International Journal of Social Sciences

Uluslararası Sosyal Bilimler Dergisi

Estimating Monetary Policy Reaction Function: The Case of Nigeria

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Abstract

The main responsibility of the Central Bank of Nigeria (CBN) is to formulate and implement monetary policy, with the primary objective of maintaining stable prices conducive to balanced and sustainable economic growth in Nigeria. It also aims to promote and preserve monetary and exchange rate stability as well as ensure a stable and sound financial system. Nigeria's monetary policy is anchored on a monetary targeting framework, and price stability represents the overriding objective of monetary policy. The transmission mechanism needs to be continually strengthened. Consequently, there is need to fine-tune the monetary policy framework so that transmission can be more effective and clear and the economic agents can view monetary authority actions as credible.

Understanding monetary authorities' behaviour is fundamental and often appears to be a daunting task. Nevertheless, the question on whether rules or discretion should be used to conduct the monetary policy is still unresolved. Thus, the objective of this paper is to estimate a monetary policy reaction function for the Central Bank of Nigeria (CBN) and examine the relevance of the Taylor's rule in the management of interest rate and inflation for Nigeria. The data utilised spanned 2000:q1 to 2018:q4, sourced from the CBN database. The paper estimated two models of monetary policy reaction function (policy rate and monetary base) for Nigeria. After pre-estimation analysis, it adopted the technique of autoregressive distributed lag (ARDL) which captures the long-and short-run dynamics of the relationship among the variables. The findings indicated that the monetary authorities should constantly

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track the inflation gap, output gap as well as the divergence in exchange rate differentials between the official exchange rate, bureau de change (BDC) and the prime lending rate cum all-share index. This is critical, given that Nigeria is a major oil exporting country and the volatility in the international oil price is transmitted directly to the economy through its impact on exchange rates. Furthermore, the results indicate that the Bank reacts to a widening gap in the exchange rate premium, which implies that the Bank considers the exchange rate when designing monetary policy in order to avoid exchange rate misalignment and ensure stability of the currency.

Keywords: Monetary Policy, Reaction Function, Nigeria

JEL Classification: C01, C13, E4, E5, E52, E58

1. Introduction

The main responsibility of the Central Bank of Nigeria (CBN) is to formulate and implement monetary policy, with the primary objective of maintaining stable prices conducive to balanced and sustainable economic growth in Nigeria. It also aims to promote and preserve monetary and exchange rate stability as well as ensure a stable and sound financial system. Traditionally, it includes achieving full employment, smoothing the business cycle, preventing financial crises, and stabilising long-term interest rates.

In 2015, the spot price of Nigeria's crude oil fell significantly by 47.3 per cent, from US$100.7 per barrel at end-December 2014 to US$53.1 per barrel by end-December 2015. This exerted a downward pressure on Nigeria's external reserves, which declined from US$34.20 billion to US$28.28 billion in 2015. The sustained fall in oil prices heightened the vulnerabilities and the structural imbalances of the Nigerian economy, as lopsided predilection for imported goods and unwholesome speculations in the domestic foreign exchange market, caused the naira to slide against major currencies, (CBN, 2015). Consequently, due to the ensued challenges, the monetary authority has intensified action on delivering price and financial system stability as well as promoting sustainable economic development.

Nigeria's monetary policy is anchored on a monetary targeting framework, and price stability represents the overriding objective of monetary policy. This is a significant departure from the past, when the promotion of rapid economic growth and employment represented the major thrusts of policy. The focus on price stability derives from overwhelming empirical evidence that sustainable growth cannot be achieved in the midst of price instability. There is indeed, a general consensus that domestic price volatility undermines the value of money as a store of value, and frustrates investments and growth. In recognition of the lagged effects of monetary policy on the ultimate target of policy, the CBN, in 2002 adopted a medium-term monetary policy strategy. The shift was intended to free monetary policy implementation from the problem of time inconsistency and reduce over-reaction due to temporary shocks. Under this framework, money growth targets that are consistent with inflation and real output growth targets are set over a two-year period, (Mordi, 2009).

With regard to monetary policy interventions, the CBN relies on market-based instruments such as open market operation (OMO), complemented with discount window operations and changes in reserve requirement policies (cash reserve requirement (CRR) and statutory minimum liquidity ratio). The minimum rediscount rate (MRR), complemented with the repurchase rate (REPO rate), used to be the key policy rate that sets the monetary policy stance. However, the MRR has not been very effective in driving the money market rates. Transmission mechanism was weakened and uncertainty as well as inefficiency was introduced in the financial system. Consequently, there is need to fine-tune the monetary policy framework so that transmission can be more effective and clear; the market can provide feedback to policy makers; the desired effect of monetary policy can be achieved; and the economic agents can view monetary authority actions as credible.

In view of the above, the CBN introduced in December 2006, a new Framework for monetary policy implementation, using the short-term interest rate as its "Operating Target". The ultimate goal of the Framework is to achieve a stable value of the domestic currency through stability in short-term interest rates. The monetary policy rate (MPR) replaced the MRR, and serves as an anchor rate for transactions in the inter-bank money market as well as other deposit money banks' (DMBs') interest rates. The MPR, at end-December, 2018 stands at 14.0 per cent, with an asymmetric corridor of +200/-500 basis points around the MPR. The cash reserve requirement ratio (CRR) and liquidity ratio (LR) remained at 22.5 and 30.0 per cent, respectively, (CBN, 2018).

Understanding monetary authorities' behaviour is fundamental and often appears to be a daunting task. From the early 1990's, the economic literature concerning monetary policy reaction function has been gaining momentum and leading economists use monetary aggregates and short-term interest rates as policy instruments (Aragón and Portugal, 2010; and Hutchison *et. al.*, 2013). Nevertheless, the question on whether rules or discretion should be used to conduct the monetary policy is still unresolved. This discussion has motivated the quest for empirical models to understand Nigeria's monetary policy reaction function.

In recent times, some researchers argued that adopting policy rule in the implementation of monetary policy increases economic growth, guarantee price stability, making monetary policy predictable and transparent. Other proponents, in contrast, opined that using discretionary monetary policy leads to policy errors (or time inconsistency), engenders economic instability, and is susceptible to political pressure (Taylor, 1993; McCallum, 1984, 2000; and Barro 1983). Most of the time, the monetary policy making process is modelled with either a McCallum rule or a Taylor-type rule. The broad idea fundamental to these policy reaction rules is to describe how the central bank adjusts its policy in response to economic conditions with reference to their policy targets[3]. When central banks take the appropriate steps, it has two significant implications. First, these rules are widely used as a benchmark to understand and assess past policymaking. Quite often, Taylor, (1993), noted that these rules, in spite of simplicity, work well with good estimates that match with the central bank's policy setting behaviour. They help to better promote more transparent and effective monetary policy, as pointed out by Orphanides (2001). Second, appropriate specification of the central bank's reaction function captures its systematic response to changes in economic conditions; therefore the estimated error term in the response function is better interpreted as exogenous monetary policy shocks.

From the foregoing, the objective of this paper is to estimate a monetary policy reaction function for the Central Bank of Nigeria (CBN) and examine the relevance of the Taylor's rule in the management of interest rate and inflation for Nigeria. An attempt will also be made to formalise central banks' behaviour and link the instruments of monetary policy, namely interest rates and money growth, to exogenous variables such as output, inflation and general market indicators.

[3]For instance, in the McCallum rule, they are measured with deviation of nominal GDP growth from its target, while in the Taylor rule they are gauged with deviations of inflation/real output from the target/potential.

Following this introduction, the rest of the paper is organised as follows. Section two provides the literature review and theoretical framework on monetary policy rules. Section three outlines the model specification, data and methodology adopted, while empirical analysis is discussed in sections four. Section five provides recommendations and conclusion.

2.0 Literature Review and Theoretical Framework

2.1 Literature Review

Monetary policy rules commonly known as reaction function simply describe the responses of a central bank's monetary policy to macroeconomic developments. According to the literature, adherence to such a rule enhances the credibility of the monetary authority as it serves as a benchmark for assessing the current monetary policy stance and/or its future direction. Central bank's responses to macroeconomic developments usually stem, though not an exhaustive list, from deviations of inflation from target, unfavorable fiscal balance, changes in domestic and foreign assets (net). In most cases, the nature and underlying fundamentals of the economy being modelled provide an insight to the variables the central bank consider when setting up its monetary policy. For instance, Berument and Malatyali (2000), opine that it is common in developing economies for the announced objectives to differ from implicit objectives. This is because unlike in developed economies, developing economies are very likely to be more concerned with improving financial stability, ensuring a stable currency as well as reducing interest rate variability. Central bank reactions may be backward and/or forward looking in nature.

A substantial literature exists on policy reactions of the central bank (Mehra, 1999; Sanchez-Fung, 2005; Nikolov, 2002; Berument and Malatyali, 2000). The most prominent is the Taylor's rule (Taylor, 1999) which describes how the Federal Reserve, between 1987 and 1992, should set interest rate (an operating instrument) as economic fundamentals change in order to achieve its output and inflation objectives.

Monetary policy rule focuses on the choice of policy instruments which are transmitted through the interest rate and monetary base. The concept of Monetary Policy Reaction

Function (MPRF) motivated by the pioneer work of Taylor 1993 emphasis the inverse coefficient of the Philips equation while explaining how central banks reacts to macroeconomic conditions by altering interest rate. In the foundational work of Taylor's Monetary Policy Response function, a linear real GDP trend was used to measure potential output and expected inflation was taken to be 2 percent (Taylor, 1993). The rationale behind this was to show that this rule can stimulate short-term nominal interest rate of the United States. The policy rule obtained therefore is that Central Bank's policy rate rises if inflation increases above the target inflation rate or if GDP rises above potential GDP. On the contrary, the Central Bank policy rates decreases if inflation is below the target rate or real GDP decreases below potential GDP.

Subsequent studies on Monetary Policy Response function sine Taylor (1993), has continue to build with care on the Taylor's seminal article and has produced various reports regarding the Central Bank response function. In the study carried out by Clarida, Gali and Gertler (1998), they estimated the Central Bank reaction functions using Generalized Method of Moments. In their study, they found the Central Banks in United State, Japan, and Germany pursued an implicit forward-looking inflation targeting which reacts to the expected inflation rather than past inflation. A similar study by Judd and Rudebusch (1998), concluded that the Taylor's rule prescribe guide on the relationships that existed among variables when conducting monetary policy. However, the study by Gerlach and Smets (2000) produced a mixed result. By examining whether monetary policy would respond to shocks in exchange rate, the authors found a mixed result across countries. They found that Australia's Central Bank is insensitive to shocks emanating from exchange rate while the Central Banks in Canada and New Zealand responded significantly to a shock to the exchange rate. Assane and Malamud (2000) using the Vector Auto-regression (VAR) model, having studied the relationship between monetary policy and exchange rates found that a weak dollar causes the Fed to raise the federal funds rate thus a rise in the federal funds rate leads to appreciation of the U.S. dollar.

The study by Romer (2001), focused on estimating the value of the coefficients of output gap and price gap to explain the effectiveness of monetary policy. The result obtained from the study showed that the values the coefficients attain can change the effectiveness of monetary policy through its effects on the level of actual inflation actual output. Hsing (2004), used a Vector Auto Regression modeling technque to estimate the Bank of Canada's monetary policy reaction function. The result from the study, showed that the Taylor rule is extended to include exchange rate since the objectives of the Bank of Canada is to maintain currency stability to promote international trade. By applying the same methodology in estimating the Bank of Korea monetary policy reaction function, Hsing (2004) found that bank of Korea call rate react positively to shocks from inflation gap, output gap, exchange rate gap, stock price gap and lagged bank call rates. The result obtained from the study showed that, the most influential short run variables that explained variations in call rates in Korea was exchange rate gap variable and inflation gap variable. The variables that contributed to long run variation in Korea call rates is the output gap variable and stock price gap variable.

In a similar study carried out for the European Union countries Galbraith, *et. al.,* (2007) found that the Federal Reserve does not react to inflation signals but to the unemployment. Estimating the monetary policy reaction function for European Union countries, Sutherland (2010) found that there exists disparity across countries as to determinants of policy response function. Specifically, the results showed monetary policy in developed economies significantly influenced monetary policy response function in the less developed countries. However, they found little evidence that output gap significantly influences monetary policy response function. Kaytanci (2008) applying vector error-correction model estimated monetary policy reaction function for Turkey based on an extended Taylor rule. He found that the policy rate responds positively to shock to the output gap, the inflation gap, or the lagged overnight rate while responding negatively to exchange rate.

Attempts to estimate a reaction function for the Central Bank of Nigeria was that of Ajayi (1978), Asogu (1996), and Doguwa (2002). The models followed a Taylor-type specification, modified to fit the proposed monetary policy framework which was later adopted in December 2006.

In a much more recent study, Inoue and Hamori (2009), employing dynamic ordinary least squares (OLS) method to the estimation of a Taylor-type monetary policy reaction function for India, concluded that output gap variable and exchange rate gap variable were statistically significant and having the right signs in explaining monetary policy response function. However, the price gap variable had the wrong sign and failed the test of significance. In Nigeria, there are very few studies that have attempted to explain the monetary policy response function. The study by Iklaga (2009) estimated a Taylor-type monetary policy response function. The result obtained from the study suggests that inflationary pressures played a significant role in influencing monetary policy decisions in Nigeria.

In a more recent study by Apanisile and Ajilore (2013), monetary policy response function was estimated under the Taylor's rule using Engle-Granger approach to co-integration. They authors reached a conclusion that the implementation of monetary policy function was carried out in effect to achieve price stability in Nigeria. The study by Agu (2007) confirm that inflation is the primary determinant of the central bank's reaction though policy targets usually differ from outcome while Doguwa and Essien (2013), found that the monetary policy response function for Nigeria fits the actual monetary policy performance of real monetary policy rate and reserve money. This work extends the body of knowledge on monetary policy response function for Nigeria by drawing extensively on the basic structure of Taylor's rule and the recent work of Doguwa and Essien (2013).

2.2 Theoretical Framework

In theory, evaluating short-to-medium-term risks to price stability is to use the New Keynesian Model (NKM) instead of the New Classical Model (NCM) in which monetary policy is essentially neutral to the real economic activity (Goodfriend and King, 1997; Romer, 2012). Following Woodford (2001), one can specify the NKM model using three structural equations, such as: aggregate supply (Phillips curve) relationship, the aggregate demand model (IS equation) and the uncovered interest rate parity model which is the foundation of Taylor (1993). Starting with the Phillips curve equation, inflation is related directly with output gap. It is captured in equation (1) as follows:

2.2.1 Aggregate Supply (Phillips curve)

$$\pi_t = \delta + \alpha\pi_{t-1} + \beta Y_t + \varepsilon_t \qquad (1)$$

Where π is inflation, π_{t-1} is inflation lagged by one period and Y is the output gap, δ, α and β are the unknown parameters while ε_t is the error term.

2.2.2 Aggregate Demand model (IS curve)

The aggregate demand model links output gap to the policy anchor rate, inflation and the nominal interest rate. The equation is expressed as follows in equation (2):

$$Y_t = \delta + \alpha i + \sigma \pi_t + \theta R_t + \varepsilon_t \quad (2)$$

Where Y is the output gap, i is the policy anchor rate, π is inflation and R is the nominal interest rate.

2.2.3 Uncovered Interest rate Parity model

The model emphasises the relationship among nominal interest rate and desired interest rate, interest rate differential between domestic and foreign interest rate, and exchange rate premium. The model is expressed in equation (3) as follows:

$$R_t = \delta + \alpha R_t^* + \sigma(\varphi_t - \varphi_{t-1}) + \mu_t \quad (3)$$

Here, R is the nominal interest rate, R^* is anticipated interest rate, φ is exchange rate and $(\varphi_t - \varphi_{t-1})$ is the exchange rate premium. However, the original version of Taylor's rule relates nominal interest rate to assumed equilibrium real interest rate and the deviation between actual inflation and target inflation rate as well as the difference between actual output and potential output. In its original form, Taylor's equation is expressed in equation (4) as follows:

$$i_t = \delta + r_t^* + \alpha(\pi_t - \pi^*) + \sigma(Y_t - Y_N) \quad (4)$$

From the three structural models, a simple model for the monetary policy reaction function (MPRF) which links policy anchor to output gap and the divergence of inflation from target as shown in equation (5) below:

$$i_t = \delta + \lambda(r_t^* + \pi^*) + \alpha(\pi_t - \pi^*) + \sigma(Y_t - Y_N) + \mu_t \quad (5)$$

Where r^* is the average (long-run) real interest rate, $(r_t^* + \pi^*)$ is the nominal interest rate, $(Y_t - Y_N)$ is the output gap. Thus, the model is simplified as:

$$i_t = \delta + \lambda R_t^* + \alpha\pi_t + \sigma Y_t + \mu_t \qquad (6)$$

The above additive model relates the policy anchor instrument (short-term interest rate) with output, inflation, and the exchange rate in a small-open economy such as Nigeria. Following Taylor's rule (1993 and 2001), (Jawadi, *et. al.,* 2011) and Doguwa and Essien (2013), the model for estimating the monetary policy response function for the CBN can be expressed in equation (7) below:

$$i_t = \delta + \lambda(r^* + \pi^*) + \alpha(\pi_t - \pi^*) + \sigma(Y_t - Y_N) + \beta X_t + \mu_t \qquad (7)$$

From the discussion so far, i_t captures the monetary policy rate (MPR), representing the anchor rate, henceforth PR, $(r^* + \pi^*)$ is the nominal interest rate proxies by the prime lending rate (PLR), henceforth P. The P stands for the rate applicable to high net worth individuals that require loans from banking institutions. The deviation between actual inflation rate and target inflation is $(\pi_t - \pi^*)$, while $(Y_t - Y_N)$ is used to explain the difference between the actual output and the potential output. In this equation X_t was introduced to cover all other control variables that may play an important role in the economy through the effect of monetary policy reaction function such as changes in the all-share index (ASI), henceforth A, the exchange rate premium between bureau de change rate and the official exchange rate, henceforth φ^*, to take care of the depreciation of the domestic currency, the Naira. Changes in the price of Nigerian representative crude oil (O), the Bonny Light was also included to cater for the important role of oil price in the Nigerian economy.

Consequently, the model can be formulated in a compact form as below in equation (8):

$$PR_t = f(\mathrm{P}, \pi^*, Y^*, \varphi^*, A, O) \qquad (8)$$

Where PR is the target short-term nominal interest rate (monetary policy rate), P is prime Lending rate, π^* is the divergence between actual inflation rate and target inflation, Y^* is the divergence between the log of real GDP and the log of potential output while φ^* is the exchange rate premium between bureau de change rate and the official exchange rate, while A is the change in all-share index and O is the change in oil price. In linear form, equation (8) becomes equation (9) as follows:

$$PR_t = \delta + \alpha P_t + \beta \pi_t^* + \lambda Y_t^* + \sigma \varphi_t^* + \eta A_t + \kappa O_t + \mu_t \qquad (9)$$

Where the *á-priori* signs are defined symbolically as:

$\alpha, \lambda, \sigma, \eta < 0, \beta, \kappa > 0$

The autoregressive distributed lag [(ARDL) (p, q)] structure employed for the estimation is expressed as follows:

$$\Delta PR_t = \delta + \sum_{k=1}^{n} \omega_k \Delta PR_{t-k} + \sum_{k=0}^{n} \alpha_k \Delta P_{t-k} + \sum_{k=0}^{n} \beta_k \Delta \pi_{t-k}^* + \sum_{k=0}^{n} \lambda_k \Delta Y_{t-k}^* + \sum_{k=0}^{n} \sigma_k \Delta \varphi_{t-k}^* + \sum_{k=0}^{n} \eta_k \Delta A_{t-k} + \sum_{k=0}^{n} \kappa_k \Delta O_{t-k} +$$
$$\text{ECT}(PR_{t-1} - \zeta - \phi_1 P_{t-1} - \phi_2 \pi_{t-1}^* - \phi_3 Y_{t-1}^* - \phi_4 \varphi_{t-1}^* - \phi_5 A_{t-1} - \phi_6 O_{t-1}) + \mu_t \qquad (10)$$

Equation (10) is the ARDL cointegration model. In the model, the symbol Δ represents the first difference operator. The summation signs incorporated into equation (10) represent the error-correction dynamics while the variables with the coefficients $\phi's$ indicate the long-run relationships. The lag structure in the E-views software was adopted by making use of the lag-length criteria to obtain the optimal lag-length appropriate for the model. The Akaike information criterion (AIC) was preferred compared with the Schwarz information criterion (SIC), as it penalises the most. To validate the usefulness of the ARDL model, the residual diagnostics, serial correlation LM test was conducted.

In addition to the smoothing of interest rate depicted in equation (10) above, the CBN also regularly monitors the base money to ensure that it does not deviate from its desired level. In this regard, it would be logical to expect that the reaction of the CBN may follow the path suggested by McCallum (2000). Consequently, drawing from the works of Sanchez-Fung

(2005) on the Dominican Republic, a McCallum-Taylor specification of the CBN is represented as follows in equation (11):

$$\Delta b_t = c + \rho \Delta b_{t-1} + \alpha P_t + \beta \pi^* + \lambda y^* + \sigma \varphi^* + u_t \qquad (11)$$

Where Δb_t is the change in base money, μ_t is white noise and other variables remain as earlier defined.

The above specifications are expected to indicate the particular rule which the CBN follows. It is argued that the changes in the monetary base which is the intermediate instrument for monetary policy is transmitted to the inter-bank market as well as the goods market (via inflation and output) and the foreign exchange market.

Equation (11), in ARDL form is expressed as follows in equation (12):

$$\Delta b_t = c + \sum_{j=1}^{m} \rho_j \Delta b_{t-j} + \sum_{j=0}^{m} \alpha_j \Delta P_{t-j} + \sum_{j=0}^{m} \beta_j \Delta \pi^*_{t-j} + \sum_{j=0}^{m} \lambda_j \Delta y^*_{t-j} + \sum_{j=0}^{m} \sigma_j \Delta \varphi^*_{t-j} + ECT(b_{t-1} - \varpi - \theta_1 P_{t-1} - \theta_2 \pi^*_{t-1} - \theta_3 y^*_{t-1} - \theta_4 \varphi^*_{t-1}) + \mu_t$$
(12)

The ARDL, which captures the long-and short-run dynamics of the relationship, is of orders (m, n). In estimating the equation, an initial lag length of four is adopted, as quarterly data is being utilised, i.e. an ARDL (4, 4). This specification is considered an appropriate starting point in this work, given that quarterly frequency of data is being utilised.

From specifications (10) and (12) above, there would be need to determine the potential levels of variables. Sanchez-Fung (2005), Hsing (2004), Hsing (2004), Knedlik (2005), Shortland and Stasavage (2004), De Brouwer and Gilbert (2005), Mehra (1999) and Chang (2005) passed the variables through the Hodrick-Prescott (HP) Filter. The potential level of the exchange rate is the Bureaux-de-change (BDC) rate which is believed to capture the dynamics in the market more effectively than that obtainable from the official foreign exchange market. The exchange rate gap is therefore defined as the premium between the BDC and the official market rates.

3.0 Model Specification, Data and Methodology

Thus, the first autoregressive distributed lag [(ARDL) (p, q)] model to be estimated is as follows:

$$\Delta PR_t = \delta + \sum_{k=1}^{n} \omega_k \Delta PR_{t-k} + \sum_{k=0}^{n} \alpha_k \Delta P_{t-k} + \sum_{k=0}^{n} \beta_k \Delta \pi^*_{t-k} + \sum_{k=0}^{n} \lambda_k \Delta Y^*_{t-k} + \sum_{k=0}^{n} \sigma_k \Delta \varphi^*_{t-k} + \sum_{k=0}^{n} \eta_k \Delta A_{t-k} + \sum_{k=0}^{n} \kappa_k \Delta O_{t-k} + \text{ECT}(PR_{t-1} - \zeta - \phi_1 P_{t-1} - \phi_2 \pi^*_{t-1} - \phi_3 Y^*_{t-1} - \phi_4 \varphi^*_{t-1} - \phi_5 A_{t-1} - \phi_6 O_{t-1}) + \mu_t \quad (10)$$

Relatedly, the second model to be estimated is the change in the monetary base, which is the intermediate instrument for monetary policy and is transmitted to the inter-bank market as well as the goods market (via inflation and output) and the foreign exchange market through the exchange rate premium. Its ARDL form is expressed as follows in equation (12):

$$\Delta b_t = c + \sum_{j=1}^{m} \rho_j \Delta b_{t-j} + \sum_{j=0}^{m} \alpha_j \Delta P_{t-j} + \sum_{j=0}^{m} \beta_j \Delta \pi^*_{t-j} + \sum_{j=0}^{m} \lambda_j \Delta y^*_{t-j} + \sum_{j=0}^{m} \sigma_j \Delta \varphi^*_{t-j} + ECT(b_{t-1} - \varpi - \theta_1 P_{t-1} - \theta_2 \pi^*_{t-1} - \theta_3 y^*_{t-1} - \theta_4 \varphi^*_{t-1}) + \mu_t \quad (12)$$

3.1 Definition of variables

PR is the target short-term nominal interest rate (monetary policy rate)

P is prime lending rate

π is inflation

Y is the output

φ is exchange rate and

$(\varphi_t - \varphi_{t-1})$ is the exchange rate premium

π^* is the deviation between actual inflation rate and potential inflation

Y^* is the divergence between the log of real GDP and the log of potential output

A is the all-share index

φ^* is the exchange rate premium between bureau de change rate and the official exchange rate

O is the price of Nigerian representative crude oil, the Bonny Light

b is the base money

Where the *á-priori* signs are defined symbolically as:

$\delta, \alpha, \lambda, \sigma, \eta < 0, \beta, \kappa, > 0$; and

μ_t is white noise.

The summation signs incorporated into equations (10) and (12) represent the error-correction dynamics while the variables with the coefficients ϕ's and θ's indicate the long- run relationships.

3.2 Data and Methodology

Given the need for high frequency data and the non-availability of monthly data particularly for real GDP, the study uses quarterly data from 2000:Q1-2018:Q4. Due to the evidence of seasonality observed in the plot of GDP, the series was de-seasonalised and a seasonally adjusted output gap (measured as the excess of actual over potential GDP) was derived. Inflation gap is defined as the excess of observed inflation above potential inflation. In addition, the monetary policy rate was utilised to capture the policy rate. All data were sourced from the Central Bank of Nigeria Statistical Bulletin and the website of the National Bureau of Statistics (NBS), Nigeria.

The uniqueness of the ARDL modeling approach makes it easy for estimation of models with a mix of I(0) and I(1) series but not in the presence of I(2) series. Other co integration test method such as Johansen-Juselius (1990) and Johansen (1991;1995) requires that all the variables used in testing for short run and long run relationship among the variables in a model must be integrated of order one or an I(1) series. Given the limitation of the ARDL modeling approach which is that the model collapses in the presence of I(2) series, we proceeded to testing for the unit root properties of the variables at their levels and first difference with the aid of the Augmented Dickey Fuller (ADF) unit root testing procedure. The result of the unit root test reported in Table 1 shows that we have no concern for I (2) variables in the model. All the variables were either stationary at levels or at their respective first difference. This presupposes that the ARDL Bound Testing procedure can be carried out by first testing the existence of cointegrating relationship among the variables in the model.

Table 1 : Augmented Dickey Fuller (ADF) Unit Root Test of the variables

	LEVELS		FIRST DIFFERENCE		Order of Integration
Variable	**ADF1**	**ADF2**	**ADF1**	**ADF2**	
LASI	-2.83	-2.34	-7.29***	-7.45***	I(1)
P	-1.51	-1.73	-6.82***	-6.77***	I(1)
LO	-1.95	-1.52	-6.93***	-6.93***	I(1)
EXRP	0.78	2.49	-7.23***	-8.16***	I(1)
IG	-6.99***	-6.94***			I(0)
OG	-8.62***	-8.60***			I(0)
B	0.95	-1.52	-11.08***	-11.01***	I(1)
PR	-1.95	-1.75	-5.55***	-5.59***	I(1)

ADF1 referred to unit root tests conducted with intercept, while ADF2 were conducted with intercept and trend. The asterisk *** and ** indicated statistical significance at 1% and 5% levels, respectively.

After ascertaining the order of integration of the variables, we proceed to testing the existence of long-run cointegration relationship between the dependent variables (PR) and the regressors – prime lending rate, inflation gap, output gap, exchange rate premium, all-share index, and crude oil price. This is done with the aid of the Wald (F-Statistic). The test for the long-run cointegrating relationship is carried out by imposing restrictions on the estimated long-run coefficients of the policy rate variable (PR). The imposition of restriction in the long-run coefficients is made possible by first determining the lag-length of the model through the Akaike Information criteria. The calculated F-statistics for the cointegration test is reported in Table 3. The null and alternative hypotheses are as follows:

$H_0 = \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 = 0$ There exists no long-run cointegrating relationship among the variables in the model.

$H_0 \neq \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq \alpha_7 \neq 0$ There exists long-run cointegrating relationship among the variables in the model.

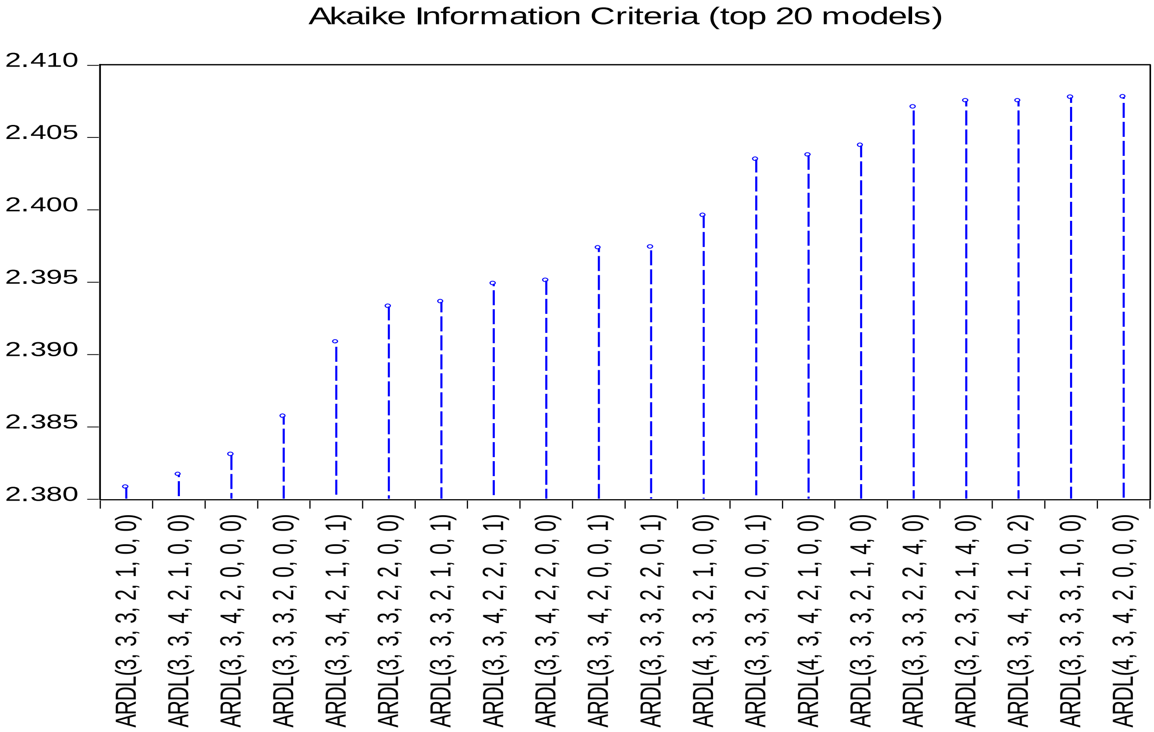
The ARDL, which captures the long-and short-run dynamics of the relationship, is of orders (m, n). In estimating the equation, an initial lag length of four is adopted, as quarterly data is being utilised, i.e. an ARDL (4, 4). This specification is considered an appropriate starting point in this work, given that quarterly frequency of data is being utilised.

4.0 Empirical Analysis

4.1 Results of the Monetary Policy Function

Figure 1 shows that, of the 20 models pre-tested for optimum lags using the Akaike Information Criteria (AIC), the ARDL (3,3,3,2,1,0,0) was found to be more parsimonious in explaining the relationship under study.

Figure 1: AIC of top 20 Models



The computed F-value from the Wald statistic is evaluated based on the critical values of tabulated in Table CI of Pesaran *et. al.*, (2001). The value of the F-Statistics is 3.33. From the critical values of the Bound test reported in Table 2, as provided in Table Ci (iii) of Pesaran *et. al.* (2001), the lower and upper bounds for the F-test statistic at 5% level of significance is 2.27 and 3.28, respectively. Given that the F-statistic value of 3.33 is greater than the upper bound at 5% level, we reject the null hypothesis of no cointegrating relationship among the time series variables.

Table 2: F-Statistics of Cointegrating Relationship among the Variables for Policy rate

F-Bounds Test				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.327844	10%	1.99	2.94
k	6	5%	2.27	3.28
		2.50%	2.55	3.61
		1%	2.88	3.99

Note: The table is the result of the cointegrating relationship among the variables in the policy rate model. The null hypothesis states that there is no long run cointegrating relationship among the variables in the model.

The result revealed interesting findings for policy rate in Nigeria. The first two lags of the policy rates, contemporaneous prime lending rate and its first two lags, the first two lags of inflation gap and first lag of output were all significant at 1.0 per cent in the short-run. The contemporaneous inflation gap and output gap, and contemporaneous exchange rate premium were not significant. The error correction term (ECT) has the right sign and it is significant at 1.0 per cent. The ECT indicates that 11.7 per cent of the previous quarter‘s disequilibrium from short-run equilibrium is corrected for within a quarter. In other words, the coefficient of the error correction term which measures the speed of adjustment back to equilibrium whenever the system is out of equilibrium indicates that adjustment is relatively low.

In the long-run, only four variables, the prime lending rate, output gap, exchange rate premium and all-share index have significant long-run effects on the policy rate. The result shows that these variables play a significant role in the Central Bank of Nigeria monetary policy reaction function.

Table 3: Short-run and Long-run Parsimonious Results for the Policy Rate

Short-run				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PR(-1))	0.259	0.104	2.481	0.016
D(PR(-2))	0.286	0.109	2.615	0.012
D(P)	0.506	0.121	4.166	0.000

D(P(-1))	-0.329	0.111	-2.975	0.004
D(P(-2))	-0.225	0.111	-2.019	0.049
D(IG)	0.004	0.021	0.187	0.853
D(IG(-1))	-0.109	0.027	-4.052	0.000
D(IG(-2))	-0.073	0.022	-3.359	0.001
D(OG)	-7.164	8.732	-0.821	0.416
D(OG(-1))	52.689	9.105	5.787	0.000
D(EXRP)	0.000	0.002	0.214	0.832
CointEq(-1)*	-0.117	0.021	-5.484	0.000
Long-run				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
P	3.115	1.016	3.066	0.003
IG	0.507	0.541	0.938	0.352
OG	-774.387	318.665	-2.430	0.018
EXRP	0.035	0.018	1.920	0.060
ASI	0.000	0.000	2.087	0.042
O	0.089	0.064	1.384	0.172
C	-58.867	25.246	-2.332	0.024

4.1.1 Post-Estimation Diagnostics Results

The result of the robustness tests conducted on the estimated model is presented in Table 4 - 6. Here, the Breusch-Godfrey Serial Correlation LM Test (Table 4), conducted under the null hypothesis of ‘no serial correlation’, shows that the estimated model is free from serial correlation in its lags, as the F-statistic, which is 0.2178, is statistically insignificant, with a p-value of 0.805. Similarly, the Heteroskedasticity Test: Breusch-Pagan-Godfrey reveals the absence of heteroskedasticity in the estimated model, as the F-statistic (0.82295), under the null hypothesis of ‘homoschedasticity, is statistically insignificant, with a p-value of 0.6662 (see Table 5). The residual of the model also appears to be normality distributed as the null hypothesis of normality cannot be rejected in the Jarque-Bera test (Table 6).

Table 4: Result of Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:

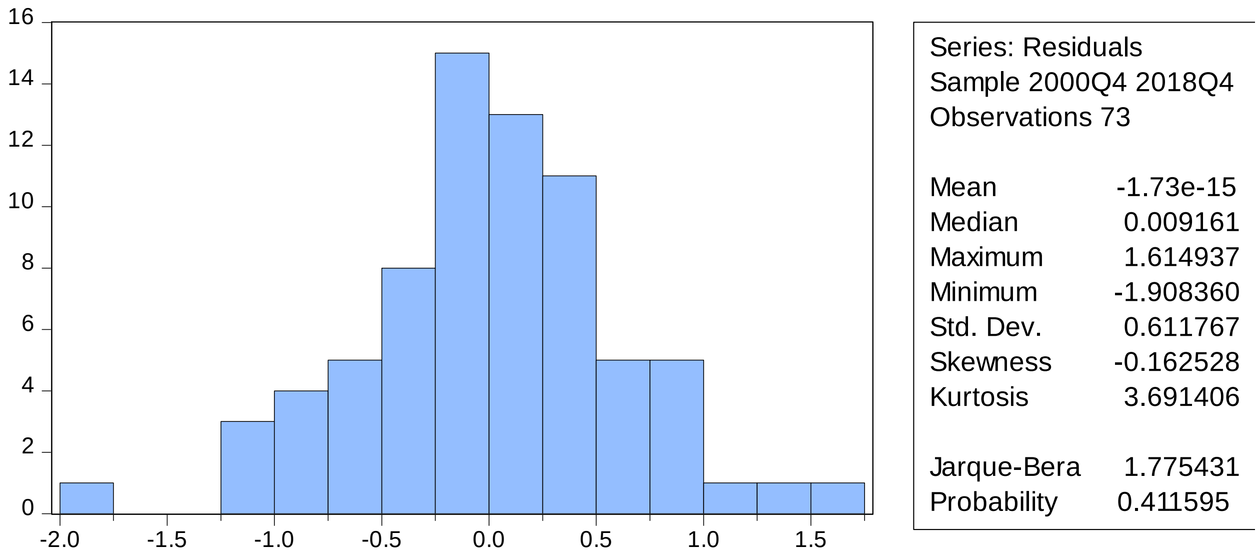
F-statistic	0.217817	Prob. F(2,52)	0.8050
Obs*R-squared	0.606481	Prob. Chi-Square(2)	0.7384

Table 5: Result of Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.822951	Prob. F(18,54)	0.6662
Obs*R-squared	15.71442	Prob. Chi-Square(18)	0.6125
Scaled explained SS	11.57149	Prob. Chi-Square(18)	0.8686

Table 6: Result of Normality Test

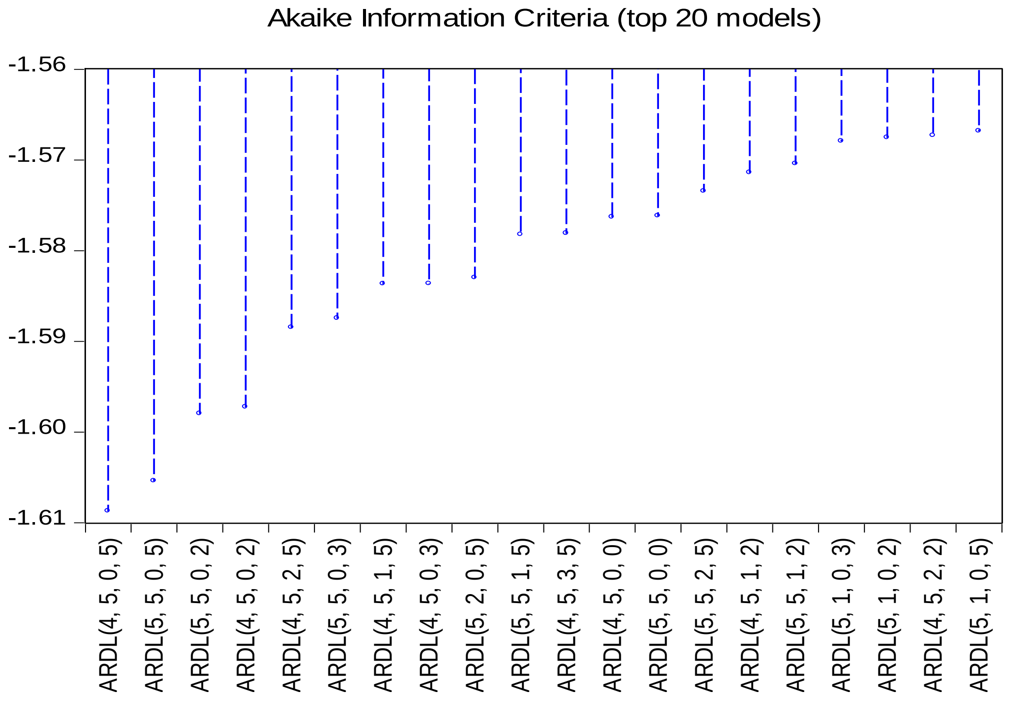


The normalisation process generated the short-run and elasticities which are reported in Table 2. The result produced interesting findings for monetary policy reaction function for Nigeria. Only prime lending rate, output gap, exchange rate premium and all-share index appear to have a significant long-run effect on monetary policy rate. These results point to the fact that these variables need to be closely monitored for policy formulation.

4.2 Results of the Base Money Function

Similar exercise was done for the base money to test the existence of long-run cointegration relationship between the dependent variables (b) and the regressors – prime lending rate, inflation gap, output gap and exchange rate premium. From the estimated AIC functions of the top 20 models presented in Figure 2, ARDL (4,5,0,5) was found to be more parsimonious in explaining the relationship under study.

Figure 2: AIC of top 20 Models



The result of F-bound test reveals the presence of long-run relationship among the variables (Table 7). More specifically, the F-statistic (7.96311) is greater than the critical value of its upper bound at 5.0 per cent level of significance (3.67) leading to a rejection of the null hypothesis of no cointegration among the variables.

Table 7: F-Statistics of Cointegrating Relationship among the Variables for Base Money

F-Bounds Test				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	7.96311	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.50%	3.15	4.08
		1%	3.65	4.66

Note: The table is the result of the cointegrating relationship among the variables in the base money model. The null hypothesis states that there is no long run cointegrating relationship among the variables in the model.

The result of the base money function is presented in Table 8. Here, in the short-run, output gap and prime lending rate has positive and statistically significant contemporaneous impact on base money. The positive impact of the prime lending rate on the base money can also be seen in lags in the first and fourth lags of prime lending rate. However, in the second and third lag of the prime lending rate, its impact on the base money is negative but statistically insignificant. Overall, it can be inferred that the impact of prime lending rate on base money is positive in the short-run. Similarly, the impact of inflation gap has a positive and statistically significant impact on base money in both contemporaneous and lagged terms. However, the statistically significant autoregressive terms points to diminishing impact of past values of base money on its current levels. In addition, the error correction term (ECT), which is -0.0295 is statistically significant with a negative sign, implying that only about 3.0 per cent of deviations from disequilibrium level of the base money is corrected every quarter.

In the long-run, the impact of output gap (OG) on base money is positive and statistically significant. More specifically, a rise in OG by one unit increases base money by about 76.0 per cent every quarter. The relationship between prime lending rate is, however, inverse and statistically significant, implying that less money is created as interest rate rises, and vice versa. Also, the relationship between inflation gap and base money is negative but statistically insignificant.

Table 8: Short-run and Long-run Parsimonious Results for the Base Money

Short-run				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(B(-1))	-0.53013	0.10498	-5.04977	0.000
DLOG(B(-2))	-0.33926	0.112659	-3.01141	0.004
DLOG(B(-3))	-0.28996	0.103154	-2.81095	0.0069
D(P)	0.049776	0.014362	3.465841	0.0011
D(P(-1))	0.032258	0.015999	2.016242	0.0489
D(P(-2))	-0.0002	0.015433	-0.01292	0.9897
D(P(-3))	-0.006	0.01568	-0.38231	0.7038
D(P(-4))	0.041655	0.014078	2.958828	0.0046
D(IG)	0.006662	0.003675	1.81267	0.0755
D(IG(-1))	0.024435	0.004524	5.401669	0.0000
D(IG(-2))	0.013551	0.004071	3.328304	0.0016
D(IG(-3))	0.011268	0.004216	2.672893	0.0100
D(IG(-4))	0.008745	0.003556	2.459263	0.0172
CointEq(-1)*	-0.02905	0.004439	-6.54374	0.0000
long-run				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
P	-0.20352	0.104321	-1.95088	0.0564
OG	76.07343	40.99652	1.855607	0.0691
IG	-0.67102	0.423412	-1.58479	0.1190
C	19.93879	2.310309	8.630357	0.0000

4.2.1 Post-Estimation Diagnostics Results for the Base Money Function

The estimated model has no serial correlation as indicated by the result of the Breusch-Godfrey Serial Correlation LM and is with constant variance with the result of the

Heteroskedasticity Test: Breusch-Pagan-Godfrey tests (Table 9 and 10, respectively). In addition, the residual of the model is normality distributed as indicated by the result of the Jarque-Bera test (Table 11).

Table 9: Result of Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:

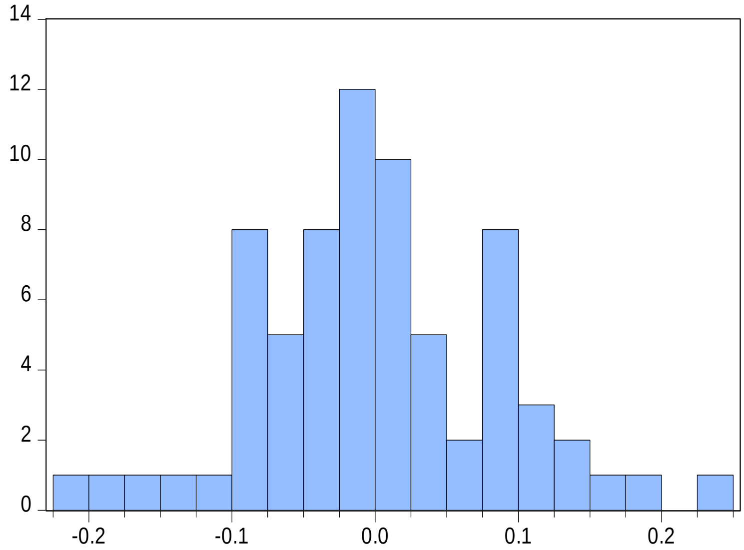
F-statistic	0.064441	Prob. F(2,51)	0.9377
Obs*R-squared	0.178970	Prob. Chi-Square(2)	0.9144

Table 10: Result of Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.762360	Prob. F(17,53)	0.7253
Obs*R-squared	13.95038	Prob. Chi-Square(17)	0.6706
Scaled explained SS	9.037967	Prob. Chi-Square(17)	0.9391

Table 11: Result of Normality Test



Series: Residuals
Sample 2001Q2 2018Q4
Observations 71

Mean	-9.18e-15
Median	-0.006308
Maximum	0.225426
Minimum	-0.223285
Std. Dev.	0.084607
Skewness	0.099574
Kurtosis	3.325303
Jarque-Bera	0.430384
Probability	0.806387

5.0 Recommendations and Conclusion

5.1 Recommendations

The findings from the study show that in pursuing the goal of price stability in Nigeria, using the Monetary Policy Rate (MPR), the CBN should track the inflation gap, output gap as well as the divergence in exchange rate differentials between the official exchange rate, bureau de change (BDC) and the prime lending rate cum all-share index. This is important given that Nigeria is a major oil exporting country and volatility in the international oil price is transmitted directly to the economy through its impact on exchange rates. The importance of inflation gap in monetary policy decision making was upheld, particularly the first and second lags. The results are quite revealing and suggest the need to consider these variables when formulating monetary policy. Furthermore, the results indicate that the Bank reacts to a widening gap in the exchange rate premium, which implies that the Bank considers the exchange rate when designing monetary policy in order to avoid exchange rate misalignment, reduce the premium between the official and BDC rates and stabilise the currency.

5.2 Conclusion

This paper estimates the reaction function of the CBN for the period 2000:Q1 - 2018:Q4, using an extended Taylor's rule specifications for both the policy rate and the base money. Potential levels of the relevant variables were derived by passing them through HP filters. The final equations estimated followed an Autoregressive Distributed Lag (ARDL) structure. The partial adjustment coefficient, which captures the smoothing by the CBN, is important when decisions are made on monetary policy rate.

In the case of the policy rate, the first two lags of the policy rates, contemporaneous prime lending rate and its first two lags, the first two lags of inflation gap and first lag of output were all significant at 1.0 per cent in the short-run. The ECT indicates that 11.7 per cent of the previous quarter‘s disequilibrium from short-run equilibrium is corrected for within a quarter. In other words, the coefficient of the error correction term which measures the speed of adjustment back to equilibrium whenever the system is out of equilibrium indicates that adjustment is relatively low. In the long-run, only four variables, the prime lending rate, output gap, exchange rate premium and all-share index have significant long-run effects on the policy rate. The result shows that these variables play a significant role in the Central Bank of Nigeria monetary policy reaction function, when the policy rate was utilised.

The paper revealed that in the short-run, the base money function has positive effect and is statistically significant on output gap and prime lending rate. Also, the impact of inflation gap is positive and statistically significant in both contemporaneous and lagged terms. Furthermore, the ECT of -0.0295 is statistically significant with a negative sign, implying that only about 3.0 per cent of deviations from the disequilibrium level of the base money is corrected every quarter. Analysing the long-run effect, the impact of output gap (OG) on base money is positive and statistically significant. Specifically, a rise in OG by one unit increases base money by about 76.0 per cent every quarter. On the other hand, the relationship between prime lending rate is, however, inverse and statistically significant.

References

Agu, C. (2007). "What Does the Central Bank of Nigeria Target? An Analysis of Monetary Policy Reaction Function in Nigeria" AERC Biannual Research Workshop.

Ajayi, S.I. (1978). "Money, Prices and Interest Rates: The Nigerian Paradigm" *Nigerian Journal of Economic and Social Studies,* Vol. 20.

Apanisile, O. T. and Ajilore, T. (2013). "Inflation Targeting Monetary Policy Rule in Nigeria: Estimates of the Policy Reaction Function", *International Journal of Economics and Finance*; Vol. 5, No. 7.

Aragón, E. and Portugal, M. (2010). "Nonlinearities in Central Bank Brazil's reaction function: The case of asymmetric preferences", Estudos Econ Ómicos, São Paulo, 40: 373-399.

Aron J., and J. Muellbauer (2002). "Estimating Monetary Policy Rules for South Africa", *Central Bank of Chile, Monetary Policy: Rules and Transmission Mechanisms,* eds Loayza N. and K. Schmidt-Hebbel.

Asogu J. O. (1996). "An Econometric Analysis of the effectiveness of Monetary Policy in Nigeria", A Ph.d Thesis, University of Lagos, Nigeria.

Assane, D., and Malamud, B. (2000). "The Federal Reserve"s Response to Exchange Rate Shocks", *Applied Financial Economics*, 10(5), October 2002, 461-470.

Barro, R. J. (1983). "Rules, Discretion, and Reputation in a Model of Monetary Policy", *Journal of Monetary Economics 12(1)*, 101-121.

Berument H., and K. Malatyali (2000). "The Implicit Reaction Function of the Central Bank of the Republic of Turkey", *Applied Economic Letters*, No.7.

Bleany M., and L. Lisenda (2001). "Monetary Policy after Financial Liberalisation: A Central Bank Reaction Function for Botswana", *Centre for Research in Economic Development and International Trade (CREDIT)*, No. 01/17, October.

Central Bank of Nigeria, (2015). *Annual Report*, Abuja, Nigeria.

Central Bank of Nigeria, (2018). *Monetary Policy Communiqué*, November 21 – 22, Abuja, Nigeria.

Chang H. S. (2005). "Estimating the Monetary Policy Reaction Function for Taiwan: A VAR Model", *International Journal of Applied Economics*, Vol.2, No.1, March.

Clarida R., J. Gali and M. Gertler (2000). "Monetary Policy Rules and Macroeconomic Stability: Evidence and some Theory", *Quarterly Journal of Economics*, CXV – Vol.1.

De Brouwer G., and J. Gilbert (2005). "Monetary Policy Reaction Functions in Australia", The Economic Society of Australia, *The Economic Record*, Vol. 81, No. 253, June.

Doguwa S. I. (2002). "Estimating Taylor-Type Monetary Policy Reaction Functions for Nigeria:1985-2001", West African Monetary Institute, *Journal of Monetary and Economic Integration* Vol. 2, No. 1.

Doguwa, S. I. and Sunday N. Essien (2013). "The Role of Central Bank of Nigeria's Analytical Balance Sheet and Monetary Survey in Monetary Policy Implementation", *CBN Journal of Applied Statistics,* Vol. 4 No.1 (June), pp.132-137.

Galbraith, J.K., Giovannoni, O. and Russu, A.J, (2007). "The Fed's Real Reaction Function: Monetary Policy, Inflation, Unemployment, Inequality – and Presidential Politics", University of Texas Inequality, Project (UTIP) Working Paper 42

Gerlach, S. and Smets, F. (2000). "MCIs and Monetary Policy," *European Economic Review*, 44(9), 1677- 1700.

Goodfriend, M. and King, R. (1997). "The New Neoclassical Synthesis and the Role of Monetary Policy", *Working Paper Series*, No. 98-05, The Federal Reserve Bank of Richmond.

Hutchinson, M., Sengupta, R. and Singh, N. (2013). "Dove or Hawk? Characterising monetary policy regimes switches in India" *Emerging Markets Review*, 16: 182-202.

Hsing Y. (2004). "Estimating the Monetary Policy Reaction Function for Canada: A VAR Model", Canadian Business Economics, *CABE Journal*, Vol.3, No.2, April.

Iklaga, F.O. (2009). "Estimating a Monetary Policy Reaction Function for the Central Bank of Nigeria (1999 – 2007)", Central Bank of Nigeria.

Inoue, T., and Hamori, S., 2009. An empirical analysis of the money demand function in **India**. Economics Bulletin 29(2), 1225–1246.

Jawadi, F., Mallick, S. and Sousa, R. (2011). "Monetary Policy Rules in the BRICS: How Important is the Nonlinearity", *Working Paper Series*, No. 18, Universidade Do Minho.

Johansen-Juslius (1990). "Maximum Likelihood Estimation and Inference on Cointegration– with Applications to the Demand for Money," *Oxford Bulletin of Economics and Statistics*, Vol. 52, No. 2, pp. 169–210.

Johansen, S. (1991). "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models," *Econometrica*, Vol. 59, No. 6, pp. 1551–1580.

Johansen, S., (1995), "Likelihood-Based Inference in Cointegrated Vector Autoregressive Models", New York: Oxford University Press.

Judd, J. P. and Rudebusch, G. D. (1998). "Taylor's Rule and the Fed: 1970-1997," *Federal Reserve Bank of San Francesco Economic Review*, 3, 3-16.

Kaytanci, B. G. (2008). “Estimating the Monetary Policy Reaction Function for Turkey”, Paper presented at the 8th Global Conference on Business & Economics, Florence, Italy.

Kelikume, I., Alabi, F. A. and Ike-Anikwe, R. C. (2016). “An Empirical Analysis of Monetary Policy Reaction Function: Evidence from Nigeria”, The *International Journal of Business and Finance Research*, Vol. 10, No. 1, pp. 13-25.

Knedlik T. (2005). “Estimating Monetary Policy Rules for South Africa”. Paper presented at the Biennial Conference of the Economic Society of South Africa, Africa’s Millennium: Trade, Investment and Growth, Durban, South Africa, 7th – 9th September.

McCallum, B. T. (1984). “Monetarist Rules in the Light of Recent Experience”, *American Economic Review, 74(2),* pp. 388-91.

McCallum, B. T. (1993). “Specification and Analysis of a Monetary Policy Rule for Japan”, Bank of Japan Monetary and Economic Studies, Vol. 29 (November).

McCallum, B. T. (2000). “Alternative monetary policy rules: a comparison with historical settings for the United States, the United Kingdom, and Japan”. *Federal Reserve Bank Richmond Econ Q*. 86, pp. 49–79.

Mehra Y.P (1999). “A forward looking Monetary Policy Reaction Function” *Federal Reserve of Richmond Economic Quarterly* Volume 85/2.

Mordi, C. N. O. (2009)**.** “Overview of Monetary Policy Framework in Nigeria” *Central Bank of Nigeria Bullion*, Volume 33 Number 1, January – March.

Nikolov K. (2002). “Monetary Policy Rules at the Bank of England” Paper prepared for a workshop on “The Role of Policy Rules in the Conduct of Monetary Policy”, European Central Bank.

Orphanides, A. (2001). “Monetary policy rules based on real-time data”, *American Economic Review,* 91, pp. 964–985.

Romer, D, (2001). Advanced Macroeconomics, second edition, Boston, MA: McGraw Hill.

Saghir, G. and Malik, W. S. (2017). “Estimating Monetary Policy Reaction Function of State Bank of Pakistan”, *Pakistan Economic and Social Review* Volume 55, No.1 (Summer 2017), pp. 119-157.

Sanchez-Fung J.R. (2005). "*Estimating a Monetary Policy Reaction Function for the Dominican Republic*" School of Economic, Kingston University, Kingston-upon-Thames, Surrey,UK.

Shortland A., and D. Stasavage (2004). "What Determines Monetary Policy in the Franc Zone? Estimating a Reaction Function for the BCEAO", Centre for the Study of African Economies, *Journal of African Economies*, Vol. 13, No. 4.

Sutherland, D. (2009). "Monetary Policy Reaction Functions in the OECD", OECD Economics Department Working Papers, No. 761.

Taylor, J. B. (1993). "Discretion versus Policy Rules in Practice", *Carnegie-Rochester Conference Series on Public Policy* 39, 195–214.

Taylor, J.B (1999). "Monetary Policy Rules", *NBER Studies in Business Cycles*, Vol 31.

——— (2001). "The role of the exchange rate in monetary policy rules", *American Economic Review*, 91: 263-267.

Woodford, M. (2001). "The Taylor rule and optimal monetary policy", *American Economic Review*, 91: 232–237.