Pass-Through Effects of Standing Facilities on Bank Interest Rates in Nigeria

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Abstract

The paper investigates the pattern of pass-through effects of standing facilities rates on commercial bank retail interest rates in Nigeria. Monthly data spanning 2007:06 to 2019:12 and the Gregory-Hansen cointegration method that accounts for structural breaks are used in the empirical analysis. The adjustment parameters for the standing deposit and lending facilities are found to be significant, but with a low speed of adjustment. This provides some evidence on the nature of the interest rate channel of monetary policy transmission in the country. Furthermore, the study could not confirm asymmetry in the adjustment of retail rates to their long-run equilibria. Lastly, we find that when the cost of funds rises, following a hike of the upper bound of the policy rate corridor by the CBN, banks tend to cut costs by reducing interest expense rather than raising deposit interest rates to aggressively pursue deposit mobilisation.

Keywords: Discount window operations, Gregory-Hansen cointegration, monetary policy, standing facilities

JEL Classification: E43, E52, E58

I. Introduction

Monetary policy typically uses money and interest rate adjustments to influence the demand side of an economy in order to attain its objectives. Understanding the mechanisms by which monetary policy impacts on key macroeconomic variables is crucial for effective policy design and management.

In Nigeria, monetary policy evolved from a system of direct control, during the earlier decades of central banking, to a more contemporary system of indirect controls and operation (Ikhide, 1996). With the adoption of market-based instruments of monetary policy in 1993, the direct control system gave way to a more market-based system, the indirect system of control. Instruments used in this system include, open market operations, complemented by discount window operations and reserve requirements. The transition from direct control to the indirect system was aimed at engendering a more robust process of liquidity management that ensures optimal transmission of monetary policy impulses to the economy.

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Mordi et al. (2019); Abayomi and Sheriffdeen (2015); Ogundipe and Alege (2013), and Sanusi (2010) highlight the recondite nature of policy rate transmission to banks' lending rates and deposit rates in Nigeria. Uncertainties around the efficacy of monetary policy transmission are not peculiar to Nigeria, but a matter of concern across developing countries (Mishra, Montiel, Pedroni & Spilimbergo, 2014; Mishra & Montiel, 2012). To strengthen the transmission mechanism of monetary policy in Nigeria, the Central Bank of Nigeria, has over the years, introduced many changes in the monetary policy operating environment. One of such changes is the introduction of the monetary policy rate (MPR) in 2006, and the creation of an interest rate corridor, the standing facilities rates, around the MPR.
The rationale for the corridor system has come under scrutiny, as some analysts question the social benefits of availing banks with liquidity through the standing facilities. They point out the possibility of undermining the central bank's control over the monetary base, the potential risk of abuse of the policy tool, and the belief that its effectiveness is weakened by stigma – unwillingness of banks to access the facility because they may be perceived as being in precarious financial condition (Carlson & Rose, 2017; Ennis & Price, 2020; Schwartz, 1992; Kaufman, 1992).

Other researchers, on the other hand, opine that standing facilities are useful as they help to smooth seasonal fluctuations in interest rates and encourage bank lending by offering a flexible source of liquidity. They also argue that standing facilities can sufficiently minimise panics in the banking system by mitigating portfolio risk. Reinforcing the 'lender-of-last-resort function of the CBN, these facilities prevent a dry-up of bank liquidity that could follow a surge in deposit withdrawals and threaten systemic liquidity (Ennis & Klee, 2021; Diamond & Dybvig, 1983).

This debate brings to the fore the importance of an empirical study of the implications of the standing facilities for bank interest rates. Most studies on monetary policy transmission utilise minimum rediscount rate (MRR), monetary policy rate (MPR), money supply and credit to the economy in the analysis of interest rate pass-through in Nigeria. This paper re-examines the evidence on monetary policy transmission to bank interest rates in Nigeria, using the standing facilities. In other words, the paper seeks to provide further evidence on monetary policy transmission by investigating the influence of standing deposit facility (SDF) and standing lending facility (SLF) on retail interest rates. Specifically, the paper re-evaluates: (a) the impact of the CBN standing lending and deposit facilities on the transmission of monetary policy to deposit and lending rates of Nigerian banks; and (b) how commercial banks' retail interest rates respond to MPR adjustments through the standing facilities.

The paper is broadly organised into six sections. Following the introduction, section 2, provides an overview of monetary policy in Nigeria. Section 3 presents the literature review, while section 4 describes the data and methodology. Empirical results and analytical discussions are presented in section 5, while Section 6 concludes the work.

II. An Overview of Monetary Policy Operations in Nigeria

In Nigeria, the prime objective of monetary policy is low inflation, which is balanced against the promotion of economic growth and attainment of full employment (CBN, 2016; Emefiele, 2019). Prior to the establishment of the CBN, the financial system was characterised by a *laissez-faire* banking system. At the inception of the CBN in 1958, exchange rate targeting was adopted, anchored to the British pound. Monetary policy focused on guiding developments in the financial sector, particularly designed to forestall bank failures. However, the civil war of 1967 and other global developments of that time caused internal economic instability, which resulted in a switch to the US dollar as the currency peg. The unfolding complexities during this period led to some amendments, including the enactment of the Banking decree of 1969 that gave autonomy to the CBN to introduce a range of monetary instruments.

The first devaluation of the Nigerian currency occurred in 1973, as a result of the external shocks and the global recession of the early 1970s, which stoked the agitation for independent and innovative management of the domestic currency without the influence of the colonial masters. So, the currency was pegged to the basket of currencies of prime trading partners in 1978. Further to the developments of the 1970s, oil became the dominant export commodity that increased Nigeria's revenue and inadvertently, the money supply of the country. The focus of policymakers then began to shift from the exchange rate pegging to greater attention on the control of the money supply. Hence, monetary targeting was introduced. Pre-established inflation and GDP growth rate were used as benchmarks for determining the appropriate rate of monetary expansion. The concern at the time was to ensure that there was balance in the dynamics of monetary aggregates to tame inflation and quicken sustainable economic growth. Direct monetary controls (including credit ceilings, administrative control of interest rates, sectoral credit allocations, and imposition of special deposits, stabilisation securities, and exchange controls) were used to support the policy framework. These were to achieve monetary policy objectives and channel bank credit to preferred sectors under the era of banking sector regulation (1960–1986).

However, the international oil market took a major downturn in the 1980s, resulting in adverse consequences on the Nigerian economy. This led to the adoption of austerity embodied in the Structural Adjustment Programme (SAP), which was aimed at cushioning the negative economic impact of the crash in oil prices and reviving the faltering economy. The introduction of the SAP in 1986 led to the deregulation of the financial market (1986–1993). It was alleged that the era of regulation left a system that was awash with liquidity and that banks were rejecting deposits as a result (CBN, 1986). SAP opened the gateway for radical policy adjustments and provided the platform for the initiation and adoption of indirect monetary controls. With SAP came the mopping of excess liquidity in the system and allowing interest rates to be market determined. This ushered in a new era through the deregulation of the financial sector, the removal of credit ceilings and other controls that characterised the direct monetary policy.

The most significant move in the migration to indirect monetary policy came in June 1993 when the central bank commenced open market operations (OMO), conducted through outright sales or through repurchase transactions. In addition to OMO, reserve requirements, which specify the proportion of a bank's total deposit liabilities that should be kept with the Central Bank; and discount window operations, under which the central bank performs the role of lender of last resort to the deposit money banks, were the other market-based instruments used. With the indirect monetary policy, CBN adopted the MRR as the nominal anchor for short-term interest rates in the domestic money market in Nigeria. The MRR was used to determine lending rates of banks, indicate the policy stance of CBN, promote efficiency and deepen the nation's financial system, as well as target money supply. It was also designed to influence credit, prices, other economic indices, and anchor expectations.

However, the MRR was not effective in its economic mandate as an anchor rate. Its effectiveness was limited by factors such as liquidity overhang, oligopolistic banking sector that created volatility in bank interest rates, and fiscal dominance, which crowded out private sector credit. Because of these challenges, interest rates were ineffectively driven by MRR adjustments. Some of the fallouts of deregulation were a sudden rise in all interest rates and growth in the number of commercial and merchant banks, prompting the policymakers to opt for guided deregulation from 1993 to 1999. Nonetheless, monetary management, as noted by Nnanna (2001), had been largely more successful under the indirect control system than the direct control.

The second wave of deregulation came into effect between 1999 and 2004 with the banking system becoming incrementally more liberalised than in the era of guided deregulation. There was more intensified use of the MRR and other market-based instruments to moderate inflationary pressures. This wave of deregulation saw banks facing high levels of competition and the extreme struggle for survival amid low capitalisation. Consequently, CBN introduced reforms to strengthen the capital base of banks and improve their potential for healthy contribution to the real economy. These culminated in the era of banking sector consolidation that started in 2004.

To address the limitations of the MRR, the monetary policy rate (MPR) was introduced in December 2006. It was hoped that the rate would calm interest rate volatility and drive credit toward the private sector. To further ensure stability, the MPR was used in conjunction with discount window operations and reserve requirements to define the interest rate corridor that would guide the interest rates in the domestic money market. In order to ensure a robust operation of the discount window and provide effective and efficient guidance for the conduct of monetary operations, especially in the face of the raging global financial crisis, the CBN expanded its discount window operations in October 2008. The discount window was expanded to admit sub-national government bonds (including state bonds and commercial papers) as eligible collateral instruments and to extend the tenor of liquidity provided under the discount window operations to include structured facilities with longer maturities of up to 360 days (CBN, 2008). This was hinged on the expectation that the expansion of the window would engender more robust processes of injection and absorption of excess liquidity in the money market. In July 2009, the expanded discount window was replaced with the CBN Guarantee of interbank transactions to encourage banks to lend to one another with ease amid market frictions, occasioned by the 2007-2009 Global Financial Crisis.

While the monetary policy in the post-consolidation era continued to be guided by the objectives of price stability and the overall health of the macro economy, there was more focus on firming up the gains of the banking sector consolidation. Therefore, attention was directed to financial deepening, development of the payment system and promotion of a cash-less economy to ensure that the banking sector contributes to the real economy, enhancing the supervision of the banking system, as well as promoting greater financial inclusion. During this era, the MPR continued to be used as the major instrument of monetary policy, complemented by other market-based tools.

III. Literature Review

III.1 Theoretical Literature

The role of interest rates in the transmission of monetary policy impulses in the economy gained prominence with the Keynesian IS-LM model (Mishkin, 1996). Within its framework, the effects of monetary expansion on aggregate demand work through the ability of interest rate changes to alter firms' investment levels. Monetary policy anchored on this theory assumes that interest rate is the link between money and output. However, such a view exposes monetary policy to certain limitations, such as the liquidity trap, which negates monetary policy. This limitation became obvious even to Keynes himself, as well as the modern monetary economists who rejected its tenets (Jhingan, 2003). The alternate view became known as the portfolio adjustment process.

The modern portfolio adjustment view of monetary policy transmission contends that central bank actions, such as OMO, will ultimately increase aggregate demand and expand output through the substitution and wealth effects. Regarding the substitution effect, if a central bank's purchase of securities results in excess cash balances in the hands of the public, they will progressively re-adjust their portfolio of an asset by substituting the excess balances for other assets whose prices are unaffected by increased demand. This chain of portfolio re-adjustments will ultimately impact economic activity by bringing about increases in the output of capital goods industries (Jhingan, 2003).

The agency cost or the credit rationing theory by Stiglitz and Weiss (1981) implies that interest rates may not always function as an efficient allocator of credits. This obtains in the face of information asymmetries in financial markets and leads to credit rationing even if interest rates were liberalised by policy. Thus, banks will rather ration credit to borrowers instead of pricing them strictly against the signals of monetary policy when it is too costly to get information about borrowers for loan administration or monitoring. When this happens, it is implied that the transmission of monetary policy impulse will be truncated. For an underdeveloped financial market like Nigeria, where identity management is in its infancy, such a theory may come close to predicting the prudential behavior of banks in lending to vaguely identifiable borrowers.

Within the theories of price stickiness in the bank loan market, the switching cost theory (by Klempere, 1987 cited in Lowe & Rohling, 1992) juxtaposes rational behaviors of the lender and borrowers to explain why interest rates may be inelastic to policy rates. In summary, the theory holds that a rational lender will, in order to cover the cost of acquiring less risky borrowers, impose an up-front fee devised to keep the borrowers from switching to their competitors. This fee (an extra cost to the borrowers) adds up with other 'search' costs to make the option of switching to alternative loan suppliers less attractive to borrowers. Therefore, to the extent that switching costs make loan demand less elastic to interest rate changes, monetary policy will be less direct in influencing aggregate variables.

The risk-sharing theory further explores price stickiness by considering the often realistic and observable risk-averse behavior of some loan seekers. This risk aversion tendency makes them prefer more stably priced interest rate regimes. To accommodate this preference, banks tend to price loans below the marginal cost of funds, while compensating with a higher average rate than obtainable with risk-neutral borrowers.

All the above interest rate transmission theories based on the price stickiness hypothesis hold varying degrees of usefulness in explaining the transmission inertia documented in the literature. Yet, each must be judged alongside the prevailing economic structure of the specific monetary authority. Such aspects as the level of competition in the banking sector, level of financial system development or even the extent of the central bank's pursuit of secondary objectives like the economic development and promotion of protected sectors as in Nigeria, all have an influence on the transmission mechanism of monetary policy.

III.2 Empirical Literature

Bassey et al. (2018) empirically examines the effectiveness of OMO as an instrument of monetary policy management in Nigeria using the ordinary least squares (OLS) technique. The study reveals the existence of a significant long-run relationship between monetary policy instruments –open market operations, cash reserve ratio, and monetary policy rate– and money supply. They argue that OMO had been an effective instrument for managing monetary policy in Nigeria and that the monetary policy rate could serve as a crucial instrument for controlling money supply, and in general, managing monetary policy effectively in the economy. That position was echoed by Okaro (2011), who concludes that credit is an important part of the transmission process of monetary policy in Nigeria.

Sanusi (2010) estimates the magnitude and speed of the pass-through of monetary policy rate and interbank interest rates to the retail lending and deposit interest rates in Nigeria, using monthly data and a structural vector auto-regression (SVAR) model. He also uses a sub-sample analysis to ascertain whether the pass-through of the policy rate to both retail and market rates has changed after the banking sector consolidation of 2005 and the introduction of the monetary policy rate in 2006. He found interest rate pass-through in Nigeria to be incomplete and quite slow with the pass-through of the monetary policy rate to interbank money market rates was established being substantially larger and faster than in the retail lending and deposit rates. Evidence of signaling effects of the policy rate changes on money market rates was established, but not on retail rates. In addition, the pass-through to the money market rates increased substantially in the post-consolidation period, while the pass-through to the retail lending and deposit rates declined relative to the pre-consolidation period of 2002-2005.

Investigating the pattern of interest rate pass-through (IRPT) and the signaling effectiveness of monetary policy stance with yearly data (1970-2011) in Nigeria, Ogundipe and Alege (2013) use maximum likelihood alongside other contemporary statistical techniques and found that monetary policy impact on bank retail rates was sticky downward both in the short and long-run. Similarly, Kelilume (2014) decompose a sticky policy rate pass-through into short-term and long-term retail interest rates and found that the effectiveness of monetary policy was confined to its impact on interbank rates.

Abayomi and Sheriffdeen (2015) find differing outcomes in a study of the IRPT on commercial banks' financial products. They documented complete transmission in the short-run, for most deposit rates, except the 12-month deposit rate. For the lending rates, the pass-through was complete in the prime lending rate but partial for the maximum lending rate. Further analyses on its speed showed a mean adjustment period of sixteen (16) months for deposit rates and seven (7) months for the prime lending rates to revert to their respective equilibria. The authors concluded that monetary policy could considerably be used to effectively influence the short-run interest rates in Nigeria, given that transmission of wholesale rates to banks' retail rates is found to be significantly high.

Mordi et al. (2019) document some robust evidence on IRPT in Nigeria. They reported a long-run relationship between the MPR and the prime lending and savings rates, despite significant structural breaks in the co-integrating vectors. The study showed that the transmission of MPR changes to retail rates was not complete and that all rates (except the savings rate) adjusted symmetrically. This, they argue, suggests that changes in savings rate depended on the nature of the shock to the policy rate. Positive shocks in the policy rate were transmitted wholly to the savings rate within two months vis-à-vis eight months for negative MPR shocks. They further found that it took about fourteen months for shocks to the policy rate to be passed fully to the prime lending rate, while the full impact on the 6-months deposit rate took about eleven (11) months.

Employing the generalised method of moments (GMM) two-step estimator, Matousek and Solomon (2018) investigate the impact of bank restructuring policies of the CBN between 2002 and 2008 on bank lending channel of transmission. Using bank-level data from 23 recapitalised banks, the study revealed that larger and more capitalised banks were less sensitive to changes in monetary policy. It further noted that the bank lending channel improved banks' resilience to monetary shocks and that the restructuring activities of the CBN helped to improve the impact of the bank lending channels. Reflecting on the role of central banks in economic development, Osadume (2018) uses the ordinary least squares, co-integration, Granger-causality and error correction model to examine how monetary policy rate and other interest rates affected economic development in Nigeria. He found that interest rates and monetary policy rates had positive and significant effects on economic development in both the short-run and long-run, with fast adjustment speeds.

Mangwengwende et al. (2011) investigate the link between banking sector concentration and interest rate pass-through in Botswana, Nigeria, South Africa and Zambia using monthly data. Applying asymmetric error correction, mean adjustment lag (MAL) and autoregressive distributed lag models, they presented some interesting results. Amidst having the lowest banking sector concentration among the set of countries studied, a cointegration of the deposit and lending rates was found in Nigeria. In addition, the symmetric error correction for deposit and lending rates was found to be significant, with the latter adjusting faster than the former. This result notwithstanding, lending rates adjustment was found not to be indicative of a relationship with bank concentration levels, which was the lowest. Furthermore, they reveal that Nigeria's lowest banking concentration level is neither related to symmetric and asymmetric response to lending rates, nor to the speed of symmetric response of deposit rate when above equilibrium and in the short-run. However, they find that lending rates have the smallest asymmetric long-run adjustment, which, like the other countries, may be related to the level of banking sector concentration.

Mishra et al. (2014) use a panel structural VAR model to examine the transmission of monetary policy to bank lending rates across a large number of countries traversing advanced economies, emerging market economies and low-income countries. They found that the response of lending rates to changes in monetary policy varied widely across countries. Additionally, they noted that the pass-through of monetary policy among developing countries was generally weaker compared to the rest. They attribute this to weak institutions and a non-competitive banking environment that characterise the low-income countries. This corroborates an earlier finding by Mishra and Montiel (2012) that the transmission of monetary policy is particularly weak among developing countries.

Anwar and Nguyen (2018) made use of the SVAR method to examine monetary policy transmission mechanisms in Vietnam. They particularly considered how the economy responded to shocks in domestic and foreign monetary policy. Their finding was that the credit channel was important because, among other channels, it stood out in the propagation of monetary policy in the country. This role, however, seen via the impact of money supply (M2) on real output, was not as strong as expected, implying a weak or muted credit channel of monetary policy transmission. With mixed outcomes as regards credit channel of transmission, attention may be turned to the interest rate mechanism.

From the reviewed literature, it is evident that whereas the incompleteness of the interest rates pass-through of monetary policy in Nigeria has been established, many of the authors have located the sources of these limitations in either the nature/level of financial markets or the inherent downward stickiness of retail interest rates. Yet, one area with potentially significant influence within the monetary policy circle that was never touched by any of the empirical studies is the role of the standing facilities in the transmission of monetary policy to bank interest rates. Motivated by the need to fill the gap this paper estimates the possible pass-through of standing lending and deposit facilities to retail interest rates in Nigeria.

III.3 Theoretical Framework

Monetary policy under a corridor-operating framework is typified by lending and deposit windows through which central banks manage reserve requests of the banking system. The rate of interest in this window is usually kept at a level above the anchor rate to restrain banks from undue resort to the monetary authority but instead foster increased inclination towards the interbank market. In the same vein, the deposit window in the corridor system serves as a medium through which banks with excess liquidity can lodge such surpluses with the central bank overnight at a fixed rate of interest. Like the typical discount rate, the deposit rate will normally be set below the anchor rate to encourage depository corporations to trade their surplus funds in the interbank market.

With the upper and lower bounds in place, the corridor system is designed to taper oscillations in the short-term rates. When banks are in need of funds to square up their statutory reserve balances, they will be discouraged to pay a rate that is more than the upper bound rate. In the same vein, when in a surplus position, they will rationally reject rates below the standing deposit rate. Besides, within the corridor, banks with surpluses and shortages of funds will be motivated to lend to and borrow from one another resulting in a vibrant interbank market. In this way, the monetary authority may be able to exercise firm control over the interest rate on short-term funds. For the banking system, the applicable rate at any point in time will depend on the liquidity situation.

In Nigeria, the standing facilities window was introduced as a discount window framework for liquidity management. It comprises two rates: the standing deposit facility (SDF) rate that is a fixed point below the MPR, and the standing lending facility (SLF) rate, above the MPR. In a deficit liquidity situation, the CBN will be injecting liquidity at the SLF rate (upper bound of the policy corridor), and in periods of excess liquidity, however, the Bank will be draining liquidity from the system at the

SDF rate (lower bound of the policy corridor).[1] In view of this, two sets of effective policy rates are considered: the SDF rate during liquidity surplus (net liquidity injection < 0); and the SLF rate during liquidity deficit (net liquidity injection > 0).

IV. Data and Methodology

Several studies on monetary policy in Nigeria (including Mordi et al. (2019); Okaro (2011) and Bassey et al. (2018)) have employed the MPR, money supply and credit to the economy as proxies for monetary policy. This study deviates from the previous ones by making use of the discount window corridor rates to investigate the transmission of monetary policy to retail interest rates of deposit money banks. Having confirmed cointegration of the potential variables in this study, an error correction model was employed to determine the short-run and long run dynamics.

IV.1 Methodological Framework

In addition to Gregory and Hansen (1996) method that accounts for a structural break, the study relied largely on the methodological framework for modelling dichotomous explanatory variables. The framework is appropriate for time series analysis with seasonality or regime-switching independent variables (Koop, 2013; Wooldridge, 2016). To ensure the corridor rates fit into the framework, the standing deposit facility and standing lending facility rates are adjusted by a liquidity condition dummy, which takes on the values 0 and 1 to align with the mutual exclusiveness of liquidity surplus and deficit. The adjustment was achieved by taking the product of each of the standing facility rates and the associated liquidity condition dummy for each period. By this adjustment, the model will be switching between the corridor lending and deposit rates according to the prevailing liquidity condition. We apply a modified version of the framework used by Das (2015) in the case of India, and incorporate into the long-run model, the standing deposit and standing lending rates that are adjusted by a liquidity condition dummy as follows:

$$BIR_{it} = \beta_{it} + \beta_{1it}SDF_t * LiqCon_t^- + \beta_{2it}SLF_t * LiqCon_t^+ + \varepsilon_{it} \quad (1)$$

Where: $LiqCon_t^+ = \begin{cases} 1\ if\ SF\ net\ injection > 0 \\ 0\ if\ otherwise \end{cases}$ during liquidity shortage

$LiqCon_t^- = \begin{cases} 1\ if\ SF\ net\ injection < 0 \\ 0\ if\ otherise \end{cases}$ during liquidity surplus

[1] The central bank also provides temporary liquidity accommodation to the banks using the repo rate and withdraws liquidity during surplus conditions using the reverse repo rate. However, this study does not cover the repo and reverse repo as the focus is on monetary policy operations via the standing facilities.

This ensures the capturing of the effects of policy switches between liquidity contraction and expansion all through the entire period of the sample, and not being restricted to the MPR that moves less frequently.

BIR_{it} are the different retail interest rates of commercial banks at time t. β_{it} is a mark-up for the different interest rates, while β_{1it} and β_{2it} capture the transmission effects of liquidity expansion and contraction through the standing facilities, respectively, for every specification of retail rates. ε_{it} is the residuals obtained from the various equations of bank interest rate.

IV.2 Data

The study makes use of monthly data on nine retail interest rates of commercial banks and the two bounds around the policy corridor. The two standing facility corridor rates are then adjusted to reflect the applicable or effective policy rates during periods of shortages and surpluses of liquidity. Net liquidity injection and proxy for liquidity conditions (surplus or deficit) were derived by taking the differential of the monthly series of the CBN claims on deposit money banks. An increase in these claims plausibly indicates the injection of liquidity into the system while a contraction of the claims points to the opposite. The nine retail rates are: prime lending rate (plr), maximum lending rate (mlr), savings rate (svr), 7-day time deposit (td7d), the rate on one-month tenor deposit (td1m), the rate on three-month tenor deposit (td3m), the rate on six-month tenor deposit (td6m), the rate on twelve-month tenor deposit (td12m) and time deposit above 12 months (tda12m). The data were sourced from the CBN's statistics database with a series spanning 2007:06 to 2019:12. The choice of this series range is guided by data availability for all the variables.

IV.3 Model Specification

For each of the interest rates, an error correction model is estimated thus:

$$\Delta BIR_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \Delta BIR_{t-i} + \sum_{i=0}^{q} \beta_i \, \Delta SDF_{t-1}^{ADJ} + \sum_{i=0}^{q} \delta_i \, \Delta SLF_{t-1}^{ADJ} + \varphi ECT_{t-1} + \mu_t \qquad (2)$$

Where SDF^{ADJ} is SDF modified by the liquidity condition, SLF^{ADJ} is SLF modified by the liquidity condition, and φ is a measure of the speed of adjusting back to long-run equilibrium after a deviation occurred. ECT_{t-1} is a one-period lag of the residuals from the selected Gregory-Hansen long-run equation for each of the bank interest rates.

As the usefulness of applied time series is based on the assumption of parameter constancy, it becomes imperative to adopt a procedure that explicitly checks if structural breaks are present in the series; hence, the choice of Gregory-Hansen cointegration method. The cointegration test with unknown break dates involves estimating the augmented Dickey-Fuller and Philips-Perron test statistics for each of the break points and then picking out the one with minimum values obtained across all possible break points since this will provide ample grounds for the rejection of the null hypothesis of no cointegration. Gregory and Hansen (1996) came up with four models for the test, namely:

(i) Standard model with no structural change:

$$y_{1t} = \mu + \alpha^T y_{2t} + e_t \qquad t = 1, \dots, n \qquad (3)$$

Where y_{it} is *I(1)* and e_t is *I(0)*, μ and α are the intercept and slope, respectively. To specify models with structural shifts, a dummy variable is introduced:

$$\theta_{t\tau} = \begin{cases} 0 \; if \; t \leq [n\,\tau], \\ 1 \; if \; t > [n\,\tau]. \end{cases}$$

Where the unknown parameter $\tau \in (0,1)$ is the timing of the point of the break.

(ii) Model with a level shift in which only the intercept shifts:

$$y_{1t} = \mu_1 + \mu_2\theta_{t\tau} + \alpha^T y_{2t} + e_t \qquad t = 1, \dots, n \qquad (4)$$

Where μ_1 is the intercept prior to the break and μ_2 is the change in intercept when the shift occurred.

(iii) Model in which level shifts with trend;

$$y_{1t} = \mu_1 + \mu_2\theta_{t\tau} + \beta t = \alpha^T y_{2t} + e_t \qquad t = 1, \dots, n \qquad (5)$$

(iv) Model with regime shift in which the slope also shifts.

$$y_{1t} = \mu_1 + \mu_2\theta_{t\tau} + \alpha^T y_{2t} + \alpha^T y_{2t}\theta_{t\tau} + e_t \qquad t = 1, \dots, n \qquad (6)$$

Where μ_1 and μ_2 are as defined in equation (4), α_1 and α_2 the slope before and after the regime shift respectively.

The best-performing model in terms of fit is then chosen. In this study, model selection is based on the Akaike information criterion. To account for possible bias from misspecification due to structural breaks, the vector of residuals from the selected Gregory-Hansen equation is incorporated into equations (2) and (7) as the error correction term (ECT).

To check for asymmetric adjustment, we estimate the following dynamic equation:

$$\Delta BIR_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \Delta BIR_{t-i} + \sum_{i=0}^{q} \beta_i \, \Delta SDF_{t-1}^{ADJ} + \sum_{i=0}^{q} \delta_i \, \Delta SLF_{t-1}^{ADJ} + \varphi_1 ECT_{t-1}^{pos} + \varphi_2 ECT_{t-1}^{neg} + \mu_t \quad (7)$$

Where BIR are commercial bank retail rates; SDF^{ADJ} and SLF^{ADJ} are the standing deposit facility and standing lending facility rates adjusted by taking the product of each of them and the associated liquidity condition dummy as explained under equation (1). This adjustment allows the model to switch between the standing deposit and lending rates according to the prevailing liquidity condition. ECT^{pos} and ECT^{neg} are obtained by splitting the residuals from the applicable Gregory-Hansen specification into positive and negative values corresponding to when they are above and below their long-run average, respectively.

Estimation of equation (7) yields the error correction coefficients φ_1 and φ_2 for testing whether the effects are the same for monetary loosening and tightening. The test for ascertaining whether the adjustment process is asymmetric or not is executed by checking the restriction that the adjustment parameters in equation (7) are equal (Ho: $\varphi_1 = \varphi_2$). If the Wald test fails to reject the null, then, we can rule out any suggestion of asymmetry.

A note on the implications of changes in SLF and SDF may be apt at this point, an increase in SLF implies an increase in the cost of funds from the CBN source. This can have a positive or negative impact on banks' interest rates. When there is an increase in the cost of funds from CBN, banks may try to save costs by reducing interest rates paid on different tenures of their deposit products. In this case, we expect the effect of an increase in SLF on the deposit rate to be negative. If, however, an increase in SLF drives banks to resort to the alternative of aggressive deposit mobilisation by offering high interest rates to depositors, the effect of an increase in SLF on deposit rates as well as on lending rates will be positive. Therefore, while the long-run effect of an increase in SLF on banks' lending rates will be positive, the effect on deposit rates will depend on which one dominates the desire for cost reduction versus the desire for aggressive deposit mobilisation.

Furthermore, an increase in SDF implies a heightened desire to mop up liquidity. In other words, an increase in SDF is an incentive for banks to deposit at the central bank, thereby reducing the amount of liquidity in the system. This happens mostly during persistent liquidity overhangs. During this period, bank interest rates, especially on deposits, tend to fall naturally. Since the cost of funds sourced from CBN and the cost of funds sourced by deposit mobilisation both fall in periods of excess liquidity, we expect the effect of an increase in SDF on banks' interest rates to be negative in the long-run.

IV.4 Estimation Procedure

First, we check the statistical properties of the variables. Thereafter, we conduct a single equation test for cointegration using the Gregory and Hansen (1996) algorithm. Following the cointegration test, an error correction model is estimated for the bank interest rates as specified in equation (2). Test for the existence of asymmetric adjustment follows the approach used by Scholnick (1996), which was also applied by Das (2015) and Mordi et al. (2019). The equilibrium condition between the bank interest rate and policy rates is defined as the mean of the residual series from the cointegrating equation. The approach involves splitting the residuals from equation (1) into their positive (ECT^{pos}) and negative (ECT^{neg}) values which correspond to when the residuals are above and below their long-run average, respectively, as specified in equation (7).

V. Results and Discussion

The main findings are presented in this section.

V.1 Unit Root Tests

As part of the pre-estimation diagnostics, the time series properties of the variables were examined using standard statistical and econometric tests. The order of integration of each variable is checked with the Augmented Dickey-Fuller (ADF) test. The results show that each of the eleven variables is integrated of order one, at the 5.0 per cent level of significance, and are therefore differenced once to achieve stationarity (Table 1).

Table 1: Results of Stationarity Tests

Variable	Level	p-value	1st Difference	p-value	Order of Integration
sdf^{adj}	-1.743463	0.4072	-21.62629	0.0000	I(1)
slf^{adj}	-2.262155	0.1858	-21.60497	0.0000	I(1)
Mlr	-1.443604	0.5592	-4.077640	0.0014	I(1)
Plr	-2.091192	0.2486	-3.413829	0.0120	I(1)
Svr	-0.755810	0.8279	-6.132546	0.0000	I(1)
td7d	-1.791244	0.3837	-3.308107	0.0163	I(1)
td1m	-2.147397	0.2267	-3.106170	0.0283	I(1)
td3m	-2.188975	0.2112	-4.742910	0.0001	I(1)
td6m	-2.180099	0.2145	-3.546302	0.0081	I(1)
td12m	-2.308206	0.1708	-3.160517	0.0245	I(1)
tda12m	-2.037227	0.2708	-16.76165	0.0000	I(1)

Source: Authors' compilation.

V.2 Cointegration Test

The Gregory-Hansen residual-based cointegration test was used to determine the long-run relationship between corridor rates and selected retail rates, and also resolve biases derivable from structural breaks (see section IV.2).

The results of the tests, which are presented in Table 2, indicate that at the 5.0 per cent level of significance, the policy rates are cointegrated with a 7-day time deposit, 1-month time deposit, 3-month time deposit, 12-month time deposit and time deposit above 12 months. This implies that the error correction approach can be applied to examine the long-run relationships between the standing facility rates and interest rates of banks. As further shown in the table, structural breaks occurred in February 2010 for the 7-day time deposit and March 2010 for the other four variables. The breaks occurred during the period of re-emergence of liquidity surfeit in the banking system after the Global Financial Crisis of 2007–2009, which prompted the CBN to change from monetary easing to a tightening stance in September 2010. The test statistics, however, did not indicate any long-run relationship between the policy rates and maximum lending rate, prime lending rate, saving rate and 6-month time deposit. As shown in Table 2, the computed ADF or Z-statistics are larger than their critical values at the 5.0 per cent level of significance. Therefore, these variables cannot be carried along in the error correction model estimations.

Table 2: Results of Gregory-Hansen Cointegration Tests

	Statistics	intercept shift	intercept shift with trend	intercept and slope shift
mlr	ADF t-stat	-3.557453	-3.872139	-3.681776
	Break date	2016M06	2011M04	2015M11
	AIC	-4.566523	-6.21864	-4.546727
plr	ADF t-stat	-3.515419	-3.411952	-3.39585
	Break date	2009M08	2009M07	2015M07
	AIC	-6.218095	-6.212207	-6.242201
svr	ADF t-stat	-4.010619	-3.912805	-4.507788
	Break date	2013M10	2010M08	2013M10
	AIC	-6.725381	-7.005925	-6.7056
td7d	Za-stat	-51.20868**	-52.17658	-54.54624
	Break date	2010M02	2010M03	2010M02
	AIC	-5.859161	-5.988142	-5.836561
td1m	Za-stat	-56.05271	-65.6814**	-62.60071
	Break date	2010M03	2010M03	2010M03
	AIC	-4.723161	-4.751063	-4.701479
td3m	Za-stat	-52.8912	-56.34552**	-57.52493
	Break date	2010M03	2010M03	2010M03
	AIC	-4.832387	-4.861392	-4.814729
td6m	ADF t-stat	-3.512944	-5.265278	-5.311011
	Break date	2010M06	2010M05	2010M05
	AIC	-4.531669	-4.525363	-4.509146
td12m	Za-stat	-39.8476	-54.50849**	-43.03647
	Break date	2010M03	2010M03	2010M03
	AIC	-4.325258	-4.31434	-4.301011
tda12m	Za-stat	-76.54178	-80.92498**	-84.01182
	Break date	2010M03	2010M03	2010M06
	AIC	-4.632225	-4.744413	-4.607116
5% crit. Values	ADF t-stat	-4.92	-5.29	-5.50
	Za-stat	-46.98	-53.92	-58.33

Source: Authors' compilation.

V.3 The Long-Run Models

Of the five retail rates estimated, the long-run coefficients for three of them (1-month time deposit, 3-month time deposit and time deposit above 12 months) are negative and significant. The coefficient for another one of the five rates (7-day time deposit) is also negative but only significant at 10.0 per cent, while that of the fifth rate (12-month time deposit) is negative but not statistically significant (Table 3). The consistent negative coefficients for the SDF for all the rates is congruent with *a priori* expectation as bank interest rates tend to fall generally when the SDF rises in accord with CBN's intention to mop up during liquidity surplus. Furthermore, as shown by the negative coefficients of the SLF, the results indicate that the higher cost of CBN-sourced funds is associated with a fall in deposit rates of banks. The implication, therefore, is that banks' desire to save costs by lowering deposit rates dominates over their desire for aggressive deposit mobilisation in periods of tight liquidity. In other words, banks are more inclined to cutting costs during tight liquidity than offering higher interests to attract more deposits. This is a key finding of this study.

Table 3: Result of Long-Run Equations

Bank int. rates	Policy rates	Coefficients	Probability
td1m	SDF	-0.190718***	0.0061
	SLF	-0.104806**	0.0133
td3m	SDF	-0.155479**	0.0180
	SLF	-0.083856**	0.0363
td7d	SDF	-0.066430*	0.0927
	SLF	-0.044042*	0.0681
td12m	SDF	-0.093362	0.2840
	SLF	-0.024640	0.6427
tda12m	SDF	-0.258339***	0.0005
	SLF	-0.134240***	0.0032

***, ** and * imply significant at 1%, 5% and 10% respectively
Source: Authors' compilation.

V.4 Error Correction Models

The estimated coefficients of the error correction term (ECT) for the five interest rates are negative and significant at the 5.0 per cent level, signifying the existence of long-run convergence between the lower and upper bounds of the policy corridor and each of the five variables. The magnitudes of the coefficients of the error correction term appear to be clearly suggestive of a rather weak speed of adjustment of the retail rates to their long-run equilibria. At -0.06 and -0.18, the slowest and fastest speeds of adjustment were seen in the models for 3-month time deposits and time deposits above 12 months, respectively. These imply that about 6.18 per cent and 17.65 per cent of the deviations or errors are corrected within a period of one month for a 3-month time deposit and time deposit above 12 months, respectively. The speeds of adjustment for other rates lie between these two ends.

Table 4: Speed of adjustment

Bank int. rates	ECT coefficients	Probability
td1m	-0.067111	0.0373
td3m	-0.061760	0.0299
td7d	-0.064326	0.0410
td12m	-0.091703	0.0348
tda12m	-0.176467	0.0111

Source: Authors' compilation.

V.5 Asymmetric Adjustment

The results of the asymmetric error correction model show the response of retail interest rates to MPR movements via the standing facilities. The equality of adjustments of the interest rates to shifts in policy was tested using the Wald test. The results presented in Table 5 show homogeny in the adjustment of all the retail rates (whether they are low or high compared with their equilibrium) to the standing facility corridor rates. In other words, the null hypothesis that the parameters φ_1 and φ_2 are equal was not rejected for each of the five retail rates, meaning there was no asymmetry in the adjustment process of bank deposit rates to shifts in the SDF and SLF.

Table 5: Results of Tests for Asymmetric Adjustment

	Coefficients		Wald test: φ_1=φ_2	
Bank interest rate	φ_1	φ_2	χ^2	Probability
td1m	-0.096632*	-0.063950	0.192413	0.6609
td3m	-0.104529*	-0.030493	0.814296	0.3669
td7d	-0.130475**	-0.016086	1.598820	0.2061
td12m	-0.192243**	0.011918	2.077600	0.1495
tda12m	-0.158270	-0.229298*	0.111252	0.7387

***, **, * imply significant at 1%, 5% and 10% respectively
Source: Authors' compilation from Eviews 9 output.

V.6 Post-Estimation Diagnostics

Some post-estimation diagnostics were carried out to determine the health of the models. Serial correlation, heteroscedasticity, residual normality and parameter stability were checked using Breusch-Godfrey, White, Breusch-Pagan-Godfrey, and CUSUM tests, respectively. There were no serial correlations detected in the five models. Furthermore, all the models were dynamically stable as evidenced by the CUSUM test. However, heteroskedasticity was detected only in the equation for a 1-month time deposit (which was corrected using the Huber-White covariance method), while residual normality concerns were seen in all the models.

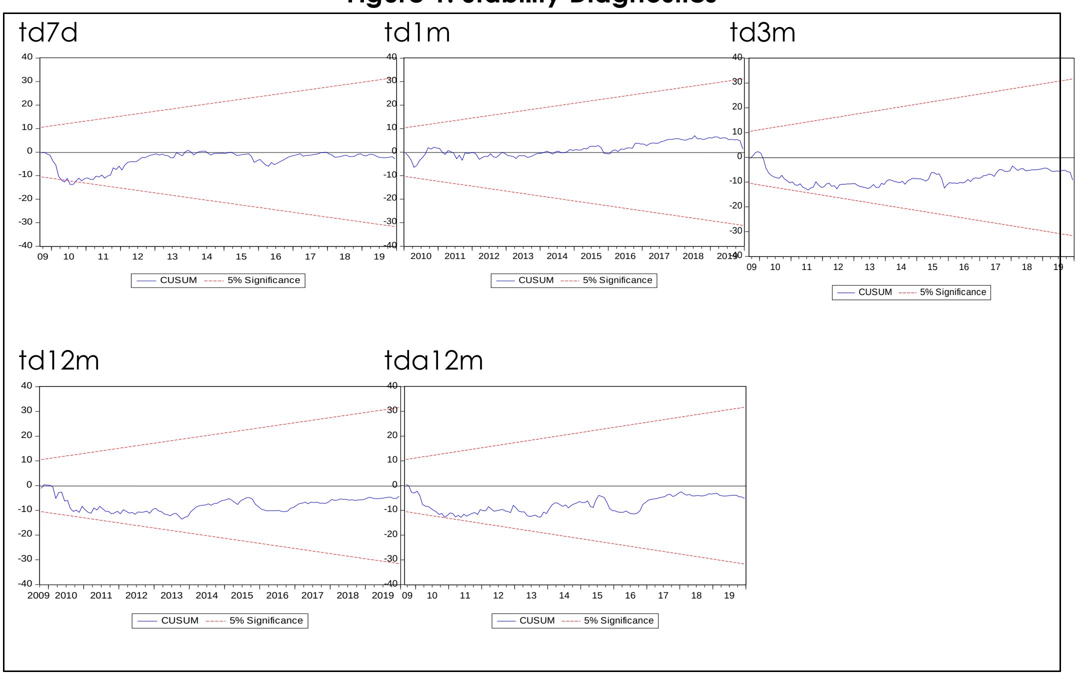
In large sample studies, residual normality concern is not a threat since the least-squares estimators of the parameter and variance are still consistent. They converge to their true values and are still useful for implementing tests and inferences. The t-statistic will be asymptotically normally distributed when error normality does not take place (Wooldridge, 2016; Greene, 2012). Therefore, we can say our models are reasonably adequate for this study.

Table 6: Post-estimation diagnostics

Variable	Issue	Statistic	Probability	Remark
td7d	Serial Correlation	1.030704	0.5973	No Serial Correlation
	Heteroskedasticity	26.13158	0.1615	Not Heteroskedastic
	Normality	33.35756	0.0000	Non Normal Residuals
td1m	Serial Correlation	0.638771	0.7266	No Serial Correlation
	Heteroskedasticity	114.2048	0.0000	Heteroskedastic
	Normality	360.3113	0.0000	Non Normal Residuals
td3m	Serial Correlation	0.072064	0.9646	No Serial Correlation
	Heteroskedasticity	35.48127	0.1271	Not Heteroskedastic
	Normality	52.62421	0.0000	Non Normal Residuals
td12m	Serial Correlation	0.907849	0.6351	No Serial Correlation
	Heteroskedasticity	27.61572	0.1188	Not Heteroskedastic
	Normality	29.37539	0.00000	Non Normal Residuals
tda12m	Serial Correlation	2.364548	0.3066	No Serial Correlation
	Heteroskedasticity	38.99800	0.0634	Not Heteroskedastic
	Normality	301.4893	0.0000	Non Normal Residuals

Source: Authors' compilation.

Figure 1: Stability Diagnostics



Source: Authors' compilation.

V.7 Robustness Checks

For robustness checks, three variables are included and estimated in another model (equation 8) to control for other factors that influence commercial bank interest rates apart from the standing facility rates. Such factors may include regulatory thresholds and other elements that reflect activities in the interbank market. Hence, private sector cash reserve requirements (CRR), inter-bank call rate (IBC) and open buy-back rate (OBB) were selected as the control variables.

$$\Delta BIR_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \Delta BIR_{t-i} + \sum_{i=0}^{q} \beta_i \, \Delta SDF_{t-1}^{ADJ} + \sum_{i=0}^{q} \delta_i \, \Delta SLF_{t-1}^{ADJ} + \sum_{i=1}^{P} \rho_i \, \Delta CRR_{t-i} + \sum_{i=1}^{P} \omega_i \, \Delta IBC_{t-i} + \sum_{i=1}^{P} \xi_i \, \Delta OBB_{t-i} + \varphi ECT_{t-1} + \mu_t \quad (8)$$

The results of equation (8) are presented in Table 7.

Table 7: Speed of adjustment (model with control variables)

Bank int. rates	ECT coefficients	Probability
td1m	-0.033402	0.0279
td3m	-0.072240	0.0147
td7d	-0.073208	0.0302
td12m	-0.094958	0.0308
tda12m	-0.135618	0.0372

Source: Authors' compilation.

The results confirm the validity of the earlier results. The estimated coefficients of the error correction term (ECT) for bank interest rates are negative and significant at the 5.0 per cent level even when control variables are included in the model. This implies that long-run convergence exists between the standing facility rates and each of the retail rates. From a minimum of about -0.03 for a one-month time deposit to about -0.14 for time deposits above 12 months, the speeds of adjustment range from 3.34 to 13.56 per cent per month across the five retail rates, indicating a slow speed of reverting to their long-run equilibria.

V. Conclusion

In this paper, we examined interest rate pass-through from the perspective of the discount window operations using monthly data from 2007:06 to 2019:12. The cointegration tests based on Gregory and Hansen (1996) show that just five of the nine interest rates examined have long-run relationships with the standing deposit facility and standing lending facility rates, with structural breaks occurring around 2010:M02 and 2010:M03 in all the relationships.

The influence of the structural breaks is therefore built into the error correction model estimated for each bank retail interest rate. For each of the five variables that have a long-run relationship with the standing facilities, we estimate the long-term interest rate pass-through and examine how they adjust to monetary policy impulses through the policy corridor rates of the CBN. We found these to be significant but with slow speeds of adjustment. Accommodating structural breaks in our modelling approach, we also found no asymmetry in the adjustment process of retail rates to their long-run equilibria. However, adjustment speed analyses suggest sluggish transmission of changes in the standing facility rates to the five rates as well as a slow reversion to equilibrium.

Furthermore, there exists a long-run relationship between the standing deposit and lending facilities on one hand, and five deposit rates (7-day time deposit, 1-month time deposit, 3-month time deposit, 12-month time deposit and time deposit above 12 months) on the other. We also delineated a weak pass-through of the policy rates to the retail interest rates of commercial banks. The observed slow pass-through is largely in line with the results of many previous studies on the subject such as Mordi et al. (2019) and Sanusi (2010). The implication is that monetary policy transmission through the interest rate channel is not very strong in Nigeria. Therefore, factors other than the market as currently constituted may have an overwhelming influence on retail interest rates in Nigeria. Finally, we found an inverse adjustment of the deposit rates to changes in the standing lending facility. The implication of this is that, when the cost of funds rises due to a higher standing lending facility rate, banks' desire to reduce interest expense outweighs the inclination for aggressive deposit mobilisation via higher deposit interest rates.

Therefore, there is a need for greater efforts toward further development of the money market in Nigeria to enhance its sensitivity to monetary policy signals. There is also the need for cautious investigation of possible non-market factors that could be affecting the efficacy of monetary policy transmission.

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