda_i x_i \quad (4)$$

Where  $y_i$  denotes the set of regressors,  $(\alpha_i, \beta_i, \lambda_i)$  represents the coefficients for all  $i=0, \dots, n$ . Notice that equation 4 encompasses equations 1, 2 and 3 but these equations (1, 2 and 3) do not nest or encompass one another. If the model represented by equation 1 is correct,  $\alpha_1 = \alpha_2 = 0$  whereas if the model represented by 2 is correct,  $\beta_1 = \beta_2 = \beta_3 = 0$ . Lastly, if the model represented by equation 3 is the correct one,  $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ .  $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$ .

#### IV.1 Unit root test

The Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests are used to test the stationarity of the variables. For the ADF, the null hypothesis is that the variables being considered have unit root against an alternative that they do not. The ADF model is specified below:

$$\Delta y_t = \alpha_0 + \alpha_1 T + \gamma y_{t-1} + \beta_i \sum_{i=1}^p \phi_i \Delta y_{t-1} + \mu_t \quad (5)$$

$$\phi_i = - \sum_{k=i+1}^p \gamma_k \quad \text{and} \quad \gamma = \left( \sum_{i=1}^p \gamma_i \right) - 1 \quad (6)$$

Where  $y_t$  is the variable being considered,  $T$  is the time trend (allowed only if significant), and  $\mu_t$  is a random error term. The Schwarz Information Criteria (SIC) is used to select the lag length (p) after testing for first and higher order serial correlation in the residuals. The lagged variables controls for possible autocorrelation of the residuals.

The Phillips Perron (PP) test uses models similar to the Dickey Fuller tests but employs the Newey and West (1994) non-parametric method to control for possible autocorrelation rather than the inclusion of lagged variable method employed in the ADF test. The Phillips-Perron test is computed based on

estimation of the non-augmented Dickey-Fuller test denoted by equation 8, and modifies the t-ratio of the coefficient of the lagged dependent variable so that autocorrelation does not influence the asymptotic distribution of the test statistic.

$$\Delta y_t = \alpha y_{t-1} + x_t' \delta + \varepsilon_t \quad (7)$$

Where  $x_t'$  are optional exogenous regressors,  $\alpha$  and  $\delta$  are parameters to be estimated, and the  $\varepsilon_t$  is assumed to be white noise.. The PP test is an alternative non-parametric test method of controlling for serial correlation when testing for a unit root.

#### **IV.2 Co-integration and Error Correction Model (ECM)**

The study relied on the Johansen and Juselius and the Engle and Granger cointegration tests to establish the existence of a long-run relationship among the variables. Subsequently, we employ the ECM which incorporates the full short run dynamics of the model to correct for disequilibrium and is given as:

$$\Delta Y_t = X_t' \beta + \gamma \Delta z_t + \lambda (y_{t-1} - \theta z_{t-1}) + \varepsilon_t \quad (8)$$

The model describes the variations in  $Y_t$  around its long run trend in terms of a set of I(0) exogenous factors  $X_t$ , the variation of  $Z_t$  around its long run trend, and the error correction  $(y_{t-1} - \theta z_{t-1})$  which is the equilibrium error in the co-integrated model. . The nature of the error correction term  $(y_{t-1} - \theta z_{t-1})$  is what determines the nature of the co-integration relationships amongst the variables (Engsted and Bentzen, 1997). The  $(y_{t-1} - \theta z_{t-1})$  is known as the error correction term since the deviation from long run equilibrium is corrected gradually through a series of partial adjustments. This paper uses data from 1970 to 2009 which are sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin (various issues) and the CBN annual Report and Statement of Account (various issues).

### **V. Empirical Analysis and Results**

#### **V.1 Estimated Model and Time-Series Diagnostics**

The ADF test on the variables reveals that they are stationary at first difference, that is, they are I(1). The PP test carried out reinforces the ADF test results (see appendix Tables 1 and 2 for the unit root test results). Table 1 reports the values of the F-statistic for the three models. The buffer stock model and mercantilist model

were found to be significant at 1 per cent and 5 per cent level respectively. However, the buffer stock model performed best as its F statistic is the most statistically significant of all the models. It is pertinent to note that the difference between the F-statistic of the buffer stock model and its rival models is quite large. Hence, despite the Nigerian government's drive towards promoting export led growth and domestic monetary stability, the role of external reserves as a backup mechanism against unforeseen contingencies remains glaring as revealed from the encompassing test. We conclude on the basis of the Mizon-Richard encompassing principle that the buffer stock model has the best overall fit with the Nigerian data, as it was the only model whose variables were most significant when the sum of the estimated coefficients were computed from the nested model.

**Table 1: The Mizon-Richard Encompassing Test (1986)**

Model	Variables	P(F-Statistic)
Buffer Stock Model	$\sum_{i=0}^2 \alpha_i$	0.000199
Mercantilist Model	$\sum_{i=0}^2 \beta_i$	0.027969
Monetary Model	$\sum_{i=0}^4 k_i$	0.740861

Source: Authors' Computation

We specify an augmented buffer stock-based reserves holding equation which follows closely the specification of Parent and Gosselin (2005); where reserves depend on the opportunity cost, terms of trade, money supply, capital account variability, and current account variability. The modified version is stated as<sup>5</sup>:

$$R_t = \beta_0 + \beta_1 OC_t + \beta_2 TOT_t + \beta_3 Mss_t + \beta_4 CAV_t + \beta_5 CUV_t + \mu_t \quad (9)$$

Where  $R_t$  is international reserves,  $OC_t$  is the opportunity cost,  $TOT_t$  is terms of trade,  $Mss_t$  is money supply,  $CUV_t$  is current account vulnerability, and  $CAV_t$  denotes capital account vulnerability<sup>6</sup>. Opportunity cost is the variable that

<sup>5</sup> Our model differs slightly in that we consider money supply as an explanatory variable and thus expect money supply to significantly influence accumulation of reserves via the interest rate channel. The terms of trade was included in view of Nigeria's overdependence on crude oil earnings which invariably distorts the balance of payment account as a result of its fluctuations and thus affects reserve holding.

<sup>6</sup> Share of exports in output was used to capture current account variability while the ratio of broad money to GDP was used to capture capital account variability (See Parent and Gosselin (2005)).

captures the earnings forgone if the reserves were invested and this is measured by government bond yield or discount rate. Terms of trade which is the relationship between prices of exports and prices of imports is measured by the ratio of export and import prices. Money supply is the amount of money in the economy measured by broad money (M2). Capital and current account variability are proxied by the ratio of broad money to GDP and trade openness, respectively. A priori, it is expected that OC, CUV, CAV, and Mss should have positive signs while TOT is expected to be negatively related to external reserves. The sign of the opportunity cost variable has been observed to produce inconclusive results from the literature. This variable according to Edwards (1985) is often found to be insignificant in the empirical literature. However, Ben-Bassat and Gottlieb (1992) show that the opportunity cost, if measured correctly (according to its theoretical definition), turns out to be a strong determinant of external reserves demand. Thus, we expect the opportunity cost variable to be a positive function of international reserves.

The co-integration analysis provides potential information about the long-run equilibrium relationship of the model. This technique is pivotal and necessary in estimating an equilibrium relationship with non-stationary variables. Having confirmed from the unit root test that some of the variables are I(1), the Johansen and Engle and Granger (EG) methodology to test for co-integration is used. The ADF and PP test is conducted to assess whether the error term or residuals of the long run estimates have unit root or not (See appendix table 3). The null hypothesis is that the residuals from the static long run equation has a unit root. The test is carried out with no exogenous variable for both the ADF and PP test. The maximum lag length equals 9 for the ADF test while bandwidth 9 was selected on the basis of Newey-West, utilizing Bartlett Kernel for the PP test. As observed from the results of the ADF and PP tests, the ADF and PP test statistic are -4.73125 and -4.743996 respectively with p-value of 0.000. The test statistic for both the ADF and PP tests are statistically significant at 1%. This result provides evidence to support the existence of a long run co-integrating relationship between international reserves and the variables being considered.

The Johansen co-integration test indicates the presence of at least one co-integrating relationship in the model as revealed by the trace and maximum eigenvalue statistic which rejects the null hypothesis against the alternate hypothesis at the 5 per cent level (Tables 2 and 3). This shows that there exists a long run relationship between international reserves and the variables considered in the model. The Chow break point test conducted showed that only the structural adjustment programme in 1986 had a significant effect on the model while the change from military to democratic administration in 1999 and financial



crisis in 2007/2008 were insignificant<sup>7</sup>. Analogous to the Johansen test, the E-G co-integration result also revealed the existence of a stable long run relationship between the variables in the estimated model. The ADF and PP unit root test of the long run estimated model's residual was found to be significant at 1 per cent.

**Table 2: Unrestricted Co-integration Rank Test Result**

Null Hypothesis	Trace Statistic	Critical Value at 5%	Null Hypothesis	Maximum-Eigen Value Statistic	Critical Value at 5%
$r=0$	175.6353*	146.76	$r=0$	51.16061*	49.42
$r\leq 1$	124.4747*	114.90	$r\leq 1$	33.47834	43.97
$r\leq 2$	90.99632*	87.31	$r\leq 2$	30.79480	37.52
$r\leq 3$	60.20152	62.99	$r\leq 3$	24.38579	31.46
$r\leq 4$	35.81573	42.44	$r\leq 4$	19.63096	25.54
$r\leq 5$	16.18477	25.32	$r\leq 5$	9.650536	18.96
$r\leq 6$	6.534233	12.25	$r\leq 6$	6.534233	12.25

Note:  $r$  implies number of cointegrating vectors. Trace statistic indicates 3 cointegrating equations at the 5% level while the maximum-eigenvalue statistic shows 1 cointegrating equation. Asterix (\*) denotes rejection of the null hypothesis at 0.05 level.

**Table 3: Normalized Cointegrating Vector**

	IR	OC	CAV	CUV	MSS	TOT	C
<b>Coefficient</b>	1.0000	-0.474444	-2.005006	0.183960	0.627984	-2.159690	-2.149297
<b>SE</b>		(0.05775)	(0.05992)	(0.03437)	(0.03643)	(0.06408)	(0.10037)

**Log Likelihood:** 234.7324

## V.2 Long run and Contemporaneous Error Correction Model Estimates

From Table 4, the estimated long run effect of a 1 per cent increase in money supply on external reserves while keeping the other variable constant is approximately 1.03 per cent while the long run elasticity of capital account variability is 0.93 per cent. The long run elasticity of opportunity cost in the model in terms of its influence on reserves is 0.036 while that of current account variability is 0.953 per cent. The Table indicates an adjusted R-square value which suggests that the regressors explain about 95% of the variations in external reserves while the F-statistic, an indicator of the overall significance of the model, shows that the model employed is statistically significant at 1% confidence level. The D-W statistic of 1.98 falls within the acceptance region of the null hypothesis of the absence of autocorrelation. Further analysis of the model shows that the coefficient of current account variability (proxied by the ratio of export to imports) which measures exposure to external shocks is statistically significant with a positive sign.

<sup>7</sup> Dummy variable was used to capture the various regimes. The results from the Chow Break point tests and VECM are available on request.

This conforms to the results obtained by Parent and Gosselin (2005) and Choi, et al (2007).

The coefficient of capital account variability, captured by the ratio of broad money to GDP, departs from theory as it carried an unexpected negative sign even though it is statistically significant. This may be attributable to the persistent capital flow variations which induced external sector deficit via the capital account and thus require reserves financing. The terms of trade (TOT), as expected, is positively related to reserves holding but is not statistically significant. The opportunity cost variable measured by the discount rate is also not statistically significant and is not in conformity with theoretical expectation as it has a positive sign thus contradicting the findings of Flood and Marion (2002), Frenkel and Jovanovic (1981) and Ben-Bassat and Gottlieb (1992). The coefficient of money supply carried expected positive sign. This implies that international reserves holding are a positive function of domestic money supply.

According to *a priori* expectation, there is a short run negative relationship between changes in reserves holdings and one period-lagged and two-period lagged value of changes in terms of trade (TOT). Both carried the expected negative sign and are highly significant at the one percent confidence level. The one period lag of the change in the opportunity cost variable (OC) carries the expected positive sign indicating that it is positively related to reserves though it is not statistically significant in explaining current level reserve holding.

The one-period lag of the change in the money supply variable is statistically significant but with a wrong sign. The change in the current account variability measure carries the expected positive sign and is significant at the ten percent level. The two-period lagged change in capital account variability (CAV) is statistically significant at ten percent but also carries an unexpected negative sign. The error correction estimate of 0.9551 indicates that 95% of the preceding period's disequilibrium is eliminated in the current period, with contemporaneous response captured by difference terms. The disequilibrium error term (ECM (-1)) was found to be statistically significant and negative as expected. The significance of the error correction model buttresses and confirms the presence of a long run relationship among the variables.

**Table 4: Long run and Short run Demand for Reserves**

Independent Variables	Long Run Demand Equation		Short run Demand Equation	
	Coefficient	Prob.	Coefficient	Prob.
Constant	-5.5989 (2.2095)**	0.0352	0.0799 (0.6503)	0.5219
Log of Current account variability	0.9539 (4.1074)*	0.0003		
Log of Capital account variability	-0.9396 (- 3.2033)*	0.0033		
Log of Opportunity cost	0.0366 (0.0627)	0.9504		
Log of Terms of Trade	0.7176 (1.3168)	0.1982		
Log of Money supply	1.0306 (4.9051)*	0.0000		
First difference Log of Capital Account variability with two period lag			-0.1869 (-1.8848)***	0.0721
First difference Log of Current Account variability			0.2476 (1.7871)***	0.0871
First difference Log of Opportunity cost with one period lag			0.7371 (1.0286)	0.3144
First difference Log of Money supply with one period lag			-0.3372 (-1.6970)***	0.1032
First difference Log of terms of trade with one period lag			-0.8291 (-1.7813)***	0.0881
First difference Log of terms of trade with two period lag			-1.3564 (-3.3963)*	0.0025
First difference Log of Reserves with one period lag			0.8218 (3.8520)*	0.0008
Error correction mechanism (ECM(-1))			-0.9551 (-3.9939)*	0.0006
R-squared	0.9565		0.6120	
Adjusted R-squared	0.9475		0.4602	
Durbin-Watson stat	1.9837		1.7376	
Prob (F-statistic)	0.0000 (106.430)		0.0032 (4.032)	
Mean dependent var.	9.8701		0.3047	
S.D. dependent var.	3.0152		0.7871	

Source: Authors' Computation; t-statistic are in parenthesis; \*, \*\*, \*\*\* implies significant at 1%, 5% and 10% confidence level respectively.

Overall, four of the variables are found to be statistically significant and of the right signs and the general goodness of fit is acceptable for the differenced variables. The value of the R-square shows that the model accounts for about 61% of the changes in the demand for reserves holdings, while with respect to the

adjusted R-square, the regressors accounted for 46% of the variations in the dependent variable.

To check for the constancy of the ECM we carry out stability tests via recursive estimates. The output obtained from the CUSUM and CUSUM of squares test showed that the estimates fell within the acceptable 5% significance. The CUSUM test is based on the cumulative sum of the recursive residuals using on 2 lags. This option plots the cumulative sum together with the 5% critical lines. The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines/bounds. The CUSUM of squares test provides a plot of the variable at a particular period against another and the pair of 5 percent critical lines. As with the CUSUM test, movement outside the critical lines is suggestive of parameter or variance instability. The cumulative sum of squares is generally within the 5% significance lines, suggesting that the residual variance is somewhat stable. The CUSUM and CUSUM of square test results are shown in the appendix.

## **VI. Concluding Remarks**

International reserves holding in the absence of sovereign wealth fund serves as a buffer against unforeseen contingencies and as such the role of its determinants towards policy fine-tuning and formulation cannot be ignored. International reserves holding in Nigeria can be observed to be driven by inter alia global crude oil production and prices, net capital inflows and imports. This paper examined the determinants of international reserves holding in Nigeria, where a huge amount of foreign reserves is necessary and is expected to play a pivotal role in, among others, the country's overall macroeconomic policies, assessment of its credit worthiness, managing its external debt service obligations and the insulation of the domestic economy in the event of contagion and spillover effects of abrupt capital flight occasioned by a regional or global economic slowdown.

Adopting a dynamic modeling approach through the use of co-integration and error correction (ECM) framework, subsequent on testing the appropriate theory of reserves demand through the Mizon-Richard encompassing test, we find evidence of both precautionary and mercantile motives behind holding reserves in Nigeria. Specifically, the need to ensure current account viability is mostly the reason why Nigeria holds international reserves. The results confirm that variations in the current account component of the balance of payments and past levels of reserves drive reserves holding in the short run. In the long run, current account variability and the money supply determine the demand for international reserves. Therefore, the central bank can minimize the variability of the current

account by taking measures that enhance exports through support for quality and competitiveness of non-oil export commodities in the international markets. Hence, there is need to design optimal strategies that maximise non-oil export revenues. This external resource inflow through export revenues can be utilised to enhance domestic investment, particularly to stimulate diversification of exports away from primary products to manufactures and services. Such measures would ensure that the domestic economy is better insulated from crude oil-related external disturbances and the source of reserves accumulation becomes reasonably stable.

Furthermore, the empirical result suggests that Nigeria should reposition its reserves management strategies within a broader economic development policy framework, particularly due to the significance of the money supply as a determinant of international reserves holding. While macroeconomic stabilisation remains a key macroeconomic policy target, the impact of expansionary monetary policy on reserves and other intervening macroeconomic variables should be constantly taken into account. In relation to previous studies, which in addition to the fact that they did not consider the model with the best fit from amongst competing models, this study applies an encompassing technique to Nigerian data to fill this gap. In addition, a modified long run demand for reserves equation that takes into consideration the determinants of Nigeria's external reserves holding within a buffer stock approach that incorporates terms of trade and money supply as explanatory variables.

Finally, areas that this paper have not dwelt on which may have direct or indirect implications for the examination of reserves holding determinants include among others, the optimal level of external reserves holding in Nigeria, the currency composition of reserves, the adequacy and cost of international reserves holding, insurance value of reserves, oil price volatility and its implication for international reserves holding. Another area of research could be to examine the interactions between the financial system and the process of foreign exchange reserves accumulation.

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## Appendices

**Table 1: Augmented Dickey Fuller (ADF) test results**

Variables	Levels			First Difference		
	Constant	Constant and Linear Time Trend	None	Constant	Constant and Linear Time Trend	None
LOGCAV	-1.449219	-4.311203*	-1.566846	-4.608564*	-4.601138*	-7.882467*
LOGCUV	-1.087287	-4.298867*	-0.995151	-8.208538*	-8.082986*	-8.004538*
LOGTOT	-3.924254*	-3.811705**	-0.131980	-6.077161*	-6.024033*	-6.139127*
LOGINF	-3.621016*	-3.566739**	-0.937015	-6.607376*	-6.592058*	-6.706326*
LOGMPR	-1.544387	-1.239822	0.259269	-6.761953*	-5.621980*	-6.754719*
LOGOC	-1.484360	-0.425109	0.249532	-7.492004*	-7.674457*	-7.465567*
LOGOP	-2.559691	-2.548273	1.006582	-5.216912*	-5.184439*	-5.006792*
LOGRES	-0.433625	-2.232723	2.143429	-6.268315*	-6.187186*	-5.457983*
LOGMSS	-0.618551	-4.248404*	3.329611	-9.453001*	-9.315844*	-7.483385*

The Null Hypothesis is the presence of Unit Root. Lags were selected based on Schwarz Information Criteria (SIC). Figures with (\*, \*\* and \*\*\* asterisks indicate the level of significance at 1%, 5%, and 10% respectively. None implies that intercept and trend and intercept were excluded from the test equation. The maximum lag length of 14 was automatically selected based on schwartz information criteria

**Table 2: Phillips-Perron (PP) test results**

Variables	Levels			First Difference		
	Constant	Constant and Linear Time Trend	None	Constant	Constant and Linear Time Trend	None
LOG(CAV)	-1.270821	-4.319935*	-1.684176***	-15.02349*	-14.79278*	-8.568879*
LOG(CUV)	-1.203881	-4.303931*	-1.291452	-12.31720*	-12.07743*	-8.342040*
LOG(TOT)	-3.799647*	-3.892762*	-0.319734	-16.33864*	-17.91084*	-12.88637*
LOG(INF)	-3.376475**	-3.307224***	-0.725947	-12.54118*	-13.29508*	-12.67964*
LOG(MPR)	-1.462362	-0.995514	0.433092	-6.883205*	-6.961196*	-6.796436*
LOG(OC)	-1.411391	-1.000194	0.390539	-7.418009*	-7.714889*	-7.361002*
LOG(OP)	-2.575700	-2.543209	1.006582	-5.185611*	-5.146233*	-5.011276*
LOG(RES)	-0.200337	-2.232723	2.977983	-6.476380*	-6.401471*	-5.457778*
LOG(MSS)	-0.429610	-4.271261*	4.306442	-12.06612*	-11.92128*	-7.284769*

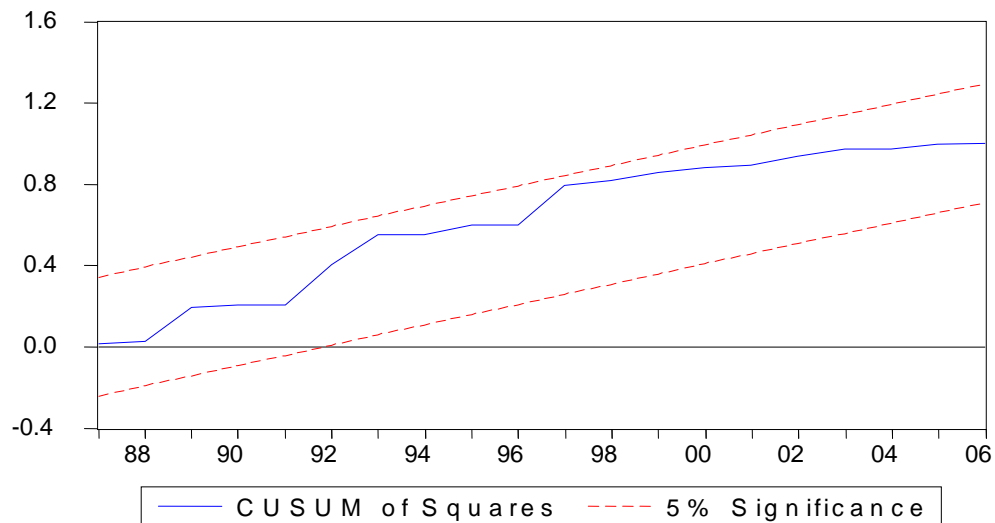
The Null Hypothesis is the presence of Unit Root. The bandwidth was chosen using Newey-West method with Bartlett Kernel spectral estimation. Figures with (\*, \*\* and \*\*\* asterisks indicate the level of significance at 1%, 5%, and 10% respectively. None implies that intercept and trend and intercept were excluded from the test equation. The maximum lag length of 14 was automatically selected based on schwartz information criteria

**Table 3: Unit root test for the error term obtained from the long run demand for reserves equation estimation**

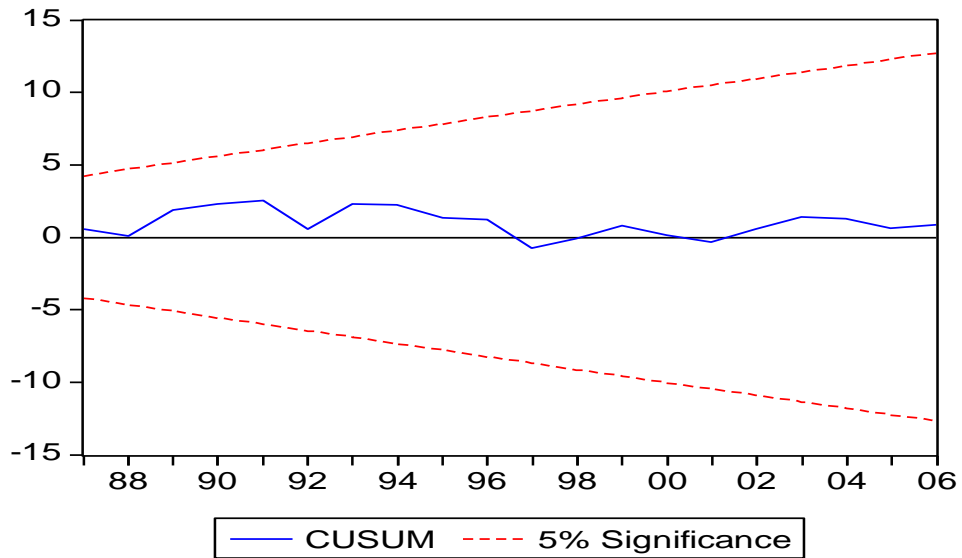
ADF				PP			
Null Hypothesis: ECT has a unit root				Null Hypothesis: ECT has a unit root			
Exogenous: None				Exogenous: None			
Lag Length: 0 (Automatic based on SIC, MAXLAG=9)				Bandwidth: 1 (Newey-West using Bartlett kernel)			
		t-Statistic	Prob.*			Adj. t-Stat	Prob.*
Augmented Dickey-Fuller test statistic		-4.73125	0.0001	Phillips-Perron test statistic		-4.743996	0.0001
Test critical values:	1% level	-2.630762		Test critical values:	1% level	-2.630762	
	5% level	-1.950394			5% level	-1.950394	
	10% level	-1.611202			10% level	-1.611202	
*Mackinnon (1996) one-sided p-values.				*Mackinnon (1996) one-sided p-values.			

Source: Authors' Computation

**Figure 1: Result from Stability Test**



**Figure 2: Result from Stability Test**



Source: Authors' Computation