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Article

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INTERNATIONAL CAPITAL FLOWS AND MONETARY POLICY REACTION IN NIGERIA - ARE THERE ASYMMETRIC EFFECTS?¹

Audu Isa, Adeleke Adegoke Ibrahim and Adedeji Kayode Ezekiel²

Abstract

This paper examines the monetary policy response to fluctuations in international capital flows to Nigeria. This study improves on previous studies by employing the recent asymmetric ARDL approach to examine whether capital flow fluctuations have symmetric or asymmetric effects on monetary policy reaction in both the short- and long-run for the period 2000Q1-2018Q4. The estimated results revealed that positive and negative components of capital flows as well as other explanatory variables have statistically significant effects on the behaviour of monetary policy both in the short- and long-run. The implication of the results is that different monetary sterilization index is required for managing the inherent pressure that can emanate from asymmetric capital flows. Hence, this may explain the continuous adjustment of monetary policy in order to attract foreign capital flows, facilitate stable prices and exchange rate as well as accretion to foreign reserves.

Key Words: *International Capital Flows, Monetary Policy, NARDL, Nigeria*

JEL Classification: *E52; F32; C51*

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1.0. INTRODUCTION

In recent time, a remarkable rise in private inflows has been witnessed in Nigeria. This is due to the enhanced reforms, which resulted in a relatively stable financial system and improved macroeconomic atmosphere. Moreover, financial developments at the global stage may also have contributed to the country's experience. Also, the low level of integration of the developing countries with the rest of the world, or the thought that this category of economies was "shielded" from the global financial crises that overwhelmed foremost financial hubs, gives the impression that the economies are "temporary harbour" for international capital. Reinforced by the oligopolistic nature of markets in the developing economies, there was rapid flows of capital in the 2000s for perceived financial benefits as a result of the persistent uncovered interest rate disparities. Capital flows to the sub-Sahara Africa (SSA), for example, rose from about \$10 billion in 2000 to above \$113 billion in 2017. Nigeria was a recipient of about 30 percent of the FDI element of the inflows (IMF-REO, 2018).

Nevertheless, the upsurge in highly volatile flows like portfolio flows can be devastating to an economy and monetary policy, if not effectively managed. The experiences of Asian countries in the 1990s and significant financial centres during the global financial crisis (GFC) are cases in reference. Empirical evidence has revealed that the benefits of massive foreign capital inflows mainly, foreign direct investment (FDI), include improved output, employment generation, and financial sector development. Many other impacts of volatile and large capital inflows have been acknowledged in topical economic literature, which include real exchange rate appreciation, capital markets and real estate boom, reserve accretion, monetary expansion as well as impacts on production and consumption. The outflow, on the other hand, generates a dearth of liquidity in the system, which drives up interest rate, with negative impacts on capital markets and causes contraction in monetary policy. It could also lead to a depreciation of the domestic currency, resulting in reserves loss. Thus, capital flows have various impacts on financial markets and the monetary policy.

Hinged on this background, the foremost objective of this study is to examine the monetary policy reaction to fluctuations in international capital flows to Nigeria. Most of the existing literature on the subject assumed symmetric or linear relationship between capital flows volatility and monetary policy response (Gupta, 2016; Davis and Zlate, 2019). In Nigeria, for instance, the study by Okpanachi (2013) attempted to address this issue, but it adopted a simple analytical framework and ordinary least squares regression that only accounts for single variable to estimate the strength (and efficiency) of monetary sterilization by the Central Bank of Nigeria (CBN) in response to the upsurge in capital inflows. The study also assumed symmetric relationship between capital flows and monetary policy reaction without accounting for the time series properties of the variables.

However, several recent studies have shown that the asymmetric reaction function of monetary policy is more realistic and it is often based on either the preferences of the policymakers or is compelled by the existing economic structure (Castro, 2011; Sznajderska, 2014; Caporale et al., 2017), particularly in the developing and emerging markets. Hence, monetary policy responses can be represented in a nonlinear form contingent on the phase of the business cycle. For instance, output stabilisation or what is often called pro-growth monetary policy might be more prominent during economic recessions while price stability objectives may be the major focus during the economic expansions phase (Sznajderska, 2014; Caporale et al., 2017). Also, the broad objectives of attracting and managing foreign inflows to augment the existing domestic resources, often influence the monetary authorities' preferences for asymmetric monetary policy depending on the prevailing economic conditions.

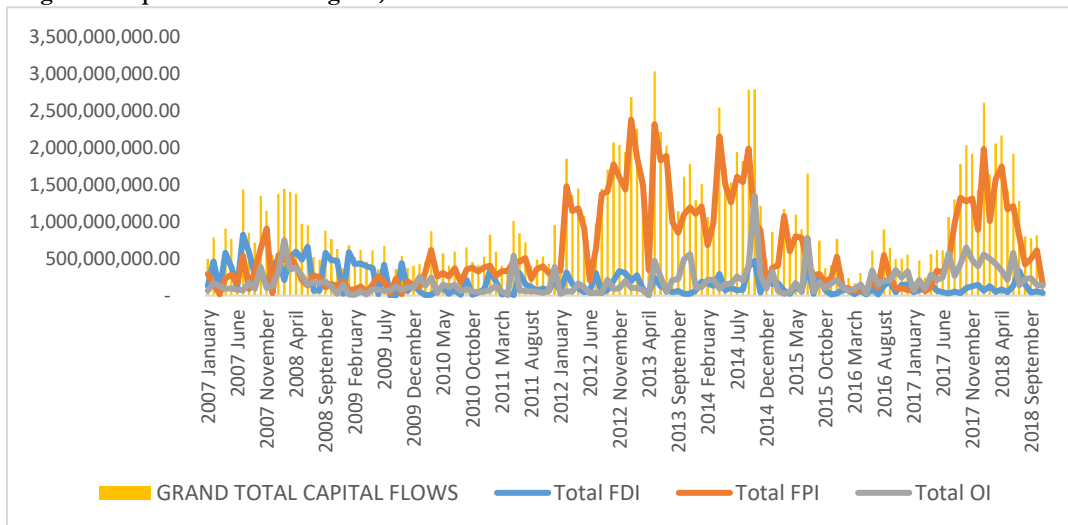
Therefore, the current study improves on the previous studies in several ways; it employs the recently developed methodology by Shin et al., (2014), the asymmetric ARDL approach to estimate the reaction function of monetary policy to international capital flows to Nigeria. This approach allows us to test the response of monetary policy to capital flow volatility that is decomposed into negative and positive partial sums. It also enables us to examine whether fluctuations in capital flow elicit symmetric or asymmetric response from monetary policy, both in the short- and the long-run. This study also utilizes more recent data to update our knowledge on this important issue.

Following this introductory section, the rest of the paper is organized as follows; section 2 provides stylized facts on the trends and pattern of capital flows, with special attention on monetary policy. Section 3 provides systematic literature review on the topic while section 4 outlines the methodology of the study. Results presentation and discussion are the major thrust of section 5 while the final section of the paper summarizes and concludes the study.

2.0 STYLIZED FACTS ON CAPITAL FLOWS AND MONETARY POLICY IN NIGERIA

Nigeria experienced a phenomenal increase in capital inflows of about 500 per cent from approximately N494 million in January 2007 to N3bn in May 2013 (Figure 1). This coincided with the period of high oil prices and low interest rates in advanced economies and the associated search for higher yields by investors. The subsequent downturn in capital flows from late 2014 to mid-June 2017 also coincided with the decline in oil prices, the devastating invasion of the terrorist group, ‘Boko Haram’, in the country, pre-election uncertainties in 2015, economic recession in 2016 as well as uncertainty surrounding the shift to a more flexible exchange rate regime. As strong signs of economic recovery emerged in 2017, capital inflows also regained momentum, but dipped again in 2018, possibly due to monetary policy normalization stance in major advance economies.

Figure 1: Capital Inflows in Nigeria, 2007-2018

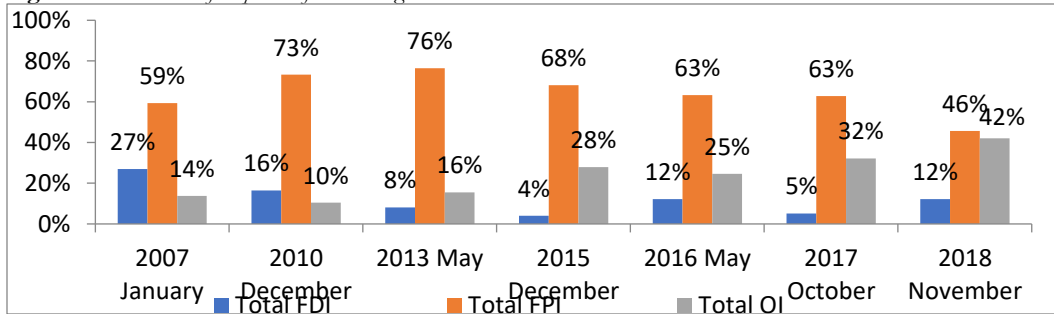


Source: Central Bank of Nigeria

Note: FDI: Foreign Direct Investment; FPI: Foreign Portfolio Investment; OI: Other Investment

A breakdown of the components of capital inflows to Nigeria show that foreign portfolio investment (FPI) has the largest contribution, followed by 'other investment (OI)' and foreign direct investment (FDI). Out of the total capital flows between 2007 and 2018, FPI accounted for 65 per cent, on average, though its absolute share has been on a decline. FDI accounts for about 12 per cent, on average, while OI contributes 24 per cent of the total capital inflows (Figure 2).

Figure 2: Breakdown of Capital Inflows in Nigeria

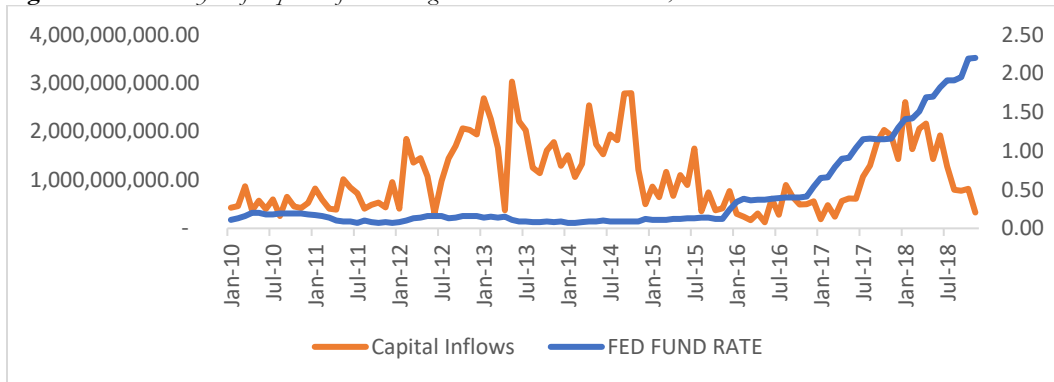


Source: Central Bank of Nigeria

Note: DI-Foreign Direct Investment; FPI-Foreign Portfolio Investment; OI-Other Investment

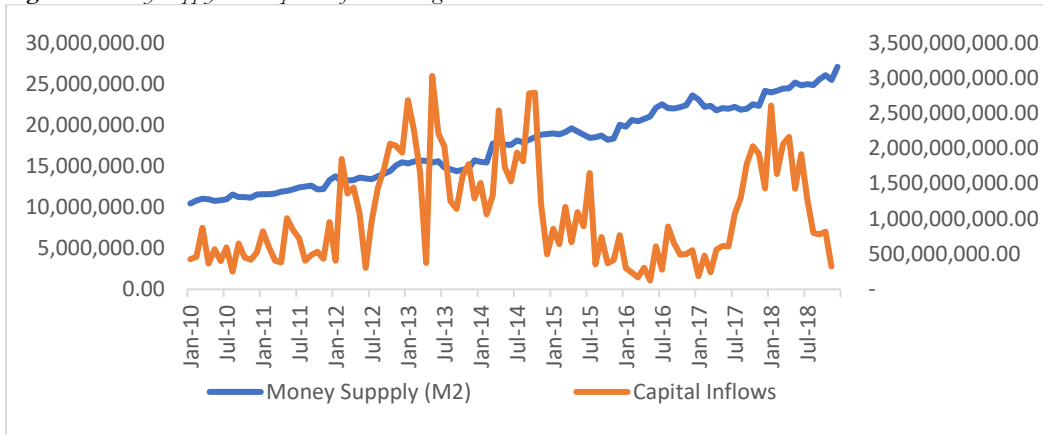
Figure 3 shows the trend analysis of capital inflows to Nigeria vis-à-vis the US Fed fund rate, between 2010 and 2018. A critical examination of the figure clearly reveals an inverse relationship between capital flows to Nigeria and the US Fed fund rate. It appears to suggest that whenever the US Fund rate was low (2010-November 2015), Nigeria has higher opportunity to attract foreign capital inflows, and as the US fund rate start rising (November 2015 to 2018), the trend of capital inflows begins to nosedive, although other intervening factors also contribute to the observed trend. This clearly points to the likely spill over effects of the US Fed monetary normalisation on the capital inflows to Nigeria and the fact that foreign investors often prefer to keep their funds in a more stable environment that yields higher returns.

Figure 3: Trend Analysis of Capital Inflows in Nigeria and US Fed Fund Rate, 2010-2018



Source: Central Bank of Nigeria and US Federal Reserve Boston Online Database

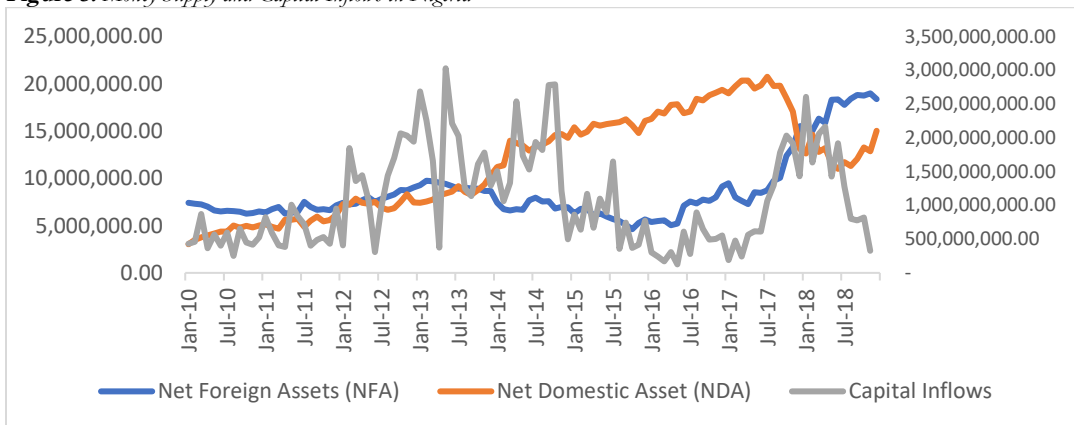
Figure 4: Money Supply and Capital Inflows in Nigeria



Source: Central Bank of Nigeria

In Figure 4 we also analyse the likely repercussions of foreign capital inflows on money supply in Nigeria. The figure reveals an interesting outcome, as money supply appears to track the trend in capital inflows. This buttresses the fact that an economy must always determine the equilibrium position for optimum flows it needs in order not to jeopardize the functionality of the economy by exposing it to the shocks that could arise as a result of volatility of the flows. Furthermore, we try to investigate deeper by breaking down money supply into its broad components--Net Domestic Assets (NDA) and Net Foreign Assets (NFA) and trend this with capital inflows. The outcome reveals that NFA tracks capital inflows closely (see Figure 5).

Figure 5: Money Supply and Capital Inflows in Nigeria



Source: Central Bank of Nigeria

3.0 RELEVANT LITERATURE REVIEW

Literature has shown that increased capital inflows often provides ambiguous results in an economy. While some argue that unregulated influx of capital flows is harmful, others are of the view that increased capital flows are beneficial. Bernanke (2005) observed that free movement of capital affords countries the opportunity to exploit promising investment options; savers could earn higher returns while nations could accumulate foreign assets in good times and deplete those assets in bad times. Through transfers of technology, managerial know-how and other intangible assets, foreign direct investment (FDI) is said to have positive effects on productivity, and the efficiency of domestic resource utilization (Agenor, 1998; Kinda, 2009). On the other hand, Spiegel (1995) suggested that massive volatile capital flows could generate or aggravate financial system instability by causing large swings in banking system liquidity.

Monetary policymakers must therefore, incorporate these varied effects of capital flows in the decision-making process to achieve both internal and external stability. Some of the recent studies have focused on the response of monetary policy based on the Taylor rule (Taylor, 1993), which averred that monetary policy can generally be defined by an interest rate rule, based on the variations of the inflation and output from set target (Bernanke, 2005; Taylor, 2013). Most of these empirical studies have documented that Taylor rule fairly fits the monetary policy reaction function of many countries well (Bechmann et al., 2016 for US; Shibamoto, 2008 for Japan; Sanchez-Fung, 2011 for Brazil). However, it is only recently that studies have begun analysing the asymmetric reaction function of monetary policy to international capital flows particularly in emerging and developing countries where they are always in need to attract foreign capital. Despite this, most of the policy tools often used to address capital flow variabilities (foreign exchange intervention, macro-prudential measures, capital controls, amongst others) are monetary in nature and could vary widely.

In this regard, Meng et al., (2018) observed that large capital flows could negatively affect the effectiveness of monetary policy in China. The study utilised a time-varying parameter structural vector auto-regression (TVP-VAR) model with stochastic volatility and a modified offset coefficient model, it showed that the impact of short-term international capital flows on the effectiveness of monetary policy is positive and much more significant than long-term international capital flows. In addition, short-term capital flows offset about 58.8 per cent of any change in monetary policy while long-term capital flows offset only 10.9 percent of a change in China's monetary policy. In a similar vein, Caporale et al., (2017) utilized the augmented-Taylor principle in five (5) emerging economies of Indonesia, Israel, South Korea, Thailand, and Turkey to analyse the non-linear specification. The outcomes indicated that the central banks' reaction to deviations from either inflation or output target or output gap varies considering the magnitude and the statistical significance of the coefficients in the low and high inflation era for the economies. Specifically, foreign exchange rate has an effect in the latter, but not in the former era. The study concluded that the behaviour of monetary authorities in the emerging economies seems to be more accurately captured by an augmented non-linear Taylor principle.

Moura and de Carvalho (2010) analysed the response of monetary policy in seven (7) Latin American economies. They found an asymmetric reaction function for output, exchange rate and inflation, in Chile, Mexico and Brazil. Similarly, Hasanov and Omay (2008) examined nonlinearity of monetary policy on the business cycles in Turkey. They analysed a threshold Taylor-rule based on GMM estimation techniques with output gap as the transition variable. The study revealed that the monetary authority responded more intensely to output variabilities when there are economic downturns than during economic growths. Also, it reacted to real exchange rates, foreign reserves, and short-term capital

inflows mutually in recession and expansion phases, while this reaction is only during economic expansion phases for budget deficits, net foreign assets and money growth.

In Nigeria, several studies have examined the reaction function of monetary policy. For instance, Agu (2011) examined the linear monetary policy reaction function for Nigeria using the Taylor rule. It found dominance of inflation and credit to the real sector in the Central Bank of Nigeria (CBN) reaction function for monetary policy. However, it noted that none of the macroeconomic variables specified in the policy document of the Bank is considered in the interest rate setting, while empirical estimates could not validate the significance of fiscal dominance in the function. This suggests that CBN works consistently with its stability of price and real sector-driven growth attainments, while allowing variations in her targets and actual outcomes in line with the Taylor rule. In the same vein, Okpanachi (2013) analysed the effectiveness of monetary sterilization by the CBN in response to increased capital inflows in the 2000s, using a simple ordinary least squares (OLS) technique. The study found evidence of less-than-full, but significantly high sterilization intensity, with no indication of sterilization smoothing by the CBN during the review period. In addition, there was evidence of slacking sterilization over time, attributable in part to the high cost of liquidity management as well as financial system stability considerations. Also, Kelikume et al., (2016) formulate a linear monetary policy reaction function premised on the Taylor rule. The study employed the linear ARDL modelling technique and ECM framework. The results from the study are used for stability tracking and the dynamics of the monetary authority's reaction function, for predicting future direction for monetary policy in Nigeria.

It is clear from the above that many of the studies in Nigeria assume that the relationship between monetary policy and capital flows is symmetric. Considering the unpredictable nature of capital flows particularly to developing countries like Nigeria, a symmetric assumption may be counterfactual as monetary policy may respond to capital flows expansions and contractions differently. This is because asymmetric response of monetary policies is often determined by either the preferences of the policymakers, existing economic structure and/or phase of the economy on the business cycle. This will influence whether output stabilisation (pro-growth monetary policy) should be the focus, particularly during economic recessions or price stability mandate during the economic expansions phase (Castro, 2011; Sznajderska, 2014; Caporale et al., 2017). Also, the need to attract and manage international capital flows to augment existing domestic resources often sway the monetary authorities' preferences for asymmetric monetary policy depending on the prevailing economic conditions. Therefore, this paper seeks to contribute to the body of knowledge by examining the asymmetric responses of monetary policy to international capital flows in Nigeria.

4.0 THEORETICAL FRAMEWORK AND METHODOLOGY OF THE STUDY

4.1 Theoretical Framework

Since the mid-1970s, the field of macroeconomics had been revolutionized by the rational expectations' theory. Economists (Kydland and Prescott, 1977, among others) maintained that policy guidelines must be more objective and devoid of time-inconsistency for proper planning and evidence-based economic policies. Based on this theory, several practical rules that were modest and easy to understand to provide clear signals for economic agents were advanced. One of the most prominent was developed by Taylor (1993). He proposed the simple rule of monetary policy as:

$$i_t = r^* + \pi_t + \alpha(\pi_t - \pi^*) + \beta(y_t - y_t^*) \quad (1)$$

where i represents the nominal monetary policy rate; r^* depicts the real equilibrium policy rate; π denotes the inflation rate; while π^* is the target rate of inflation; the last term is equal to the percentage variance in real GDP relative to the level of its target. Given this context, the monetary policy rate tends to increase as inflation rate rises higher than its target rate π^* or if the real output (GDP) is higher than its target value. When both GDP and inflation rate targets are achieved, the nominal monetary policy rate would be equivalent to the addition of real equilibrium policy rate r^* and the inflation target π^* . This rule can be re-written below, for clarity, as:

$$i_t = k + \alpha(\pi_t - \pi^*) + \beta(y_t - y_t^*) \quad (2)$$

where $k = r^* + \alpha \pi^*$. Consistent with the above equation, the real interest rate form of the rule can be written as:

$$r_t = k + \alpha \pi_t + \beta(y_t - y_t^*) \quad (3)$$

The inflation target π^* and the real interest rate equilibrium r^* are set by Taylor (1993) equal to two (2) while assigning the same weight of 0.5 to inflation rate as well as values of output gap. Given these values, the Taylor principle reasonably trails the real direction of the federal funds rate in the United States (US). The parameter's values in equation (3) shows the monetary authority's preferences, with a condition of stability of α higher than zero (0) often presumed. Thus, it is obvious to realize that if α is lower than zero (0), an increase in the inflation rate would, all other things being equal, lead to a decrease in the real interest rate, offering a positive impetus to output. The implication of this is that the coefficient estimated for inflation rate in a rule for nominal interest rate category in equation (2) should be higher than one (1) for the condition of stability to stand. Though the parameter values of α and β are proposed by Taylor as realistic thresholds (it is assumed that the two are equal 0.5), the parameters' optimal value would eventually be a function of the model structure being considered (Svensson, 2000).

This theory is premised on the fact that the monetary authorities often aim at stabilizing inflation at a set target rate as well as curtailing the cyclical oscillations in economic activities through stabilization close to its potential value. One of the key principles of Taylor rule is that monetary authorities are inclined to setting rates of interest in line with the level of the inflation rate and output variation. This theory is in line with the Neoclassical synthesis which also attempted to explain the rules of monetary policy decisions based on the New Keynesian Phillips Curve (NKPC) (Taylor, 1999). The NKPC allowed measuring the effects of monetary policy on real GDP, even in the short- to medium-term.

Some other economists (Orphanides, 2000; Svensson, 2000; among others) have broadly criticized this rule and were not satisfied with using such a tricky technique for a dynamic rule of monetary policy to produce equilibrium. They also contended its sufficiency to offer explanations for the policy framework adopted for monetary policy by the Federal Reserve during the Alan Greenspan era of 1987 to 2006.

In line with this argument, many studies (Hasanov and Omay, 2008; Moura and de Carvalho, 2010; Caporale et al., 2017; among others) have contended for special considering for emerging markets and developing economies, which are susceptible to external shocks. This is often referred to as an augmented-Taylor Rule in the literature. Hence, in studying emerging market economy like Nigeria, it is often necessary to introduce other intervening variables, such as the foreign exchange rate (Svensson, 2000, 2003; Ghosh et al., 2016), capital flows (Canterbery, 1969; Calvo et al., 1993; Hasanov and Omay, 2008) among other relevant factors. Thus, the augmented Taylor principle can be re-written as:

$$i_t = k + \alpha(\pi_t - \pi^*) + \beta(y_t - y_t^*) + \gamma(e_t - e_{t-1}) \quad (4)$$

where e denotes the real exchange rate.

Furthermore, to adequately capture the importance of capital flows, we introduce another variable, in term of net capital flows. Consequently, equation (4) becomes:

$$i_t = k + \alpha (\pi_t - \pi^*) + \beta (y_t - y^*) + \gamma (e_t - e_{t-1}) + \delta (c_t - c_{t-1}) \quad (5)$$

where c represents the net capital flows.

Equation (5) is the augmented-Taylor rule that accounts for inflation deviation, output gap, exchange rate and capital flows movements.

4.2 Methodology: The Non-Linear ARDL (NARDL) Specification

Economic literature has shown that many macroeconomic variables tend to have non-linear relationships among themselves in contrast to the common linear assumptions (Caporale et al., 2017 among others). As earlier illustrated, it has been revealed that the effects of downward trending in macroeconomic variables may not be the same as when it is trending upward, therefore implying a non-linear situation. Accordingly, the quality of information entrenched in linear relationships could be unsuitable in arriving at a robust analysis (Shin et al., 2014). The consequence is that the hesitancy of negative and positive elements of independent variables surrounding an assumed zero threshold have key part to play in creating long-run economic relationships.

The simultaneous employment of linear and nonlinear ARDL methodologies facilitate the detection of linear co-integration, non-linear co-integration, or no-co-integration in these models. In the same vein, the determination of a long-run equilibrium relationship between capital flows and monetary policy, if they exist, could be investigated by how monetary policy responds to capital flows (symmetric or asymmetric effects). Moreover, the model permits testing for asymmetric effects of capital flows on monetary policy. The asymmetric ARDL (Auto-Regressive Distributed Lag) of Shin et al., (2014) extends the linear ARDL by Pesaran et al., (2001). The non-linear long-run equation is stated as:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \varepsilon_t \quad (6)$$

where y_t is the dependent variable, $\beta^{+(-)}$ is the coefficient of the positive (negative) component of the variable and x_t is a $k \times 1$ vector of independent variable (positive and negative) and ε_t is the error term.

Given that x_t is defined to be a random walk, such that:

$$x_t = x_{t-1} + e_t, \quad e_t \sim \mathcal{N}(0, \sigma_e^2) \quad (7)$$

The above data generating process may be re-written as follows, after recursive substitution;

$$x_t = x_0 + \sum_{j=1}^t e_j \quad t = 1, \dots, T \quad (8)$$

Supposing there is zero-threshold, the stochastic term can be separated as;

$$e_t = e_t^+ + e_t^- \quad (9)$$

Taking partial sum, we arrive at;

$$\sum_{j=1}^t e_j = \sum_{j=1}^t e_j^+ + \sum_{j=1}^t e_j^- \quad (10)$$

Deriving from the above, this term below follows:

$$e_j^+ = \Delta x_j^+ \text{ and } e_j^- = \Delta x_j^- \quad (11)$$

x_t^- and x_t^+ are partial sums of the negative and positive changes in x_t . Therefore, x_t is a $k \times 1$ independent variables which are defined as:

$$x_t = x_t^+ + x_t^- \quad (12)$$

The unrestricted nonlinear ARDL-ECM equivalent of equation (6) can be written as;

$$\Delta y_t = \alpha + \rho y_{t-1} + \omega_2^+ x_{t-1}^+ + \omega_2^- x_{t-1}^- + \sum_{j=1}^{\rho-1} \theta_j \Delta y_{t-j} + \sum_{j=0}^{q-1} \pi_j^+ \Delta x_{t-j}^+ + \sum_{j=0}^{q-1} \pi_j^- \Delta x_{t-j}^- + \varepsilon_t \quad (13)$$

Notice that θ_j is the AR structure; π_j^+ and π_j^- are the (non-)linear lag distribution parameters; ε_t is the error term that is IID, with zero mean and constant variance. Equation (8) can also be re-written as;

$$\Delta y_t = \alpha + \rho y_{t-1} + \omega_2^+ x_{t-1}^+ + \omega_2^- x_{t-1}^- + \sum_{j=1}^{\rho-1} \theta_j \Delta y_{t-j} + \sum_{j=0}^{q-1} (\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{t-j}^-) + \varepsilon_t \quad (14)$$

While the restricted ARDL-ECM can be written as:

$$\Delta y_t = \alpha ECM_{t-1} + \sum_{j=1}^{\rho-1} \theta_j \Delta y_{t-j} + \sum_{j=0}^{q-1} (\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{t-j}^-) + \varepsilon_t \quad (15)$$

This equation is an asymmetric ARDL model where non-linearity is introduced by creating partial sum components. This model has been used in many empirical studies (see Eboime et al., 2016) and can effectively capture the response of monetary policy to capital flows volatility in a more flexible structure.

4.3 Model Specification

Based on equations specified above and the theoretical framework derived in equation (5), we re-specify an augmented-Taylor rule that incorporates inflation deviation (INFD), output gap (OUTG), exchange rate variation (EXCV) and net capital flows variation (NCFV) as:

$$MPR_t = k + \alpha (INFD_t) + \beta (OUTG_t) + \gamma (EXCV_t) + \delta (NCFV_t) + \varepsilon_t \quad (16)$$

where MPR^3 represents the behaviour of monetary authority to changes in some key macroeconomic variables as explained above. In this case, given the objective of this study, it is only the NCFV component that takes the partial sums while other variables (X) take their natural form and thus equation (16) is specified as:

$$\Delta MPR_t = \alpha + \rho MPR_{t-1} + \omega_2^+ NCFV_{t-1}^+ + \omega_2^- NCFV_{t-1}^- + \sum_{j=1}^{\rho-1} \theta_j \Delta MPR_{t-j} + \sum_{j=0}^{q-1} (\pi_j^+ \Delta NCFV_{t-j}^+ + \pi_j^- \Delta NCFV_{t-j}^-) + \alpha_t X_t + \varepsilon_t \quad (17)$$

³ In this study, prime lending rate is used to proxy MPR in the estimation of equation 17, as data and experience has shown overtime that more than 75% of facilities in the banking system is granted at the prime rate and this rate is often used empirically to mimic the behaviour/ effects of MPR on the economy.

Where ΔMPR represents the changes in monetary policy⁴; $\Delta NCFV$ denotes changes in international capital flows. Hence, $NCFV_{t-j}^+$ and $NCFV_{t-j}^-$ are the partial sums of positive and negative variations in the net capital flows, while p and q signify the selected lag length for the model. Also, included in the model are other important explanatory variables represented as X_t , which include inflation deviation (INFD), output gap (OUTG) and exchange rate variation (EXCV) that have been identified from the previous literature to elicit the response of the monetary authority.

In terms of *a priori* expectation in equation (17), ω_2^+ and ω_2^- measure monetary policy sterilization⁵ indices and they are expected to be greater than zero but less than 1. If they are equal to 1, then monetary policy is said to be fully sterilized (i.e. totally offset the increase in foreign assets) while if more than unity, then monetary policy is said to be over-sterilized. The most unlikely situation is where the index is equal to zero, that is the monetary authority does not make any efforts to sterilize at all. This is based on the reasoning that monetary policy response to international capital flows is usually in terms of sterilization, where central banks dampen domestic assets when faced with high volatile capital flows in order to preserve the ability to control monetary conditions and liquidity in the economy (Glick, 2008; Okpanachi 2013; Meng et al., 2018).

4.4 Data Measurement and Sources

The study draws on quarterly data of relevant variables covering the period 2000Q1 to 2018Q4. The data are sourced from the various publications of the Central Bank of Nigeria. In terms of measurement, as explained above we used prime lending rate to proxy MPR, while net capital flows are measured as the log difference between capital inflows and outflows. Following Sznajderska (2014); Caporale et al., (2017) among other recent studies, we utilised consumer Price Index (CPI) to calculate the inflation rate, as inflation deviation (INFD) is derived as the difference between actual inflation and inflation rate target, while the real effective exchange rate (REER) is used to measure foreign exchange rate in this study. Gross Domestic Product (GDP) is used to proxy output, while output gap (OUTG) is derived as the proportional deviation of the log of GDP from its Hodrick-Prescott trend⁶.

5.0 EMPIRICAL ANALYSIS AND INTERPRETATION OF RESULTS

This section presents the different estimation results to understand the monetary policy response to capital flow in Nigeria. It analyses basic descriptive statistics, correlation matrix, unit root (stationarity) tests, cointegration and symmetry tests as well as long-run and short-run estimation results, including the error correction model in order to achieve the objective of the study.

5.1 Descriptive Statistics

Table 1 below provides the descriptive statistics for the variables used in the analysis containing the means, medians, minimum, maximum, standard deviation, skewness, kurtosis as well as Jacque-Bera statistics and corresponding probabilities (p-values). The results of the summarised statistics indicate

⁴ This assumes that monetary policy response often takes the form of sterilization, where the monetary authorities endeavour to lower domestic assets whenever they are faced with large and persistent capital flows.

⁵ This is often achieved through open market operations and other forms of sales of financial instruments, expansion of reserve requirement to weaken the money multiplier as well as other unconventional means such as withdrawal of government deposits from commercial banks, amongst other instruments.

⁶ Despite several criticism of this approach, we decided to utilize HP filter largely because of its empirical adaptability as well as its flexibility in tracking trend of output.

that all the variables exhibit a positive mean return and that the standard deviations are not too far apart except for the exchange rate (EXCV).

Table 1: Descriptive Statistics Table

	MPR	NCFV	EXCV	OUTG	INFD
Mean	24.3078	5.5203	110.7506	6.8982	11.8879
Median	23.6950	5.5600	103.1782	6.9253	11.9781
Maximum	31.7700	5.7300	179.5902	7.5181	18.8737
Minimum	17.5800	5.2000	56.1488	6.1729	5.3822
Std. Dev.	4.1520	0.1579	30.8125	0.4432	2.9177
Skewness	0.1881	-0.5740	0.5351	-0.1490	-0.0129
Kurtosis	1.9697	2.2345	2.9404	1.5588	2.6325
Jarque-Bera	3.8097	6.0295	3.6375	6.8587	0.4299
Probability	0.1488	0.0491	0.1622	0.0324	0.8066
Observations	76	76	76	76	76

Source: Authors' Computation

5.2 Pearson Correlation Matrix

Table 2 presents the correlation analysis based on the variables used in the models. One of the fundamental postulations of the OLS is that there must be low correlation between the independent variables in the model. The effect of high collinearity is that the variables would not be able to offer adequate information in explaining the dependent variable and estimating their separate effects in the model may be difficult.

Table 2: Correlation Matrix

	MPR	NCFV	EXCV	OUTG	INFD
MPR	1.0000				
NCFV	-0.4655	1.0000			
EXCV	-0.1184	-0.5982	1.0000		
OUTG	0.2879	0.5620	-0.5151	1.0000	
INFD	0.2081	-0.4602	0.2185	-0.3172	1.0000

Source: Authors' Computation

Exploring the correlation among the variables of interest in Table 2 indicates that most of the variables are negatively correlated with capital flows variable. This may point to the fact that monetary authority often uses counter-cyclical policy to address the capital flows volatility. The correlation is not high among the variables, hence, no significant multi-collinearity is suspected among the variables of interest as this implies that most of the variables have independent role to play and are not substitutable in the model.

5.3 Unit Root Test Results

The unit root time-series properties of each of the series is presented in Table 3, using the Augmented Dickey-Fuller (ADF) and Philips-Perron (P-P) tests at both level and first difference of the series, allowing for both trend and intercept. The result presented in Table 3 shows that the integration properties of the variables are mixed in terms of stationary at both level and at first difference. Hence, the ARDL methodology is appropriate for the study since it allows for both I(0) and I(1) variables to be used in a model.

Table 3: Unit Root Test Results

	Augmented Dickey-Fuller Test		Philips-Perron test		REMARK
	At Level	1st Diff	At Level	1st Diff	
MPR	-1.3573	-7.1903***	-1.5438	-7.2146***	I(1)
NCFV	-1.6400	-6.6970***	-1.2079	-5.2634***	I(1)
EXCV	-2.3400	-7.4197***	-2.2658	-8.2588***	I(1)
OUTG	-2.0981	-5.8252***	-1.2842	-5.7047***	I(1)
INFD	-4.0035**	-7.7395***	-3.3034**	-5.4835***	I(0)

Source: Authors' Computation

Note: *** and ** Indicate significant at 1 and 5 per cent significance level, respectively.

5.4 ARDL Bound Test Results

To determine whether there is asymmetric cointegration among the variables of interest, we computed the Pesaran et al., (2001) F-statistics in Table 4. This analysis helps us to ascertain if there is non-linear cointegration involving both the I(1) and I(0) series. The Akaike Information Criterion (AIC) was utilized to select the optimal lag length.

Table 4: ARDL Bound Test

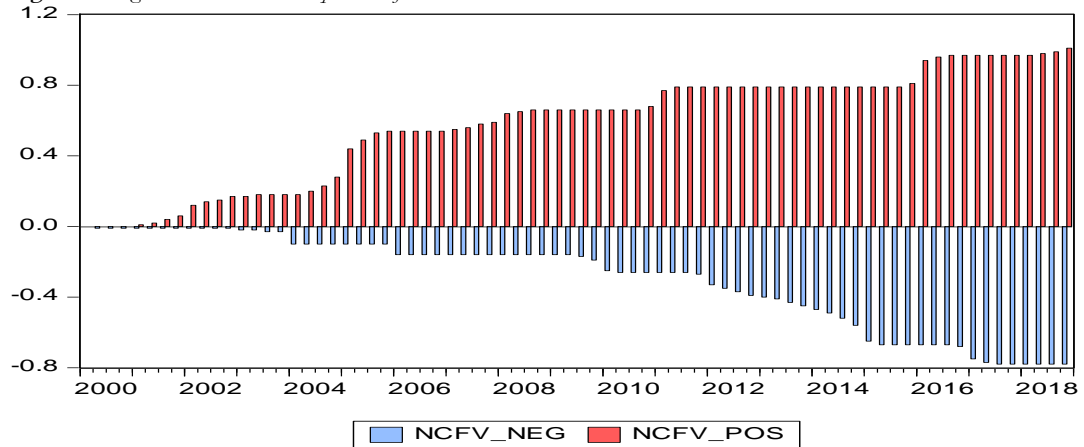
Equation	F-Stat	F-Bounds Test Critical Value			REMARK
		Significance (%)	Lower	Upper	
NCFV	6.33	1	3.69	4.84	Cointegration
EXCV	2.90	10	2.48	3.33	Inconclusive
OUTG	5.64	1	4.05	5.09	Cointegration
INFD	5.58	1	4.05	5.09	Cointegration

Note: Asymptotic critical value bounds are obtained from Pesaran, et. al (2001)

It is clear from the Table that the null hypothesis of no cointegration cannot be rejected for exchange rate. As the F-stat lies between the upper and lower bounds at 10 per cent level of significance, in that way, generating inconclusive cointegration result. On the other hand, the Pesaran et al., (2001) bounds tests show that three macroeconomic variables of net capital flows, output gap and inflation deviation support the evidence of long run cointegrating relationship. Then, we proceed to test for both short- and long-run symmetric effect, using the Wald statistics (WS). Note that the rejection of these null

hypotheses connotes that the asymmetric ARDL by Shin et al., (2014) will be required. From the estimated results, the WS of 6.90 and a p-value of 0.00, provide the evidence of rejection of the null hypothesis of the long-run symmetric effect. Conversely, with WS of 4.36 and a p-value of 0.02, we reject the null hypothesis of the short-run symmetry albeit at 5 per cent. Hence, the conventional symmetric ARDL model is not appropriate. Thus, the non-linear ARDL (NARDL) by Shin et al (2014) specified in this study is more appropriate. Hence, the analysis of this study begins from the negative and positive components of NCFV (see Figure 6).

Figure 6: Negative and Positive Components of NCFV



This study seeks to examine the asymmetric response of monetary policy to changes in capital flows. The estimated coefficients of NARDL model both at the short and long-run are reported in Table 5. From the Table, the coefficients of the positive and negative components of the explanatory variables have statistically significance effects on the behaviour of monetary policy both in the short- and long-run, albeit, at varying significance level. Therefore, the response of monetary policy to changes in capital flows (whether positive or negative) in the estimated results for both the short- and long-run are quite distinct.

Specifically, in the long-run model, almost 95 per cent of the variations in monetary policy reaction are explained by the explanatory variables, as indicated by the R-squared statistic. The estimated results revealed that the monetary authority takes cognisance of the level of previous MPR before responding to changes in capital flows and that its response differs, depending on whether the economy is experiencing expansion or recession. For instance, positive changes in capital flows is accompanied by lowering the monetary policy rate by almost 0.20 per cent, while negative changes in capital flows intensify monetary policy response by 0.81 per cent. This indicates that monetary authority often utilises counter-cyclical policy to respond to capital flows in order to achieve its set objectives. It also suggests that monetary policy also react significantly to changes in exchange rate, output gap and inflation deviation in Nigeria.

In the short-run, monetary policy responds differently to changes (positive and negative) in capital flows. Specifically, higher inflows of foreign capital appears to result in a decline in the rate of increase of monetary policy rate by 0.82 per cent, while negative changes in capital flows that is generated by decline in net foreign capital tends to strengthen changes in monetary policy by about 0.42 per cent.

This result sheds more insight on the study by Okpanachi (2013), that the response of monetary sterilization to capital flows is less than full, as the coefficient is negative, significant and less than 1. This also points to the fact that it is more likely that monetary policymaker would respond more aggressively to negative changes in capital flows, given its monetary and financial stability risks. This result is statistically significant at 1 per cent.

In this vein, the estimated result also shows the importance of other explanatory variables. It reveals that changes in exchange rate, output gap and inflation deviation are important consideration for CBN in making monetary policy decision in Nigeria, albeit at diverse significance levels. For instance, it reveals that monetary policy measure respond positively to changes in EXCV, INFD and OUTG. This implies that monetary sterilization tends to lessen the pressure from increased capital flows on inflation and exchange rate in the Nigerian economy. Hence, Monetary Policy Committee’s (MPC) decision to sustain tight policy rate can be linked to the continued desire to attract capital flows, stabilize prices and exchange rate, and boost accretion to foreign reserves in the Nigerian economy.

This result is similar to that found by Moura and de Carvalho (2010) for some Latin American countries and Hasanov and Omay (2008) for Turkey. It clearly portrays asymmetric monetary policy reaction function for output gap, inflation deviation, exchange rate and short-term capital flows movement in Nigeria. The study also buttresses the fact that the monetary authority responded more intensely to output variabilities during economic recessions and to price stability during the expansions phase.

Table 5: Short-Run and Long-Run Asymmetric ARDL Model Results

Variable	Short Run Coefficient	t-Statistic	Prob.
C	0.0871	0.2313	(0.0818)
D(MPR(-1))	1.1158**	5.7942	(0.0000)
D(NCFV_POS)	-0.8238*	-1.7550	(0.0193)
D(NCFV_NEG)	0.4247**	0.9740	(0.0038)
D(EXCV)	0.0305*	1.4764	(0.0449)
D(OUTG)	0.5556*	0.3530	(0.0253)
D(INFD)	0.2593**	2.6032	(0.0015)
ECT01(-1)	-0.3076**	-5.6877	(0.0000)
R-squared	0.6042		
Durbin-Watson stat	2.1061		
Variable	Long Run Coefficient	t-Statistic	Prob.
C	-4.1815	-0.3172	(0.0752)
MPR(-1)	0.8580**	17.7686	(0.0000)
NCFV_POS	-0.2010**	2.6198	(0.0039)
NCFV_NEG	0.8071**	-3.0119	(0.0017)
EXCV	0.0494**	3.8225	(0.0003)
OUTG	0.1054**	-3.0179	(0.0036)
INFD	0.1709**	2.9009	(0.0051)
R-squared	0.9467		

Durbin-Watson stat	1.9637		
Asymmetries	Wald Test		
	Long-Run	Short-Run	
	6.900	4.3556	
	(0.0032)	(0.0187)	

Source: Authors' Computation

*Note: ** and * represent 1% and 5% significance level, respectively. Probability values are in parentheses.*

To determine the speed of adjustment of the model from the short-run to the long-run equilibrium state whenever there is a shock, we consider the first lag of the error correction term ECM(-1). The higher the coefficient of the error correcting term, the faster the speed of adjustment of the model from the short-run disequilibrium to the long-run equilibrium. In the results obtained from the estimation, the co-efficient of ECM(-1) is negative, less than unity and significant as expected and it shows that the adjustment speed from short-run to long-run is about 31 per cent per quarter. This indicates that the ECM(-1) has a relatively low speed of adjustment. This outcome is consistent with the fact that monetary policy is likely to respond gradually to the capital flows and other explanatory variables used in the short-run model. The significance of the ECM coefficient validates cointegration relationship among the variables.

5.5 Robustness Test

Further observation on the estimated results reveals that the short-run model has fairly a good fit, with the co-efficient of determination of 0.60. This means that 60 per cent of the variation in the dependent variable is explained by the independent variables. This basically means that the explanatory variables simultaneously explain the variations in the dependent variable. The Durbin Watson value of 2.11 against the R^2 value of 0.60 means that the model is reliable in explaining the response of monetary policy to capital flows and other related variables in Nigeria. Also, since we know that whenever the lagged dependent variables are included as part of the explanatory variables, then the use of Durbin Watson statistics may not be appropriate, hence, Durbin's h-test or likelihood ratio tests are commonly utilised in this case. Therefore, we computed the Durbin's h-test and found that there is no first-order autocorrelation problem in the short-run model. In general, we estimated the model based on general-to-specific approach as it does not suffer from any diagnostic challenges such as serial correlation and heteroscedasticity problems.

Figure 7: NARDL-CUSUM

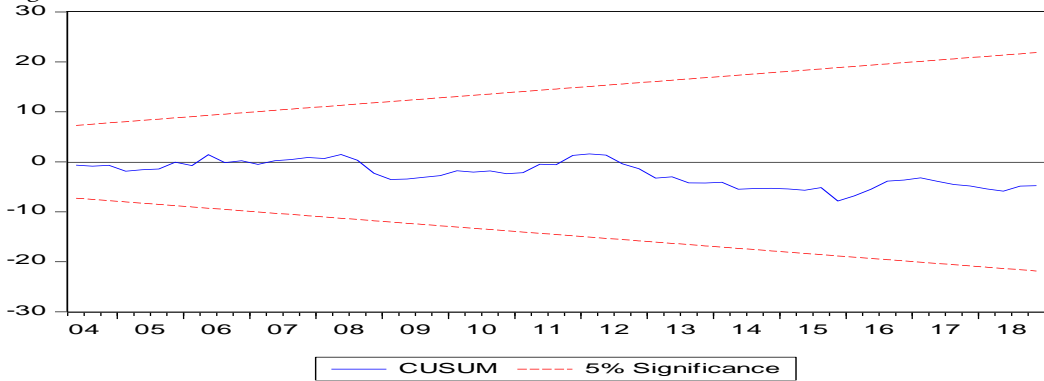
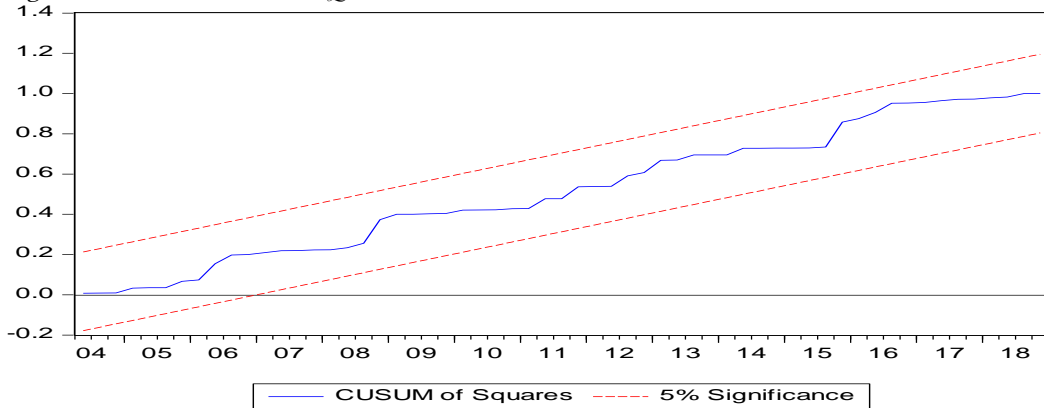
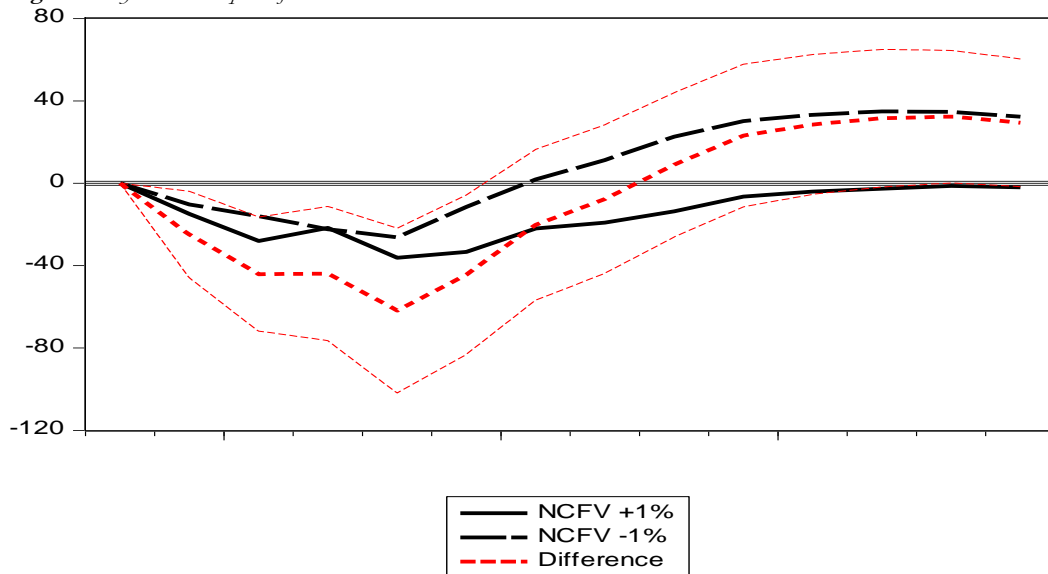


Figure 8: NARDL-CUSUM OF SQUARES



The stability of the estimated model is verified through CUSUM and CUSUM of squares. It is clear from Figures 7 and 8 that both recursive residuals tests are within the acceptable boundaries of 5 per cent significance level, hence, the estimated models are stable. In the same vein, Figure 9 shows the cumulative multiplier effects of changes in net capital flows on monetary policy measure. The vertical axis identifies the magnitude of positive and negative shocks in NCFV and the horizontal axis shows the time (quarter) to achieve the long run equilibrium relationship between the key variables.

Figure 9: *Dynamic Multiplier of NCFV*

6.0 SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

This study set out to examine the asymmetric response of monetary policy to fluctuations in capital flows in Nigeria. It noted that previous studies on the subject inadvertently assumed symmetric or linear relationship between capital flows and monetary policy which is incompatible with economic realities. This study, therefore, improves on the previous studies by employing the recent asymmetric ARDL approach to estimate the inter-relationship between capital flow fluctuations and monetary policy in Nigeria. This approach allows us to examine whether capital flow fluctuations has symmetric or asymmetric effects on monetary policy in both the short- and the long-run. The estimated results revealed that the positive and negative components of capital flows as well as other explanatory variables have statistically significant effects on the behaviour of monetary policy both in the short- and long-run. These findings are congruent with the works of Cavoli and Rajan (2005), Okpanachi (2013), as well as Meng et al., (2018). The implication of the results is that monetary sterilization often reduces the inherent pressure that can emanate from increased capital flows on inflation and exchange rate. Hence, this may explain the concerns of the MPC in sustaining monetary policy tightening in order to attract foreign capital flows, facilitate stable prices and exchange rate as well as engender accretion to foreign reserves in the Nigerian economy.

Several policy lessons can be drawn from the findings of this study. One of the obvious implications is that different monetary sterilization index is required for managing the inherent pressure that can emanate from asymmetric capital flows. Hence, this may explain the continuous adjustment of monetary policy in order to attract foreign capital flows, stabilise prices and exchange rate as well as stimulate accretion to foreign reserves. Therefore, appropriate policy measures should always be mindful of the asymmetric effects of fluctuations in capital flows in arriving at the appropriate monetary policy response. More importantly, capital flows (whether positive or negative) is found to be significant in

explaining response of monetary policy and this policy response must be implemented within a coherent set of macroeconomic, structural and social policies.

It is recommended that the monetary authority, in the course of managing capital flow fluctuations, should keep its policy menu open and respond appropriately. In this regard, the Bank should respond when there is need, and effectively establish a buffer through reserves accumulation, as a means to have a firm grip on the boom and bust inherent in capital mobility. Complementary focus on other key monetary aggregates will also provide long-term benefits in sustaining capital flows and the effective management of its volatility. The study, therefore, concludes that the monetary authority should always be mindful of the asymmetric effects of fluctuations in capital flows in arriving at the appropriate policy response.

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