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An Assessment of Monetary Policy Response To Capital Inflows in Nigeria1

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Large and persistent capital inflows can be a double-edged sword. Accompanying its many attractions is the tendency to display a boom and bust pattern (volatility and reversals) in addition to the possibility of causing rapid exchange rate appreciation, inflation and loss of monetary policy independence. These downside risks create very strong impetus for some sort of policy response like sterilization, fiscal consolidation or controls. This study employs a simple analytical framework to estimate the intensity (and effectiveness) of monetary sterilization by the Central Bank of Nigeria (CBN) in response to increased capital inflows in recent years. The study finds evidence of less-than-full, but significantly high sterilization intensity, albeit no indication of sterilization smoothing by the Bank. The paper reports also, evidence of slacking sterilization over time, attributable in part to cost and financial system stability considerations. Rising cost of sterilization, especially, could soon undermine the sustainability of the current approach, predicated on a heavy reliance on market operations, should inflows of the magnitudes observed in the past persist. The situation calls for adoption of supplementary measures.

Keywords: Capital inflows; monetary policy; sterilization; sterilization index; sterilization intensity; Nigeria**.**

JEL Classification: E52, F21, F32

1.0   Introduction

The basic macroeconomic framework of an open economy suggests that external capital financing (whether in the form of foreign direct investment (FDI), portfolio (equity) investment, external debt or any combination thereof) is warranted by the existence of gap between domestic savings and investment. Historically, all the three kinds of external finance have featured

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simultaneously as sources of financing for developing countries. External debt, in particular, became a highly problematic source for many developing countries especially in the 1980s as debt levels became unsustainable and were blamed for the wide-spread macroeconomic imbalances during the period. However, two decades on, particularly as from 2004, external debt in the portfolio of external financing sources of many countries has tended to diminish in prominence owing to the wave of massive debt cancellations that blew across the highly indebted poor countries (HIPCs) and some low-income countries as part of the International Monetary Fund (IMF) and the World Bank poverty reduction/debt cancellation initiatives. Nigeria also benefited from the initiative.

In the last few years, Nigeria has experienced a phenomenal increase in private inflows. Key triggers included the increased tempo of reform which led to a more stable financial system and better macroeconomic environment. More fundamentally, financial developments at the world stage might also have played quite an important role. The fact that the less developed economies were by and large less integrated with the rest of the world, or were thought to be relatively insulated from the crises that engulfed major financial centers made them appear like 'temporary safe havens' for international capital. Bolstered by the oligopolistic nature of markets in such economies, capital flows to them rapidly increased in 2000s to take advantage, also, of the persistent uncovered interest differentials. For instance, capital flows to the sub-Sahara Africa (SSA) increased from about $10 billion in 2000 to over $50 billion in 2007. Nigeria received nearly 30% of the FDI component of the inflows (IMF-REO, 2008).

Until the 2000s, foreign direct investments (FDIs) and debt were the major kinds of inflows to Nigeria. However, as the capital market opened up, the country started to receive substantial inflows in the form of portfolio investment especially from 2004. Both the bonds and equities segments of the market have in recent years experienced unprecedented inflows. As the global financial and economic crisis intensified, inflows slightly recessed as from mid-2008 but picked in 2010 (Figure 1). Overall, total new capital inflows have remained higher in the last five years relative to the past.
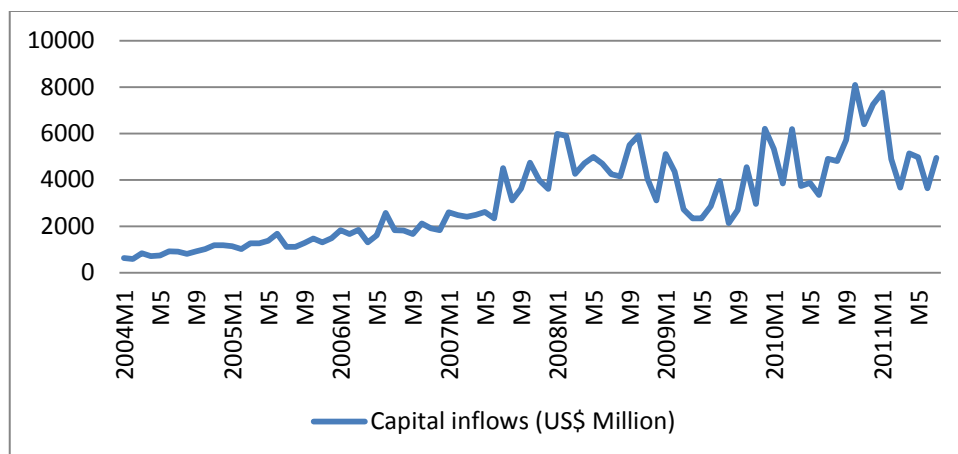
Figure 1: Private Capital inflows to Nigeria, 2004-2011
Source: CBN Annual Report (several editions)

Discussions and debates about the consequences of, and policy responses to private capital flows have remained alive, and easily refreshed in terms of vigour by any fresh episode of financial or currency crisis. The 2007/2008 financial systems crises have rekindled interest in this subject. Of course, as the debate goes on, country case examinations would continue to prove essential, throwing more light on the issues and improving understanding of the nexus among capital inflows, macroeconomic balance and policy response. Such examinations are more urgently desirable for low-income countries, many of which have becomes more important destinations for international capital and which are at the same time often less prepared to handle some of the adverse consequences of inflow surge like real currency appreciation, inflation and sudden stops or reversals.

Central banks directly or indirectly play crucial roles in either lessening the impact of large inflows or in preventing the associated risks from crystalizing. They do so using monetary policy mainly. This is justified by the fact that inflows could lead to rapid deterioration of monetary and financial conditions and thereby make their task of ensuring price stability harder. The Central Bank of Nigeria (CBN) is the sole monetary authority in Nigeria, and conducts monetary policy with a considerable degree of autonomy. The Bank's monetary policy is tailored towards ensuring price stability, among other objectives. In doing so it has adopted, since 1974, the monetary targeting framework which basically relies on the assumption of a stable relationship between money and prices (CBN, 2007). Over time, some

refinements in the way monetary policy is conducted have taken place. It has moved from the initial regime of direct controls to the use of indirect or market-based instruments in the last two decades, even though the basic framework of targeting monetary aggregates has not changed.

In addition to signaling the direction policy (using its policy rate[3]) to rein in inflation expectations, the CBN uses reserve requirements, and conducts regular open market operations (OMOs) to ensure optimal liquidity at all times. Capital inflows increase domestic liquidity by increasing foreign assets of the banking system with the effect of increasing pressure on domestic prices. Therefore, the liquidity management operations of the CBN, especially the mop-up actions, can be thought of as a form of response to inflows. It, however, needs to be seen from the analysis in subsequent sections of this paper whether this response has been systematic and effective overall. Against the foregoing background, this paper investigates sterilization responses to increased capital inflow in Nigeria. Specifically, the paper examines how the CBN has attempted to insulate domestic monetary conditions, or in narrow sense, liquidity, from the expansionary effect of capital inflows and how effective this has been.

The paper is organized as follows. Section two reviews the literature on consequences of large and persistent inflows and policy responses. Section three focuses on methodology and the analytical framework of the study. The main findings of the study are presented and discussed in section four. Section five presents some reflections on policy implications of the findings while section six concludes the paper.

2.0   Literature Review

In the 1990s considerable research effort was directed at re-interrogating the standard economic wisdom that investment finance, on net, should flow from North to South, i.e., from countries with abundance of capital to those in dare need of same due to their relatively low domestic savings. In what is commonly referred to as the 'paradox of capital', it is agreed today, that the flow of financial resources has not always obeyed this simple rule of logic as a

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[3]The CBN used as policy rate, the "Minimum Rediscount Rate" (MRR) up to 2006 when it changed to the current Monetary Policy Rate (MPR), supported by a standing lending/deposit facility.

general rule. As Lucas (1990) and many other studies have shown, there has been, instead, considerable "uphill" flow of financial resources, a pattern which is unlikely to change even in the present era of 'horse race' financial globalization. Goswami *et al*. (2007) outlined its features to include the fact that gross capital flows have expanded rapidly since 1995 from roughly 3.0 per cent to about 15.0 per cent of world GDP in 2005; and that emerging countries have become key providers of capital to mature markets, paradoxically. By the end of 2010, gross capital flows had risen to about 17 percent of world output (IMF-REO, 2011).

The empirical literature suggests that external capital does not simply flow in reaction to investment opportunity as measured by the magnitude of the financing gap or the current account deficit alone. International investors typically factor-in exit potentials/strategies in their decision to move into any economy. In this regard, a country's current earning and also the size of its official reserves matter a great deal. It is a measure of confidence in the economy and obviously offers some kind of unwritten guarantee that the exchange rate can be reasonably defended against wild swings over the short-term. Apparently, increased domestic savings and comparatively impressive growth are important attractions for private capital inflows. Typically, arbitrage opportunities and prospects for quick capital gains emerge and are often inadvertently protected by the weak regulatory environment (often presenting as poor or absence of market regulating institutions). In the circumstance, short-term capital flows are attracted by such opportunities - high returns on equities, high interest rates, exchange rate appreciation, etc.

Given the very wide nature of the subject of inflow and the vastness of research on the subject, the temptation to drift a review of the literature far afield is always strong. To avoid this, the rest of the literature review is structured around two aspects that are more relevant to the particular questions this paper seeks to answer.

2.1   Consequences of large and persistent inflows

Opinions on the growth benefits of financial integration commonly measured by aggregate financial liabilities (size of external debt, FDI and portfolio investment) have continued differ. In fact, increased capital inflow can be a double-edged sword. Whereas some scholars including Stiglitz (2002) view unfettered capital flows as unhealthy and disruptive, others have argued that

increased openness to capital flows has aided some low-income countries to move to middle income status. Bernanke (2005) wrote:

> "The free movement of capital across borders has created, and will certainly continue to create, enormous economic benefits. Capital flows afford developing countries and other regions the means to exploit promising investment opportunities while providing savers around the globe the means both to earn higher returns and to reduce risk through international portfolio diversification. Access to international capital markets also permits nations to accumulate foreign assets in good times and to deplete those assets or to borrow in bad times, mitigating the effects on living standards of shocks to domestic income and production" (p. 1)

Fears about increased flows to developing countries have been commonly associated with the potentials for rapid real exchange rate appreciation, current accounts deterioration, inflation, loss of monetary policy independence and, more crucially, "sudden stops" or flow reversals and the often attendant financial crisis. The tendency of inflows to display a boom and bust pattern is particularly the policy makers' nightmare. Some analyses have even questioned the ability of financial systems in developing countries in particular to handle efficiently huge and persistent private inflows, leading to the insinuation that large inflows may threaten financial stability (Bercuson and Koeing, 1993). Spiegel (1995) has suggested that large and volatile flows could trigger or exacerbate financial system instability by causing large swings in bank liquidity. This could lead to what Calvo, Leiderma and Reinhart (1993) have referred to as "improper intermediation" a situation in which, for example, banks become overly exposed to markets such as real estate and equities, which are highly prone to speculative burbles.

The experiences of countries like Mexico, Argentina and some East Asian nations in the 1980s and second half of the 1990s are quick reference points to the dangers associated with surges in inflows. Those reference points notwithstanding, Kose *et al*. (2007) noted that attempts at studying the manifestations have failed to show evidence that those countries which are more open to financial flows have a higher tendency of experiencing crises than otherwise. Yet, the possibilities of adverse consequences create very strong impetus for some sort of policy interventions when an economy is faced with huge and persistent capital inflows.

2.2 Policy responses to large inflows

Policy interventions are called up to mitigate the so called negative consequences of large inflows while reinforcing their beneficial effects. In the literature, four broad spectrums of policy interventions are easily discernible – fiscal retrenchment, capital controls and exchange rate flexibility and monetary sterilization (Cardarelli *et al.,* 2009; Lee, 1997). Fiscal retrenchment has been used by some countries to mitigate the impact huge inflows. The idea is that reducing government expenditure (contractionary fiscal policy stance) would have a countervailing effect on aggregate domestic liquidity when inflows are on the increase. Liquidity-driven consequences like inflation and real exchange rate appreciation are thereby avoided.

A flexible exchange rate can act as a shock absorber in times of large and persistent inflows. The automatic nature of adjustment helps to contain many of the adverse impacts of inflows. A flexible exchange rate may, however, have some negative repercussions for trade especially owing to its tendency to become more volatile when left to the whims and caprices of the market (Rose 2000; Klien and Shambaugh 2004). This is linked to what is commonly referred to as *fear of floating[4],* the reason countries are either unwilling to float or doing so only slowly (Calvo and Reinhart, 2000). However, proponents of flexible exchange rates as an appropriate mechanism for dealing with huge inflows (for example, Bernanke, 2005) do admit that a flexible exchange rate could exhibit significant volatility in the short run, but that such is unlikely to affect trade substantially since they are easily hedged.

Controls on capital flows as a response, though losing relevance and popularity remains (potentially) the most direct way to avoid undesirable inflows, especially of short-term nature, which often easily become speculative. There are usually varying degrees of control on capital and policy measures for ensuring control. Among developing countries, especially, control more commonly seek to achieve tow ends: slow capital repatriation or flow reversals and prevent hot money. Capital control measures could range from minimum (allowable) investment tenor specified to exclusion of certain assets category from foreign investor the shop list. In Nigeria, until 2011, foreign investors could not subscribe to Nigerian treasury

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[4] It is the view that high exchange rate volatility could harm a country by translating to instability in consumer prices and/or by raising the value of foreign liabilities in the event of a sharp devaluation.

bills (NTBs) of less than one year tenor. When used for a long period, capital controls tend to inhibit growth particularly for a country that seriously needs external capital.

As noted previously, capital inflows translate to increases in domestic liquidity with (potential) negative consequences including inflation to which the central bank must respond. Monetary policy response typically takes the form of monetary (reserves) sterilization. Sterilization in this context refers to the attempt by the central bank to attenuate the effects of increased capital inflows on system's liquidity and monetary conditions in general, by depressing the domestic asset through market operations or by some other means. This is commonly achieved either by increasing the required reserve ratio or through the sale of financial securities (open market operations). Often, central banks use both.

Theoretically, the two operations work through a consequential reduction in system liquidity (money supply) from the domestic credit side thereby counteracting the inflow-induced expansion of system liquidity from foreign assets side. This effect is demonstrated by a backward shift of the LM function. Also, as bank loans become more expensive, particularly if the non-bank financial sector is not in the position to substitute formal intermediation, investment reduces (through a cut back in credit) as in the augmented Bernanke-Blinder IS-LM model (Bernanke and Blinder, 1987).

Of the four options for managing inflows identified earlier, only fiscal policy is completely outside the purview of the central bank. Capital controls, exchange rate flexibility and monetary sterilization, are within the central bank's administrative and technical reach and control. Until 2011, the CBN for example, used regulations to block inflow of some categories of foreign capital. However, owing to the country's commitments under Article 8 of the International Monetary Fund (IMF), among other considerations, the Bank has not been able to use stricter measures of control on capital in recent years. There are indications, nonetheless, that monetary management policies of the Bank have taken into account the surge in inflows in recent years. With regard to monetary sterilization, Figure 2 shows the net domestic assets (NDA) and net foreign assets (NFA) side-by-side. The opposing appearances of the two aggregates especially as from 2004 suggest some deliberate sterilization by the CBN. This is further investigated in the subsequent sections of this paper.
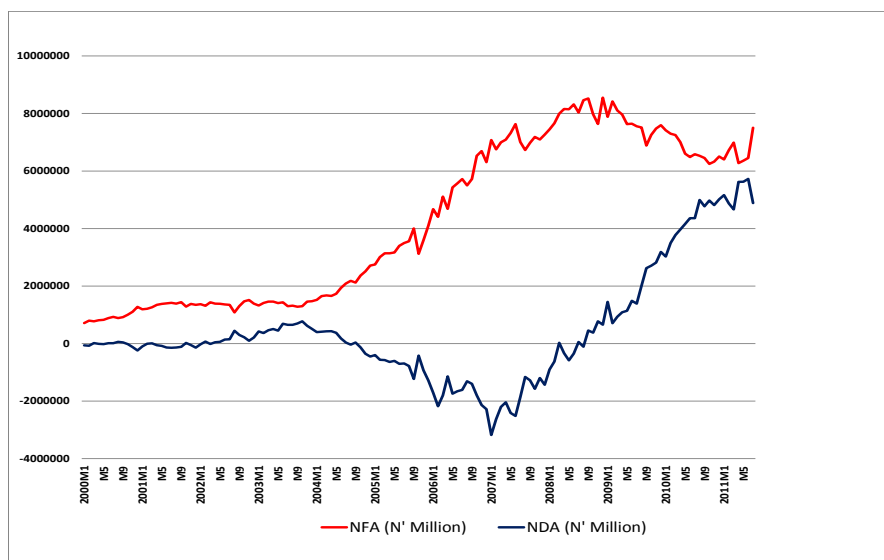
Figure 2: Net Domestic Asset and Net Foreign Asset, 2000-2011
Sources: 1. CBN Annual Report (several editions), 2. CBN Statistical Bulletin (several editions)

3.0 Methodology

3.1. Which model type is ideal?

The central research question of this paper is: To what extent has the CBN attempted to insulate domestic monetary conditions from the effects of the increased inflows to Nigeria since 2004? In other words, how has the CBN ensured monetary stability in the face of the recent surge in capital inflows to Nigeria?

From the literature, three main classes of models have been used to answer similar questions, i.e., to analyze the monetary policy responses to increased capital inflows, in a number of countries, especially, for some Latin America and Asian countries. They are the multi-equation model; vector auto-regression (VAR) and simple linear model. Each of these has its strengths and weaknesses. Studies which are based on VARs and other multi-equation models typically endogenize capital flows (e.g Christensen 2004) and other variables that may not in reality belong to the system (Kwack 2001, Glick and Hutchison, 2000). Besides, these models require lengthier data points to accommodate more degrees of freedom. Problem of multicollinearity easily creeps in, in multi-equations models particularly if foreign asset and a

measure of sterilization are included – both are often highly correlated. Due to these limitations the simple equation model estimated using the ordinary least squares (OLS) has gained greater popularity with studies that either partly of fully focused on the monetary policy response to inflows[5]. This model type (and the OLS estimation technique) is used in this study following Cavoli and Rajan (2005); Glick (2008); Glick and Hutchison (1994); Kwack (1994) and Fane (2000). As has been elaborated in the previous section, monetary policy response typically takes the form of sterilization, an attempt by monetary authorities to depress domestic assets when confronted with large and persistent flows[6]**.** These studies attempted to determine the occurrence and intensity of sterilization over time**.** The OLS estimation technique enables direct extraction of the sterilization indices from estimated slope coefficients of the model.

3.2   **Analytical framework**

We begin from the basic premise that the CBN like every other central bank acts in some ways (systematized or not) to offset the inflows-induced rise in foreign assets by depressing domestic assets in order to ensure monetary stability. Such an action, irrespective of the way it is done, is referred to as sterilization. The basic premise for modeling sterilization operations of a monetary authority is the simple identity that states that the monetary base is the sum of net foreign assets (NFA) and net domestic assets (NDA) subsequently denoted as simply F and D, respectively. A change in the monetary base (ΔH) is traceable to one of three possibilities: a change in net foreign assets (ΔF), a change in net domestic assets (ΔD) or a change in both classes of assets.

$$\Delta H_t = \Delta D_t + \Delta F_t \tag{1a}$$

$$H_t - H_{t-1} = D_t - D_{t-1} + F_t - F_{t-1} \tag{1b}$$

$$H_t = \Delta D_t + \Delta F_t + H_{t-1} \tag{2}$$

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[5] See for example, Cavoli and Rajan (2005) and Glick (2008)

[6] Sterilization is done either by the usual open market sales of financial securities; increase in reserve requirements to depress the money multiplier or by some unorthodox means like withdrawal of public deposits from DMBs

If we assume that the CBN sterilizes completely an increase in foreign assets, then:

$$\Delta H_t = 0 = \Delta D_t + \Delta F_t \tag{3a}$$

Or,

$$\Delta D_t = -\Delta F_t \tag{3b}$$

Equation 3b implies that the derivative of D with respect to F is (-1). If we denote this derivative by φ, we may then rewrite (3b) as:

$$\Delta D_t = \varphi \Delta F_t \tag{4}$$

Therefore, φ is a measure of the extent to which the CBN attempts to insulate domestic liquidity from the direct impact of increases in foreign assets. To assess the magnitude or extent of sterilization operations, we follow Cavoli and Rajan (2005), Glick (2008) and Cardarelli *et al.* (2009), to specify the following linear relationship between net domestic assets and net foreign assets:

$$\Delta D_t = \alpha + \varphi \Delta F_t + \varepsilon_t \tag{5}$$

where; ΔD_t is change in net domestic assets and ΔF_t is change in net foreign assets.

The slope of equation 5 (φ) is actually the measure of sterilization[7]. When multiplied by (-1), we have the sterilization index (Cardarelli *et al.*, 2009). It follows that a sterilization index equal to unity (1) means that the central bank is able to fully offset the rise in foreign asset[8]. Conversely, a sterilization index equal to zero (0) means the central bank does not attempt to sterilize at all. The latter is a highly unlikely scenario because large and persistent inflows typically compel defensive monetary policy actions by central banks to retain control over liquidity and monetary conditions. It is therefore more

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[7]Apriori, φ should be less than zero. If it is exactly -1, then the monetary authority has sterilized fully; less than -1 signifies over sterilization.

[8] From the study by Cavoli and Rajan (2005) the index for Thailand, Indonesia, Malaysia and Philippines during 1990 – 1997 when these countries experienced large inflows ranged from 0.77 to 0.98. This study also found incidence of over-sterilization in Korea (1.11) over the same sample period

plausible to expect the sterilization index to be greater than zero but less than one[9].

Equation 5 captures only contemporaneous adjustment in domestic assets, it does not address the possibility that the monetary authority undertakes to more gradually adjust it in view of expansion in net foreign assets (F) or correct itself in subsequent period if it perceives under or over-sterilization in an earlier period (sterilization smoothing). Following Cavioli and Rajan (2005), we are able to ameliorate this limitation by including a one-period lagged (F) as in equation 6.

$$\Delta D_t = \alpha + \varphi_1 \Delta F_t + \varphi_2 \Delta F_{t-1} + u_t \tag{6}$$

A significant (φ_2) evidences sterilization smoothing. If, $\varphi_2 > 0$, the monetary authority is correcting a perceived over sterilization while if, $\varphi_2 < 0$, it may be interpreted that the monetary authority is attempting to sterilize inflow (gradually) over two periods.

Strictly speaking, equations 5 and 6 enable us to assess sterilization in a narrow context. Since the CBN could also sterilize increases in NFA using some other means, for example, raising the reserve requirement[10], it makes sense to consider, as well, a broader measure of domestic liquidity. Rather than the change in NDA, we investigate the change in broad money supply, M2, in the case of Nigeria, with respect to changes in the net foreign assets. Hence:

$$\Delta M_t = \alpha + \beta \Delta F_t + u_t \tag{7}$$

Equation 7 may be modified to take account of possible sterilization smoothing by the CBN as in equation 8.

$$\Delta M_t = \alpha + \beta_1 \Delta F_t + \beta_2 \Delta F_{t-1} + u_t \tag{8}$$

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[9] It is understood that that even under such circumstances as full sterilization, domestic credit or money supply could change, but in response to other exogenous variables like expected inflation and output gap and not to balance of payment movements

[10] Raising reserve requirements of the banking system decreases the money multiplier with an attendant depressing effect on money supply

Sterilization in this case is full if a central bank is able to completely prevent inflow-induced increases in base money from increasing the money supply by, for example, raising reserve requirements which then alters the money multiplier. In the circumstance, β (or β_1 in equation 8) is zero. On the contrary if base money fluctuations are completely transmitted to the money supply, then β is 1 (any increase in net inflow is reflected in an equal increase in money supply). Both extremes are, however, rare in reality. We assume therefore that: $0 < \beta < 1$.

3.3   Data and sources

The study utilized monthly series from 2000 to 2011 on inflows, exchange rate, treasury bills rate, and various monetary aggregates. The data were obtained mainly from Central Bank of Nigeria sources, including various editions of the Annual Report, Statistical Bulletin, Monetary Policy Review and the Bank's Half-Year Report.

4.0   Results and Analysis

4.1   Overall monetary policy response to capital inflows

The assessment in this paper focuses on the sterilization response of the Central Bank of Nigeria to the inflow of foreign capital. We first estimate four equations (5, 6, 7 and 8) using the ordinary least squares estimation technique. The results are presented in Tables $1 - 4$.

The returned (slope) coefficients from for equations 5 and 6 above are presented in Tables $1 - 4$. In assessing these results we note that the adjusted R-square is low suggesting possible under-specification of our model, which could be ameliorated by introducing additional variables on the right-hand side of the model. However, doing so could further complicate matters as candidate variables are likely to be highly correlated with net foreign asset, and may therefore soak-up part of the monetary sterilization response to inflows. In the circumstance, estimated coefficients of change in net foreign asset would no longer be full measures of monetary sterilization. On this note, we admit the low coefficient of determination as a limitation of this study. A general note of caution is that these results should not be interpreted as evidencing causation, in fact that's not the purpose of the models; instead they only offer us slope coefficients for the computation of sterilization indices.

Table 1: Estimation Results

Dependent Variable: DNDA				
	Coefficient	Std. Error	t-Statistic	Prob.
DNFA	-0.691119	0.068918	-10.02820	0.0000
C	69884.10	20221.10	3.455999	0.0007
R-squared	0.425104	Mean dependent var		35852.47
Adjusted R-squared	0.420877	S.D. dependent var		307719.7
S.E. of regression	234175.1	Akaike info criterion		27.57991
Sum squared resid	7.46E+12	Schwarz criterion		27.62234
Log likelihood	-1901.014	Hannan-Quinn criter.		27.59715
F-statistic	100.5647	Durbin-Watson stat		2.109121
Prob(F-statistic)	0.000000			

Table 2: Estimation Results

Dependent Variable: DNDA				
	Coefficient	Std. Error	t-Statistic	Prob.
DNFA	-0.689134	0.071837	-9.593079	0.0000
DNFA(-1)	0.007799	0.075209	0.103700	0.9176
C	69623.24	20837.46	3.341255	0.0011
R-squared	0.425086	Mean dependent var		36204.30
Adjusted R-squared	0.416505	S.D. dependent var		308821.1
S.E. of regression	235898.7	Akaike info criterion		27.60185
Sum squared resid	7.46E+12	Schwarz criterion		27.66579
Log likelihood	-1887.727	Hannan-Quinn criter.		27.62783
F-statistic	49.53912	Durbin-Watson stat		2.105931
Prob(F-statistic)	0.000000			

First, these results suggest that the CBN systematically responded to the surge in inflows through offsetting reductions in domestic assets between (NDA)

during the sample period with estimated sterilization index of 0.69 in Table 1. Second, we found no direct evidence of an attempt by the CBN to smoothen sterilization over time as the estimate of φ_2 in equation 8 reported on Table 2, (i.e., 0.0077) is statistically insignificant.

The observed sterilization intensity (0.69) is, however, lower than those estimated by other studies for a number of countries during similar episodes of huge inflows in the past. For example, Cavoli and Rajan (2005) reported 1.1, 0.91, 0.77, 0.94 and 0.98, respectively, for Korea, Thailand, Indonesia, Malaysia and Philippines in the period 1990 -1997.

Next we turn to the broader measure of domestic liquidity, money supply (M2). Our estimates of equations 7 and 8 are presented in Tables 4 and 5.

Table 3: Estimation Results

Dependent Variable: DM2				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNFA	0.308106	0.068719	4.483583	0.0000
C	69922.26	20162.76	3.467891	0.0007
R-squared	0.128778	Mean dependent var		85093.82
Adjusted R-squared	0.122372	S.D. dependent var		249247.3
S.E. of regression	233499.4	Akaike info criterion		27.57413
Sum squared resid	7.41E+12	Schwarz criterion		27.61656
Log likelihood	-1900.615	Hannan-Quinn criter.		27.59137
F-statistic	20.10251	Durbin-Watson stat		2.108228
Prob(F-statistic)	0.000015			

Table 4: Estimation Results

Dependent Variable: DM2				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNFA	0.310621	0.071627	4.336618	0.0000
DNFA(-1)	0.009958	0.074990	0.132797	0.8946
C	69544.75	20776.80	3.347231	0.0011
R-squared	0.128939	Mean dependent var		85172.86
Adjusted R-squared	0.115938	S.D. dependent var		250160.2
S.E. of regression	235212.0	Akaike info criterion		27.59602
Sum squared resid	7.41E+12	Schwarz criterion		27.65996
Log likelihood	-1887.327	Hannan-Quinn criter.		27.62200
F-statistic	9.917714	Durbin-Watson stat		2.104005
Prob(F-statistic)	0.000096			

The slope coefficients from equations 7 and 8 are, in general, consistent with those obtained from equations 5 and 6. Sterilization intensity here is (1minus estimate of β in equation 7 or 1 minus estimate of $β_1$ in equation 8). Increases in foreign assets are transmitted to money supply at less than full (β = 0.31). The balance (0.69) is neutralized through the sterilizing actions of the CBN which results in depressing the domestic credit. It follows that the sterilization index is (0.69). The results reported in Table 4 validate our earlier finding that there was no attempt at smoothening sterilization over time as the estimate of $β_2$ (i.e., 0099) was found to be statistically insignificant.

4.2   Inter-temporal assessment of monetary policy Response

Sterilization coefficients for all the rolling regressions were statistically significant, implying that the CBN sustained some level of sterilization throughout the sample period (2000-2011), even as intensities differed. The sterilization indices reported in Table 5 were computed simply by multiplying by (-1) the slope coefficients of the linear relation between changes in NDA and NFA (equation 5).

Table5: 48-month Rolling Regression Results and Sterilisation Indices commencing 2000M01

Regression End Period	Coefficient (φ)	S Index ($|φ|$)
2003M12	(0.77)	0.77
2004M06	(0.78)	0.78
2004M12	(0.81)	0.81
2005M06	(0.75)	0.75
2005M12	(0.88)	0.88
2006M06	(0.65)	0.65
2006M12	(0.58)	0.58
2007M06	(0.66)	0.66
2007M12	(0.75)	0.75
2008M06	(0.69)	0.69
2008M12	(0.60)	0.6
2009M06	(0.65)	0.65
2009M12	(0.59)	0.59
2010M06	(0.60)	0.6
2010M12	(0.61)	0.61
2011M06	(0.66)	0.66

Source: Author's computation

The indices provide information with which to gauge adjustments to the tempo of sterilisation activity by the CBN during the period. It is interesting to view the changing magnitude of sterilization interventions by the CBN in response to increased inflows. A key finding here is that the intensity of monetary sterilisation has varied during the sample period (Table 5). The numbers suggest that up to 2005, the CBN maintained a relatively high tempo of sterilization but slowed significantly thereafter as inflows grew even more rapidly from 2006. Sometime between the second half of 2007 and first half of 2008, the Bank stepped-up sterilization but soon back-pedaled as from the second half of 2008.

Cost might have played a role in the apparent moderation of sterilization intensity as much as the swift decline in external conditions which led to the adjustment of the exchange rate by the bank in December of 2008. Post-2008, increased financial system fragility also limited the ability of the CBN to pursue aggressive sterilization.

Rolling sterilization indices also provide useful indications bout the stance of monetary policy (Cardirelli, 2009). The lower sterilization intensities between 2008 and 2010 may therefore be interpreted as monetary easing. However, such a reading must be done cautiously especially because the broad money multiplier has in recent year exhibited some degree of instability.

5.0   Reflections on Policy Implications

Sterilization obviously reduces pressure from increased inflows on prices in the domestic economy. More sterilization generally means less pressure (demand) on the exchange rate, for example. In December 2006, the CBN commenced direct sales of foreign exchange to BDCs and gradually increased sterilization intensity until the second half of 2008. During the period, the huge premium between the official exchange rate (i.e. rate at the whole-sale Dutch Auction System) and the bureau de change rate crashed. The exchange rate pressure remained subdued from then through the first half of 2008. As sterilization intensity reduced thereafter, pressure on the naira exchange intensified leading to serial depreciation of the naira exchange rate. The pressure on the exchange rate remained elevated up to 2011 (Figure 3). Likewise, more domestic liquidity has meant more inflation pressures to which the CBN has had to respond during the period.   However, we do not view the decision to relax the tempo of sterilization since 2009, as of

necessity, a bad or inefficient policy. Instead, the paper draws attention to the fact that policy making always involves tradeoffs which need to be appreciated. The pressure in the exchange rate market (and on consumer prices) could therefore be seen, in part, as a necessary price for relaxing the sterilization tempo (Table 5), unavoidably, to soothe inter-bank as well as equities market pressures and weaknesses.
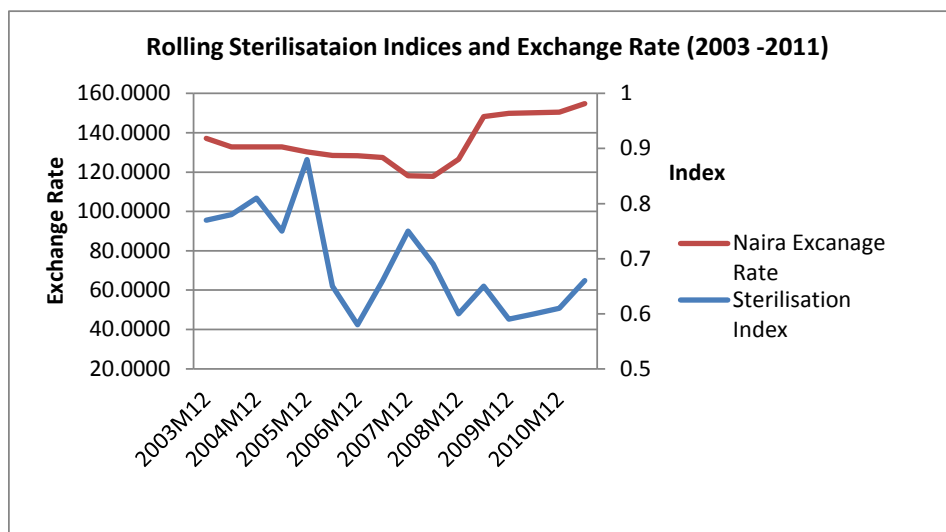

Figure 3: Rolling sterilization indices and exchange rate, 2003-2011
Sources: 1. CBN Annual Report (several editions) 2. CBN Statistical Bulletin (several editions)

Second, Nigeria relies extensively on open market operations for sterilization as compared to use of reserve requirements or transfer (withdrawal) of public deposits from the DMBs. But, more sterilization through this means implies more costs which can be prohibitive[11]. In effect, should large inflows persist

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[11] We did not find clear evidence that changes in the intensity of sterilization during the period were in actual fact dictated by volume of inflow; hence the suggestion that cost considerations may have played a key part, given the rising yields on TBs. In addition, the entire sample period was characterized by growing concerns and apprehensions about the health of many DMBs (segmented inter-bank) which prompted consolidation in 2005 and other interventions to date. A highly aggressive liquidity or sterilization operations at such a time could have had a worsening effect on the balance sheets of the weaker banks through higher market rates. This may have been part of the consideration to slow sterilization operations even as inflows surged.

over a much longer period, the ability of the CBN to sustain sterilization using OMO could diminish markedly[12]. There are other reasons why a central bank may not be able to sustain optimal use of this instrument. For example, by preventing a decrease in the uncovered interest differential, sterilization fails to mitigate the conditions that initially gave rise to huge inflows, and may give rise to 'increased fiscal burden' (Rajan, 2002; Spiegel, 1995; Calvo, Leiderman and Reinhart, 1993; Kiguel and Leiderman 1993; Frankel, 1994, 1999). In Nigeria, indications from movements in treasury bills rates suggest that the cost of OMO operations may have started to rise since 2009 in view of the observed increases in TB rates (Figure 4). Obviously the quasi-fiscal burden of sterilization in Nigeria was bound to increase given that TBs were the main instruments used by the CBN for OMO operations[13].
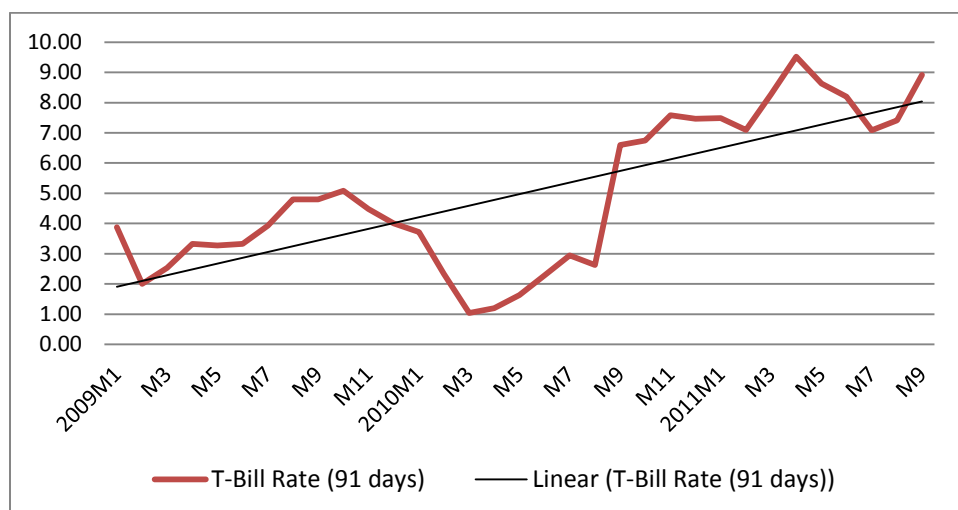

Figure 4: Treasury Bills Rate, 2009-2011
Sources: CBN Annual Report (several editions)

Third, whatever the reasons for slacking sterilization, cost considerations or financial system stability or both, there were consequences. Figure 3 shows

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[12] Calvo, et al (1993) elaborated this cost factor as follows – "The monetary authority earns less from its investment of foreign reserves but pays higher rates on the financial securities it sells in the domestic economy to ensure offsetting reductions in domestic credit leading to rising 'semi-fiscal costs"

[13] Figure 3 shows the CBN already relenting effort at sterilization

increased pressure on the naira exchange as sterilization intensity eased[14]. Attempts by the CBN to bodily defend the naira from yielding to the pressure have meant reserve rundown in recent times. In fact, indications were that the share of capital inflows that became increases in foreign reserves continued to decline. This could continue unless the necessary trade-offs are promptly recognized and admitted.

Interestingly, central banks have other ways of sterilizing excess reserves like raising commercial banks' required reserves (CRR), foreign exchange swaps, and public sector deposit withdrawal. The reserve requirement instrument, in particular, reduces the impact of inflows by limiting the portion that settles in the banking system. It is cheap (when slowly remunerated) and could help mitigate the risk of banking system descent into crisis due to large capital inflows. In developing countries, Calvo, et al (1993), have questioned ability of these institutions to efficiently intermediate external capital. Beyond a certain threshold, however, the use of such instruments could lead to greater inefficiency in the system, yet they are very useful short-term recourse when cost becomes a key consideration.

Finally, monetary sterilization provides only temporary relief. It is unable to permanently mitigate the risks associated to huge and persistent flows partly because the offsetting reductions in domestic assets lead to higher domestic interest rates relative to foreign rates. The resulting uncovered interest rate differentials could lead to more inflows (Lee, 1997). It appears monetary policy in Nigeria is confronting the fundamental policy tri-lemma, the *impossible trinity*. It is the observation that a country can only successfully combine any two of free capital mobility, fixed exchange rate and monetary autonomy as part of its policy strategy. Of course, like many emerging and developing countries today, Nigeria appears to have given up fixed exchange rate in favour of greater capital and monetary policy freedoms. Often the difficulty with this choice arises from the fear of floating. Even when countries declare officially to be moving towards floating, they are often tempted to do the opposite in practical terms, i.e., they try to manage the exchange rate as closely as possible. This is the major difficulty. Resolving

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[14] Inadequate sterilization in the face of more inflows means increased transmission of inflows to domestic liquidity which normally fuels demand for foreign exchange, among other consequences

the tri-lemma for a developing country like Nigeria is never an easy task partly because monetary authorities almost permanently have to deal with the threat of inflation. In fact, they are judged mainly on this note. In the fight against inflation, central banks in these countries find a lot of help in keeping the exchange rate stable. In Nigeria, the exchange rate is a focal point for inflation expectation such that by maintaining a predetermined band within which it manages the exchange rate, the Central Bank of Nigeria is able, today, to reasonably anchor inflation expectation and achieve relative stability in consumer prices. In fact some may argue that the exchange rate is the unannounced monetary policy anchor.

6.0   Conclusion

This paper uses a simple model to measure the monetary policy responses to the surge in capital inflows especially in the second half of the 2000s. The study finds evidence of less-than-full, but significantly high sterilization across the period, albeit no evidence of sterilization smoothing by the CBN. Inflows have remained high, driven partly, perhaps, by high interest rate differentials. In addition, the study finds evidence of slacking or declining sterilization intensity. This, we attribute in part to the rising cost of sterilization as measured by the increasing yields on TBs, a situation that could soon derail or undermine the sustainability of the current approach which is predicated on heavy reliance on market operations, and especially so should inflows of the magnitudes observed in the past persist. Clearly, monetary sterilization alone isn't enough to address fully the risks associated with increased capital inflows in Nigeria. Perhaps, fiscal policy and some measure of capital controls may be considered as part of the arsenal for managing inflows. An analysis of the feasibility of each of the alternative (or complimentary) policy responses to increased inflows in Nigeria is very deserving, though beyond the scope of this paper.

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