

3-2016

Empirical Estimation of Optimal International Reserves for Nigeria: The Sudden Stop Model

G. K. Sanni

Central Bank of Nigeria, gksanni@cbn.gov.ng

T. S. Olusegun

Central Bank of Nigeria, tsolusegun@cbn.gov.ng

Z. Sani

Central Bank of Nigeria, zsani@cbn.gov.ng

Follow this and additional works at: <https://dc.cbn.gov.ng/efr>



Part of the [Finance Commons](#), and the [International Economics Commons](#)

Recommended Citation

Sanni, G. K., Olusegun, T. S. and Sani, Z. (2016). Empirical Estimation of Optimal International Reserves for Nigeria: The Sudden Stop Model. CBN Economic and Financial Review. 54(1), 1-23.

This Article is brought to you for free and open access by CBN Institutional Repository. It has been accepted for inclusion in Economic and Financial Review by an authorized editor of CBN Institutional Repository. For more information, please contact dc@cbn.gov.ng.

Empirical Estimation of Optimal International Reserves for Nigeria: The Sudden Stop Model

Sanni, G. K., Olusegun T. S. and Sani Z.*

Abstract

The study examined the issue of optimum external reserves for Nigeria during 2010 – 2014, using Jeanne and Ranciere (2006) and Goncalves (2007) sudden stop model approach. The study showed that resident foreign currency deposit accounted for over 90 per cent of the total foreign currency deposit, while non-resident foreign currency deposit accounted for the remaining. The result of the model suggested that external reserves were adequate in 2010 but beyond that period, it was far below optimal level. On average, the optimum external reserves were around 15.7 per cent of GDP in the past four years, translating to US\$54.52 billion.

Keywords: Optimum Reserves, Sudden Stop, Capital Flow, Foreign Currency Deposits

JEL Classification Numbers: F31 and F320

I. Introduction

Globally, central banks aim at holding optimum level of external reserves because of its implications for capital flows, trade and exchange rate stability. Optimum reserves is the level of reserves that ensure stability in domestic currency in the event of global economic shocks, which could be financial crises, terms of trade shock and sudden capital flow reversal. Optimal reserves vary from country to country, depending on the structure, stage of economic development as well as the level of economic and financial integrations of such economies. Thus, countries whose economies are externally-driven and well-integrated into the global economy would need to build more reserves to be able to absorb shocks than a closed economy. Based on the foregoing, an optimal level of reserves can be described as a form of insurance against external shocks emanating from natural disaster, terms of trade shocks and sudden stop in capital flow (Barnichon, 2009).

Optimum reserve is important to central banks because it creates buffer stock against crisis and serves as early warning signal to central banks to mitigate future crisis, amongst others. When a country's level of reserves is above the optimum level, the costs to the domestic economy are huge. The country is denied resources that could have been used to step up more productive investments and also, the monetary authority is saddled with the cost of managing it. However, when external reserve is below the optimum level, the

* The authors are staff of the Research Department, Central Bank of Nigeria. The views expressed in this paper are those of the authors and do not necessarily reflect the opinions of the Central Bank of Nigeria.

economy becomes more vulnerable to sudden external shocks. This development could encourage speculative attack on the domestic currency, hamper trade flows, trigger capital reversal, and erode confidence in the domestic economy, which may eventually lead to currency crisis, exchange rate instability, and increased capital flight. In order to avert these costs, most central banks strive to keep optimum level of external reserves. In addition, the resilience of the economies with huge foreign exchange reserves during the global financial crisis has further strengthened the necessity for central banks to keep and ensure optimal reserves against the event of sudden shocks (Calvo et al., 2012).

An examination of the global reserves accumulation over the past decade revealed that some central banks in emerging and developing countries hold large external reserves far above what could be considered optimum¹. For example, in 2013, China, Japan, Brazil, Algeria, and Libya held external reserves of US\$3.88 trillion, US\$1.27 trillion, US\$358.82 billion, US\$201.44 billion and US\$119.71 billion, respectively. One reason for large reserves accumulation is insurance against sudden crisis². Also, the shift in the direction of capital flows from developed economies to emerging and developing markets in the last two decades contributed to huge external reserves accumulation. For example, capital flows to emerging markets in 2013 was US\$1.24 trillion and projected to be US\$1.16 trillion in 2014³. Also, sub-Saharan Africa have been one of the recipients of global capital movements, due to sustained robust growth and improved macroeconomic environment with portfolio investment accounting for the highest share of aggregate foreign capital inflow. In Nigeria for instance, portfolio investment inflow accounted for 38.1 and 70.7 per cent, in 2010 and 2012, respectively.

Portfolio investments are temporary in nature and highly volatile, for development. Therefore, the surge in portfolio investment in the past two years and dwindling trend in foreign exchange receipts from oil export have necessitated concern for the determination of optimal level of reserves in order to keep the Nigerian economy on sustainable path of growth. Previous studies on Nigeria such as Oputa (1997), Nda (2006), Abeng (2007), Onwioduokit (2008) Migap (2010) and Igwe and Ogunleye (2012) did not focus on the optimal level of reserves. For instance, Oputa and Ogunleye (2010) estimated reserves

¹ Jeanne and Ranciere (2006); Goncalves (2007); Drummoon and Dhasmana (2008); Rodriguez and Funk (2012)

² Countries hold large external reserves for different reasons, including prevention of output reduction, export-led growth strategy, limitation of the behaviour of other economies, amongst others.

³ Source: IIF, IMF, National Sources.

adequacy for Nigeria but failed to establish optimal reserves threshold during the study period. This study therefore sets to fill this gap.

Nonetheless, sudden stop framework was adopted by Jeanne and Ranciere (2006) for emerging markets and established an average Reserve/GDP ratio of 10 per cent for the sample countries. The objective of this study, therefore, is to estimate optimum external reserves for Nigeria using sudden stop framework. Following this introduction is Section 2, which presents the empirical framework and review of relevant literature, Section 3 presents the synopsis and implications of capital flow for external reserves in Nigeria. Section 4 focuses on the methodology and presentation of results, while Section 5 concludes the paper.

II. Theoretical and Empirical Literature Review

II.1 Theoretical Literature Review

The framework of sudden stop was originally provided by Jeanne and Ranciere (2006) and later extended by Goncalves (2007) to accommodate economy with some degree of dollarisation. The framework is built on the assumptions of small open economy that traded one good consumed locally and abroad. The economy is also made up of two sectors, namely, private sector and the government, and that the economy is susceptible to sudden stop i.e. loss of access to external credit.

The literature contains various perspectives to the determination of optimum reserves (Jeanne and Ranciere, 2006) and Goncalves, 2007) model. We employ Jeanne and Ranciere (2006) sudden stop model to derive optimal level of foreign reserves for Nigeria.

Reserves accumulation is undertaken to allow government to smoothen consumption when it is faced with financial crises. The sudden stop framework shows the link between domestic absorption, output and reserves in sudden stop scenarios. Domestic absorption could be defined as follows:

$$ASP = Y_{gdp} - TAB \quad (1)$$

Where ASP represents domestic absorption, Y_{gdp} is output, while TAB stands for trade balance.

From the balance of payments identity, TAB can be expressed as follows:

$$TAB = -FNA - NFI - \Delta RES \quad (2)$$

Where FNA stands for financial account, NFI is the net income and transfers from abroad, while ΔRES is the change in foreign reserves. A negative

$\Delta RES(\Delta RES < 0)$ implies accumulation, while a positive $\Delta RES(\Delta RES > 0)$ implies depletion of central bank reserves. Substituting equation (2) into equation (1), the domestic absorption ASP becomes:

$$ASP = Y_{gdp} + FNA + NFI + \Delta RES \quad (3)$$

The effect of capital reversal or sudden stop on domestic absorption is shown in equation (3). Reduction in FNA or financial account, which could be due to capital reversal, reduces domestic absorptive capacity. Reduction in domestic absorption in turn could further trigger panic withdrawal of foreign currency deposits from the banking system by residents and non-residents. This development could lead to liquidity shortage and this in turn could incapacitate the banks' ability to lend to the real sector, which may eventually result in loss of output. However, the effects on domestic absorption could be mitigated through effective use of foreign reserves by the central bank. For example, if FNA falls in equation (3), the effect on ASP could be neutralised by adjusting reserves. This can be achieved if central banks use their reserves to settle foreign currency credit lines that are not rolled over. If unfavourable, this possesses significant risks.

II.2 Theoretical Underpinning

In anticipation of risk of sudden stop of capital inflow or capital reversal, the country keeps stock of foreign exchange reserves to mitigate the effects on the domestic economy. In the event of sudden stop, the extended work of Goncalves (2007) showed that larger portion of foreign currency deposits are withdrawn from the banking sector, short-term foreign currency debts are not rolled over, output falls and the real exchange rate depreciates. Following this framework, the private sector of the economy, which represents the consumers would face the following budget constraint (Jeanne and Ranciere, 2006):

$$C_t = Yd_t + \alpha_t [L_t - (1 + r_L)L_{t-1} + P_t - (1 + r)P_{t-1} + Tg_t] \quad (4)$$

Where C_t represents domestic consumption, Yd_t stands for domestic output, α_t is the real exchange rate, L_t is the banks' short-term dollar lending to private sector, P_t represents private sector's short-term external debt and Tg_t is government transfer. The constants r_L and r stand for interest rates. The model also assumes that r is risk free whereby consumers do not default on the short-term external debt obligations. However, the banks are subject to other set of budget constraint as specified in Equation (5):

$$L_t - (1 + r_L)L_{t-1} + RL_t - (1 + r)RL_{t-1} = D_t - (1 + r_D)D_{t-1} \quad (5)$$

Where RL_t represents banks' dollar deposits invested in risk free short-term foreign assets at r interest rate. It is a measure of banks' self-insurance against crises. The r_D is the interest rate that banks pay on dollar deposits D_t , the dollar deposit D_t is interpreted to measure precaution against sudden withdrawal of foreign currency deposits. The model further assumes that some portion of short-term foreign currency deposits are constant such that $RL_t = qD_t$, $0 < q < 1$ and that $r_D = r$. Therefore, the equation 5 becomes:

$$L_t - (1 + r_L)L_{t-1} = (1 - q)[D_t - (1 + r)]D_{t-1} \quad (6)$$

Substituting equation (6) into (4), we derived aggregate private sector consumption that includes banking and non-financial private sectors, such that equation (4) becomes:

$$C_t = Yd_t + \alpha_t \{ (1 - q)[D_t - (1 + r_L)D_{t-1}] + P_t - (1 + r)P_{t-1} + Tg_t \} \quad (7)$$

In order to derive the second component of consumption for the economy, i.e. government consumption, Jeanne and Ranciere (2006) framework assume that issuance of long-term security by the government is constant at price P and produces a unit of good every period until the sudden stop occurs, but seized to yield any income during sudden stop (Goncalves, 2007). Furthermore, the framework use the present discounted value of the expected future returns to derive the price of security before the sudden stop such that:

$$P = \frac{1}{1 + r + \eta} [1 + (1 - \kappa)P]$$

Where κ represents probability of sudden stop occurrence, η stands for the term premium and r is the short-term interest rate on short-term external debt. Solving for P , we have:

$$P = \frac{1}{r + \eta + \kappa}$$

To determine the number of security required to finance stock of external reserves R_t , number of long-term securities N_t issued by government is multiplied by P . That is:

$$R_t = PN_t$$

The framework also situates a condition where government issues short-term foreign debt Gd_t and the interest payment r on this debt is risk-free, which implies no default in payment. Then, budget constraint before the sudden stop becomes:

$$P(N_t - N_{t-1}) - N_{t-1} + Gd_t - (1+r)Gd_{t-1} = Tg_t + R_t - (1+r)R_{t-1} \quad (8)$$

Substituting N_t , N_{t-1} and P in to equation (*), government transfer to the private sector before the sudden stop is derived as follows:

$$Tg_t^{before} = Gd_t - (1+r)Gd_{t-1} - (\eta + \kappa)R_{t-1} \quad (9)$$

The expression above indicates that before sudden stop, government transfers Tg_t is an increasing function of short-term external public debt Gd_t i.e. issuance of debt can increase government transfers. However, issuance of short-term external public debt comes at a cost of holding reserves and default risk premium. The situation defers from the scenario presented in equation (9) during sudden stop, because both public and private sectors would no longer be able to issue short-term external debt. To smoothen consumption during sudden stop, government therefore would need to transfer its external reserves to consumers. However, government must still maintain the component of equation (9) $(\eta + \kappa)R_{t-1}$ which is the payment on its long-run security (Jeanne and Ranciere, 2006). In view of this, government transfer during sudden stop becomes:

$$Tg_t^{during} = -(1+r)Gd_{t-1} - (1-\eta + \kappa)R_{t-1} \quad (10)$$

During sudden stop, balance of payments crisis unfolds, leading to loss of significant proportion of output γ , a proportion of dollar deposits is withdrawn from the bank θ , and the real exchange rate, ΔRER depreciates. With these assumptions and with cognisance of scenarios in equations (9) and (10), domestic consumption before and during crisis, therefore, becomes:

$$C_t^{before} = Yd_t^{before} + (1-q)D_t^{before} + P_t^{before}T + Gd_t^{before} - (1-r)[(1-q)D_{t-1}^{before} + P_{t-1}^{before} + Gd_{t-1}^{before}] - (\eta + \kappa)R_{t-1} \quad (11)$$

$$C_t^{during} = (1-\gamma)Yd_t^{before} + (1+\Delta RER)\{(1-\theta)D_{t-1}^{before} - (1+r)[(1-q)D_{t-1}^{before} + P_{t-1}^{before} + Gd_{t-1}^{before}] + (1-\eta - \kappa)R_{t-1}\} \quad (12)$$

To determine optimum reserves, government chooses reserves that maximise consumers' welfare function, given that reserves at period t only matter for consumption at period $t+1$. Therefore, government chooses reserves that take cognisance of the probability of sudden stop, and consumers' welfare before and during crisis, such that:

$$\max (1 - \kappa) \cdot u(C_{t+1}^{before}) + \kappa \cdot u(C_{t+1}^{during}) \quad (13)$$

The first order condition of equation (13) becomes:

$$\kappa \cdot (1 - \eta - \kappa) \cdot (1 + \Delta RER) \cdot u'(C_{t+1}^{during}) = (1 - \kappa) \cdot (\eta + \kappa) \cdot u'(C_{t+1}^{before}) \quad (14)$$

Equation (14) shows the optimum state that equate the probability of a sudden stop multiplied by utility of reserves during sudden stop with the probability of no sudden stop multiplied by the marginal cost of holding reserves (Goncalves, 2007). Manipulating equation (14), marginal rate of substitution p_t that shows the ratio between consumption during the sudden-stop and consumption in the non-sudden-stop period is generated, such that:

$$p_t = \frac{u'(C_t^{during})}{u'(C_t^{before})} \quad (15)$$

At the optimum state, the ratio of the price of a sudden stop dollar and the price of a non-sudden stop dollar p , a proxy for liquidity premium induced by sudden stop equals marginal rate of substitution p_t i.e.

$$p_t = p = \frac{(1 - \kappa)(\eta + \kappa)}{\kappa(1 - \eta - \kappa)(1 + \Delta RER)} \quad (16)$$

Also, λ_t represent the sum of total deposit withdrawal to output λ_D , private short-term foreign currency debt λ_p to output, and public short-term foreign currency debt λ_g to output. This can be expressed thus:

$$\lambda_t = \frac{i_t^{before}}{Yd_t} \quad (17)$$

Where i_t^{before} is a set of total deposit withdrawal, private short-term foreign currency and public short-term foreign currency debt.

Substituting Equation (16) and (17) in the first order condition in Equation (14), Goncalves, (2007) derived ρ thus:

$$\rho = \lambda + \gamma + \frac{(1-\gamma)p^{\gamma/\sigma}\Delta RER}{1 + [p^{\gamma/\sigma}(1+\Delta RER)-1](1-\kappa-\eta)} \quad (18)$$

$$- \frac{p^{\gamma/\sigma}(1+\Delta RER)-1}{1 + [p^{\gamma/\sigma}(1+\Delta RER)-1](1-\kappa-\eta)} \left\{ 1 - \frac{r-g}{1+g} [\lambda + (1-\theta)\lambda_d] - (\kappa+\eta)(\lambda+\gamma) \right\}$$

It can be summarised that the optimum reserves R_t before the sudden stop is a constant proportion of output such that:

$$R_t = \rho Y d_{t+1}^{before} \quad (19)$$

The study, therefore, leverages on equation (18) as expressed in Jeanne and Ranciere (2006) to derive optimum reserves for Nigeria. The Nigerian economy satisfies the assumptions for using the Sudden Stop framework, which include small open economy that trade largely on one product; existence of two sectors (private and public sectors); and the economy is susceptible to shocks due to its reliance on one single product, whose both price and quantity are exogenously determined.

II.3 Review of Empirical Literature

Empirical studies showed that countries have diverse motives of holding external reserves (Nda 2006; Gosh et al., 2012; Benigno and Fornaro 2012). Generally, central banks hold external reserves for transactionary purpose; precaution against external shocks in the event of disruptions in the country's balance of payments; and safety in order to ensure that the economy remain financially solid at all times. Most recently, there has been an increase in the volume of literature on precautionary motive of holding external reserves, especially after the 2008/2009 global financial crisis. The crisis highlighted new sources of vulnerabilities, which underscored the importance of building external reserves in developing and emerging economies to prevent and mitigate sudden economic and financial shocks. There are different approaches, which have been adopted to estimate optimum reserves for an economy including the balance of payments, the Greenspan-Guidotti and other approaches.

II.3.1 Balance of Payments (BOP) Approach

Literature on external reserves adequacy during the 1960's mainly focused on the current account, because disruptions in the BOP came mainly from trade

flows. The most prominent measure of external reserves adequacy during that period was the ratio of external reserves to a country's import of goods and services. The measure focused mainly on current account and applied to countries with huge current account transactions and limited access/exposures to capital markets. Shocks, therefore, arise from the current account and external reserves serve as a buffer to these shocks. The approach simply measures the number of months of current import commitments a country's external reserves could cover if all other inflows cease. The IMF traditional rule of thumb is that adequate external reserves should cover three to four months of imports. It is expressed as stock of external reserves to import of goods and services (IMF, 2011).

The case for reserves to import ratio originated from Triffin (1947) who argued that the level of external reserves should be expected to grow with trade in a linear form and advocated the use of reserves/imports ratio to measure reserves adequacy. A study by the International Monetary Fund (1953) discovered that foreign trade was the largest item on the balance of payments of most countries and should, therefore, be considered in measuring external reserve adequacy. This was evidenced in the analysis of data, which showed that countries generally had external reserves/import ratio that ranged between 30 to 50 per cent. This formed the basis for the minimum of three months of import cover, which has been considered as the internationally acceptable benchmark.

II.3.2 Greenspan-Guidotti Approach

Following the Southeast Asian crisis in the 1990s, the focus on the effect of balance of payments crisis on the current account shifted to the capital and financial account. This development led to the emergence of new reserve adequacy measures, prominent among which are the "Greenspan-Guidotti" rule of 100 per cent cover of short-term debt. This measure compares the level of reserves to short-term external debt to show a country's capability of repaying its short-term debt. According to the "Greenspan-Guidotti" rule, a country's external reserves should be sufficient to cover all short-term external loan obligations without depending on external sources of funding (IMF, 2011).

II.3.3 Other Approaches

Another traditional measure of reserve adequacy is the ratio of external reserves to broad money (M_2) as highlighted in the works of Kaminsky (1999) and De Beaufort Wijnholds and Kapteyn (2001). This measure is expected to capture potential capital flight by residents and used as a precautionary indicator of financial crisis. An adequate reserve is expected to be equal to, at most, 20.0 per cent of M_2 for countries with fixed or managed exchange rate regime and 10.0 per cent for countries operating a flexible exchange rate regime.

Heller (1966) pioneered the use of international reserves demand model to measure optimal external reserves. He measured the cost-benefit of holding external reserves in terms of rational optimising decision that involves equating marginal utility of holding reserves to its marginal cost. He concluded that external reserves were held as a buffer stock to smoothen unexpected and temporary imbalances in international payments.

Frenkel and Jovanovic (1981) developed a stochastic model for determining optimal stock of external reserves based on the principles of inventory management. They estimated reserves demand elasticities with respect to macro-economic adjustment and opportunity cost for twenty-two developed countries, using time series data from 1971 to 1975. Their estimation results were consistent with their theoretical predictions. Ben-Bassat and Gottlieb (1992) noted that a drain of reserves could lead to default on external debt with subsequent output losses. Thus, it is the cost of default that must be incorporated in the trade-off against the opportunity cost of holding reserves.

Flood and Marion (2002), using the buffer stock model, noted that the model worked perfectly well in the floating exchange rate regime as it did in the era of fixed exchange rate. The IMF (2003) study on the emerging economies in Asia, used a standard buffer stock model and concluded that the rapid accumulation of reserves in emerging markets between 1997 and 2001 was broadly in line with the fundamentals of the model but the surge in reserves in 2002 and 2003 was above the level predicted by the model. The surge in reserves was driven, majorly by increases in current account and to a lesser extent by capital flows.

With the growing prominence of capital flows after the Asian crisis and the possibility of sudden stops of such flows, other studies attempted to estimate optimal reserve levels for emerging market economies. Garcia and Soto (2004) compute optimal external reserves for some East Asian economies and Chile and observed that the level of reserves were consistent with optimal self-insurance policy based on the assumption that monetary authorities accumulate reserves in order to reduce the probability of sudden stop. Aizenman and Lee (2005) examined empirically the importance of both precautionary and mercantilist motives in the accumulation of external reserves by developing countries using data from 1980 to 2000. They found the results to be consistent with the precautionary motive. Their findings also revealed that a more liberal capital account increased external reserves, because it provided opportunity for freer global capital movement. The paper noted that obtaining an optimal level of external reserves would require a more detailed model and infor-

mation, such as information on the probability and output costs of shocks, as well as the opportunity cost of holding external reserves.

Caballero and Panageas (2005) developed and estimated a quantifiable model of sudden stops to study the practical mechanisms likely to insure emerging markets against sudden stops. They argued that the addition of richer hedging instruments in central banks portfolios was likely to improve the efficiency of the mechanisms against sudden stops. Also, the authors emphasised the need for emerging market economies to increase the share of their contingent reserves. Jeanne and Rancière (2006) estimated optimal level of external reserves for 34 middle-income countries during 1975-2003, using an insurance model against sudden stops in capital flows. The model incorporated external reserves as a stabiliser of domestic consumption. They observed that the accumulation of external reserves in some Asian countries was far above what should be kept for self-defense against sudden capital flow reversal.

Gonçalves (2007) estimated the optimal international reserves by extending the work of Jeanne and Rancière (2006) to include the prudential perspective of the possibility of large foreign currency withdrawals in the period of crisis. The result was calibrated for Uruguay; a country with a highly dollarised financial sector. The results suggested that Uruguay's external reserves were close to their optimal levels and that further accumulation would be desirable.

Drummond and Dhasmana (2008) estimated optimal level of external reserves for 44 sub-Saharan African countries, using the two-good model of self-insurance against terms of trade and aid shocks with data from 1980 to 2007. The study indicated that optimal level of reserves depended on the size of the shocks, probabilities, and output cost associated with these shocks. The optimal reserve was, therefore, the one that maximised the consumption-smoothing benefits of holding reserves, while considering the related cost.

Barnichon (2009) developed an analytical framework for the quantification of optimal level of reserves for a small open economy with limited access to global finance and subject to sudden economic shocks. The study revealed that optimal level of reserves was sensitive to the parameter calibration, which implied that the use of three months import criterion for reserves adequacy might be inappropriate because of changing global conditions; such as degree of risk aversion, size and persistence of shocks, which had implications for setting optimal reserves level.

Hur and Kondo (2011) posited that reserves accumulation in emerging economies was a response to the increase in foreign debt rollover risk. The paper

argued that increase in debt rollover risk in emerging economies in the 1990s was responsible for the sudden stop in international capital flows.

Calvo et al., (2012) estimated optimal external reserves for 110 developed and developing countries, using the self-insurance model against sudden stops. The model incorporated the balance sheet effect of large foreign currency liability. The results indicated that the average observed external reserves were close to the optimal reserves and that the choice of optimal external reserves levels by individual countries was driven by country specific factors.

There are other studies that attempted to estimate external reserves adequacy for Nigeria. For example, Oputa and Ogunleye (2010) estimated optimum level of reserves for Nigeria during the period 1992-2009, using the Shcherbakov (2002) model. The result revealed that before 2006, the actual levels of external reserves were below the estimated adequate levels by an average of US\$19.56 billion. However, from 2006 to 2009, the actual stock of external reserves exceeded the optimum levels by US\$9.1 billion, US\$15.4 billion, US\$2.6 billion and US\$0.7 billion in 2006, 2007, 2008, and 2009, respectively. The study concluded that the reserves accumulation during the period was in line with global trend, especially in emerging economies but could not be adjudged to be sufficient.

Moreover, Abiola and Adebayo (2013) examined the reserves adequacy in Nigeria using the traditional approaches of external reserves adequacy. They concluded that Nigeria's foreign reserve was adequate, based on international benchmarks of import cover and debt based measures. Udo and Antai (2014) examined the opportunity cost of Nigeria's external reserves using OLS. The study found that the accumulation of external reserves impacted negatively on investment and economic productivity in Nigeria. The paper recommended de-accumulation of external reserve with a view to channeling additional foreign exchange into productive investment. Tule et al., (2015) examined the optimal level of international reserves for Nigeria. The study found the external reserves to be optimal between 2008Q1 and 2010Q4. They, however, noted that the average core reserve available to the economy was insufficient to absorb the adverse economic impact of financial crises, if they occur in future. Irefin and Yaaba (2012) estimated the determinants of foreign exchange reserves in Nigeria, using an Autoregressive Distributed Lag (ARDL) approach to modify the Frenkel and Jovanovic (1981) 'Buffer Stock Model'. The study found strong evidence in support of income as a major determinant of external reserves management in Nigeria.

These studies on Nigeria, however, did not consider optimal reserves level under a sudden stop scenario. The study intends to fill this gap through the application of sudden stop framework by Jeanne and Rancière (2006) and Gonçalves (2007) to Nigeria specific conditions.

III. Synopsis of Foreign Capital Inflow and External Reserves in Nigeria

The stylised facts on foreign capital inflows and external reserves in Nigeria are presented, thus:

III.1 Capital Inflow

Foreign capital inflow to Nigeria is composed of foreign direct investment (FDI), portfolio investment (PI) and other investment liabilities, which comprised of foreign currency deposits and trade credits, among others. Aggregate foreign capital inflow to Nigeria, which averaged US\$10.07 billion between 2007 and 2010 increased to an average of US\$19.98 billion during 2011 to 2014. The improved inflow of foreign capital to the country was attributed to policy consistency, occasioned by coherence between the fiscal and monetary policies, macroeconomic stability and attractive rate of return on domestic financial assets.

Out of the total capital inflow, FDI averaged US\$7.27 billion and accounted for 72.2 per cent of total flows, while portfolio investment averaged US\$2.06 billion and accounted for 20.5 per cent of total flow between 2007 and 2010. Other investment inflow in form of loans accounted for the balance. The average share of portfolio investment inflow into domestic equity and debt markets increased significantly to US\$10.33 billion between 2011 and 2014, accounting for 51.7 of total, while FDI inflow at US\$6.59 billion accounted for 33.0 per cent of total. The dominance of portfolio inflow, sometimes regarded as 'hot money', has created fear of capital reversal and exchange rate volatility, given the experiences of Asian countries in the 1990's and most industrialised nations during the global financial crisis of 2008-2009. For example, the global economic crisis of 2009 triggered large capital outflow from Nigeria, which was reflected in the draw down on external reserves of about US\$12.00 billion. Thus, the reserves fell from US\$62.08 billion in September, 2008 to US\$50.04 billion in 2009.

Analysis of other investment inflows, particularly foreign currency deposits, revealed that resident foreign currency deposit as a percentage of total foreign currency deposit remained over 99 per cent throughout the period while that of non-resident foreign currency deposit was less than 1 per cent during the same period as indicated in Figure 2.

Figure 1: FDI and Portfolio Investment Flows (US\$ Billion)



Source: CBN

Nigeria experienced sudden stop in capital inflow between 2008 and 2009. This was traced to a number of factors, which included the adverse impact of global financial crisis on developed economies that hindered access to international capital market; the collapse of the oil market, which affected investment in the Nigerian oil sector; and the lack of coherent and clear policy direction, which discouraged the growth of both domestic and foreign investment. Consequently, foreign reserves went down by 20.0 per cent to US\$42.38 billion in 2009. The declining trend persisted till end-December, 2014 at US\$34.24 billion. This development led to the continual depreciation of the average nominal exchange rate from N118.53/US\$1.00 in 2008 to N148.90/US\$1.00 in 2009 and further to N169.68 /US\$1 in 2014.

Figure 2: Resident and Non-Resident Foreign Currency Deposit (Share of Total Foreign Currency Deposits)



Source: Authors' computation

III.2 External Reserves

Nigeria increased its external reserves from US\$9.39 billion in 2000 to US\$16.96 billion, US\$28.28 billion and US\$42.30 billion in 2004, 2005 and 2006, respectively, and peaked at US\$53.00 in 2008. The accumulation was driven majorly by receipts from oil exports, occasioned by increase in the oil prices at international oil market. At the inception of global economic crisis in 2009, the external reserves stood at US\$42.38 billion, but dropped to US\$32.33 billion in 2010. However, in 2012, the reserves further increased to US\$43.83 billion but declined by 21.9 per cent to US\$34.24 billion at end-December, 2014. The decline in external reserves was attributed to global dynamics, which led to crash in oil prices and sharp drop in foreign exchange inflow.

III.3 Relationship between External Reserves and Capital Flow in Nigeria

External reserves have been identified as one of the pull factors for attracting capital flow to an economy. Choi et. al., (2007) examined the interaction between capital flows and international reserves holdings in the context of financial integration. The authors noted that capital flow was sensitive to international reserve holdings. Alberola et. al., (2014) described external reserves as stabiliser of international capital flows, in particular during period of global financial stress. These views are applicable to Nigeria. There is no gainsaying in the fact that capital flow has influenced the growth pattern of Nigeria's external reserves over the past five years. This is because capital flow surges tend to stem foreign exchange demand pressure which culminates in growing external reserves. Also, in recent times, short-term capital flow reversal has contributed to declining external reserves in Nigeria.

Figure 3: External Reserves and Capital Inflow (US\$ Billion)

Source: CBN

IV. Data, Methodology and Results

IV.1 Data and Data Source

The data used for this study were generated from two sources, namely, CBN database and some calibrated variables from past studies. The CBN data is from 2010 to 2014 because the rebased GDP only exists for these periods.

IV.2 Model Specification

We applied the formula for optimum reserves specified in Equation (18) of Section 2, using the variables in Table 1 and calibrated parameters in Table 2.

$$\rho = \lambda + \gamma + \frac{(1 - \gamma) p^{\gamma/\sigma} \Delta RER}{1 + \left[p^{\gamma/\sigma} (1 + \Delta RER) - 1 \right] (1 - \kappa - \eta)}$$

$$- \frac{p^{\gamma/\sigma} (1 + \Delta RER) - 1}{1 + \left[p^{\gamma/\sigma} (1 + \Delta RER) - 1 \right] (1 - \kappa - \eta)} \left\{ 1 - \frac{r - g}{1 + g} \left[\lambda + (1 - \theta) \lambda_d \right] - (\kappa + \eta)(\lambda + \gamma) \right\}$$

IV.3 Estimation Procedures

The estimation of optimum reserves for Nigeria was leveraged on Jeanne and Ranciere (2006) model, which held the following assumptions during sudden stop: that banking system would lose larger fraction of foreign currency deposits, short-term foreign currency debt was not rolled over; real exchange rate depreciates and output falls.

Table 1: Variable Parameters

Variable Parameters (%)	2010	2011	2012	2013	2014
Residents' Foreign Currency Deposits/Total foreign currency deposits (RD)	99.91	99.88	99.96	99.95	99.79
Non-Residents' Foreign Currency Deposits/Total foreign currency deposits (NRD)	0.09	0.12	0.04	0.05	0.21
Banks' liquid Foreign assets/Foreign Currency Deposits	196.19	164.87	87.63	86.06	86.62
Private sector short-term foreign currency debt/GDP λ_p	0.001	0.003	0.008	0.008	0.012
Total Foreign Currency deposit/GDP λ_d	0.007	0.008	0.024	0.017	0.025
Public sector short-term foreign currency debt/GDP λ_g	0.006	0.005	0.016	0.009	0.013

Source: Authors' Computation

In calibrating the parameters, we adopted standard assumptions used in most studies, such as Jeanne and Ranciere (2006) and Goncalves (2007), for developing countries. We set risk aversion parameter σ at 2, number mostly adopted in business cycle literature. The risk free rate of 5 per cent was adopted, which was derived from average of US 3-month Treasury bill rates, mostly adopted on studies for developing countries. We assumed 6 per cent growth potential for Nigeria, using average of real growth for the past five years. Based on the recent experience in Nigeria during global financial crisis where real exchange rate depreciated by around 20.0 per cent, we assumed the same level of depreciation in the future occurrence of sudden stop. For the term premium, 1.5 per cent was assumed as in other studies for developing countries (Jeanne and Ranciere, 2006; Goncalves, 2007). The term premium is usually derived from differences between averaged yields on 10 year US Treasury bond and the federal fund rate in the last 20 years as in most studies for developing countries.

Table 2: Fixed Parameters

Fixed Parameters	In Per cent
Coverage of non-residents' deposits(NRD)	1.00
Coverage of Residents' deposits (RD)	0.70
Accumulated output loss (γ)	0.10
Probability of sudden stop (κ)	0.08
Term premium (η)	0.02
Risk-free rate (r)	0.05
Risk aversion (σ)	2
Real exchange rate depreciation(ΔRER)	0.20
Long-run GDP growth rate(g)	0.06

Source: Authors' Computation

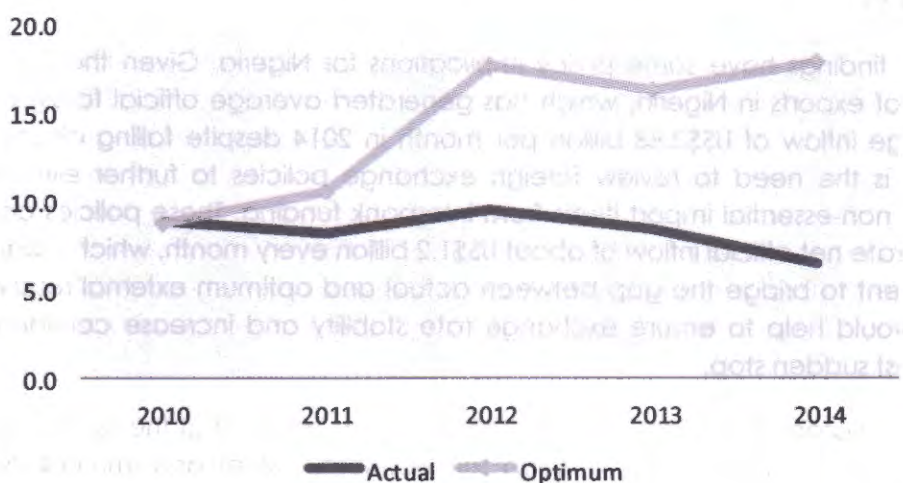
We further assumed that 100.0 per cent of non-residents' currency deposits by official reserves and banks' liquid foreign assets would be covered in the occurrence of sudden stop to insulate the domestic economy from the sudden withdrawals by non-residents. However, we also assume that residents would withdraw about 70.0 per cent of their foreign currency deposits during sudden stop. In terms of output loss during crisis, we assume that only 10.0 per cent of output would be lost.

IV.4 Model Results

The result of the calibrated model for Nigeria was reported in Table 3 and Figure 4. The results showed that the optimum reserve in 2010 was 8.4 per cent of GDP almost at the same level with 8.9 per cent for the actual level of reserves. However, the actual reserves fell slightly below the optimum reserves by 2.4 percentage point in 2011. The result further suggested that from 2012, the actual reserves were far below optimal levels. On average, the optimum reserve was around 15.7 per cent of GDP in the past four years, translating to optimum reserves of US\$4.52 billion. However, the actual level of reserves was US\$28.56 billion as at end-May, 2015, indicating that the actual level of reserves was far below the trigger or optimum level in Nigeria.

Table 3: External Reserves (% of GDP)

	Actual Reserves	Optimum Reserves
2010	8.9	8.4
2011	8.2	10.6
2012	9.6	17.7
2013	8.4	16.4
2014	6.5	18.0

Figure 4: External Reserves as a Percentage of GDP

IV.5 Discussion of Results/ Policy Implication

These findings have some policy implications for Nigeria. Given the current level of exports in Nigeria, with an average official foreign exchange inflow of US\$3.88 billion per month in 2014, there is the need to review foreign exchange policies and further eliminate some non-essential import items from interbank funding. Also, the CBN should reduce the frequency of its interventions at the interbank. These policies would generate net official inflow of about US\$1.2 billion every month and would bridge the gap between current actual and optimum external reserves in Nigeria within one year, ten months. Therefore, CBN should intervene occasionally in the interbank market and the foreign exchange supply base enhanced through addressing the challenges to economic and export competitiveness.

V. Conclusion

The study has estimated optimum external reserves for Nigeria during 2010 – 2014, using Jeanne and Ranciere (2006) model of sudden stop, which was later modified by Goncalves (2007). The study showed that resident foreign currency deposit accounted for over 90 per cent of the total foreign currency deposit, while non-resident foreign currency deposit accounted for the balance. The study also showed that non-resident foreign currency deposits, which is the most vulnerable during sudden stop era, is small in Nigeria. However, there has been an increased private sector participation in short-term foreign currency debt. The result from the estimated model suggested that external reserve was adequate in 2010 but beyond that period, it was far below optimal levels. On average, the optimum reserve was around 15.7 per cent of GDP for the past four years, translating to optimum reserves of US\$54.52 billion.

These findings have some policy implications for Nigeria. Given the current level of exports in Nigeria, which has generated average official foreign exchange inflow of US\$3.88 billion per month in 2014 despite falling oil prices, there is the need to review foreign exchange policies to further eliminate some non-essential import items from interbank funding. These policies could generate net official inflow of about US\$1.2 billion every month, which is barely sufficient to bridge the gap between actual and optimum external reserves. This would help to ensure exchange rate stability and increase confidence against sudden stop.

The estimated optimal reserves of US\$54.52 billion implies that the government has to be fiscally prudent to keep the economy afloat and immune from global economic shock, largely manifested in capital flow reversal from developing countries such as Nigeria. Also, at this level of reserves, foreign investors would be willing to invest in Nigeria, since the country has enough buffer to withstand sudden repatriation of capital.

In conclusion, to ensure sustainable optimal level of reserves, monetary authority should revisit its foreign exchange management policies by intervening occasionally in the foreign exchange market in order to grow the reserves over and above the optimal level. In addition, the supply base could be enhanced by focusing on growing the non-oil sector and tackling the challenges to export competitiveness by drastically reducing high cost of doing business in Nigeria. By so doing, the Nigerian economy will be less vulnerable to external shocks.

References

- Abeng, M. O. (2007). "Foreign Exchange Reserves Accumulation: Implications for the Nigerian Economy", *Central Bank of Nigeria Bullion*, Volume 31, 3, pp. –
- Abiola, A. G. and Adebay, F. O., (2013). "Channeling Nigeria's Foreign Exchange Reserves into Alternative Investment Outlets: A Critical Analysis", *International Journal of Economics and Financial Issues*, Vol. 3, No. 4, 2013, pp. 813-826.
- Aizenman, J. and Lee, J., (2005). "International Reserves: Precautionary Versus Mercantilist Views, Theory and Evidence", *IMF Working Paper*, 05/198.
- Alberola, A. E., Erce, A and Serena, J. M., (2014). "International Reserves and Gross Capital Flows Dynamics", *Documento de Discusion No. 3*, Banco de Espana, Madrid, Spain.
- Barnichon, R. (2009). "The Optimal Level of Reserves for Low-Income Countries: Self-Insurance against External Shocks", *IMF Staff Papers* 56, 852-875.
- Ben-Bassat, A. and Gottlieb, D., (1992). "Optimal international reserves and sovereign risk", *Journal of International Economics*, Vol. 33, pp. 345–62.
- Benigno, G. and Fornaro, L., (2012). "Reserve Accumulation, Growth and Financial Crisis", *Mimeo*, Centre for Economic Performance, LSE.
- Caballero, R. and Panageas, S., (2005). "A Quantitative Model of Sudden Stops and External Liquidity Management", *NBER Working Papers*, no. 11293.
- Calvo, G. A., Alejandro, I. and Rudy, L., (2012). "Optimal Holdings of International Reserves: Self-Insurance against Sudden Stops", *NBER Working Paper*, no. 18219.
- Choi, W. G., Sharma, S. and Maria, S., (2007). "Capital Flows, Financial Integration and International Reserve Holdings: The Recent Experience of Emerging Markets and Advanced Economies", *IMF Working Paper*, 07/151.
- DeBeaufort-Wijnholds, J. A. H. and Kapteyn, A., (2001). "Reserve Adequacy in Emerging Market Economies", *IMF Working Paper*, WP/01/143.
- Drummond, P. and Dhasmana, A., (2008). "Foreign Reserve Adequacy in Sub-Saharan Africa", *IMF Working Paper*, WP/08/150.
- Flood, R. and Marion, N., (2002). "Holding Reserves in an Era of High Capital Mobility", *IMF Working Paper*, no. 62.
- Frenkel, J. A. and Javanovic, B., (1981). "Optimal International Reserves: a Stochastic Framework", *Economic Journal*, Vol. 91, pp. 507-514.
- García, P. and Soto, C., (2004). "Large Hoardings of International Reserves: Are they worth It?", *Central Bank of Chile's Working Paper*, no. 299.
- Ghosh, A. R., Jonathan, D. O. and Charalambos, G. T., (2012). "Shifting Motives: Explaining the Buildup in Official Reserves in Emerging Markets since the 1980s", *IMF Working Paper* 12/34.

- Goncalves, F. M. (2007). "The Optimal Level of Foreign Reserves in Financially Dollarised Economies: The Case of Uruguay", *IMF Working Paper*, 07/265.
- Greenspan, A. (1999). Currency Reserves and Debt, remarks before the World Bank Conference on Recent Trends in Reserves management, Washington DC.
- Heller, H. R. (1966). "Optimal International Reserves", *Economic Journal*, Vol. 76 (June), PP. 296-311.
- Hur, S. and Kondo, I., (2011). "A Theory of Sudden Stops, Foreign Reserves, and Rollover Risk in Emerging Economies", *Mimeo*, University of Minnesota
- Igue, N. N. and Ogunleye, T. S., (2012). "Demand for Foreign Exchange Reserves in Nigeria: A Co-integration Approach", *CBN Economic and Financial Review*, Vol. 50, no. 2. Pp.
- International Monetary Fund (1953). "The Adequacy of Monetary Reserves", *IMF Staff Papers*, Vol. 111 no. 2, October 1953. Pp. 181-229.
- International Monetary Fund (2003). "Are Foreign Exchange Reserves in Asia too High?", *World Economic Outlook*, (September): 64-77.
- Irefin, D., and Yaaba, B., (2012). "Determinants of Foreign Reserves in Nigeria: An Autoregressive Distributed Lag Approach", *CBN Journal of Applied Statistics* Vol. 2 No.2 69.
- Jeanne, O. and Ranciere, R., (2006). "The Optimal Level of International Reserves for Emerging Market Countries: Formulas and Applications", *IMF Working Paper*, 06/229.
- Kaminsky, G. L. (1999). "Currency and Banking Crises: The Early Warnings of Distress", *IMF working paper*, 99/178.
- Migap, J. P. (2010). "The Decline of the Dollar: Implications for Nigeria's Foreign Reserves", *International Journal of Economic Development Reserch and Investment*, Vol. 1, 2 & 3,
- Nda, M. (2006). "Effective Reserve Management in Nigeria: Issues, Challenges and Prospects", *Central Bank of Nigeria Bullion*, Vol. 30, 3.
- Onwioduokit, E. A. (2008), "Investing Africa's External Reserves in Africa: Issues, Challenges and Prospects". Central Bank of Nigeria, Bullion, Vol. 32, 4.
- Oputa, N. C. (1997). "Determinants of Currency Composition of External Reserves in Nigeria: An Empirical Exploration", *CBN Economic and Financial Review*, Vol. 35, 1, March
- Oputa, N. C. and Ogunleye, T. S., (2010). "External Reserves Accumulation and the Estimation of the Adequacy Level for Nigeria", *CBN Economic and Financial Review*, Vol. 48, no. 3.
- Rodriguez, C. S. and Funk, K., (2012). "Estimation of Optimal International Reserves for Costa Rica: A Micro-Founded Approach", *Central Bank of Costa Rica Research Paper Series*.

- Shcherbakov, S. G., (2002). "Fifteenth Meeting of the IMF Committee on Balance of Payments Statistics", Canberra, Austria, October 21-25, 2002.
- Triffin, R. (1947). "National Central Banking and the International Economy", *Review of Economic Studies*, no 1947.
- Tule, M. K., Egbuna, E. N., Sagbama, J. E. L. , Abdussalam, S., Ogundele, A., Oduyemi, O. S., and Oladunni, S., (2015). "Determination of Optimal Foreign Exchange Reserves in Nigeria", *CBN Working Paper Series* CBN/WPS/01/2015/06
- Udo, A. B. and Antai, A. S., (2014). "Opportunity Cost of Nigeria's External Reserves", *IOSR Journal of Economics and Finance (IOSR-JEF)* Volume 3, Issue 5. (May-Jun. 2014), PP 07-16.