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Effect of Monetary Policy Rate on Market Interest Rates in Nigeria: A Threshold and NARDL Approach

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This study examines the effect of monetary policy rate (MPR) on market interest rates in Nigeria. For parsimony, we develop two indexes called the short-term interest rate (SINT) and Lending interest rate (LINT) to represent deposit and lending rates respectively. The nonlinear autoregressive distributed lag (NARDL) and threshold regression models are adopted. The study uses monthly data from 2002:M1 to 2019:M12. The results of the threshold regression model indicate that the degree of the effect of MPR on SINT and LINT above the estimated threshold of 11 and 13 percent respectively is greater and significant than if MPR were to be below the threshold. Moreover, estimates from the nonlinear ARDL model show that increasing MPR induces a positive effect on short-term and lending interest rates, while a negative effect holds if MPR is decreased. For LINT, the magnitude of the negative effect is little, while for SINT, the effect is statistically insignificant. This depicts the downward stickiness of prices, which supports the argument that the inefficitveness of MPR only holds when it is adjusted downward. We recommend that the monetary authority should focus on reforming the banking system in ways that remove downward rigidities in the effect of MPR on interest rates in order to engender greater efficiency of monetary policy.

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1. Introduction

In Nigeria, as it obtains in several other countries, the central bank traditionally uses monetary policy as a key policy framework for achieving the desired macroeconomic objectives. A key monetary policy instrument employed by the monetary authority in this regard is the monetary policy rate (MPR). The Central Bank of Nigeria (CBN)

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introduced the MPR in 2006 to replace the minimum rediscount rate (MRR) due to the latter's relative ineffectiveness. Since its adoption, the MPR has been one of the monetary policy tools employed by CBN in setting targets and directions of other rates (Aliyu *et al.*, 2017). Therefore, one channel through which to evaluate the effectiveness of monetary policy is interest rate pass-through (IRPT).

The IRPT is the process through which interest rates of banks respond to movements in the MPR (Rehman, 2009). The MPR is expected to communicate the decision of the Monetary Policy Committee and act as an anchor to other interest rates. However, the effectiveness of the MPR in influencing other interest rates remains a topical issue. Various attempts at determining MPR effectiveness (using different methodologies, to assess cases within and across countries), have generated conflicting results. While some argue that IRPT is weak and incomplete (Aydin, 2007; Marotta, 2009), Weth (2002) argued that in the short-run IRPT is weak, though, it is complete in the long run. Another group, however, contends that IRPT is complete in the short run (Crespo-Cuaresma *et al.*, 2004).

In Nigeria, the CBN adjusts the MPR, as a policy instrument, in order to maintain monetary and price stability in a way that encourages economic growth. The continuous use of this instrument by the CBN suggests the implicit faith of the monetary authority in the effectiveness of the instrument. However, the effectiveness of this instrument has been challenged. It has been demonstrated that the MPR hardly reflects in the movement of long-run and short-run interest rates in the country (Kelilume, 2014).In line with this assertion, the achievement of macroeconomic objectives through monetary policy is rendered unrealistic, since there may be little or no effect on the control of credit, and consequently money supply.

Therefore, in the light of the continuous reliance on the MPR, and the argument against its effect on interest rates, a deeper understanding of the nexus between the MPR and interest rates in Nigeria is germane to the conduct of monetary policy in the country. The literature on IRPT in Nigeria, however, remains limited in scope. It is against this backdrop, that this paper investigates the impact of the MPR on a selected number of market interest rates in Nigeria. As highlighted by Sanusi (2010), IRPT in Nigeria has weakened further since the banking sector consolidation. Therefore, in an era of an increasing need for policy effectiveness, greater value could be harnessed by determining the specific and various levels at which MPR influences other rates.

This paper is unique in that it examines the aforementioned relationship in Nigeria using a non-linear and threshold regression analysis. Studies that examine the relationship between the policy rate and other market interest rates in Nigeria, adopt a linear framework, that is, vector autoregression (VAR), structural VAR (SVAR), or ridge regression (Sanusi, 2010; Kelilume, 2014; Aliyu *et al.,* 2017; Mordi *et al.*, 2019). Although these frameworks may be suitable for analyzing interest rate passthrough, they do not detect non-linear (i.e. proportionate increase or decrease) effects of monetary policy on other rates. This is what this paper seeks to uncover, particularly given the presence of interest rate rigidities (Hannan & Berger, 1991). Mordi *et al.* (2019), provide evidence for the possibility of asymmetries in the adjustment process of the retail rates (savings rate) in response to the monetary policy rate. Using a non-linear autoregressive distributed lag (NARDL) model, we examine the effect of an increase and a decrease of MPR on other market rates. The effect of policy shocks can vary in direction, significance and magnitude. Such a non-linear analysis provides relevant policy insights into the effectiveness of a positive or negative change in the MPR.

In addition, we hypothesize that the aforementioned relationship could be sensitive to various thresholds. Since the financial crisis of 2008, during which MPR fell to a record low of about 6 percent, the policy rate has increased to a rate above 10 percent, fluctuating steadily between 12 and 14 percent. Therefore, this study adds further value by testing the effect of MPR on other market interest rates, based on the various directions towards which the MPR has been adjusted. The investigation can, therefore, identify the MPR levels that are effective (or not) in influencing other market rates. Lastly, for parsimony, we developed two indices called the short-term interest rate (SINT) and lending interest rate (LINT) to represent deposit and lending rates respectively. These indices provide a unique representation of short- and long-term interest rates, aggregating them into their individual metrices.

Overall, this study provides evidence on nonlinearities as well as effects of the regime-switching behaviour of the MPR. These findings are germane for policymaking, as it sheds light on the direction in which monetary policy can be deployed towards greater effectiveness.

The remaining sections of this paper are as follows: Section 2 presents a literature review and stylised facts. Section 3 provides an exposition of the data and methodology used. In Section 4, the results are presented and discussed and in Section 5, the study concludes and provides some policy recommendations.

2. Literature Review

2.1 Theoretical Literature

Interest rate pass-through (IRPT) is the process by which the MPR transmits to other interest rates (Rehman, 2009; Kovanen, 2011). This section provides coverage of the main arguments and approaches in the theoretical literature. These theories generally agree that MPR is important in determining other interest rates. However, they differ in the degree or mechanism through which MPR influences market rates.

The standard theoretical model for analysing the effects of MPR on market rates is provided by Monti and Klein (1971). This framework assumes that IRPT will be fully symmetrical and swift in response to the monetary policy rate if markets are perfectly competitive. Undergirding this model is the assumption of the absence of switching cost, information asymmetry, and imperfect competition in financial markets, thereby making the full pass-through a long-run phenomenon while deviations from long-run equilibrium occur only in the short run.

IRPT can be found to be sticky, complete or incomplete, and symmetric or asymmetric for a number of reasons. On asymmetric IRPT (Stiglitz & Weiss, 1981; De Bondt, 2005), if banks perceive the possibility of a high default risk situation, they may opt to pass on the cost of the increase in the policy rate to borrowers by raising the bank rate beyond the increase in the policy rate, to compensate for the risk. A different scenario could ensue such that an increase in the policy rate does not lead to an increase in interest rate. This is because an increase in bank rate would likely disincentivise low-risk borrowers, leaving high-risk borrowers (i.e. adverse selection) in the market, who would likely take on high-risk activities (i.e. moral hazard). In other words, borrowers tend to take on risky projects in response to an increase in lending rates. Thus, bankers do not raise their rates beyond the increase in the policy rate since asymmetric information exists, rather they ration credit to attain equilibrium in the loan market. Such a mix of scenarios turns out to be asymmetric.

Also, Bernanke *et al.* (1996) showed that financial frictions can trigger huge swings in economic activities, which then affects retail rates. In an environment of information asymmetry whereby lenders cannot distinguish between low and high-risk borrowers, then all borrowers are mandated by lenders to collateralize their assets. Consequently, an increase in the policy rate denoting monetary policy tightening devalues the assets of the borrowers, which further reduces their ability to borrow for investment. A vicious cycle arises, whereby a dampened economic climate further reduces the value of assets, which leads to tightening financing conditions, which, in turn, further reduces economic activities. Such a vicious cycle can cause the policy rate to trigger an overpass-through on retail rates.

Similarly, macroeconomic conditions affect retail rates' stickiness (Egert *et al.,* 2007; Egert & Macdonald, 2009). High volatility in macroeconomic conditions dilutes the information content of policy signals. Therefore, bankers may choose to be slow in adjusting their interest rates, denoting slow IRPT. Conversely, interest rate pass-through can be faster during periods of high macroeconomic volatility (i.e., high inflation). In an environment of quick-changing prices, banks seek to adjust their rates accordingly to maximise their gain, thus IRPT is faster.

Another explanation for interest rate stickiness is menu cost (Rotemberg & Salone, 1987). According to the menu-cost theory, banks will adjust their rates only if the cost of adjustment (for example, communication, and new price list advertising) is lower than the benefits therein. In other words, small changes in policy rates may lead to a delayed (or zero) change in retail rates.

Lowe and Rohling (1992) argued that switching costs is another reason for retail rate rigidity. Customers may find it more costly to switch banks if the cost of moving to a different bank outweighs the burden of a higher interest rate imposed by the bank. As a result, a high switching cost may indicate both stickiness of retail rates and asymmetric adjustment. Conversely, banks who wish to preserve the long-term relationships with their clients would likely offer them implicit contracts that offer more stable interest rates (Fried & Howitt, 1980; Berger & Udell, 1992).

Interest rate Pass-through can also be affected by the ownership structure of the financial system (Grigoli & Mota, 2017). In a context where, non-profit maximizing, policy-oriented, state-owned financial institutions exist, they may prefer to delay adjustments in interest rates due to political considerations and inefficiencies. Similarly, a financial system dominated by a few banks may lead to collusive oligopolistic behaviour (Hannan & Berger, 1991). According to the collusive conduct hypothesis, deposit rates may become stiff upward following a hike in the MPR, as higher deposit rates imply an extra expense for banks. Similarly, lending rates may demonstrate downward rigidity in response to monetary policy rate reductions, as lower lending rates indicate reduced bank profits.

In summary, the aforementioned theories highlight that the perfectly competitive market premise of the standard theoretical model for analysing the effects of MPR on market rates may not always hold. A review of the theoretical literature on IRPT reveals that there are numerous micro and macroeconomic factors responsible for the pace at which MPR affects other interest rates. Moreover, a number of these factors are not within the control of policymakers, which gives explanations for the ineffectiveness of the monetary policy rate in determining other rates and in turn the outcomes of macroeconomic aggregates.

2.2 Empirical Literature

Most empirical studies on IRPT focus on the degree and speed to which changes in money market rates lead to adjustments of banking rates, along with variations concerning short- and long-term changes in market interest rates to monetary policy rates. These studies differ in methodology or scope – whether they examine individual or cross-country behaviour.

At a continental level, Tai *et al* (2012) investigated the differences in the degree of pass-through from the monetary policy rate to lending and deposit rates across Asian countries. Adopting a seemingly unrelated regression (SUR), the study showed that the transmission rate is sluggish, though, the pass-through to the lending rate is slightly higher compared to the deposit rate. Investigating the effect after the 1997 dot-com crisis, the study showed that the adjustment rate was much slower for most countries.

Egert *et al.* (2007) examined IRPT in five Central and Eastern European countries (the CEE-5) namely Slovenia, Slovakia, Poland, Hungary and the Czech Republic. Findings from the study confirmed the already established empirical fact that IRPT is low for overnight rates but considerably higher for corporate lending rates and short- to long-term deposits. The key finding from the study was the evidence that the pass-through was higher for CEE-5 countries compared to other core euro-area countries, though, the pass-through appeared to decline over time in the CEE-5, suggesting a stop to the increase in heterogeneities in the euro-area.

Samba and Yan (2010) examined the monetary transmission mechanism of IRPT from short-term interest rates to long-term rates in the Central African Economic and Monetary Community. Findings showed that the policy rate had a very low and incomplete long-run pass-through to the deposit rate. On the other hand, they found a huge overshooting effect on lending rates.

In Turkey, Yildirim (2012) investigated how monetary policies and financial market conditions can result in the asymmetric movement of lending rates. Employing threshold autoregressive models (TAR), the study found that substantial asymmetries exist and that banks adjust their lending rates faster in response to an increase in money market rate, but act slower following a decline in money market rates. It also found sectoral heterogeneities, in that the degree of banks' reluctance to follow decreases in money markets rates varies across lending rates.

Adopting a similar econometric approach (the TAR model), Tang *et al.* (2015), investigated the Malaysian case of policy rate pass-through effect on retail rates. Besides finding incomplete policy rate pass-through to deposit and lending rates, the study also found downward rigidities in the response of both lending and deposit rates. These results corroborate the findings of Levine and Loeb (1989), Dueker (2000) and Tkacz (2001). In the same vein, Grigoli and Mota (2017) using the same methodology explored the data for the Dominican Republic, the asymmetries in the adjustment of retail rates to changes in the monetary policy rate. Unlike the previous studies, it found a complete pass-through, suggesting the effectiveness of the monetary policy transmission mechanism. However, contrasting results emerge, as deposit rates react faster to increases in the policy rate, whereas lending rates react faster to policy rate reductions.

In Nigeria, the studies on the effect of monetary policy on market rates are few (Sanusi, 2010; Mordi *et al.*, 2019; Aliyu *et al.,* 2017; Kelilume, 2014), and largely investigate its size and speed. Kelilume (2014) investigated the effect of MPR on short-and long-term interest rates using the multivariate vector autoregressive (VAR) model. Findings indicate that the monetary policy pass-through to interest rates in Nigeria was incomplete. The study found a complete pass-through for the interbank, treasury bill and prime lending rates, whereas the pass-through to savings rate and the maximum lending rate was incomplete. The findings emphasised that a weak incentive system might be responsible for the poor and incomplete tracking of the savings rate.

Aliyu *et al.* (2017) examined the effect of MPR on the short- and long-term interest rates in Nigeria. Using a mix of models (principal component, ridge regression and OLS), the study found that the Monetary policy rate influences the Treasury bill and interbank rates the most. It, however, found a negative and statistically insignificant relationship between the MPR and lending rates. This raises questions about whether the MPR should be retained as a determinant of lending rates.

Likewise, Sanusi (2010), using a structural VAR (SVAR) approach, estimated the magnitude and speed of the IRPT of the monetary policy rates and interbank interest rates to the retail and deposit interest rates in Nigeria. The study revealed that the pass-through is generally incomplete and slow in Nigeria. Nevertheless, MPR to interbank rate is considerably larger and quicker than it is to the retail lending and deposit rates. Also, the pass-through of MPR to money market rates increased during the post-consolidation period, though, the pass-through to retail and deposit market rates decreased relative to the pre-consolidation period. Thus, the study concludes that distortions in the retail and deposit market remained, despite financial sector reforms, thereby rendering monetary policy ineffective and inefficient.

Further, Mordi *et al.* (2019) investigated the adjustment pattern and size of interest rate pass-through of the MPR to selected retail interest rates in Nigeria. The study adopted an error correction model (ECM) approach, accounting for structural breaks and asymmetry in adjustment. The findings showed the existence of a long-run relationship between the monetary policy rate and savings and prime lending rates, along with significant structural breaks. Albeit, the findings revealed incomplete IRPT with a rigid adjustment process of the retail rates in the response to the monetary policy rate. Moreover, except for savings rate, all other retail rates adjust symmetrically, implying that savings rates respond differently, depending on whether MPR increases or decreases. That is, positive shocks to MPR transmit faster to changes in savings rates than negative shocks.

Furthermore, Tule (2014) assessed the responsiveness of short-term interest rates in Nigeria to changes in the monetary policy rate, using a VAR model. The study showed that in the long run, IRPT to money market rates is lower in the 3-month deposit rate and the Treasury bill rate than in the maximum and prime lending rates. The findings suggest that the differences in impact are indicative of the presence of structural rigidities that may obstruct the transmission of monetary policy signals. And to offset these shortfalls, banks place a bigger weight on changes in the interbank rate when evaluating their decisions relating to their marginal cost of funds.

The literature for IRPT in Nigeria has examined the pass-through of MPR on other interest rates, using various econometric techniques including OLS, VAR, SVAR, ridge regression and ECM. The findings, though agree about the stickiness and incompleteness of the effect of MPR on other rates, are still limited in their scope. Studies in Nigeria largely treated the IRPT of MPR and other rates as linear, whereas in reality, a non-linear relationship may exist. Mordi *et al.* (2019), using data that terminated in 2014, provided evidence for the possibility of asymmetries in the adjustment process of the retail rates (savings rate) in the response to the monetary policy rate. Howbeit, our study extends the scope to include important periods marked by recent economic downturns. Using a non-linear autoregressive distributed lag (NARDL) model, we examine the effect of an increase and decrease of MPR on other market rates, in terms of significance, magnitude and direction.

Findings from Mordi *et al.* (2019) reveal that most lending rates except savings rate have a symmetrical response to changes in MPR. In this study, for parsimony, we combine these other rates into an index using principal component analysis. The study refers to the index as short-term interest rate (SINT) and Lending interest rate (LINT), which represents short term deposit rates and lending rates respectively. This index is a unique representation of short-run and lending interest rates which aggregates information about the selected short-run and lending interest rates into separate indices respectively. Moreover, as highlighted by Sanusi (2010), IRPT in Nigeria has weakened further since the banking sector consolidation, thus in the era of an increasing need for policy effectiveness, greater value could be harnessed by examining the various levels at which MPR influences other market rates, using threshold analysis.

To this end, this study adds to the IRPT literature by further exploring the responses of short term deposit rates to changes in the monetary policy rate in Nigeria, using a threshold and non-linear analysis. Given the research done in the literature so far, this study is unique by attempting to explore possible nonlinear effects as well as effects of the regime-switching behaviour of the monetary policy rate. This study is of policy relevance as it sheds light on the direction in which monetary policy can be wielded towards greater effectiveness.

2.3 Stylised Facts

Delving deeper into the issues surrounding the effectiveness of MPR, this section explores the behaviour of the MPR vis-à-vis a selection of other market rates and key macroeconomic variables. As seen in Figure 2, in the period 2002-2005 the domestic macroeconomic environment was characterised by sharp increase and sharp falls in real GDP, an increase in external reserves and relative stability in the Naira exchange rate. However, in the year 2006, disruptions such as the vandalism of oil pipelines in the oil-producing region, affected oil production and earnings, which led to a decline in GDP growth (CBN Communique, 2006). Also, the year 2006 was also characterized by an increase in the inflation rate. The monetary policy committee (MPC), in the bid to ensure price stability decided to increase the MRR to 14% from 13% (see Figures 1 and 2), but retained the CRR (Cash Reserve Ratio) at 5%. This rate was not reviewed until June 2007, when there was a decline in the inflation rate (CBN Communique, 2007).

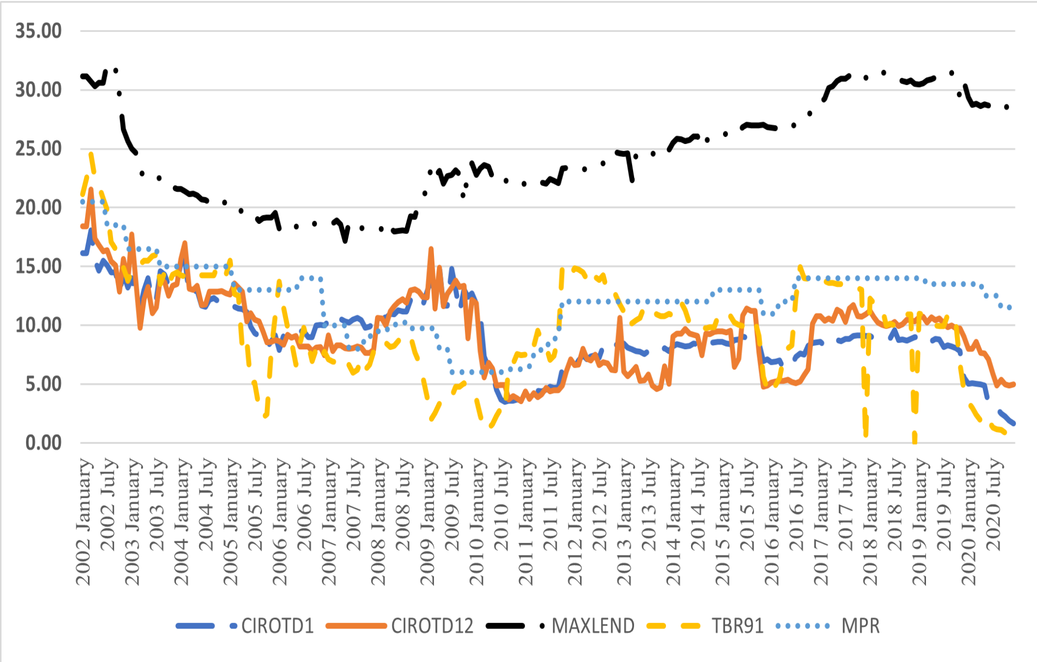

Figure 1: Interaction Between MPR and some selected market rates.

In 2014, even with the fall in oil prices resulting partially from the shale oil revolution, the macro environment in Nigeria remained strong and resilient despite global headwinds, with a level of stability in prices and output (CBN Communique, 2014). This led to improved liquidity in the banking system. Due to incomplete interest rate pass-through, the improvement in liquidity conditions of the banking system which was aimed at enhancing its resilience and stability was unable to translate into an expansion of credit availability to the real sector. Instead, the improvement in the liquidity conditions led to increasing inflation (see Figure 2). To curtail these inflationary effects, the MPC decided to impose a tightening measure by increasing MPR to 13% from 12% (CBN Communique, 2014).

Between 2014 and 2016, the MPR witnessed changes in different directions (see Figures 1 and 2), as a result of global and domestic happenings. One of such events is the BREXIT vote which led to unpredictability and increased fragility in the financial market globally (CBN Communique, 2016). On the domestic front, particularly in

March and July 2016, there was a persistent rise in MPR from 11-12%, and 12-14% respectively (CBN Communique, 2016). This was to curb the consistent upward inflationary pressure (as seen in Figure 2) which was a result of fuel scarcity; increased energy tariffs; forex scarcity; and high costs of factor inputs associated with the economic recession experienced in the country at that period.

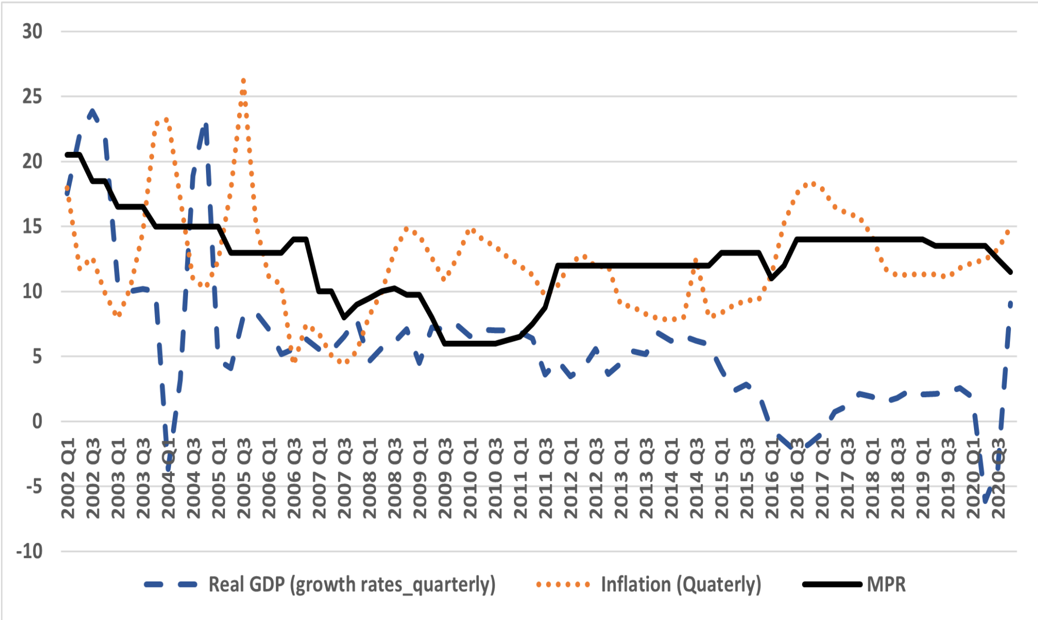

Figure 2: Interaction Between MPR and some selective macroeconomic variables.

However, the year 2019 witnessed major global events such as the trade war between the US and China, global output decline, persisting uncertainties surrounding BREXIT negotiations, regional hostilities in the Middle East, and dampening output growth in China (CBN Communique, 2019). Despite these global headwinds, the domestic economy remained fairly stable, with a gentle growth in real GDP and a moderate decline in headline inflation (see Figure 2). Hence, the MPR was retained in most of the periods, asides from a slight reduction from 14 to 13.50% in March 2019 (CBN Commnunique, 2019).

Given the lingering inflationary pressure (which stood at 11.98% as of December 2019) as a result of border closure in 2019, the CRR was raised from 22.5-27.5% in January 2020 (CBN Communique, 2020). However, the continuous spread of the coronavirus, leading to exchange rate volatilities, rising corporate and public debt, rising levels of unemployment, tightening financial conditions, capital flow reversals, negative shocks to commodity prices, and the slowdown in industrial activities around the world, led the MPC in May 2020 to reduce the MPR from 13.5-12.5% (see Figures 1 and 2), to ease some of the effects of the COVID-19 pandemic.

3. Data and Methodology

3.1 Data

The study used secondary data extracted from the 2020 Central Bank of Nigeria Statistical bulletin. It covers a monthly period of 2002M1 to 2019M12. The variables used include the short-term interest rate (SINT) index, lending interest rate (LINT), monetary policy rate, and money supply (M2). The short-term interest rate index is computed, using the principal component analysis. Two indexes are computed. SINT which represents the short-run savings rate and LINT which represents the lending rate. The variables adopted for the computation of SINT are commercial banks' interest rate on time deposits maturing for 7 days (CIROTD7), 1 month (CIROTD1), 3 months (CIROTD3), 6 months (CIROTD6) and for 12 months (CIROTD12). These interest rates are deemed to fit into the short-term interest rate because of their maturity periods. The variables adopted for the computation of LINT include the prime lending rate (PLR) and the minimum lending rate (MLR). Money supply (M2) serves as a control variable in the model because of its theoretical linkage to interest rates (Mishkin, 1996).

Principal Component Analysis (PCA)

PCA is a multivariate statistical technique adopted to reduce the number of variables in a set of data into a sizable number of dimensions (Abdi & Williams, 2010). Algebraically, from an initial set of n correlated variables, PCA generates uncorrelated components, where each component is a linear weighted combination of the original set of variables. Given a set of variables X_1 through X_n,

$$
\begin{aligned}
PC_1 &= a_{11}X_1 + a_{12}X_2 + \cdots + a_{1n}X_n \\
&\vdots \\
PC_m &= a_{m1}X_1 + a_{m2}X_2 + \cdots + a_{mn}X_n
\end{aligned}
$$

Such that a_{mn} represents the weight for the mth principal component and the nth variable. These weights are given by the eigenvectors of the correlated matrix. The variance for each principal component is derived by the eigenvalue of the corresponding eigenvector. These components are arranged such that the first component explains the largest possible amount of variation in the original, subject to the constraint that the sum of the squared weights ($a_{11}^2 + a_{12}^2 + \cdots + a_{1n}^2$) is equal to one.

3.2 Theoretical Framework

The theoretical approach adopted for the study is the marginal cost pricing model (De Bondt, 2005). This follows the Monti-Klein framework (Monti 1971; Klein 1971) which assumes that a perfectly competitive market exists, where price equals marginal cost, without menu cost, transaction cost, and asymmetric information. In such conditions, the marginal change in price with respect to the marginal cost is unity. In other words, the official rate reflects the true cost of funds, therefore, the transmission is direct. Applying the framework algebraically, the relationship between the various market rates and the monetary policy rate is depicted by the following model:

$$MR_t = a + b * MPR_t + e_t \tag{1}$$

where MR represents the market interest rates (SINT; LINT), MPR is the monetary policy rate, *a* is the constant mark up and *b* is the coefficient for the interest rate pass-through. Under a perfectly competitive market, the MPR coefficient, *b*, would equal unity. Lastly, *e* is the error term. In this study, equation 1 extends the existing theoretical model by considering nonlinear relationship as discussed in the model specification.

3.3 Model Specification

A threshold regression estimation approach by Hansen (1999) and non-linear ARDL models were utilized for the analysis of the study. The threshold regression allows for regime-switching, which helps in ascertaining the effect of MPR on interest at a threshold level, while the non-linear ARDL helps in ascertaining the nonlinear effect of changes in MPR on short-term interest rate and the degree and significance of the effect of the nonlinear relationships.

3.3.1 The Threshold regression

The threshold estimation technique is preferred for the study over Markov switching models owing to two important conceptual differences. First, the Markov switching models incorporate less prior information than threshold regression and second, regime changes are predetermined in threshold regression, but are endogeneous in Markov switching models. In Markov switching, even if the model parameters were known, these changes could not be predicted with certainty from past data due to the presence of additional disturbances in the Markov evolution equation (see Koop & Potter, 1999).

Assume that the relationship between MPR and other interest rates is specified in a linear model as presented below:

$$r_t = \propto_0 + \propto_1 MPR + \beta M2 + \varepsilon_t \tag{2}$$

where r_t stands for the interest rates (SINT; LINT), MPR_t, the monetary policy rate (the threshold variable), M2, money supply and ε_t, the error term in the model. $\propto_0$, $\propto_1$ and β are the regression parameters.

Referring to the framework of Hansen (1999), equation (1) can be re-specified to accommodate threshold components. To model the Hansen framework with Equation (2), a threshold is established using MPR, such that MPR is equal to or less than the threshold, as well as greater than the threshold, is measured against the interest rate as shown in equation (3) below:

$$r_t = \propto_0 + \propto_1 MPR_t r\,(MPR \leq \lambda) + \propto_2 MPR_t r\,(MPR > \lambda) + \beta M2_t + \varepsilon_t \tag{3}$$

where MPR is the threshold variable and it is adopted to test for the presence of the threshold effect of MPR on interest rates. λ is the threshold parameter and I(.) elicits the function that assumes unity (1) if MPR is lower than or equals to the determined threshold value (λ) and 0 otherwise. A complete effect would occur if a unit increase in MPR results in a unit or more than a unit increase in I, that is, if $\propto_1$and $\propto_2$ are each greater than or equal to one. Otherwise, the effect is incomplete.

Equation (2), can also be partitioned into two regimes, relying on if the threshold variable is lower than or higher than the estimated threshold. These regimes are isolated by different regression parameters in $\propto_1$ *and* $\propto_2$ as follow:

$$r_t = \propto_0 + \propto_1 MPR_t + \beta M2 + \varepsilon_t,\ if\ MPR \leq \lambda \quad (4)$$

$$r_t = \propto_0 + \propto_2 MPR_t + \beta M2 + \varepsilon_t,\ if\ MPR > \lambda \quad (5)$$

Equations 4 and 5 represent the regime below and above the threshold respectively. Money supply (M2) which is a control variable in the model is regime invariant. To identify the threshold in equation 3, the ordinary least square is estimated, and the sum of squared errors (S_1) is computed for all estimable values of the threshold variables in the model. S_1 is computed as $\dot{\in}(\lambda')\dot{\in}(\lambda)$ (this reflects the sum of square error in matrix notation, identifying the gap between the mean observation and its group mean). Next, the threshold parameter is obtained by minimizing (S_1), such that $\bar{Y} = argminY\ S_1(Y)$ (that is, the parameter for the threshold variable is obtained by minimizing the sum of the squared errors). Once the endogenous threshold is ascertained, it is important to test if the threshold is statistically significant. The null hypothesis is that there is no threshold effect (H_0: $\propto_1$=$\propto_2$). This implies that the slope coefficients are similar in the two regimes. Hence, under the H_0, equation (3) is similar to the linear model in equation (2). The likelihood ratio test of the null hypothesis is based on the F-statistic:

$$F_1 = \frac{(S_0 - S_1(\bar{Y}))}{\grave{\alpha}^2}$$

where S_0 and S_1 represent the sum of squared errors under the null hypotheses, and $\grave{\alpha}$ is the estimate of the regression error variance (α^2). Given that the threshold value is not identified under the null hypotheses, the asymptotic distribution of F_1 is not standard. To address this, Hansen (1999) suggests a bootstrap method to simulate the probability value for the F-statistic (F_1). For threshold to exist, it is expected that from equation (3), $\propto_1 \neq \propto_2$.

Non-linear ARDL model

The Non-linear ARDL (NARDL) model was developed by Shin *et al.* (2013). It is the asymmetrical expansion of the traditional ARDL model developed by Pesaran et al. (2001). The ARDL model possesses the advantage of yielding valid results regardless of whether the series are I(0), I(1), or a mixture of both. It also allows for both dependent and independent variables to be included in the model and possibly correct for endogeneity in the explanatory variables (Caporale & Pittis, 2004).

Since the NARDL is the asymmetrical derivative of the linear ARDL model, the study presents the traditional ARDL model, out of which the NARDL is constructed. Given two variables x and y, the ARDL model is specified as:

$$\Delta y_t = \sum_{i=1}^{q} \alpha_i \Delta y_{t-i} + \sum_{j=0}^{p} \beta_i \Delta x_{t-j} + \gamma_1 y_t + \gamma_2 x_t + \varepsilon_t \tag{6}$$

Following the work of Shin et al. (2013), NARDL can be derived from equation 6 by replacing x_t with (X^+) and (X^-) in the linear ARDL model as follows:

$$\Delta y_t = \sum_{i=1}^{q} \alpha_i \Delta y_{t-i} + \sum_{j=0}^{p} \beta_{1i} \Delta x^+_{t-j} + \sum_{j=0}^{p} \beta_{2i} \Delta x^-_{t-j} + \gamma_1 y_t + \varphi_1 x^+_t + \varphi_2 x^-_t + \varepsilon_t \tag{7}$$

Equation (7) can be reparametrized to incorporate the variables of interest as follows:

$$\Delta r_t = \sum_{i=1}^{q} \alpha_i \Delta r_{t-i} + \sum_{j=0}^{p} \beta_{1i} \Delta MPR^+_{t-j} + \sum_{j=0}^{p} \beta_{2i} \Delta MPR^-_{t-j} + \sum_{j=0}^{p} \beta_{3i} \log(M2)_t$$
$$\gamma_1 r_t + \varphi_1 MPR^+_t + \varphi_2 MPR^-_t + \varphi_3 \log(M2)_t + \varepsilon_t \tag{8}$$

The independent variable is decomposed into positive (X^+) and negative (X^-) changes in Shin *et al,* (2013) as follows:

$$MPR^+{}_t = \sum_{k=1}^{t} \Delta MPR^+_k = \sum_{k=1}^{t} \max(\Delta MPR_{k,}\ 0) \tag{9}$$

$$MPR^-{}_t = \sum_{k=1}^{t} \Delta MPR^-_k = \sum_{k=1}^{t} \min(\Delta MPR_{k,}\ 0) \tag{10}$$

Equations (9) and (10) isolate the positive and negative changes in the policy variables in the model, where X is a vector of policy variables in the model.

4. Results and Discussion

Table 1 below presents the descriptive characteristics of the series adopted in the models. Over the period of study, the country witnessed an average monetary policy rate (MPR) of 12.29 percent, with a minimum rate of 6 percent and a maximum of 20.5 percent. This rate is expected to influence other interest rates in the market. A high MPR should lead to a high short-run interest rate and vice versa. The short-run interest rate (SINT) recorded an average rate of 17.67 percent within the period of study, with a minimum of 14.58 percent and maximum of 26.38 percent. Also, the lending interest rate (LINT) recorded an average rate of 30.19 percent within the period of study, with a minimum of 25.65 percent and maximum of 30.68 percent. The broad money supply also recorded a mean value of about NGN12.3 trillion within the periods, having a minimum supply of NGN 1.3 trillion and a maximum of NGN 29.1 trillion.

Table 1: Descriptive statistics

	MPR	M2	SINT	LINT
Mean	12.29	12232. 221	17.67	30.187
Median	13.00	11543.528.00	17.00	30.675
Maximum	20.50	29137.800	26.38	32.270
Minimum	6.00	1347.266	14.58	25.650
Std. Dev.	3.19	8356.076	2.27	2.036
Skewness	-0.08	0.28	2.06	-1.348
Kurtosis	3.32	1.84	7.80	3.572
Jarque-Bera	1.16	15.05	360.36	3.796
Probability	0.56	0.00	0.00	0.150
Observations	216.00	216.00	216.00	362.240

Table 2 shows the principal components of the short-term interest rate indicator (SINT) and the lending interest rate (LINT). The results show that the first component (CIROTD7) accounts for 93 percent of the total variance of the five short-term interest rates, while the remaining four components account for about 7 percent of the variance. Similarly, the first component (PLR) emerges as the dominant component of the two Lending interest rates.

Table 2: Principal components analysis (PCA) result

Component	Eigenvalue	Proportion	Cumulative
SINT			
CIROTD7	4.683	0.937	0.937
CIROTD2	0.205	0.041	0.978
CIROTD3	0.071	0.014	0.992
CIROTD6	0.032	0.006	0.998
CIROTD12	0.009	0.002	1.000
LINT			
PLR	1.208	0.604	0.604
MLR	0.792	0.396	1.000

Table 3 presents the stationarity properties of the series using the Augmented-Dickey Fuller and Philip-Peron tests. It shows that the series are stationary only at first difference in both tests. The ARDL model is well suited for models containing series of this stationarity feature (Pesanran et al. 2001). Hence, the ARDL model is adopted for the study.

Table 3: Unit root test

	ADF		PP		
variables	levels	first diff	levels	first diff	I(d)
SINT	-3.038	-16.894***	-3.003	-16.817***	I(1)
M2	-2.742	-16.506***	-2.518	-16.751***	I(1)
MPR	-2.266	-14.556***	-2.266	-14.556***	I(1)
LINT	-3.541**	-14.947***	-3.932***	-15.042***	I(0)

***, **, * denote significance at 1%, 5%, and 10% respectively.

Table 4 is the correlation matrix of the variables in the model. It shows that the correlation between short-term interest rate (SINT), Lending interest rate (LINT), money supply (M2) and monetary policy rate (MPR) is relatively low, and can therefore be combined in the same model without producing a spurious result.

Table 4: Correlation matrix

Variables	SINT	MPR	M2	LINT
SINT	1			
MPR	0.555 (0.000)	1		
M2	-0.499 (0.000)	-0.076 (0.266)	1	
LINT	-0.109 (0.000)	0.449 (0.000)	0.705 (0.000)	1

Note: (i) values in parenthesis are probability values; (ii) we could not add more variables to the model because we detected a high correlation between these variables and other independent variables in the model, which could result in multicollinearity. Thus, we dropped them to avoid spurious regression results for the study (see Table A1 in the appendix).

Table 5 presents the bound test results showing whether or not a long-run relationship exists in the two models. The F-statistics exceed the upper bound critical value at 5 percent significant level. Therefore, the null hypothesis of no long-run relationship is rejected, and the study concludes that a long-run relationship exists among the variables.

Table 5: Bound test – Null Hypothesis: No long-run relationship

Test Statistic	Value	Significance	I(0)	I(1)
Dependent Variable: SINT				
F-statistic	4.2495	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.50%	3.55	4.38
		1%	4.13	5
Dependent Variable: LINT				
F-statistic	4.549	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.50%	3.15	4.08
		1%	3.65	4.66

Table 6 shows the threshold regression results, identifying an important point of change in the effect of MPR on short-term interest rate (SINT) and Lending interest rate (LINT). The threshold is pre-determined by the model at 11 and 13 percent respectively. At this point, a shift is observed in the magnitude of the effect of MPR on short-term interest rate. MPR below the 11 percent threshold exerts 0.3 percent influence on SINT. That is, a percentage increase in MPR at these levels is expected to increase SINT by 0.3 percent, which points to an incomplete effect of MPR on SINT.

This effect is negligible in the case of LINT. MPR below the 13 percent threshold exerts 0.0 percent influence on LINT. That is, a percentage increase in MPR at these levels is expected to increase LINT by 0.0 percent, which essentially points to a zero effect of MPR on LINT.

On the other hand, MPR above the 11 percent threshold influences SINT by 0.65 percent. A percentage point increase in MPR in this regime increases SINT by 0.65 percent. The pass-through in this regime is also incomplete since the coefficient of MPR is less than unity. Likewise, MPR above the 13 percent threshold influences LINT by 0.51 percent. A percentage point increase in MPR in this regime increases LINT by 0.51 percent. The pass-through in this regime is also incomplete since the coefficient of MPR is less than unity. However, compared to the alternative regime, the effect is stronger and significant.

Moreover, the degree of the effect of MPR above the 11 and 13 percent threshold exceeds the magnitude of effect where the MPR regime is below 11 and 13 percent for the short-term and lending interest rate models respectively. Thus, the results imply price stickiness below the threshold, and the degree of stickiness varies depending on the market interest rate under investigation, be it SINT or LINT. Also, the MPR threshold for LINT is higher than that of SINT, implying that the lending rates are far less responsive than deposit rates to MPR at lower levels. On the other hand, both SINT and LINT respond comparatively to MPR rates above their respective thresholds.

The policy implication of these findings is that MPR can play an important role in achieving the price stabilization objective of the CBN. This is because, the higher the MPR, the higher the SINT, which consequently increases the cost of holding money and could imply a reduction in the total liquidity in the economy which affects the aggregate price level. However, the results also imply that there is little space for monetary authority to manoeuvre with respect to using the MPR to reduce lending rates in the economy. MPR rates below 13 percent are essentially ineffective in determining changes in the lending rate.

Table 6: Threshold regression result

Dependent Variable	SINT		LINT	
	regime 1 (MPR $< \lambda$)	regime 2 MPR$\geq \lambda$	regime 1 MPR $< \lambda$	regime 2 MPR $\geq \lambda$
MPR	0.300	0.651***	0.000	0.513***
LOG(M2)	-2.034***	-0.601***	1.398***	1.062***
C	29.745***	0.9402	-2.307***	-2.384***
Identification of thresholds				
λ	11		13	
Other diagnostics				
R-sqr	0.64		0.89	
adj. R-sqr	0.64		0.89	
F-stat	75.89***		374.61***	

***, **, * denote significance at 1%, 5%, and 10% respectively.

The asymmetric effects of MPR, and money supply (M2) on SINT and LINT is depicted in Table 7. The regression results reveal that both positive and negative changes in the MPR have incomplete effects on SINT and LINT. While an increase in MPR raises the short-term interest rate significantly, a decrease in MPR reduces SINT insignificantly. A percentage increase in MPR induces about 0.13 percent increase in SINT. Moreover, a decrease in MPR marginally reduces SINT by 0.06 percent, howbeit, insignificantly. On the other hand, an increase in MPR raises the lending interest rate marginally and insignificantly, while a decrease in MPR reduces LINT significantly. A percentage increase in MPR induces about 0.01 percent increase in LINT. Moreover, a decrease in MPR barely reduces LINT by 0.04 percent, nevertheless, significantly.

The non-linear effects of MPR on SINT and LINT produced theoretically expected results, nevertheless, the negative effect of MPR on SINT is statistically not significant, while the opposite is the case for LINT. Mordi *et al.* (2019) could only provide evidence for the possibility of asymmetries in the adjustment process of the retail rates (savings rate in particular) in response to changes in MPR. However, the findings of this study reveal that a non-linear effect exists for both short-term and lending interest rates.

What is striking is the significant influence a negative change in MPR exerts on lending rates. The practical experience in Nigeria suggests that prices are sticky downwards. And indeed, this experience is supported by a small coefficient of the negate MPR change. However, the "small" effect is significant. This could be explained by the fact that prime lending rates outweighs the maximum lending rate, as shown in the results of the principal component analysis. In reality, given that the prime lending rate is the rate used by the bulk borrowers of credit in Nigeria, these borrowers by sheer dominance in the borrowers' market possess high bargaining power to negotiate a reduction in lending rates in response to a decrease in the MPR.

Furthermore, the theoretical literature hinted that prices can be sticky downward and this could explain why a downward review in MPR might have an insignificant effect on SINT in this case. In Nigeria, these distortions come in the presence of asymmetric information, high switching costs and oligopolistic practices. A reason for asymmetric information is a shortage in consumer creditworthiness data, which makes it difficult for banks to accurately assess consumers' risk levels, and thus loan prices (Sanusi, 2010). Switching costs emerge as a result of depositors' lack of viable alternatives to bank deposits. This cost is further reinforced by the collusive behaviour of the few banks that dominate the banking industry. This is further perpetuated by banks' drive for short-term profits, which in part, shortens the liquidity cycle in the banking system, thereby narrowing the scope for long-term lending and real investments (Tule, 2014; Itaman & Awopegba, 2021).

For the goodness of fit of the model, the adjusted R-squared suggests that positive and negative changes in MPR and money supply account for about 93 percent of the change in SINT. The F-statistic confirms the joint significance of the parameters in the model and the Durbin Watson test establishes the absence of serial correlation in the model.

Table 7: NARDL model result

Variable	SINT	LINT
	Coefficient (S.E) P-value	Coefficient (S.E) P-value
MPR_POS	0.135 (0.063)**	0.013 (0.009)
MPR_NEG	-0.061 (0.039)	-0.042 (0.022)*
log(M2)	-0.022 (0.01) **	0.112 (0.200)
C	0.116 (0.072)	-0.612 (1.223)
R-squared	0.933	0.982
Adjusted R-squared	0.930	0.981
S.E. of regression	0.250	0.136
Sum squared resid	12.636	3.405
Log likelihood	-1.888	116.870
F-statistic	314.240	1117.601
Prob(F-statistic)	0.000	0.000
Durbin-Watson stat	2.034	2.210

***, **, * denote significance at 1%, 5%, and 10% respectively.

5. Conclusion and Recommendations

This paper examines the effect of MPR on market interest rates in Nigeria. The specific objectives take two forms. First, we examined the nonlinear relationship between MPR and other market rates, and second, investigated the threshold at which this impact is prominent. Two indicators of interest were constructed – the short-term interest rate (SINT) and the Lending interest rate (LINT).

For the analysis, we adopted nonlinear ARDL and threshold regression models to address the two objectives. Guided by the Monti-Klein theoretical framework, the coefficient representing MPR needs to be unity for a complete effect to be inferred. In both models, the estimates were less than one, indicating an incomplete effect of MPR on short-term and lending interest rate. These findings corroborate what is generally established in literature: an incomplete pass-through of MPR to interest rates in Nigeria.

Moreover, the threshold regression model established MPR threshold of 11 and 13 percent for SINT and LINT respectively. The results of the model indicated that the degree of the effect of MPR on SINT and LINT above the estimated threshold is greater than if MPR were to be below the threshold. The results imply price stickiness below the threshold, and the degree of stickiness varies depending on the market interest rate under investigation, be it SINT or LINT. Further, the results from the non-linear ARDL model show that raising MPR induces positive effects on short-term and lending interest rates, while the opposite effect also holds. The results are theoretically consistent, as a decrease in MPR is expected to lead to a decrease in SINT and LINT, however, for LINT the magnitude of decrease is little, while for SINT the effect is statistically insignificant, depicting overall downward stickiness of prices.

The use of the monetary policy rate is increasingly becoming important, particularly in an economy punctuated by more regular economic crises since the global financial crisis of 2008. The findings of the study have important implications on the use of monetary policy for expansionary or contractionary purposes and gives specific insights into the expected outcome of changes in the policy rate. More so, the ineffectiveness of MPR as a monetary policy tool only holds when it is adjusted downward. Lowering the policy rate is less likely to have an effect on other market rates, and more so at a threshold level below 11 or 13 percent depending on the specific interest rate market.

Based on the findings of our study, we recommend that the monetary authorities should focus on reforming the banking system in ways that remove downward rigidities in the effect of MPR on market rates in order to engender greater effectiveness of monetary policy. An example of reform would be to reduce the size (or increase the number) of banks which would lead to more efficient banking institutions and competitive practices.

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Appendix:

Table A1: Correlation matrix including excluded variables from the study

	SINT	MPR	M2	CPI	EXCHR
SINT	1				
MPR	0.480	1			
	(0.000)				
M2	-0.539	-0.076	1		
	(0.000)	(0.266)			
CPI	-0.484	0.014	0.979	1	
	(0.000)	(0.839)	(0.000)		
EXCHR	-0.309	0.174	0.871	0.929	1
	(0.000)	(0.011)	(0.000)	(0.000)	