INVESTIGATING THE EFFECTIVENESS OF STERILIZATION POLICY IN CONTROLLING MONEY SUPPLY AND CAPITAL INFLOWS IN NIGERIA

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A B S T R A C T

Over the last decade, Nigeria has witnessed rising capital inflows that have kept the monetary authorities on their toes. This study, therefore, investigated the effectiveness of sterilization policy in controlling money supply and capital inflows in Nigeria. The need for this investigation arose from observed dearth of study in this area in Nigeria as well as the surge in capital inflows within the study period with its likely macroeconomic implications. The study would answer the question: (1) to what extent does sterilization effort of the Central Bank of Nigeria effective in controlling capital inflows in Nigeria, (2) to what extent is sterilization policy able to regulate money supply in Nigeria. By utilizing monthly data spanning a period of 2010-2018 under the framework of Two Stage Least Squares (2SLS), findings show that the sterilization policy of the CBN is effective in regulating money supply and depressing capital inflows both in period of normal

capital inflows and in period of intensive capital inflows. We therefore recommend that in periods of sudden and volatile capital inflows, sterilization measure should be given a priority in order to stave off the negative consequences of such unexpected inflows. We also recommend fiscal prudency on the part of the fiscal authorities, especially within the period of high and volatile capital inflows just as the observance of a synergy between fiscal and monetary policies is not ruled out.

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1. INTRODUCTION

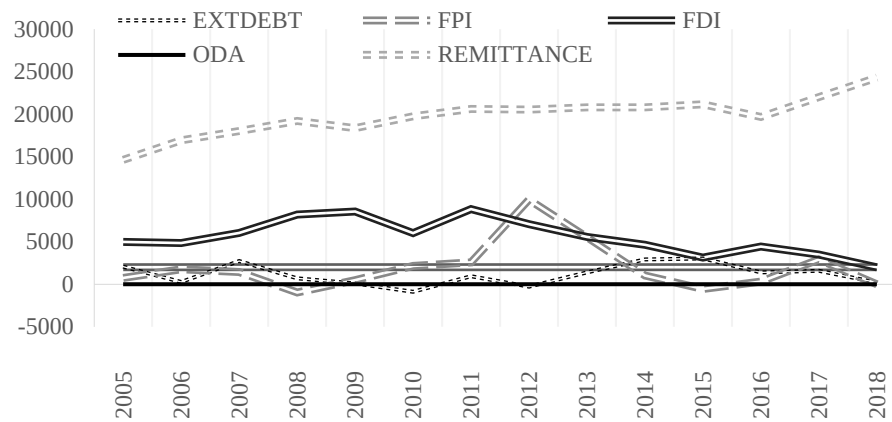
Capital inflows have become a veritable source of revenue particularly to resource constraint countries like Nigeria. As noted by Hashmi et al. (2011), capital inflows to developing countries is a blessing which should be utilized for their development. It should however be noted that rising inflows, if not well managed, could destabilize the macroeconomic environment through appreciating exchange rate, rising inflation among others (Lee, 1997; Blanchard et al, 2015). Nigeria is not exempted from the monetary effects of capital inflows as Tomasz (2016) observed that the banking and financial crisis that hit the country in 2009 were mainly due to shock to capital inflows. As a reaction to the consequences of capital inflows, policy makers in different countries have adopted measures to reduce their economy's vulnerability. Kawai and Lamberte (2008) noted that countries facing rising capital inflows can avail themselves of three broad categories of macroeconomic measures such as sterilization, exchange rate flexibility and fiscal tightening. However, sterilization policy remains the most popular (Bazot et al, 2019; Lee, 1997; Reinhart & Reinhart, 1998).

The need for an investigation into the effectiveness of sterilization policy stems from the fact that Nigeria is thought to have low absorptive capacity to accommodate such inflows. The effectiveness of a sterilization policy can be evaluated by how this policy can reduce the monetary impact of capital inflows on the domestic economy. In a bid to investigate the impact of sterilization policy on

money supply, previous studies (Cavoli, 2005; Takagi & Esaka, 1999; Okpanachi, 2013; Zhang, 2011) used the coefficient of change in net foreign asset (NFA) as proxy for sterilization policy.

It was observed that the intensity of capital inflows is high in some periods and this has encouraged an intensive use of sterilization tools to cushion their effects within those periods. In recent times, apart from the monetization of oil receipts and other oil-related inflows which the International Monetary Fund (IMF, 2013) regarded as the primary source of liquidity, Nigeria has been experiencing an upsurge in capital inflows. The trend in capital inflows is shown in Graph1. below. The Graph shows rising trend of External debt (EXTDBT), Foreign portfolio investment (FPI), Foreign direct investment (FDI), Official development assistance (ODA) and Personal remittances

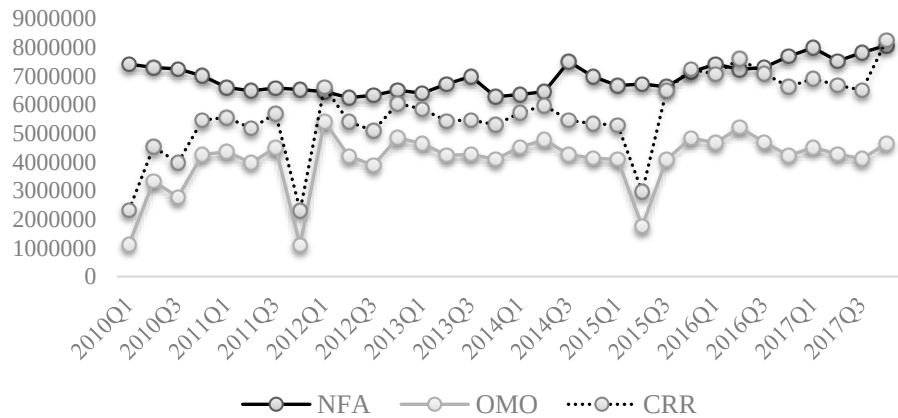
(REMITTANCE) over the years. Remittances have been rising since 2008 and all through 2015, however it fell in 2016 and rose in 2017. FDI got to its peak in 2009 and 2011 and got to another peak in 2016. FPI on the other hand got to its highest peak in 2012. External debt got to its peak in 2007, 2011, and 2015.



Graph 1. Sources of Capital Inflows in Nigeria from 2005-2018, milions US dollars

Source: Compiled by the authors with data from World Development Indicator (WDI, 2019)

According to the International Monetary Fund (IMF, 2013), the Central Bank of Nigeria (CBN) relies heavily on foreign exchange sales to sterilize systemic liquidity. The report noted that the CBN also issues government bills and bonds in primary market as well as changes in cash reserve ratio (CRR) as other instruments to manage systemic liquidity. The use of open market operations (OMO) and cash reserve ratio (CRR) as a response to rising inflows has been given preeminence in recent times by the CBN. Graph 2 below shows that as the NFA increases, the use of both CRR and OMO (proxy by OMO sterilization ratio) also increased with the rising inflow. In the third quarter of 2011, the use of both instruments reduced as NFA rose. They were also used extensively in the third quarters of 2013, 2014 and 2016 respectively.

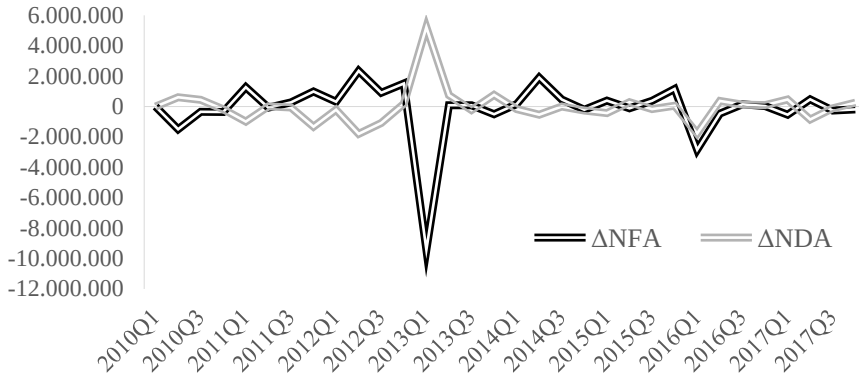


Graph 2. Quarterly Trend in NFA, CRR and OMO for Nigeria

Source: Compiled by the researcher with data from the CBN Bulletin (2018)

N/B: NFA is measured in millions of naira, while CRR and OMO are measured in % and ratio respectively.

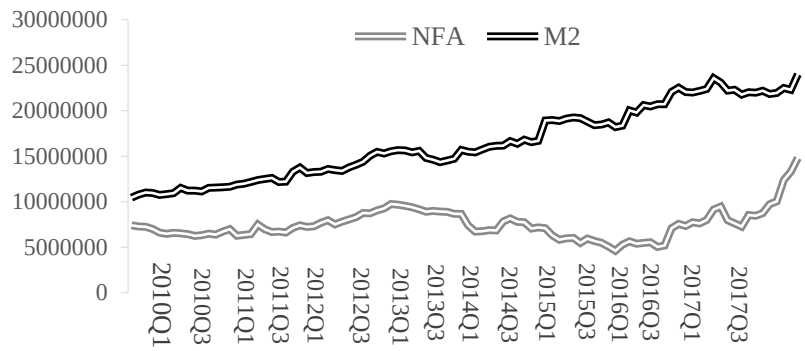
Graph3 below depicts a scenario to describe the sterilization measure of the CBN in recent times. It can be seen that in almost all the quarters, the CBN engaged in moderate sterilization measure as an increase in NFA was neutralized by a reduction in net domestic assets (NDA). Sterilization measure of the CBN became relatively high within 2013 judging from the wide band in NFA and NDA.



Graph 3. Quarterly Trend in ΔNFA and ΔNDA for Nigeria between 2010-2017
Source: Compiled by the author with data from the CBN Bulletin (2018)

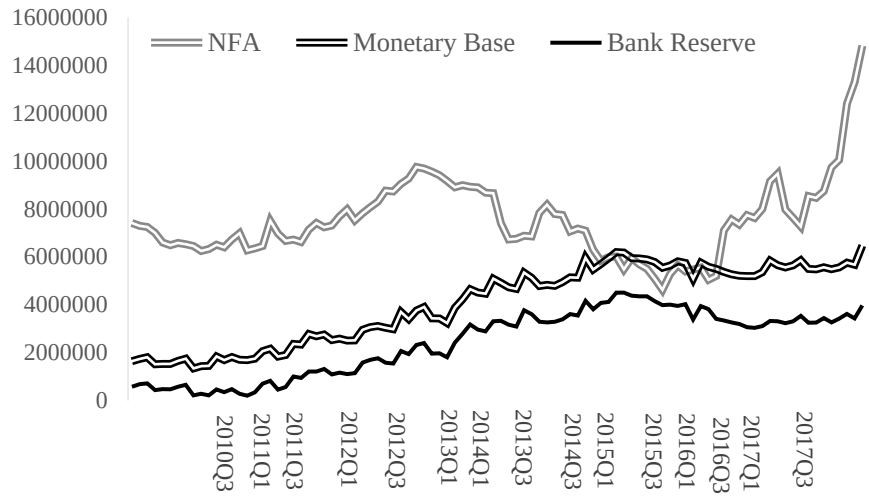
1.1. Stylized facts on the Trend of NFA and some macroeconomic variables in Nigeria

The effect of capital inflows is mainly to raise money supply which will then transmit to other macroeconomic variables. To capture this scenario, Graph 4 below shows a co-movement between net foreign assets (NFA) and broad money supply (M2) in Nigeria. In particular, they rose in the third quarter of 2013 and again in the first quarter of 2017. This scenario led to the common view that the rise in NFA associated with capital inflows somehow caused the rapid growth of money supply during the capital inflow episode.



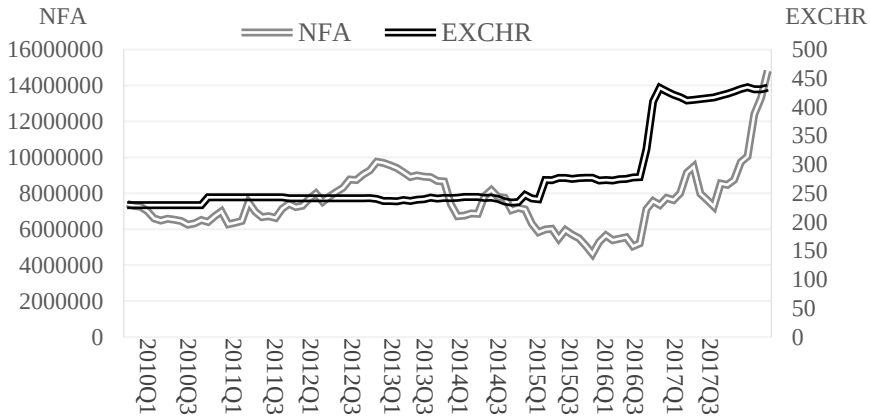
Graph 4. Quarterly Trend in NFA and M2 in Nigeria, million of naira
Source: Compiled by the author with data from the CBN Bulletin (2018)

By increasing money supply, capital inflows also leads to growing monetary base and bank reserve. Graph 5 below shows the quarterly trend in bank reserve and monetary base and how they relate with NFA in Nigeria. Information on the Graph indicates that NFA rose from 2011 to 2013Q3 and fell sharply up to 2016Q3, when it started rising again. Monetary base and bank reserve had uniform behaviour, falling sharply in 2015Q3 and rising in 2017Q1.



Graph 5. Quarterly Trend of NFA, Bank Reserve and Monetary Base in Nigeria, millions of naira. Source: Compiled by authors with data from the CBN Statistical Bulletin (2018)

As the NFA rose, it came with an appreciating exchange rate. Graph 6 below shows that as the trend in NFA rose, that of exchange rate fell. The falling trend of exchange rate means a currency appreciation. From the Graph, as the NFA rose between 2012Q1 to 2013Q3, the trend of exchange rate marginally fell (appreciated). However, as NFA fell between 2014Q3 to 2017Q3, exchange rate rose (depreciated).



Graph 6. Quarterly Trend of NFA and Exchange Rate, millions of naira, US Dollars

Source: Compiled by the author with data from CBN Statistical Bulletin (2018)

The paper is organized as follows. After the introduction (section 1), section two reviews the theoretical framework as well as related empirical studies on the subject matter. The empirical model and methods used for the analysis are described in the third section. The results of the analyses are presented and discussed in section four, while summary, conclusions and policy implication of findings are offered in section five.

2. PREVIOUS RESEARCH

2.1. Theoretical Issue

Some studies have developed theoretical framework to analyze the sterilization measure of the monetary authorities. Cumby and Obstfeld (1983) derived a monetary policy reaction function model that enables the estimation of the degree of sterilization. The theoretical model assumes that the central bank neutralizes the monetary effects of capital inflows via changing its net domestic assets (NDA). It also assumes that owing to inflows, the central bank creates reserve money through exchange rate intervention and that if the Bank employs monetary policy instruments to withdraw the reserves created, it could lead to zero reserves. As NFA increases, the NDA is reduced to offset the impact of the increased NFA. The coefficient of NFA in the model indicates the degree of sterilization and is

called the sterilization coefficient. Its value ranges from minus one to zero. When $a_1 = -1$, sterilization is complete, if it is closer to zero, the sterilization is partial and if $a_1 = 0$, each net inflow or net outflow of foreign capital will result in an equal change in the domestic money supply.

2.2. Review of empirical Literature

The relevance of sterilization as a tool to cushion the effect of the monetary impact of capital inflows has led to its studies in different countries with varying results. In a country-specific study for China, Ouyang and Rajan (2005) investigated the extent of monetary sterilization using Two Stage Least Squares. Result reveals that China has sterilized around 75 percent of capital inflows on average since 1995. In another study for China, Ouyang et al (2007) assessed the extent of sterilization and capital mobility using monthly data between mid 1999 and late 2005 using simultaneous equation framework. The study finds that China has been able to successfully sterilize most of these reserve increases and this is in line with finding by Ouyang and Rajan (2005).

Similarly, Zhang (2011) adopted a Two Stage Least Squares method to estimate the extent of China's sterilization using quarterly data from 1995 to 2010. The study found that sterilization has been highly effective within this period confirming the results from Ouyang and Rajan (2005) and Ouyang et al (2007). Zhang (2011) examined the effectiveness and cost of monetary sterilization in China. The study adopted Two Stage Least Squares method to estimate the extent of China's sterilization. It concludes that the sterilization has been highly effective. However, another study for China by Chung et al. (2014) examined the sterilization policy for the country. The empirical results showed that Chinese monetary authorities sterilized almost all of the effects of international capital inflows and increased foreign exchange reserves on the monetary base. This finding is in line with Ouyang and Rajan (2005) and Zhang (2011).

Cavoli (2005) empirically examined the impact of sterilization on interest rate for Asia using OLS, Two Stage Least Squares and VAR analysis. The results show that there are some contemporaneous effects of sterilization on domestic interest rate. In a cross-country study, Lavigne (2008), using descriptive analysis,

examined recent trends in sterilized intervention among emerging-market economies. The study found that all the countries sterilized over 60% of their inflows between 2000-2006 while between 1990-1996, some sterilized less than 60%. Aizenman and Glick (2008) investigated the degree of sterilization within emerging market countries using OLS. Findings showed that the extent of sterilization has risen in recent years to varying degrees in Asia as well as in Latin America. In another cross country study comprising Pakistan, Korea, Philippines and Japan, Hashmi et al. (2011) estimated the monetary policy reaction function and degree of sterilization using Johansen multivariate co-integration technique. Findings show that over the period of study, all the central banks of these countries have conducted a strong sterilization policy, but did not fully sterilize capital inflow. Lin (2012) applied Error Correction Model (ECM) and OLS to estimate the monetary response functions for sterilization and capital mobility for Thailand, Indonesia, the Republic of Korea and Malaysia. The results of the study showed that except for Indonesia that had a medium degree of sterilization with a medium degree of capital mobility, others had perfect sterilization with high capital mobility.

However, in a cross-country study involving some emerging market economies, Ponomarenko (2019) sought to investigate if sterilized interventions could create money. By adopting a VAR technique, the study found that an increase in central bank's NFA results in lower interbank interest rates, which suggests an incomplete sterilization that has an expansionary effect on the real sector. The study therefore recommends that theses effects should not be overlooked when assessing the macroeconomic consequences of foreign exchange accumulation.

However, in a country-specific study for Croatia, Ljubaj et al. (2010) examined the degree of sterilization in the period from 2000 to 2009 under the framework of Two Stage Least Squares. Result revealed that sterilization was strong, but not full. Begum (2014) investigated the extent of sterilization of Bangladesh Bank to offset the monetary expansionary effect of reserve accumulation. By applying Johansen cointegration technique and Vector Error Correction (VEC), the study finds that there exist a long run relationship between NDA and NFA. In another study for Pakistan, Khushk et al. (2015) investigated the extent the Central Bank of Pakistan sterilizes the effect of changes in net foreign assets on domestic monetary base using monthly data from 1982M1 to 2013M2 under the framework of

2SLS. The study finds that the Central Bank partially sterilizes its foreign exchange operation. This finding supports the finding by Qayyum and Khan (2003).

Similar studies have been conducted in some African countries. For Egypt, Elhendawy (2015) investigated the long-run relationship between sterilization and inflation using annual data from 1980-2011, under the framework of Granger Causality, VECM and Variance Decomposition. The study found a bi-directional causality in two, three and four lags. The VECM result indicates the existence of a long-run positive relationship between sterilization and inflation. In a country-specific study for Algeria, Djedaiet and Ayad (2017)investigated how the Algerian Bank sterilized hard currency in flows using monthly data and under the framework of ARDL. Results showed evidence of full sterilization. In another study that applied OLS, Okpanachi (2013)examined the monetary policy response to capital inflows in Nigeria. The study finds evidence of less-than-full, but significantly high sterilization intensity for Nigeria.

3. MATERIAL AND METHODS

3.1. Theoretical framework

The theoretical framework that guided our study followed the estimation of the monetary policy reaction function by Cumby and Obstfeld (1983). The monetary policy reaction function enables the estimation of the degree of sterilization and it may be written as follows:

$$\Delta NDA = a_1(CA + K) + Y^1 x_t \quad (1)$$

Where: ΔNDA = change in the net domestic assets, a_1 = the degree of sterilization, CA = is the current account balance, K = the capital account balance, X = the vector of other variables that could also affect monetary policy actions. Since, in accordance with the balance of payments, the sum of current and capital account balances (CA + K) is equal to the change in the net foreign assets (ΔNFA), which is approximated by the change in international reserves, equation 1 may be rewritten as follows:

$$\Delta NDA = a_1 \Delta NFA + Y^1 x \quad (2)$$

This relation is actually a simplified monetary policy reaction function, where the coefficient a_1 indicates the degree of sterilization and is called the sterilization coefficient. Its value ranges from minus one to zero. When $a_1 = -1$ sterilization is complete, if it is closer to zero, the reserve money generated by central bank's intervention will not be entirely withdrawn from the market and if $a_1 = 0$, each net inflow or net outflow of foreign capital will result in an equal change in the domestic money supply.

3.2. Empirical model specification

The empirical model that guided this study is derived from the analytical framework outlined above. Specifying the monetary policy reaction function for the estimation of sterilization coefficient, the model we adopted is a modification from Chung et al. (2014) and it is specified as follows:

$$\Delta \log NDA_t = \alpha_0 + \alpha_1 \Delta logNFA_t + \alpha_2 MM_t + \alpha_3 TBR_t + \alpha_4 CPI_t + \mu_t \quad (3)$$

where: ΔNDA = change in Net Domestic Assets, ΔNFA = change in Net Foreign Assets, MM = money multiplier, TBR = treasury bills rate, CPI = consumer price index and U = error term. The range of values for the coefficient of NFA is expected to be between -1 and zero. If a_1 and $a_2 = -1$, sterilization is complete, if closer to zero, sterilization is partial and if = 0, sterilization has no effect on inflows. MM is calculated as a ratio of M2 to Monetary base and we calculated with the excel package.

In investigating the impact of sterilization on money supply, we made a departure from previous studies by regressing money supply against total sterilization. The formula used to generate the series for total sterilization is obtained from Lavigne (2008) and it is as follows:

$$TSTR = (\Delta RD - \Delta NDA)/\Delta NFA \quad (4)$$

Where: TSTR = total sterilization, ΔRD = change in reserve deposit. Other variables are as explained above. We calculated the series for total sterilization using an excel package. The relationship is thus specified as follows:

$$logM2 = \bar{\omega}_0 + \bar{\omega}_1 TSTR_t + \bar{\omega}_2 TSTR_{t-1} + \bar{\omega}_3 CPI_t + \bar{\omega}_4 EXCHR_t + \bar{\omega}_5 CRGOVT_t + \bar{\omega}_6 logRESERV_t + U \quad (5)$$

where: M2 = bread money supply(proxy for money supply), TSTR = total sterilization, CPI = consumer price index, CRGOVT = credit to government and RESERV = bank reserve

To investigate the effectiveness of sterilization, we modeled this based on the modification from Takagi and Esaka (1999). As a departure from previous studies that investigated the intensity of sterilization (Reinhart &Reinhart, 1998; Montiel& Reinhart, 1999; Takagi &Esaka, 1999), we computed the OMO sterilization ratio to guide us in constructing the dummy variable. The formula for the OMO sterilization ratio is obtained from Lavigne (2008) and is calculated as follows: OMO sterilization ratio = ΔNDA/ΔNFA. We used the excel package to generate the series for OMO sterilization ratio. The model is thus as follows:

$$logM2_t = \sigma_0 + \sigma_1 TSTR_t + Dum_1 * Dum_2 * \sigma_2(TSTR_{t-1}) + \sigma_3 EXCHR_t + \sigma_4 CPI_t + \sigma_5 CRGOVT_t + \sigma_6 logRESERV_t + U_t \quad (6)$$

where: Dum_1 = dummy variable for OMO sterilization ratio, Dum_2 = dummy for cash reserve ratio, σ_2 = coefficient of lag of TSTR. Other variables are as explained previously.

The threshold we used to indicate when the CBN used sterilization intensively is when the OMO sterilization ratio is close to -1 and above and when the cash reserve ratio turned to double digit.

Therefore, we shall assign dummy 1 when the OMO sterilization ratio is close to -1 and above and dummy zero otherwise. Also dummy 1 shall be assigned when the cash reserve ratio is double digit and dummy zero when otherwise (see appendixes 1 and 2 below). From Graph 2 above, it can be seen that both OMO and cash reserve ratio trend together, suggesting that the CBN simultaneously uses the two to neutralize the effect of increasing money supply. According to Takagi and Esaka (1999), if the policy of intense sterilization was particularly effective in limiting the impact of an increase in capital inflows on the growth of money supply, we should expect the value of the coefficient of the dummy to be negative, so that as in our own case, the coefficient of ($TSTR_{t-1}$) under intense sterilization (ieσ_2) is algebraically smaller than that under normal conditions (σ_1).

3.3. Estimation techniques and data sources

As observed in literature, the relationship between NFA and NDA entails endogeneity. Therefore, we handled problem of endogeneity by using the Two Stage Least Squares (2SLS) method which requires the selection of instrumental variables to replace the endogenous variables. Therefore, in eq.3 the lag of the dependent variable was chosen as the instrumental variable. We also used world oil price as an instrument in equations 5 and 6. This is because as observed by Vinayagathasan (2013), world oil price is a proxy for expected inflation. If that is the case, we expect it to correlate with the variables used in the calculation of total sterilization, namely NDA, NFA and reserve deposit since the monetary authorities consider expected inflation when manipulating these variables. Following Fair (1997), we included the lag of the left and right-hand side variables in the instrument list. After obtaining the results of the estimates we subjected them to the following tests: endogeneity test, weak instrument diagnostics, instrument Orthogonality test, model specification test, serial correlation test and heteroskedasticity test. The data for the study were sourced as follows: Data on CPI and exchange rate were sourced from the International Financial Statistics (IFS) of International Monetary Fund (IMF, 2018). The data for world oil price was sourced from the US Energy Information Administration (EIA, 2017), while the rest of the data were sourced from the Central Bank of Nigeria Statistical Bulletin (2018).

4. RESULTS

We first present and analyze the results of stationarity test before analyzing our major findings. We carried out this test by relying on the Augmented Dickey Fuller (ADF) and Phillip Perron (PP) tests. The null hypothesis of no stationarity was tested against the alternative at the 5% level. Tables (1) and (2) below show the results of our findings both at level and at first difference respectively. The results from both the ADF and the PP show that none of the variables achieved stationarity at level. However, when differenced, all the series became stationary.

Table 1. Result of Stationarity at Level

Variables	ADF t-stat.	PP t-stat.	Critical value at 5% ADF	Critical value at 5% PP	Order of integration
NFA	1.467091	0.883849	-3.500669	-2.892200	NS
NDA	-1.491718	-1.505443	-2.892200	-2.892200	NS,
CPI	3.234494	2.752651	-2.892536	-2.892200	NS
TBR	-2.369256	-2.083046	-2.892536	-2.892200	NS
EXCHR	0.179970	0.151394	-2.892879	-2.892200	NS
CRGOVT	-0.790064	-1.086200	-1.086200	-2.892200	NS
RESERVE	-1.057255	-0.946130	-3.500669	-3.500669	NS
MM	-1.642570	-2.893230	-1.319989	-2.892200	NS

Source: Compiled by the author. Note: NS means Not Stationary

Table 2. Result of Stationarity at first Difference

Variables	ADF t-stat.	PP t-stat.	Critical value at 5% ADF	Critical value at 5% PP	Order of integra-tion
ΔNFA	-7.238695*	-7.246113*	-2.892536	-2.892536	I(1)
ΔNDA	-9.268842*	-9.344171*	-2.892536	-2.892536	I(1)
ΔCPI	-7.384786*	-7.552742*	-2.892536	-2.892536	I(1)
ΔTBR	-4.623282*	-4.623282*	-2.892536	-2.892536	I(1)
ΔEXCHR	-6.466169*	-5.306834*	-2.892879	-2.892536	I(1)
ΔCR-GOVT	-13.70787*	-13.70787*	-2.892536	-2.892536	I(1)
ΔRE-SERVE	-11.53000*	-11.71702*	-3.501445	-3.501445	I(1)
ΔMM	-11.92011*	-18.84383*	-2.892536	-2.892536	I(1)

Source: Compiled by the author *Note: Graphs with asterisks (*) indicate the rejection of the null hypothesis at the 5% level*

The result of the estimated degree of sterilization (eq. 3) is displayed in Table 3 and it shows that the coefficient of sterilization is approximately -0.74 or 74%. By implication this result shows that the CBN sterilized about 74% of the capital inflows within the period under review. The result is slightly higher than the 69%

reported by Okpanachi (2013) for Nigeria. The difference could be as a result of the different methodology adopted by both studies. The time period in which the two studies were carried out could equally be responsible. The CBN's commitment to sterilize capital inflows is low compared to other developing countries such as -0.99 for Algeria (Djedaiet & Ayad, 2017), -0.80 for China (Zhang, 2011) and -0.981 and 1.056 for Korea and Thailand respectively (Lin, 2012). Finding alsoshows that the coefficient of money multiplier is negative and non-significant. The negative value indicates that the higher the MM, the more the central bank will reduce the NDA in order to fight inflation (Mansour, 2012). The coefficient of Treasury bill rate also exhibits a negative link with NDA, though it is not significant. The reason for the negative value is that a higher Treasury bill rate induces higher capital inflows and this requires stronger sterilization by way of reducing the central bank's net domestic assets. Our result also shows a negative link between NDA and CPI which goes along with apriori expectation even though it is not significant. A rising CPI will force the monetary authorities to reduce money supply and such measure will lead to reduction in NDA. The value however was not significant with $\rho>0.1$.

Table 3. Result of the estimated degree of sterilization. Dep. Var. logNDA

Variable	Coefficient	t-Stat.	Prob.
C	0.091	1.029	0.306
Dlog(NFA)	-0.740*	-2.751	0.007
MM	-0.004	-0.450	0.656
TBR	-0.004	-1.440	0.154
CPI	-0.001	-0.340	0.732
R^2	0.102		
Adj.R^2	0.062		
F-Stat	4.630		
Prob	0.002		
D.W	2.36		

Source: Summary of result compiled by authors from E-Views 9 *Note *, ** and *** denotes significance at 1%, 5% and 10% respectively.*

The estimated result of the impact of sterilization on money supply (eq.5) is displayed in Table 4 below. The result showed that in the current period, steriliza-

tion leads to a marginal fall in money supply, but with a one period lag, the impact of sterilization on money supply is not significant even though it has a depressing influence on money supply. By implication, the use of sterilization instruments to neutralize the growing money supply occasioned by capital inflows is effective in Nigeria within the study period. The relatively high degree of sterilization as our finding shows lends credence to this result. Findings also indicate that both bank reserve and credit to government have positive influence on money supply. The positive influence of bank reserve on money supply indicates how potent a policy targeted at influencing money supply through manipulating the bank reserve can be. Also, the influence of credit to government on money supply goes to show the implication of expansionary fiscal policy stance of the government which may frustrate the sterilization effort of the government. We also noticed that both consumer price index and exchange rate have a positive link with money supply even though they are not significant. The R square value of 0.75 indicate that about 75 percent in the variation of money supply in Nigeria is accounted for by the independent variables in the result presented in table 4. The D.W value of 1.91 indicate the absence of white noise in the model.

Table 4. Result of estimated impact of sterilization policy on money supply

Variable	Coefficient	t-Stat.	Prob
C	13.852*	27.213	0.000
TSTR	-0.009**	-2.270	0.026
TSTR (-1)	-0.0012	-1.151	0.254
Log(RESERV)	0.181*	3.750	0.000
CRGOVT	3.840*	2.742	0.008
CPI	0.002	0.083	0.934
EXCHR	0.0006	0.790	0.4287
R^2	0.752		
Adj. R^2	0.730		
F-Stat.	56.209*		
Prob.	0.000		
D.W	1.91		

Source: Authors computation, 2020 using EViews 9. *Note *, ** and *** denotes significance at 1%, 5% and 10% respectively.*

To measure the intensity of sterilization, Table 5 below presents the result of eq.6. From the results presented, the coefficient of TSTR without a dummy is -0.008272 and the coefficient of TSTR with a dummy is -0.008272.According to Takagi and Esaka (1999), the effectiveness of the intensity of sterilization can be evaluated if the sum of the two coefficients is less than the first coefficient. Therefore, adding the two coefficients, we obtain -0.016544 which is lower than -0.008272. With this result, we conclude that the policy of intensity of sterilization of the CBN is effective in limiting the impact of capital inflows on money supply in Nigeria. By implication, as capital inflows rise, intensive sterilization policy becomes potent in curtailing their effect on money supply. We also found bank reserve and credit to government to significantly influence money supply positively in Nigeria, just as CPI and exchange rate positively relate to money supply even though they are not significant.

Table 5. Result of the estimated intensity of sterilization policy. Dep. Var. Δlog(M2)

Variable	Coefficient	t-Stat.	Prob.
C	13.861*	28.110	0.000
TSTR	-0.009**	2.411	0.018
DUM_1*			
DUM_2*TSTR (-1)	-0.008	-1.252	0.213
Log(RESERV)	0.173*	3.850	0.000
EXCHR	0.001	0.621	0.534
CRGOVT	3.910*	2.870	0.005
CPI	0.0005	0.180	0.856
R^2	0.76		
Adj.R^2	0.74		
F-Stat	57.85		
Prob	0.000		
D.W	1.82		

Source: Authors computation, 2020 using EViews 9. *Note *, ** and *** denotes significance at 1%, 5% and 10% respectively.*

The results of the post diagnostics show that the models passed all the tests conducted. All the tests are evaluated at the 5% level of significance. Of much concern to us is the validity of the instruments we used in the models. The results of the Instrument Orthogonality Test showed that the lag of the dependent variable we used as instrument in equation 3 is valid, just as the world oil price we used

as instrument in equations 5 and 6 is valid as we cannot reject the null hypothesis that they are valid.

5. DISCUSSION AND CONCLUSION

Based on the foregoing results, we conclude that the degree of sterilization though not complete, is relatively high in Nigeria. Also, even though other explanatory variables in the model exhibit the correct sign, they are not significant. We also conclude that sterilization policy is effective in depressing money supply arising from capital inflows both in normal period and in period of high capital inflows. Based on the positive influence of credit to government on money supply we also conclude that the fiscal stance of the government could thwart the effort of the monetary authorities in their quest to sterilize capital inflows. In another respect, we conclude that the positive influence of bank reserve on money supply shows how policy targeted at reducing money supply can work well if bank reserve is influenced.

Following from the above results, we recommend that in period of high and volatile capital inflows, sterilization measures should be given a priority over other measures available to neutralize the monetary impact of capital inflows. This is because sterilization policy is more flexible, timely and does not require much political interference before it is implemented (Yan & Yang, 2008). However, much as sterilization is recommended, we caution that the true cost of sterilization should be evaluated because sterilization has its own cost implications. For instance, when debt instruments are floated through the open market operation in order reduce money supply occasioned by excessive inflows, this will increase the debt profile of the government and retiring such debts in future becomes a problem to the fiscal authorities. Also, frequent increase in the cash reserve ratio as a way to cushion the impact of capital inflows could affect the liquidity position of the deposit money banks and hence their intermediation role.

Secondly, as the result indicated that credit to government leads to a rising money supply, we also recommend fiscal prudency on the part of the fiscal authorities, especially in periods of high and volatile capital inflows and that there should be harmony between fiscal and monetary policies. The era when the monetary authorities implement contractionary monetary policy at the same time the fiscal

authorities exhibit expansionary stance in the face of rising monetary aggregates should end. By extension, there is need to combine sterilization policy with fiscal tightening in periods of rising and unsustainable capital inflows.

Finally, apart from other measures to influence money supply, we recommend that bank reserve should be targeted owing to the tendency of this variable to influence money supply as showed by our results.

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ИСПИТИВАЊЕ ЕФЕКТИВНОСТИ ПОЛИТИКЕ СТЕРИЛИЗАЦИЈЕУ КОНТРОЛИ НОВЧАНЕ МАСЕ И ПРИЛИВА КАПИТАЛА У НИГЕРИЈИ

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САЖЕТАК

Током посљедње деценије, Нигерија је била свједок повећаног прилива капитала који је монетарне власти држао на ногама. Стога је ова студија истраживала ефикасност политике стерилизације у контроли новчане масе и прилива капитала у Нигерији. Потреба за овим истраживањем произашла је из уоченог недостатка проучавања у овој области у Нигерији као и пораста прилива капитала у току периода изучавања са могућим макроекономским импликацијама. Студија је одговорила на питања: (1) у којој мјери су напори стерилизације Централне банке Нигерије ефективни у контролисању прилива капитала у Нигерији, (2) у којој мјери је политика стерилизације у могућности да контролише новчану масу у Нигерији. Коришћењем мјесечних података у периоду 2010-2018. под окриљем двофазне методе најмањих квадрата, резултати показују да је политика стерилизације ЦБН ефикасна у регулисању новчане масе и смањењу прилива капитала како у периоду нормалног прилива капитала, тако и у периоду интензивног при-

лива капитала. Због тога препоручујемо да се у периодима наглог и нестабилног прилива капитала даје предност мјерама стерилизације како би се избјегле негативне посљедице неочекиваног прилива. Такође, фискалним властима препоручујемо опрез, посебно у периоду високог и нестабилног прилива капитала, баш као што се не искључује ни поштовање синергије између фискалне и монетарне политике.

Кључне речи: политика стерилизације, прилив капитала, новчана маса, монетарна политика.

Appendix 1 Data on CRR

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	4	4	4	4	4	4	4	4	4	4	4	4
2011	4	4	4	4	4	4	4	4	4	4	8	8
2012	8	8	8	8	8	8	8	12	12	12	12	12
2013	12	12	12	12	12	12	12	30	30	30	30	30
2014	31	31	31	31	31	31	31	31	31	31	31	31
2015	31	31	31	31	31	31	31	31	31	25	25	20
2016	20	20	20	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
2017	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5

Source: Compiled by the researchers with data from the monetary policy decisions of the CBN during her various monetary policy committee meetings

Data on OMO Sterilization ratio

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2010	-0.088	-0.255	-0.173	-1.26	-2.09	-0.57	-41.8	-0.088	0.32	-1.0	-0.49	0.88
2011	2.06	-1.11	-1.28	-0.74	17.47	1.082	-1.26	-0.81	-0.73	-0.10	-0.72	0.89
2012	1.80	0.42	1.60	-1.09	52.24	-1.35	-0.76	2.04	3.67	-3.61	-0.04	2.8
2013	-0.37	-1.9	-0.35	-1.37	2.68	-0.58	0.48	-0.30	0.37	-0.13	-0.51	-0.02
2014	-0.27	-1.11	0.11	0.66	0.008	0.66	2.11	-4.2	-0.083	-1.59	7.25	-0.03
2015	1.60	-1.28	1.20	0.3	-1.15	-0.55	2.1	-0.73	-0.647	8.75	-1.32	0.28
2016	-1.80	0.10	-0.34	-0.66	-0.96	-3.49	-42.9	0.80	-0.90	-0.421	-2.21	21.76
2017	0	-2.4	-0.78	2.02	-1.2	-14.9	-4.50	-0.74	-1.47	-1.30	-0.82	8.68

Source: Tabulated by the researchers with data from the CBN Statistical Bulletin (2018)

Appendix 2 Post Diagnostic Test Results for Model One

Model Specification (Ramsey RESET Test)	P-value = 0.7646
Heteroskedasticity Test: Breusch-Pagan-Godfrey	P-value = 0.3189
Endogeneity Test	P-value = 0.0393
Weak Instrument Diagnostics	Cragg-Donald F-stat = : 1.774827
Instrument Orthogonality Test	P-value = 0.4565
Serial Correlation	P-value = 0.0890

Source: Compiled by the authors

Post Diagnostic Test Results for Model Two

Model Specification (Ramsey RESET Test)	P-value = 0.6880
Heteroskedasticity Test: Breusch-Pagan-Godfrey	P-value = 0.9982
Endogeneity Test	P-value = 0.0000
Weak Instrument Diagnostics	Cragg-Donald F-stat = 0.998687
Instrument Orthogonality Test	P-value = 0.6974
Serial Correlation	P-value = 0.4274

Source: Compiled by the authors

Post Diagnostic Test Results for Model Three

Model Specification (Ramsey RESET Test)	P-value = 0.9106
Heteroskedasticity Test: Breusch-Pagan-Godfrey	P-value = 0.9981
Endogeneity Test	P-value = 0.0000
Weak Instrument Diagnostics	Cragg-Donald F-stat = 0.734778
Instrument Orthogonality Test	P-value = 0.6667
Serial Correlation	P-value = 0.6190

Source: Compiled by the authors