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Determination of an Optimal Threshold for the Central Bank of Nigeria's Monetary Policy Rate

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Abstract

This paper examines the threshold of Nigeria's Monetary Policy Rate (MPR) using threshold techniques that provide appropriate procedures for estimation and inference. The study found the optimal MPR levels which are 10% for GDP growth, 9% for investment, 15% for external reserves and 8% for inflation. The study also observed that setting a threshold for monetary policy rate should be based on a forward guidance monetary policy communication strategy anchored on developments in output, investment, external reserves, inflation and inflation expectations. This result also suggests the existence of tradeoff in policy choices.

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1.0 Introduction

The identification of a policy rate that promotes price stability without constraining economic growth is the preoccupation of the monetary authorities[2]. This is because interest rates[3] are important toolkits of monetary policy as they are taken into account when dealing with issues involving investment, inflation, exchange rate and unemployment. Central banks tend to lower interest rates when they want to increase investment and consumption in order to stimulate economic growth. However, anecdotal evidence suggest that pursuing low interest rate as a macroeconomic policy could have adverse implications including inducing a cycle of economic bubbles as experienced in Japan in 1990s and the United States leading to the global economic and financial crisis in 2007 to 2012. In view of this, the monetary authorities have explored various interest rate levels, designed to influence the tempo and direction of economic activities in the desired directions.

In times of economic recession, some central banks resort to zero policy rate to improve the tempo of economic activity. Thus, they induce the economy through additional stimuli such as quantitative easing; involving the purchase of assets by the central bank from financial institutions to address liquidity shortages. In the same vein, central banks increase policy rates to slow down economic growth so as to deal with inflation and/or attract foreign capital inflows. However, they are also mindful of the negative impact on business of these policy swings.

Central banks, however, do not set short term interest rates (MPR) by manipulating banking system reserves but rely often on the announcement effect as the fulcrum of monetary policy implementation (Friedman and Kuttner: 2011). The authors observed that the monetary policy rate under the standing facilities arrangement should be above the standing deposit facility and below the standing lending facility. It is expected that bank reserves and interest rates always move in tandem.

[2] Taylor (1993) argued that a simple linear regression equation could account for the movement in the policy rate of the central bankers. This proposition became known as the Taylor Rule. In more recent times, the new Keynesian literature which underpins this framework has tried to prove that an optimal monetary policy rule is a possibility Woodford (2003).

[3] Romer and Romer (1989) have shown that the central bank's monetary policy actions impact the real economy with a time lag of between 4 months to 2 years.

Money market rates are then monitored to oscillate within the interest rate corridor (Friedman and Kuttner: 2011).

The Monetary authorities generally use monetary policy instruments including interest rates to achieve stable prices and output. In fact, even central banks like the European Central Bank (ECB), which targets inflation also admits that special attention should be paid to stabilizing output and keeping the economy near full employment. Similarly, the Fed in the US has explicit dual mandates of employment and inflation stabilization. Policy makers in this respect must strike a balance between the inflation and output objectives as policies to address these goals are conflicting. Recently, the UK and US adopted a threshold approach to monetary policy, where changes in the policy rate were tied to thresholds of inflation and unemployment. However, in 2013, ECB stated that the threshold-based approach to monetary policy would be abandoned. Similarly, in 2014, the Fed indicated its readiness to abandon their 6.5 per cent unemployment threshold in considering further adjustment to the policy rate, and employ a less direct position on the new direction of monetary policy (Praet: 2013).

Generally, policy actions such as adjustments in policy rate get transmitted to the real economy through different channels including the interest rate channel[4]. When the central bank tightens money supply by raising the policy rate, borrowing costs are expected to increase, lowering aggregate consumption as investors reduce new investment outlay because of a reduction in net worth. This scenario justifies the need to identify the threshold for the policy rate beyond which an increase would be detrimental to growth in investment and consumption. This is justified by the fact that as more capital inflows are attracted to a developing economy, the currency continues to appreciate to the extent that domestic goods become non-competitive and hence, imports become cheaper, which negatively affect external reserves.

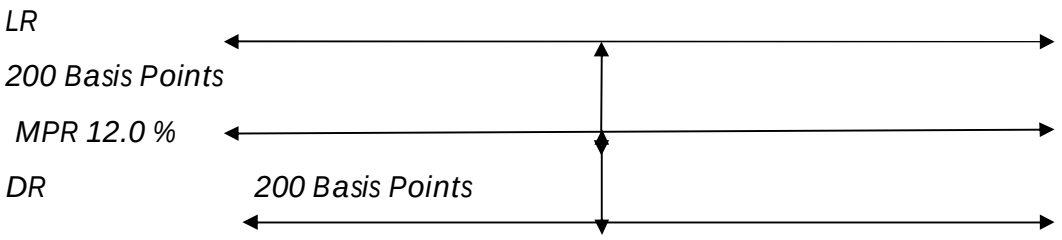
[4]Six channels of monetary policy transmission are identifiable; namely: interest rate, bank lending, balance sheet, asset price, exchange rate and the expectations channel. The interest rate channel is a leading channel of the monetary policy transmission channel because it anchors the behavior of all the other channels (Isakova, 2008).

The objective of this paper is to identify the MPR threshold suitable for investment, output growth and price stability in Nigeria. To achieve this, the paper is structured into seven sections. Section 2 looks at the stylized facts on the potency of the monetary policy rate in Nigeria. Country experiences and lessons for Nigeria were discussed in Section 3. Section 4 reviews related theoretical and empirical literature while Section 5 provides the theoretical model and empirical basis for the investigation. Empirical analysis is the subject of Section 6, while Section 7 provides conclusion and recommendations.

2.0 Stylized Facts on the Use of the Minimum Rediscount Rate/Monetary Policy Rate in Nigeria

The Minimum Rediscount Rate (MRR) was introduced by the Central Bank of Nigeria as a discount rate for its lender of last resort functions but was later replaced by the Monetary Policy Rate (MPR), when the MRR failed to serve as an appropriate anchor for other interest rates in the financial system. The MPR is an anchor rate that influences other money market interest rates. Thus, an increase in the MPR signifies the desire of the monetary authorities to pursue a restrictive monetary policy, while a decrease implies a more accommodating or expansionary monetary policy. A change in the MPR has implications for the money market interbank interest rate, growth in credit and price developments in the economy.

Fig 1: Operating Band for the Overnight Interest Rate



The new monetary policy implementation framework introduced in December 2006 aims at addressing the persistent interest rate volatilities in the short end of the market; ensuring the responsiveness of overnight rate to policy rate changes; and attaining monetary targets (M2). At inception, it involved averaging of reserve requirement over a maintenance period and the use of Standing Facilities (Lending and Deposit) to define an interest rate corridor which was to drive interest rates in

the money market. Conceptually, banks were and are still expected to quote their overnight interest rate in relation to, or as a ratio of the MPR (Chart 1).

Following the adverse impact of the global financial crisis which seriously affected the liquidity of the banking system, the CBN stopped monetary tightening and commenced monetary easing. The Bank progressively reduced the MPR from 10.25 to 9.75, 8.0 and 6.0 per cent. Similarly, the cash reserve requirement (CRR) was reduced from 4.0 to 2.0 and 1.0 per cent as well as the liquidity ratio (LR) from 40.0 to 30, and 25.0 per cent. The introduction of the Expanded Discount Window (EDW) to increase deposit money banks' (DMBs') access to facilities from the CBN, replaced the CBN guarantee of interbank transactions to help encourage banks to trade amongst themselves.

The MPR remained at 12.00 per cent since October 2011 except for dichotomization of the CRR regime and its subsequent adjustments from 8.0 per to 15.0 per cent for private sector deposits, while that of the public sector deposit was raised to 75.0 per cent. These changes were designed to forestall speculative attacks on the foreign exchange market. The adjustment in the CRR was underpinned by the understanding that being a blunt monetary policy instrument, the CRR was better positioned to mop up the excess liquidity in the system at least cost and without much direct impact on interest rate. It was also understood that banks could use adjustments in the MPR as a basis for increase in their lending rates and may also reprice existing loan facilities of their customers.

Chart 1

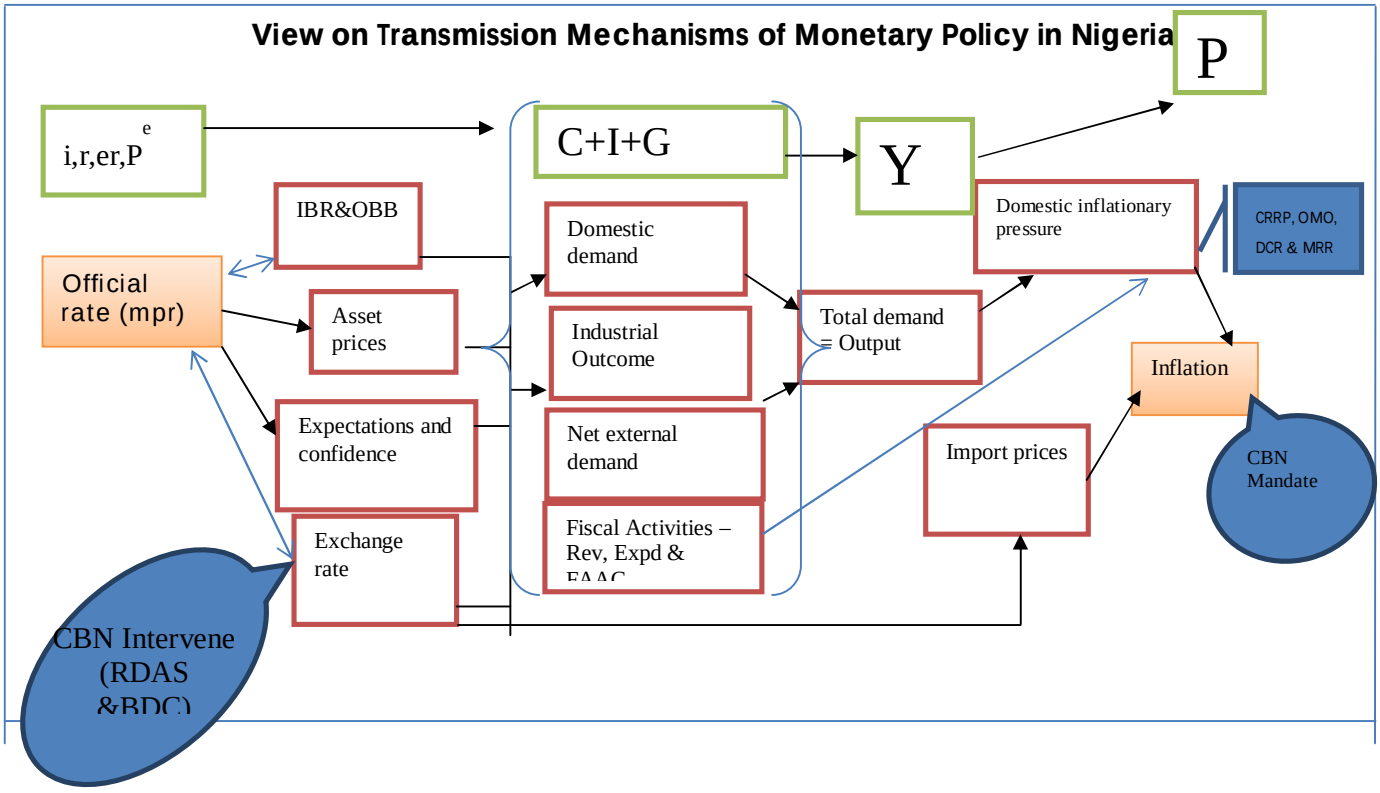
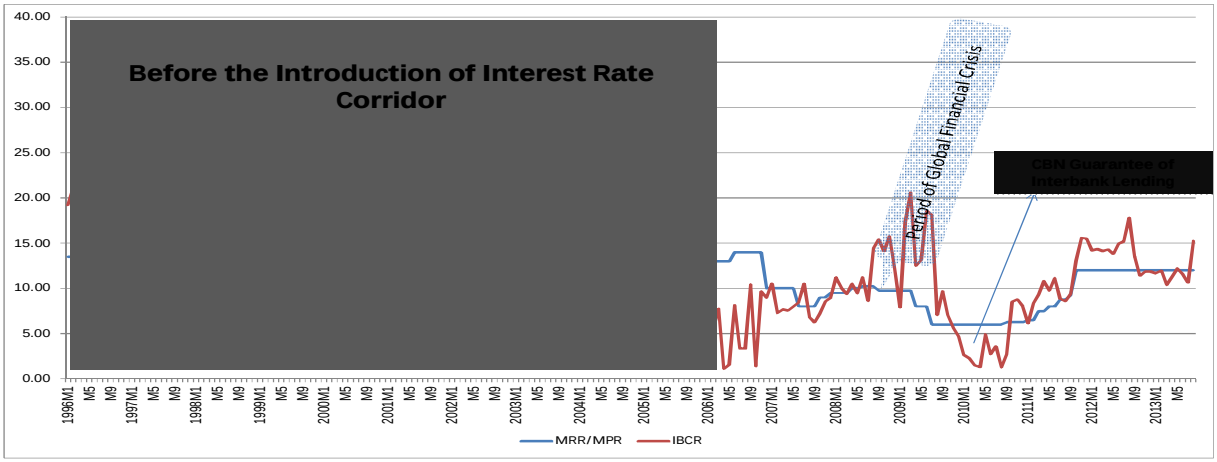


Fig 2

Relationship between MPR and Interbank call Rate between 1996 and 2013

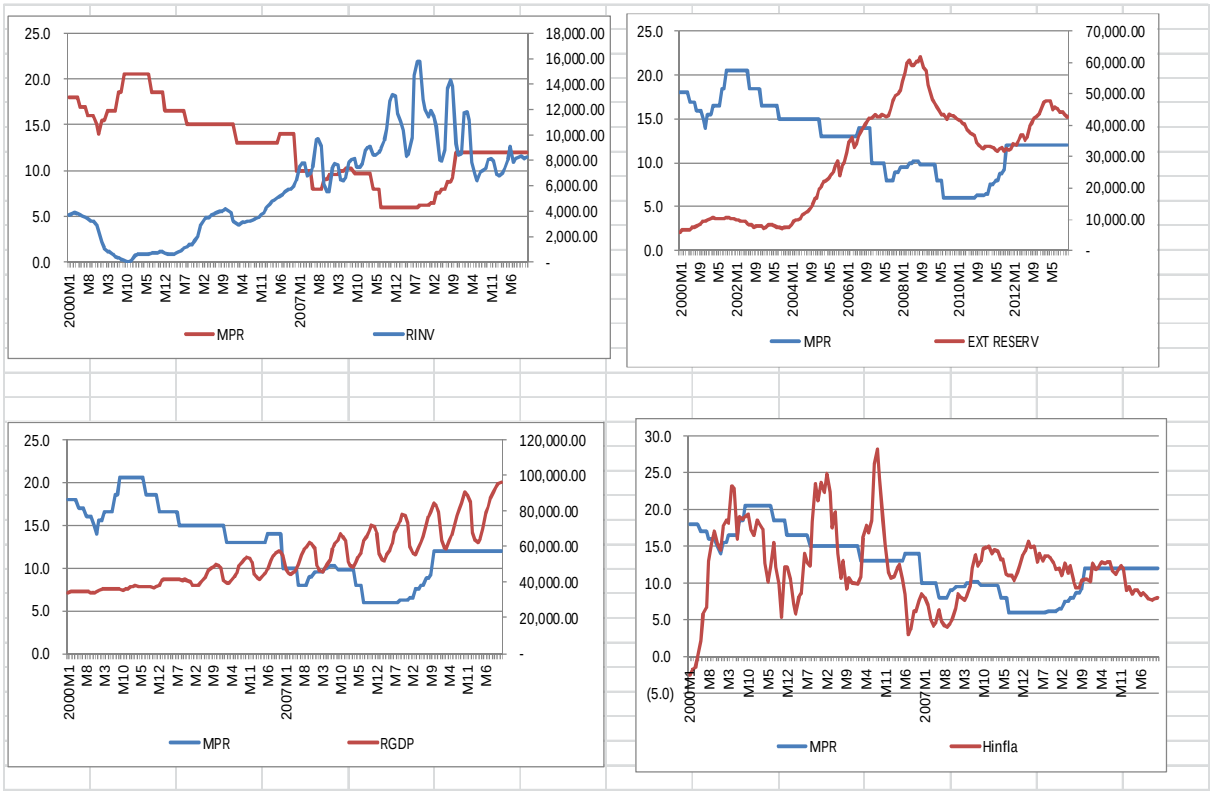


Prior to the introduction of the MPR, interbank call rates were very volatile, but this phenomenon changed and the volatility in the interbank rates moderated after the MPR replaced the MRR. The global economic and financial crisis led to a sharp increase in the interbank rate, while the reduction in the MPR and introduction of

the CBN guarantee of interbank transactions reduced the interbank rate below the MPR, implying the effective anchor function of the MPR on the interbank rate.

Fig 3

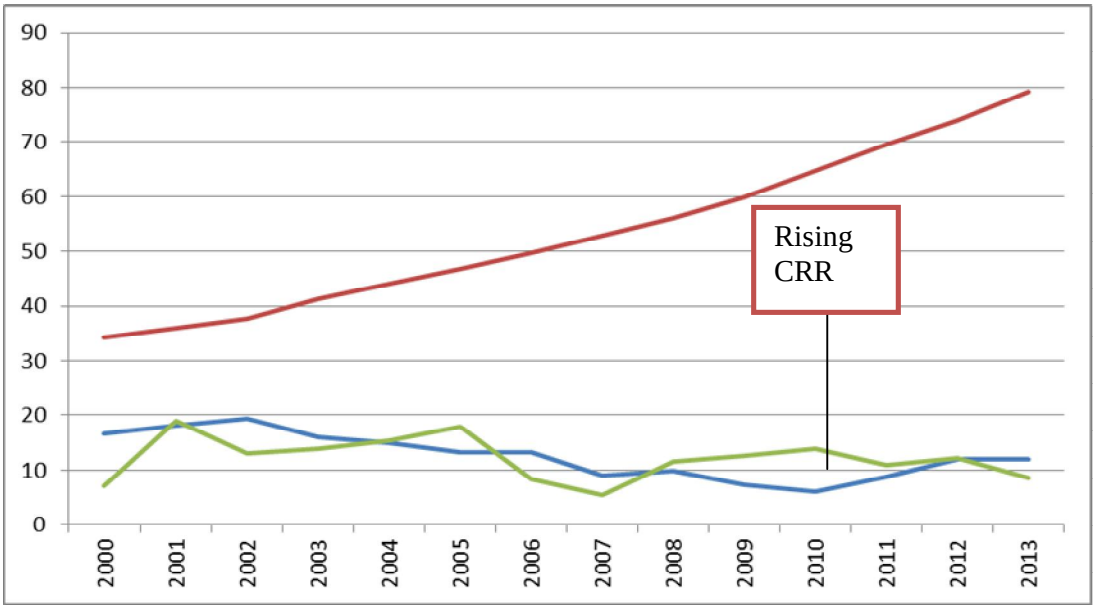
Relationships between MPR and Key Macroeconomic Indices



The relationship between the MPR and selected macroeconomic indices is largely non-linear as shown in the hyperbolic nature of the charts.

Fig 4

MPR, Inflation, and CRR



The relationship between the MPR and inflation is in line with a-priori expectations. By decoupling the MPR and inflation, as MPR declines inflation increases and vice versa. However, since October 2011 the MPR remained unchanged but by end 2012 inflation started to witness a downward trend due to continuous increase in cash reserve requirement, implying that the MPR can be complemented by CRR including other monetary policy instruments in order to achieve low and stable inflation as well as stability in the exchange rate.

3.0. Country Experiences

The global financial crises of 2008/2009 had different but far-reaching impact on various countries, while the reaction of the central banks was monumental and epoch making, which marked a dramatic turn in the mandate of monetary policy. A number of central banks employed unconventional monetary policy involving large scale asset purchases and forward guidance, including setting of thresholds for policy instruments, to manage the crisis.

3.1 The Federal Reserve Bank of the United States

As part of forward guidance, the Federal Reserve Open Market Committee, following series of meetings in 2012 and 2013, agreed on a change in the federal

funds rate to range between 0 - 25 per cent. This was based on the expectation that the unemployment rate would remain above the 6.5 per cent target while the 1-2 year inflation forecast would not exceed 0.5 percentage point above the 2 per cent long-run goal; and the longer-term inflation expectations. A striking feature of the policy was the use of labor market conditions, inflation and inflation expectations as a guide for interest rate decisions. This is partly because no single indicator was capable of providing an all-time signal and required guidance for policy. Hence, there is need for a consistent balanced approach in line with long-term economic goals. In addition, formulating 'forward guidance' based on thresholds is expected to clarify policy makers' intentions to the public. It further infuses transparency and predictability into monetary policy by more clearly outlining the linkages between future monetary policy and economic conditions. This is expected to contribute to more rapid and automatic adjustments by financial markets to changes in economic conditions. The policy direction is a novel but unorthodox blend in the menu of policies by a number of central banks as several countries contend with the new mediocre recovery from the global financial crisis.

3.2 The European Central Bank (ECB)

European Union (EU) Member countries are obligated under the Treaty of Rome to observe the Stability and Growth Pact (SGP); a framework designed to promote price stability and fiscal responsibility in the EU countries. The pact has witnessed several reforms to accommodate changes in the global environment. An important requirement in the criteria is that long-term interest rates would not exceed a 2.0% level above the yield of a 10-year government bond using its unweighted arithmetic average of 3 EU member states with the lowest Harmonized Index of Consumer Price (HICP). The ECB may indeed be considering the establishment of interest rate thresholds for the purchase of low rated euro zone country bonds. The policy proposes that the ECB would purchase such cheap bonds once prices rose above a pre-determined premium over the German bonds.

3.3 The Bank of England (BoE)

The Bank of England maintains a consistent front regarding its monetary policy stance. At one of the meetings of the Bank's Monetary Policy Committee, it was decided to keep interest rate unchanged at 0.5% as they prepare for the forward guidance policy. This decision supersedes an earlier option to raise interest rates from 0.5 per cent only when the unemployment rate dropped to 7 per cent. On the forward guidance, the Governor of the Bank of England (BoE) maintained that decisions on interest rates would be anchored on a variety of factors such as excess capacity, labour productivity and growth in wages. Hence, any threshold on interest rates will be based on labour market considerations/developments.

4.0 Theoretical Consideration and Empirical Literature Review

In pursuit of price stability, central banks employ open market operations, reserve requirements and discount window operations in their toolkit of instruments. In Nigeria, the Monetary Policy Rate (MPR) is adopted as the operating instrument for monetary policy. The MPR is the policy rate which anchors the inter-bank money market and other deposit money banks' (DMBs) interest rates in the economy (Bulus: 2010). Thus, a change in the MPR directly or indirectly influences the direction of other interest rates, credit growth and price developments in the economy. For instance, a monetary policy that persistently attempts to keep short-term real rates low (expansionary stance) will eventually lead to higher inflation and higher nominal interest rates.

The literature is replete with studies which attempt to estimate a threshold inflation, exchange rate and policy rate on investment, reserves and economic growth. For instance, Andrew and Boris (2014), examined a number of central banks which used different approaches in forward guidance to enhance the efficacy of monetary policy at the zero lower bound. Using financial stability risk analysis, the study established the role of forward guidance in lowering volatility in expectations about the future path of short term interest rates. However, the study failed to show how the response of the financial markets impact interest rate expectations. However, the study did observe that forward guidance as a monetary policy communication tool could raise significant challenges especially in relation to its

management. Mishra (2012) however argued that for an import driven economy, the resetting of the monetary policy rate alone would be ineffective in controlling inflation since the source of inflation is largely external to the domestic economy.

The exact process through which a change in monetary policy transmits to achieving the desired policy objective has been a subject of long-time controversy (Ndekwu, 2013). The theoretical constructions of the monetary policy transmission mechanism is anchored on the relationships enunciated in the price and wage rigidity hypothesis, linkage between short and long term real interest rates as well as the aggregate demand theories (Loayza and Schmidt-Hebbel: 2002). Five key channels of transmission have been identified in the literature (Taylor, 1995).

First is the interest rate channel; often regarded as the main transmission medium due to its quick pass-through effects on aggregate output, demand and prices.

The second is the asset price channel which is premised on the postulation that expansionary monetary policy increases equity prices and attracts more investment thus raising aggregate demand. The theoretical basis underpinning the impact of higher money supply on equity prices of the Monetarists and Keynesians was amply documented by Meltzer (1995). In the monetarists arguments, higher levels of money supply increases asset prices and the wealth of consumers, leading to higher expenditure by households and enterprises on assets acquisition. The Keynesians, however, believe that an increase in money supply triggers low interest rate and attracts more investment into the equities market.

The exchange rate channel works through its influence on both aggregate demand and supply. On the demand side, expansionary monetary policy induces lower domestic interest rates, initiates a real depreciation of the exchange rate, a development expected to increase exports and generate higher aggregate demand. Supply side effects occur when the real depreciation of the local currency, resulting from monetary expansion, increases the domestic prices of imported inputs. This leads to a decrease in aggregate supply and consequently, reduced output and high inflation (Obstfed and Rogoff, 1995).

The monetary and credit aggregates channel is the fourth arm of the transmission mechanism. Here, two major schools of thought exhibit strong but contending perspectives. While the Classical Monetarists consider narrow or broad money as playing a key role in determining developments in the prices of goods, factors of production and assets, which ultimately impacts the inflation level, the second approach postulated by Bernanke and Gertler (1995) emphasize the domineering impact of credit rationing on output and price levels, a product of information asymmetry between lenders and borrowers.

The fifth arm of the transmission mechanism is the expectations channel which addresses the role of private sector expectations on the future direction of interest rates and related variables. The expectations of agents about the severity and direction of future shocks to the economy and the reaction of the central bank will be determined in a futuristic manner. The expectations channel works through inter-temporal constructs of the asset price theories, exchange rate, static interest rate and the monetary policy and credit mechanism. The effectiveness of the expectation channel according to Persson and Tabellini (1997) depends largely on the perceived commitment and credibility of the monetary authorities.

Quartey (2010) indicated that these channels are not mutually exclusive as there could be considerable feedbacks and interactions among them. Also, Loayza and Schmidt-Hebbel (2002) attempted to evaluate the relative importance of each of the five transmission channels in a six country study and found the results shown below.

Table 1

Country Experience of the Monetary Policy Transmission Mechanism

Country	Interest Rate	Credit	Asset Prices	Exchange Rate	Expectations
Australia	Yes	No	No	Yes	No
Canada	Yes	No	No	Yes	Yes
Chile	Yes	Yes	No	Yes	No
United Kingdom	Yes	No	No	Yes	Yes
Israel	Yes	Yes	No	Yes	No
South Africa	Yes	No	No	Yes	No

The study identified the traditional interest rate and the exchange rate as the most relevant of the five channels while asset price channel was the least relevant. Furthermore, the study noted the important role played by structural features of individual economies in the choice of effective transmission mechanisms for monetary policy.

In Nigeria, Ishioro (2013) found that interest rate and the exchange rate channel were the most significant channels of monetary policy transmission because of their unidirectional linkages with other channels. However, another study that applied the vector-auto-regression (VAR) model to explain the monetary policy transmission mechanism in Nigeria identified the credit channel as the most critical in transmitting monetary policy to the real economy (Ndekwu, 2013). The study found interest rate and exchange rate to have weak effect on the real economy and therefore recommended a drastic reform to improve the supply and accessibility of credit to the real productive sector.

Most countries including Nigeria employ the instruments of monetary policy in achieving price and exchange rate stability. This is particularly so because price stability is a necessary condition for attracting investment into the country but is not a sufficient condition for achieving that objective. Price instability poses a more serious challenge in developing economies than in developed economies largely because, most developing countries are import dependent. Taylor (1996) agrees that low inflation is required for economies to achieve higher and long-term growth rates as well as enhanced employment opportunities.

Rasche and Williams (2005) in a study of 21 emerging market economies, considered how effective monetary policy could be in achieving price stability within pre-defined inflation targets. The study found monetary policy to be effective in 16 of the sampled countries except Brazil, Colombia, Hungary, Mexico and Philippines. Similarly, Hammond, Kanbur and Prasad (2009) conducted a study to determine the effectiveness of monetary policy in a selected number of developing countries. They identified several factors including the lack of autonomy of the central bank, poorly developed financial markets and lack of

fiscal indiscipline as responsible for ineffective implementation of monetary policies in the emerging economies.

A number of studies also investigated the impact of monetary policy on economic growth in several countries. Olweny and Chiluwe (2010) examined how monetary policy impacted private sector investment in Kenya. The study adopted quarterly time series data spanning 1996 – 2009 and found an inverse relationship between the monetary policy variables with private sector investment while money supply and domestic savings moved in tandem with private sector investment. Empirical findings from the study suggest that tightening monetary policy by 1% tend to reduce investment by 2.63% while loosening the monetary policy by 1 % increases investment by the same rate of 2.63%. On the contrary, a study of four Asian countries (Bangladesh, India, Pakistan and Sri-Lanka) by Mallik and Chowdhury (2001) found that inflation and economic growth had a positive relationship.

In Nigeria, several empirical studies on the impact of monetary policy on key variables have produced different results. Amassoma, Nwosa and Olaiya (2011) explored how monetary policy impacted key macroeconomic variables during the period 1986-2009. By adopting a simplified OLS technique, the authors found monetary policy to have had significant effect on exchange rate and money supply while its effect on price stability was insignificant. Also, applying the Ordinary Least Square(OLS) method to examine the effect of monetary policy on selected macroeconomic variables, Onyeiwu (2012) found that money supply exerted positive impact on GDP growth and balance of payment while its impact on inflation was negative. In terms of comparative efficiency of the monetary policy instruments, the work by Okwu et al (2011) found the MPR to have more immediate effect on the consumer price index than broad money supply.

There are conflicting and competing views about what constitutes an appropriate policy rate for achieving optimal economic growth. A number of studies have demonstrated that the policy rate should be adjusted to bring inflation to a particular threshold above which it is harmful to growth and employment. For instance, findings by Barro (1996) indicated the existence of a negative relationship

between inflation and growth for a set of countries when inflation is above 15 per cent. Similarly, Judson and Orphanides (1996) as well as Bruno and Easterly (1995) argued in favour of 15 and 40 per cent, respectively, as threshold values for the inflation rate. In a cross-country study involving both developed and developing countries, Khan and Senhadji (2001) estimated a threshold inflation level range of 11-12 per cent for developing countries including Nigeria. However, Kremer et al (2009) cautioned against recommending a generalized threshold for a number of countries due to heterogeneous factors that are country specific. Bawa and Abdullahi (2012), using Nigerian quarterly time series for the period 1981-2009, and employing a threshold regression model, estimated an inflation threshold of 13 per cent for Nigeria. Fabayo and Ajilore (2006) cited in Bawa and Abdullahi (2006) in their work titled "Inflation – How Much is too Much for Economic Growth in Nigeria" used annual Nigerian time series for the period 1970-2003. The authors found the threshold inflation level to be 6 per cent beyond which inflation could retard growth. Doguwa (2012) re-examined the relationship between inflation and growth in Nigeria using the Sarel's, Khan and Senhadji, and Drukker et al approaches. Sarel (1996) found a threshold point of 9.9 per cent, Khan and Senhadji (2001) established the threshold at 10.5 per cent while Drukker et al (2005) suggested a band of 11.2 and 12.0 per cent as the appropriate inflation threshold range. Leveraging on the three approaches, the study estimated the threshold level of inflation to be at 10.5 to 12 per cent for Nigeria.

High inflation is largely a phenomenon of emerging economies. While developed countries are faced with low inflation instead of high inflation due to their well-developed financial markets and less government interventions, developing countries on the other hand grapple with high inflation due to their vulnerability to supply shocks which distort their consumption, investment and production behavior (Prasanna and Gopakumar, 2010).

One of the major conclusions from the review of the literature is that the policy rate remains the key tool adopted by central banks to affect other interest rates in the economy through its influence on short-term interest rates and other rates.

Secondly, the policy rate should approximate the achievement of the closest target consistent with the country's unemployment and inflation goal.

5.0 Theoretical Model and Empirical Strategy

5.1 Theoretical Model

The interest rate channel could be explained using the Keynesian ISLM framework which postulates that an expansionary monetary policy leads to a fall in the real interest rate which in turn lowers the cost of capital causing a rise in investment spending, thus leading to an increase in aggregate demand and a rise in output (Mishkin (1996)). The analytical framework adopted for this study follows essentially the Keynesian framework which suggests that:

National income identity: $Y = C + I + G - (X - M)$ (1)

With the following behavioural equations:

Consumption: $C = a + bY^{d} \qquad b > 0$ (2)

Disposable income: $Y^{d} = Y - T$ (3)

Investment: $I = \delta - \gamma i, \quad \gamma > 0$ (4)

Government Sector: $G = \overline{G}$ (5)

Export: $X = s + \sigma e \quad \sigma > 0$ (6)

Import: $M = m + \phi Y^{d} \quad \phi > 0$ (7)

Incorporate the money sector as well as the external sector. The money market in an open economy can be represented by the following equations:

Money Demand Function: $\frac{M^{DD}}{P} = kY + \lambda i \qquad k > 0,\ \lambda < 0$ (8)

Money Supply Function: $\frac{M^{ss}}{P} = m_1 \frac{B}{P} + m_2 i \qquad m_1 m_2 > 0$ (9)

Money Market Equilibrium: $M^{DD} = M^{ss}$ (10)

Where Y is output; C, consumption; I, investment; G, government spending which is assumed to be exogenous; X, exports; M, imports; Yd, disposable income; T, tax

revenue; i, interest rate; e, exchange rate, B external reserves, P, general price level (inflation) and other symbols are coefficients.

After substituting the behavioural equations into eq. (1) and (10), we obtained equations for investment, output (GDP), reserves and inflation. Thus, we make preposition to measure certain testable hypotheses intuition formalized from a threshold model of the MPR.

5.2 SPECIFICATION OF THE MPR THRESHOLD MODEL

In specifying the empirical model, the study relied on the Keynesian theoretical framework. Variables such as interest rate, exchange rate, inflation, budget deficit, investment (change in capital stock) and real Gross Deposit Product are identified as the key variables estimating the threshold MPR for growth, investment reserves and inflation. The functional specification of the threshold model follows Sarel's (1996), Khan and Senhadji (2001); Drukker, *et al.* (2005); Mubarik (2005); Li (2005); Hussain (2005); and Sergii (2009) etc.

Thus, the general empirical threshold model is specified as follows:

$$y_t = \alpha_0 + \alpha_1 d_t f(\pi_t) + \alpha_2 (1 - d_t)\left\{ f(\pi_t) - \log(\pi^*) \right\} + \phi' \underline{X} + \varepsilon_t \qquad (12)$$

where

$$f(\pi_t) = \begin{cases} \log(\pi_t) & \text{if } \pi_t > 1 \\ \pi_t - 1 & \text{elsewhere} \end{cases} \quad \text{and} \quad d_t = \begin{cases} 1, & \text{if } f(\pi_t) \le \log(\pi^*) \\ 0, & \text{elsewhere} \end{cases}$$

Given that y_t represents real GDP growth, investment, reserves and inflation in time t, α_1 is the coefficient of the semi-log transformation of the MPR $f(\pi_t)$ at time t, α_2 defines the coefficient of excess MPR, and π^* denotes the expected MPR threshold. In addition, $\underline{X}$ shows the vector of control variables and ϕ is the corresponding vector of coefficients, while ε_t is the identical, independent and normally distributed error term with mean zero and constant variance (σ^2). The iteration of Equation (11) using different values of $\log(\pi^*)$ produces the threshold

MPR at the value of π^* for which the chosen statistical loss function is a minimum. It is expected that at the threshold point (π^*), the sum of α_1 and α_2 which determines the effect of MPR on output growth, investment, inflation and reserves should be positive, r^2 maximized and the residual sum of square of the estimation minimized. The optimal threshold level is that at which the sequence of the Residual Sum of Squares (RSS) would be minimum.

The test for stationarity of the endogenous and exogenous variables within the framework of the Augmented–Dicky Fuller (ADF) test and Philip Peron test (PP) procedure was conducted.[5] We checked for the order of integration of the variables and found them to be of order (I) and so proceeded to test for co-integration of the variables of interest. We used the Johansen Co-integration Maximum Likelihood Method of Co-integration (Johansen and Juselius: 1990) to determine the number of co-integrating vectors.

5.3 Source of data

The data on macroeconomic variables were obtained from two sources: National Bureau of Statistics (NBS) and Central Bank of Nigeria's Statistical Bulletin monthly series ranging from January 2000-December 2013. Also, we created the variables of interest from the raw data, and separated the variables into exogenous variables, endogenous variables explained by identities, and endogenous variables explained by stochastic equations.

6.0 The Model and Results

6.1 Time Series Properties Test of Goodness and Fit

6.1.1 Descriptive Statistics

Summary statistics of the variables considered for threshold equation are shown in Table 2. The Jarque-Bera statistic indicates that the null hypothesis of normality is rejected for external reserves and GDP; while the null hypothesis of normality could not be rejected for inflation, MPR as well as investment.

[5]The test is designed to avoid spurious outcomes in the regression results because of the generated processes which follow a time trend; a common outcome of such regressions.

Table 2
Descriptive Statistics

Descriptive Stat.	INF	EXTR	RINV	RGDP	MPR
Mean	12.10199	29296.59	5838.305	53285.39	12.62560
Median	12.05000	33061.59	5890.165	49901.51	12.00000
Maximum	28.20000	62081.86	15779.69	95847.02	20.50000
Minimum	-2.485768	5789.200	61.21000	34003.99	6.000000
Std. Dev.	5.294549	16876.93	3871.269	15818.47	4.040424
Skewness	0.232045	-0.012586	0.335282	0.773191	0.081068
Kurtosis	3.693762	1.672777	2.387201	2.742795	2.237125
Jarque-Bera	4.876802	12.33508	5.776262	17.20216	4.257870
Probability	*0.087300*	*0.002096*	*0.055680*	*0.000184*	*0.118964*
Sum	2033.134	4921828.	980835.2	8951946.	2121.100
Sum Sq. Dev.	4681.386	4.76E+10	2.50E+09	4.18E+10	2726.280
Observations	168	168	168	168	168

Examining the time series properties of the data using the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) procedures, the result suggests that inflation was an I(0) variable while all the other variables were I(1) variables. The autocorrelation-Durbin Watson test revealed the absence of autocorrelation between the variables. Overall, the results show that the model fits the data well and most of the results are also consistent with a priori expectations.

TABLE 3

ADF Unit Root Test Results

Variable		Unit Root		ADF test statistic	Conclusion	DW
		1%	5%			
Real GDP(RGDP)	1st Diff	-4.019151	-3.439461	-6.269804	1(1)	1.996050
External Reserve (Exreserve)	1st Diff	-3.473382	-2.880336	-5.733440	1(2)	2.009723
Inflation Rate (Infla)	level	-3.469691	-2.878723	-3.504747	1(0)	1.716845
Real Investment (Rinv)	1st Diff	-3.472259	-2.879846	-4.116214	1(1)	2.010791
Exchange Rate (Excrate)	1st Diff	-3.470139	-2.878937	-8.254491	1(1)	1.981322
Government Deficit (Govtdef)	1st Diff	-3.473382	-2.880336	-5.802611	1(1)	1.985443
Monetary Policy Rate(MPR)	1st Diff	-3.472814	-2.880088	-4.346914	1(1)	2.005165
Cash Reserve Ratio(CRR)	1st Diff	-3.469933	-2.878829	-12.84935	1(1)	1.960447

Table 4
Phillip-Perron Unit Root Test

Variable		Unit Root		Phillips -Perron	Conclusion	DW
		1%	5%	test statistic		
Real GDP(RGDP)	1st Diff	-3.469933	-2.878829	-5.538335	1(1)	1.881106
External Reserve (Exreserve)	1st Diff	-3.469933	-2.888829	-10.04027	1(1)	2.150018
Inflation Rate (Infla)	level	-3.469691	-2.878723	-3.702012	1(0)	1.716845
Real Investment (Rinv)	1st Diff	-3.469933	-2.878829	-9.334797	1(1)	1.877344
Exchange Rate (Excrate)	1st Diff	-3.469933	-2.878829	-8.735535	1(1)	1.909135
Government Deficit(Govtdef)	1st Diff	-3.469933	-2.878829	-100.5905	1(1)	2.369915
Monetary Policy Rate(MPR)	1st Diff	-3.469933	-2.878829	-12.77849	1(1)	2.001580
Cash Reserve Ratio(CRR)	1st Diff	-3.469933	-2.878829	-13.03349	1(1)	1.960447

We carried out the Granger Causality test on all the variables before estimating the model to ascertain the level linear of causation between the MPR and RGDP, investment, inflation and reserves. The test revealed that the null hypothesis is rejected, implying that changes in the MPR cause GDP growth, change in reserves and investment. While the null hypothesis was accepted for inflation, implying that inflation drives changes in the MPR. Hence the causality between four variables is uni-directional.

Table 5
Pair wise Granger Causality Tests

Null Hypothesis	Obs	F-Statistic	Prob.
MPR does not Granger Cause RGDP	166	3.48555	0.0330
RGDP does not Granger Cause MPR		0.29007	0.7486
MPR does not Granger Cause RINV	166	11.4403	2.E-05
RINV does not Granger Cause MPR		0.19451	0.8234
INF does not Granger Cause MPR	166	3.47605	0.0333
MPR does not Granger Cause INF		0.50008	0.6074
EXTR does not Granger Cause MPR	166	1.30077	0.2752
MPR does not Granger Cause EXTR		0.01412	0.9860

The trace and maximum eigen test statistics in table 6 provide evidence that there is 1 cointegrating equation at the 5 per cent critical value, implying that there exists a set of co-integrating relationship among the four variables in the system.

Table 6
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.164780	74.21674	69.81889	0.0213
At most 1	0.155526	44.86704	47.85613	0.0929
At most 2	0.070794	17.31323	29.79707	0.6169
At most 3	0.025144	5.344905	15.49471	0.7711
At most 4	0.007299	1.194044	3.841466	0.2745

Trace test indicates 1 cointegratingeqn(s) at the 0.05 level
** denotes rejection of the hypothesis at the 0.05 level*

***MacKinnon-Haug-Michelis (1999) p-values*

The trace and maximum eigen test statistics in Table 6 provides evidence that the null of 'None' co-integrating vector can be rejected at the 5 per cent critical value for the model using actual reserves, implying that there exists a set of co-integrating relationships among the four variables in the system.

6.2 Empirical Results of MPR Threshold

The growth rate of GDP, RINV, Exr, EXTR, INF, Extr are computed by using log transformation method. The estimated threshold equation gives a specific value of threshold MPR level and also quantifies the impact of that level on GDP growth, investment and external reserves (Table 6.0, 7.0, 8.0 and 9.0). For this purpose Equation (1) is estimated and the residual sum of square (RSS) for threshold level of MPR ranging from 7% to 18% were computed for the given period of 2000 – 2013[6]. The t-statistics and their p-values are given in Table 6.

The significant test statistics and value of π that minimizes the residual sum of squares (RSS) suggest that the optimal MPR levels for GDP growth are between 7% and 10%. For investment, outcomes stood at between 7% - 9%. For inflation and reserves the optimal point stood at 7% - 10%, and 7% - 15% respectively (see fig 3 – 6 and table 6 – 9).

[6]The optimal threshold level is the one that minimizes the sequence of RSS.

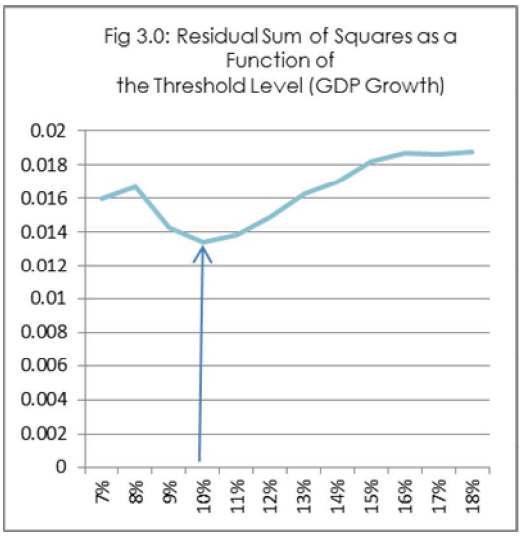


Fig 3.0: Residual Sum of Squares as a Function of the Threshold Level (GDP Growth)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
7%
8%
9%
10%
11%
12%
13%
14%
15%
16%
17%
18%

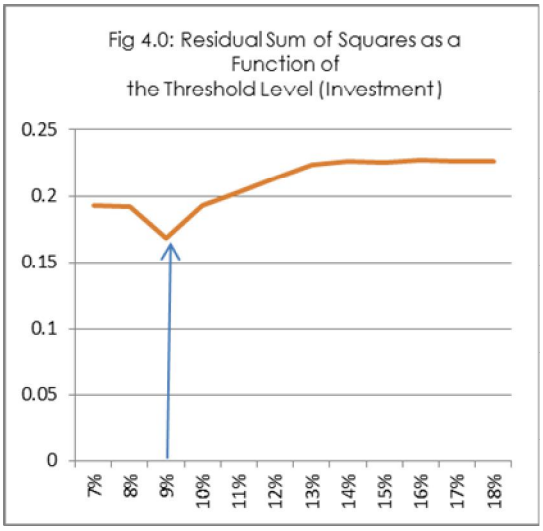


Fig 4.0: Residual Sum of Squares as a Function of the Threshold Level (Investment)
0.25
0.2
0.15
0.1
0.05
0
7%
8%
9%
10%
11%
12%
13%
14%
15%
16%
17%
18%


Fig 5.0: Residual Sum of Squares as a Function of the Threshold Level (Inflation)
7.2
7.15
7.1
7.05
7
6.95
6.9
6.85
7%
8%
9%
10%
11%
12%

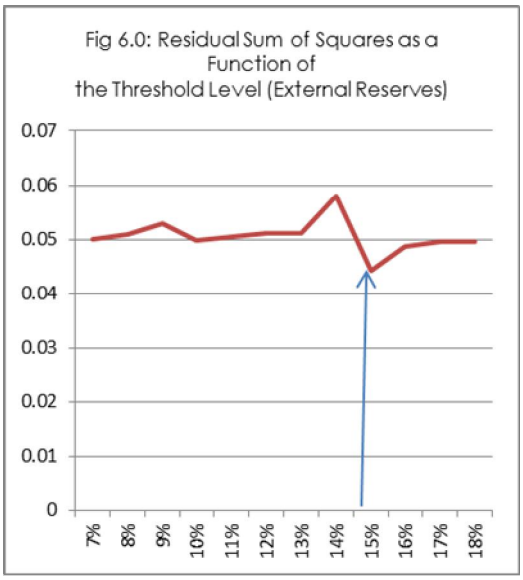


Fig 6.0: Residual Sum of Squares as a Function of the Threshold Level (External Reserves)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
7%
8%
9%
10%
11%
12%
13%
14%
15%
16%
17%
18%

Table 7
Estimation of non-Linear Model at π = 7 to 18
(Dependent Variable: GDP growth)

K –Threshold	Variable	Coefficient	Std. Error	T-statistics	Prob.	RSS	R^2	DW
7%	MPR	-0.046384	0.039904	-1.162399	0.2632	0.0160	0.43	1.52
	(MPR>7)*(MPR-7)	0.049853	0.041091	1.213246	0.2438			
8%	MPR	-0.021457	0.019448	-1.103302	0.2873	0.0167	0.43	1.52
	(MPR>8)*(MPR-8)	0.024927	0.020545	1.213246	0.2438			
9%	MPR	-0.022191	0.011279	-1.967523	0.0679	0.0143	0.53	1.48
	(MPR>9)*(MPR-9)	0.028300	0.012938	2.187346	0.0450			
10%	**MPR**	**-0.015768**	**0.007722**	**-2.041989**	**0.0591**	**0.0134**	**0.55**	**1.59**
	(MPR>10)*(MPR-10)	0.023127	0.009627	2.402241	0.0297			
11%	MPR	-0.012179	0.006669	-1.826315	0.0878	0.0138	0.53	1.64
	(MPR>11)*(MPR-11)	0.022202	0.009820	2.260937	0.0391			
12%	MPR	-0.007130	0.005345	-1.333979	0.2021	0.0149	0.49	1.64
	(MPR>12)*(MPR-12)	0.017914	0.009399	1.905910	0.0760			
13%	MPR	-0.003010	0.004299	-0.700121	0.4946	0.0163	0.45	1.64
	(MPR>13)*(MPR-13)	0.013400	0.009376	1.429088	0.1735			
14%	MPR	-0.001388	0.003877	-0.357955	0.7254	0.0170	0.42	1.70
	(MPR>14)*(MPR-14)	0.013575	0.011729	1.157401	0.2652			
15%	MPR	-6.71E-06	0.003177	-0.002111	0.9983	0.0182	0.42	1.69
	(MPR>15)*(MPR-15)	0.014032	0.012965	1.082295	0.2962			
16%	MPR	1.04E-05	0.002987	0.003490	0.9973	0.0187	0.44	1.71
	(MPR>16)*(MPR-16)	0.025260	0.019647	1.285686	0.2180			
17%	MPR	0.000544	0.002794	0.194632	0.8483	0.0186	0.44	1.68
	(MPR>17)*(MPR-17)	0.041058	0.031450	1.305512	0.2114			
18%	MPR	0.000544	0.002794	0.194632	0.8483	0.0188	0.43	1.68
	(MPR>18)*(MPR-18)	0.123174	0.094349	1.305512	0.2114			

Table 8
Estimation of non-Linear Model at π = 7 to 18
(Dependent Variable: Investment)

K –Threshold	Variable	Coefficient	Std. Error	T-statistics	Prob.	RSS	R^2	DW
7%	MPR	-0.198767	0.131255	-1.514357	0.1507	0.1930	0.50	1.98
	(MPR>7)*(MPR-7)	0.218823	0.134255	1.629900	0.1239			
8%	MPR	-0.089356	0.064398	-1.387562	0.1855	0.1920	0.50	1.98
	(MPR>8)*(MPR-8)	0.109411	0.067128	1.629900	0.1239			
9%	**MPR**	**-0.073965**	**0.039379**	**-1.878274**	**0.0799**	**0.1681**	**0.56**	**1.57**
	(MPR>9)*(MPR-9)	0.101557	0.044216	2.296858	0.0364			
10%	MPR	-0.035285	0.031904	-1.105978	0.2862	0.1932	0.49	1.71
	(MPR>10)*(MPR-10)	0.064462	0.039713	1.623203	0.1254			
11%	MPR	-0.020913	0.027711	-0.754688	0.4621	0.2025	0.47	1.73
	(MPR>11)*(MPR-11)	0.055536	0.041110	1.350902	0.1968			
12%	MPR	-0.004288	0.021372	-0.200661	0.8437	0.2137	0.44	1.76
	(MPR>12)*(MPR-12)	0.037466	0.038457	0.974237	0.3454			
13%	MPR	0.008078	0.016039	0.503649	0.6218	0.2235	0.42	1.79
	(MPR>13)*(MPR-13)	0.018301	0.036701	0.498649	0.6253			
14%	MPR	0.012422	0.013842	0.897424	0.3837	0.2264	0.41	1.80
	(MPR>14)*(MPR-14)	0.009786	0.044604	0.219387	0.8293			
15%	MPR	0.016774	0.010661	1.573379	0.1365	0.2254	0.41	1.84
	(MPR>15)*(MPR-15)	-0.016797	0.048567	-0.345854	0.7343			
16%	MPR	0.014872	0.010334	1.439186	0.1706	0.2272	0.41	1.81
	(MPR>16)*(MPR-16)	-0.001881	0.076389	-0.024622	0.9807			
17%	MPR	0.013679	0.009688	1.411968	0.1784	0.2260	0.41	1.75
	(MPR>17)*(MPR-17)	0.034225	0.122021	0.280487	0.7829			
18%	MPR	0.013679	0.009688	1.411968	0.1784	0.2260	0.41	1.75
	(MPR>18)*(MPR-18)	0.102676	0.366062	0.280487	0.7829			

Table 9
Estimation of non-Linear Model at π = 7 to 12
(Dependent Variable: Inflation)

K – Threshold	Variable	Coefficient	Std. Error	T-statistics	Prob.	RSS	R^2	DW
7%	MPR	-0.203084	0.072591	-2.797635	0.0058	6.9759	0.752	1.464
	(MPR>7)*(MPR-7)	0.209769	0.076194	2.753111	0.0066			
8%	**MPR**	**-0.096842**	**0.034187**	**-2.832683**	**0.0052**	**6.9628**	**0.752**	**1.466**
	(MPR>8)*(MPR-8)	0.103811	0.036968	2.808142	0.0056			
9%	MPR	-0.056438	0.023729	-2.378433	0.0186	7.055	0.749	1.449
	(MPR>9)*(MPR-9)	0.064066	0.026753	2.394775	0.0178			
10%	MPR	-0.036215	0.018299	-1.97905	0.0496	7.123	0.747	1.44
	(MPR>10)*(MPR-10)	0.043525	0.021213	2.051837	0.0419			
11%	MPR	-0.027836	0.015964	-1.74362	0.0832	7.156	0.745	1.436
	(MPR>11)*(MPR-11)	0.035433	0.01904	1.860979	0.0646			
12%	MPR	-0.021565	0.014069	-1.532835	0.1273	7.179	0.745	1.434
	(MPR>12)*(MPR-12)	0.028944	0.016837	1.719083	0.0876			

Table 10
Estimation of non-Linear Model at π = 7 to 18
(Dependent Variable: External Reserve)

K –Threshold	Variable	Coefficient	Std. Error	T-statistics	Prob.	RSS
7%	MPR	0.032421	0.070946	0.456975	0.6542	0.050
	(MPR>7)*(MPR-7)	-0.026152	0.073342	-0.356581	0.7264	
8%	MPR	0.019344	0.034416	0.562078	0.5824	0.051
	(MPR>8)*(MPR-8)	-0.013076	0.036671	-0.356581	0.7264	
9%	MPR	0.000799	0.023452	0.034053	0.9733	0.053
	(MPR>9)*(MPR-9)	0.007420	0.026844	0.276415	0.7860	
10%	MPR	-0.003411	0.016204	-0.210481	0.8361	0.0497
	(MPR>10)*(MPR-10)	0.013510	0.019956	0.676958	0.5087	
11%	MPR	0.001402	0.013477	0.104031	0.9185	0.0505
	(MPR>11)*(MPR-11)	0.008729	0.019323	0.451740	0.6579	
12%	MPR	0.005084	0.010173	0.499727	0.6245	0.0511
	(MPR>12)*(MPR-12)	0.003875	0.017096	0.226653	0.8238	
13%	MPR	0.006566	0.007753	0.846919	0.4103	0.0512
	(MPR>13)*(MPR-13)	0.001465	0.015591	0.093964	0.9264	
14%	MPR	0.009636	0.006506	1.481102	0.1593	0.0579
	(MPR>14)*(MPR-14)	-0.008737	0.017277	-0.505697	0.6204	
15%	**MPR**	**0.010342**	**0.005339**	**1.937052**	**0.0718**	**0.0442**
	(MPR>15)*(MPR-15)	-0.018940	0.019578	-0.967414	0.3487	
16%	MPR	0.009517	0.005004	1.901712	0.0766	0.0487
	(MPR>16)*(MPR-16)	-0.024624	0.027974	-0.880240	0.3926	
17%	MPR	0.008609	0.004691	1.835287	0.0864	0.0495
	(MPR>17)*(MPR-17)	-0.032393	0.043900	-0.737890	0.4720	
18%	MPR	0.008609	0.004691	1.835287	0.0864	0.0495
	(MPR>18)*(MPR-18)	-0.097180	0.131700	-0.737890	0.4720	

6.3 Policy Implication

The findings suggest that an increase in the MPR above the threshold could result in a decline in growth by about 1 per cent, investment will decline by 2 per cent, external reserves will decline by 0.8 per cent and inflation will rise by 6 per cent (Tables 7 – 10 and Figures 3.0-6.0 for details). This outcome is consistent with other

studies. The study also found that setting a threshold for the monetary policy rate should be based on some form of forward guidance anchored on developments in output, investment, and external reserve, inflation and inflation expectations. This result also suggests the existence of a tradeoff in policy choices.

7.0 Conclusion and Recommendation

This paper examined the MPR threshold in Nigeria using threshold techniques available in the literature and found that the optimal MPR levels for GDP growth are 10%, investment 9%, external reserves 15%, and inflation 8%. The study recommends that setting the rate for monetary policy should be based on some form of forward guidance anchored on developments in output, investment, and external reserve, inflation and inflation expectations. It also recommends a cautious choice of the policy menu as empirical evidence suggests the existence of trade off in policy outcomes. Finally, in our view, the monetary policy rate should be set in such a way as to achieve the closest target consistent with the country's overall goal of macroeconomic policy.

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