ARE GAP MODELS POLICY CONSISTENT?
A QUARTERLY PREDICTION MODEL FOR MONETARY POLICY IN NIGERIA [1]

JEL: E31, E52

Monetary Policy, Forecasting and Simulation

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ABSTRACT

The paper describes a small calibrated model for monetary policy in Nigeria — the model depict the relationship between economic developments and the central bank's response to them vis-à-vis setting its Monetary Policy Rate (MPR). In a system of behavioural equations including an aggregate demand (IS curve), aggregate supply (Phillips curve) and an uncovered interest rate parity equation, a Taylor-type reaction function is used in various scenarios to assess the efficacy of the conduct of monetary policy. Although it is a simple prediction model, the parameters and constraints fit the stylised facts, making inflation forecasts possible as is required in an Inflation Targeting framework. The results suggest that the framework is a useful way to summarize key elements of monetary policy in Nigeria. Though this type of study is common for advanced economies in recent times (e.g. Laxton et al, 2000)[2], relatively little work has been undertaken for developing countries such as Nigeria. Models do not necessarily have to be sophisticated to ensure forecast consistency, and a lot of innovation in the development of simplified modelling methods and techniques have evolve. Given the importance of macroeconomic models for structured discussions, analysis and decision making by monetary authorities, the model is a useful tool to describe the impact of monetary policy on the economy and contribute to macroeconomic policy management, specifically monetary policy.

[1]The views expressed in this paper belong to the author and do not represent the views of the Central Bank of Nigeria.

[2] Laxton, Douglas and Alasdair Scott (2000), 'Developing a Structured Forecasting and Policy Analysis System Designed to Support Inflation-Targeting' In Inflation Targeting Experiences: England, Finland, Poland, Mexico, Brazil, Chile.

ARE GAP MODELS POLICY CONSISTENT? A QUARTERLY PREDICTION MODEL FOR MONETARY POLICY IN NIGERIA [1]

1 Introduction

It can be said that there is consensus between central bankers and academic economists that the successful conduct of monetary policy hinges on the ability of policy makers to control expectations. Thus, Reddy (2006), Governor of the Reserve Bank of India stated that "…the ability to condition inflation expectations, rather than the decisions on the policy (interest) rates, is of fundamental importance to monetary policymaking now. […] credible communication with economic agents has emerged as the critical channel of monetary transmission …" Svensson (2003), affirms this further by stating that, "I think it is fair to say that central banks control the output gap and inflation mostly through the private-sector expectations ... the current instrument rate by itself has a minimal effect … what really matters is the private-sector expectations of future instrument rates. Furthermore, inflation expectations have a major impact on actual inflation." Consequently, it is implied that the current level of short-term policy interest rates has a minimal effect on longer-term interest rates and the economy. Rather, the major factors that drive the economy are hence private sector expectation about the long-term time path of the policy interest rate.

Many central banks devote considerable resources to measuring and monitoring expectations about inflation, economic activity and future interest rates which are usually inferred rather than directly observed. Building and publishing models that produce credible central bank projections have calming impact on agents' expectations and keep them aligned with policymakers' plans, which helps avoid big surprises. Therefore, monetary policy models could be used as tools for managing expectations particularly when they are perceived as sensible and easy-to-understand. They can be adjudged credible by agents if projections (forecasts) align with long-term outcomes of macroeconomic indicators.

This paper presents a model of the Nigerian economy, which can be used to support monetary policy analysis, risk assessment and forecasting. Though the model is built on the

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principle of parsimony, it can be calibrated to capture economic realism as much as possible. It is possible to use the model to derive measures of uncertainty in the underlying baseline forecasts. The model incorporates rational expectations as economic agents cannot be fooled consistently.

The model has three structural equations: A Phillips curve for CPI inflation, an aggregate demand curve for the output gap and an uncovered interest rate parity condition that relates the behaviour of domestic and foreign interest rates and the nominal exchange rate. The fourth equation in the model is a monetary reaction function (Taylor-type rule) for setting the Central Bank of Nigeria's (CBN) anchor interest rate (Monetary Policy Rate – MPR). Notwithstanding the size of the model developed here, it is still possible to describe the main ingredient of the transmission mechanism in Nigeria, with the important advantage of its simplicity and clarity which should help to enhance the monetary policy communication strategy and its outcomes.

The model links the policy instrument (a short-term interest rate) and the nexus of output, inflation, and the exchange rate in a small-open economy. Key variables are expressed as deviations-from-equilibrium, and do not try to explain the underlying real equilibrium values. However, the model can address many policy issues that arise routinely in making decisions about monetary policy actions and communicating the reasons to the public as stated earlier. It is a trimmed down version of a generic quarterly prediction model (QPM) which is used in most inflation-targeting central banks with the objective of deciding on the appropriate level of the policy rate (given the inflation target and the current state of the economy). The model provides a helpful organizing framework for establishing near - and medium-term baseline forecasts, which encourages structured and transparent discussions of current policy issues at the central bank. Due to its ability to generate alternative scenarios, the model is also a helpful tool for risks assessment in the baseline forecast in addition to analyzing the relative importance of various assumptions.

Although monetary policy[2] formulation and implementation has a standard format, country peculiarities exist. The goal is therefore, to apply this framework to the characteristics of the Nigerian economy and to develop a useful practical model that can support monetary policy analysis. Macroeconomic modelling and forecasting is useful for obvious institutional reasons since empirical evidence could help determine the manner in which the central bank implicitly reacts to key economic developments. The outcome of this study should provide a guide for monetary policymaking and analysis in Nigeria.

The paper is structured as follows. In the next section a short background on the conduct of monetary policy in Nigeria is presented. Section 3 presents the model structure, data set and calibration technique as well as the underlying assumptions. Section 4 concludes.

2 Conduct of Monetary Policy in Nigeria

Depending on prevailing circumstances, the conduct of monetary policy by the Central Bank of Nigeria has been articulated to achieve overriding objectives, contemporaneously. In view of the foregoing, when designing monetary policy, the CBN reviewed developments in the economy over a period of time, assessed the major pressure points and risk to price stability and output growth, took a policy stance and then formulated a framework to guide its implementation. Hence, the conduct of monetary policy in Nigeria was usually confronted with the challenge of managing exchange rate, capital inflows, excess liquidity and rapid credit expansion, which is common to most resource endowed economies.

The 1958 CBN Act establishing the Central Bank of Nigeria gave it the following policy mandates: issuance of legal tender currency notes and coins in Nigeria; maintenance of Nigeria's external reserves to safeguard the international value of the legal tender currency; promotion and maintenance of monetary stability and a sound and efficient financial system in Nigeria; and acting as banker and financial adviser to the Federal Government. In line with

[2]Monetary policy is the use of instruments at the disposal of a central bank to influence the availability and cost of credit/ money with the ultimate objective of achieving price stability. Monetary policy influences movements in economic aggregates and provides an enabling environment for the attainment of broad macroeconomic objectives. The central bank is charged by national governments with the conduct of monetary policy and may be mandated to attain a single objective or multiple objectives. In most developing economies, the central bank is initially mandated with two objectives - those of price stability and economic growth.

this mandate, the Bank was charged with the responsibility of conducting monetary policy in Nigeria.

Monetary policy in Nigeria has passed through two major phases, the era of direct monetary control and that of the current regime, indirect monetary control. At inception, the monetary policy framework of the CBN was formulated on the basis of a fixed exchange rate, which was supported by an arsenal of trade and exchange controls.

Specifically, between 1958 and 1986, the need to maintain price stability, provide an enabling environment for economic growth and development as well as gainful employment, while ensuring external sector viability was dictated by the application of the "visible hand", in the form of direct control, in the determination of the exchange rate, allocation of domestic credit and foreign exchange for international payments. Some of the direct monetary control instruments were credit ceilings, selective credit controls, administered interest and exchange rates, cash reserve requirements and special deposits. The Monetary Authority was persuaded that it was necessary to deliver credit to end-users at low interest rates to stimulate output while the exchange rate should also be pegged and prevented from sustained depreciation. This was intended to reduce the incidence of imported inflation because the economy needed imports of raw materials and capital goods for improved industrial output. After designing a monetary programme, the Bank issued credit, trade and exchange guidelines which stipulated the sectoral allocation of credit by banks to the private sector, interest rate regime, the trade policy and quantitative restrictions on imports, and foreign exchange modalities. The sectoral distribution of bank credit by the CBN was reflected in its annual guidelines. The control of interest rates at relatively low levels was done mainly to promote investment and growth. Furthermore, special deposits were imposed to reduce the amount of free reserves and credit-creating capacity of banks. Minimum cash ratios were stipulated for the banks in the mid-1970s on the basis of their total deposit liabilities; but they were not very effective since they were lower than those the banks on their own maintained with the Bank.

From 1986 onwards, the difficulties encountered with implementing direct monetary controls led to the introduction of indirect controls in 1992 after painstaking preparations.

With the introduction of the Structural Adjustment Programme (SAP) in 1986, direct controls were de-emphasised as the naira, the national currency, was floated and trade and exchange controls were liberalized. The delay in transiting to indirect monetary control was on account of the underdevelopment of the financial markets at the time and the need to undertake prior activities to establish an enabling environment for effective implementation of a market based system. Under the system, the use of the "invisible hand" or market forces was encouraged. Open Market Operation (OMO) was introduced, complemented by reserve requirements and discount window operations. In order to improve macroeconomic stability for the effective implementation of OMO, efforts were directed at the management of excess liquidity and strengthening monetary and fiscal policy coordination. A number of measures introduced to reduce liquidity included the reduction in the maximum ceiling on credit growth allowed for banks; the recall of the special deposits requirements against outstanding external payment arrears to CBN from banks; abolition of the use of foreign guarantees/currency deposits as collaterals for naira loans and the withdrawal of public sector deposits from banks to the CBN. Moreover, from August 1990, the use of stabilization securities for purposes of reducing excess liquidity in banks was re-introduced.

In order to give banks more leverage in the allocation of credit, sectoral credit distribution targets were merged into four sectors in 1986, and further reduced to two in 1987. From October 1996, the authorities abolished all mandatory credit allocations. The commercial and merchant banks at the time were subjected to equal treatment since their operations were found to produce similar effects on the monetary process. Areas of perceived disadvantage to merchant banks were harmonized in line with the need to create conducive environment for their operations.

As preconditions for the introduction of OMO could not be met at once, it was necessary to undertake its implementation in phases. Thus, from September 1, 1992, the CBN lifted credit ceiling on individual banks that met CBN specified criteria in respect of statutory minimum paid-up capital, capital adequacy ratio, cash reserve and liquidity ratio requirements, prudential guidelines, sectoral credit allocation and sound management. However, the use of stabilization securities to mop up excess liquidity in banks was intensified while three discount houses commenced operations from March 1993. The CBN

commenced OMO in treasury securities with banks through discount houses on a weekly basis in June, 1993.

Under the general framework of deregulating the economy in 1986, to enhance competition and efficient allocation of resources, the Central Bank of Nigeria introduced a market-based interest rate policy in August 1987. While it was generally agreed that low interest rates, which were likely to accompany deregulation, might stifle investment, the deregulation of interest rates allowed banks to determine their deposit and lending rates according to market conditions through negotiation with their customers. However, the minimum rediscount rate (MRR), which should influence other interest rates continued to be determined by the Central Bank in line with changes in overall economic conditions. The MRR, which was 15.0 per cent in August 1987, was reduced to 12.75 per cent in December 1987 with the objective of stimulating investment and growth in the economy. In 1989, the MRR was raised to 13.25 per cent in order to contain inflation. To further liberalize interest rate management, the cap on interest rate was lifted in 1992, but re-imposed in 1994 when an inflationary spiral could not be contained.

However, in October 1996, interest rates were fully deregulated, with the banks given freedom to determine the structure of interest rates in consultation with their customers. The CBN, however, retained its discretionary power to intervene in the money market to ensure orderly developments in interest rates. The policy of interest rate deregulation has been retained since 1997. In December 2006, the MRR was replaced with the Monetary Policy Rate (MPR). The MPR was brought down to 10.0 per cent from 14.0 per cent (MRR), with a lending rate of 13.0 per cent and a deposit rate of 7 per cent. This summed up to a corridor of 600 basis points and was a standing facility intended to stem volatility in interest rates, especially inter bank rates. The Bank continued to apply the tools of reserve requirements and discount window operations alongside. However, under the standing facility, discount window operations became less prominent. Subsequently, the corridor was abolished as the overnight standing deposit facility became unremunerated to encourage increased inter bank activities. The MPR became more effective than the MRR in steering interest rates and signalling a commitment by the CBN to only lend to banks as a last resort. In order to further strengthen the money market, deepen it and ensure that treasury

instruments were fully priced in the market place without moral hazard for the CBN, primary dealers were appointed to trade in securities and underwrite them as situations demanded.

The institutional framework for monetary policy has also been reviewed over the years to ensure a more robust outcome. The Bank introduced a Monetary Policy Committee (MPC) in 1999. The MPC which deliberates on the Bank's monetary programme, reviews developments in the economy, including the state of the money and foreign exchange markets, undertakes an assessment of the risks to price stability, decides whether to adjust interest rate or not, and agrees on the measures to be taken to contain unfavourable price developments. When the MPC was constituted in 1999, the major problem was the management of the naira exchange rate, so they Committee met daily to address issues relating to effectiveness of the foreign exchange market and discussed monetary policy issues. The Committee now meets bi-monthly.

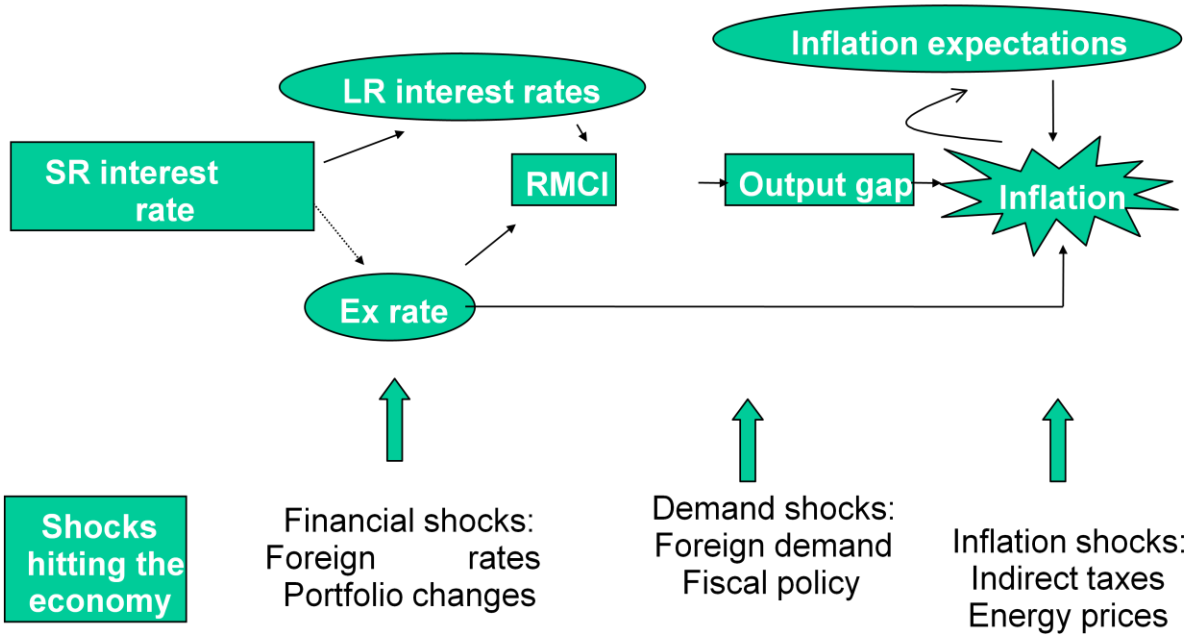
The monetary policy process has been more transparent and accountable since the MPC was introduced. At the end of every MPC meeting, a communiqué is issued and the public is able to assess the monetary policy stance of the Bank. The media makes comments on the monetary policy stance and this feeds back to the monetary policy process. The periodic reporting of the activities of the Bank to the Government (Executive and National Assembly) has also contributed to the intensified public scrutiny of the Bank's policy making.

Overall, the framework for conducting monetary policy in Nigeria witnessed some transformation. This included the shift from short-term framework to a two-year medium-term framework in the conduct of monetary policy. Although the objectives of monetary policy remained basically the same and monetary aggregates remained the intermediate target to achieve the ultimate objective of keeping inflation low and stable during these periods, there were some fundamental changes in the strategies and instruments employed in the conduct of monetary policy in order to cope with the evolving financial environment. These changes are usually analyzed under two major phases, namely, the period before the Structural Adjustment Programme (SAP) that witnessed direct control method and post-SAP era when market instruments were employed, as highlighted above.

The recent reforms in the conduct of monetary policy by the CBN have continued to yield fruitful results. However, the evolving financial and economic landscape has brought new initiatives, challenges and prospects which must be marched by effective measures in a bid to ensure macroeconomic stability. The need to capture the interrelationship between various macroeconomic variables and sectors of the economy and the ability to predict there future path is essential for attaining such laudable objectives of the CBN.

3.1 The Model

The model described below is largely based on Svensson (2000), Linde et al. (2004) and Berg et al. (2006). At several stages deviation from other formulations is made in order to adjust the model to the peculiar characteristics of the Nigerian economy. Furthermore, for completeness and in order to highlight the meaning of the structural parameters, we shall present the main stages of the model's development. The model technique is based on a simple gap model, while more complicated versions of it may be found working in many central banks around the world. Below is a description of the model structure which depicts the main transmission mechanism channels of the model.



The model consists of four core equations, namely:

1. Aggregate demand (IS curve)

2. Aggregate supply (Phillips curve)

3. Uncovered Interest Rate Parity

4. Monetary Policy Rule

3.1.1 Aggregate demand

The aggregate demand equation corresponds to the open economy type of the traditional IS curve and is of the form:

$$\hat{Y} = a_1 \hat{Y}_{t-1} - a_2 \widehat{rmc}_t + a_3 \hat{Y}_t^* + u_t \qquad (1)$$

where $\hat{Y}$ is the deviation of the log of output from its gap level, i.e., the output gap; $\widehat{rmc}$ is the real monetary condition index, defined as deviations of the long-term real interest rate from its steady state level, $\hat{r}$, and deviations of the real exchange rate from level, $\hat{z}$; while $\hat{y}$* is the foreign output gap, u is an aggregate demand shock. The coefficients a_1, a_2, and a_3 capture the persistence of output; the impact of monetary conditions on real economic activity; and the impact of the foreign environment, respectively.

3.1.2 Aggregate supply

The aggregate supply relationship, i.e., the Phillips curve is defined as follows:

$$\pi_t = b_t(b_2 \pi_{t-1} + (1 - b_2) E_t \pi_{t+1}) + (1 - b_1)\left(\pi_t^{imp} - \Delta\bar{z}\right) + b_3 \hat{Y}_t + \eta_{t,} \qquad (2)$$

where, π is the annualized quarterly change of CPI, i.e., inflation; $E\pi$ denotes model-consistent inflation expectations; π^{imp} is import price inflation; $\Delta\bar{z}$ is the trend change in the real exchange rate that reflects country's economic convergence vis-à-vis its trading partners; and η is an aggregate supply shock. Inflation pressures come from the output gap, the exchange rate gap and expected and lagged inflation.

The supply relationship encompasses multi-period, overlapping nominal contracts, extended for a direct impact of import prices, as the latter is an important feature, since small open economies usually have potent exchange rate channel of monetary transmission. The coefficient 1 (1− b_1) approximates the weight of imported goods in the consumer basket. Second, inflation in emerging-market economies partly results from the income convergence process — each percentage point of real income convergence corresponds to

one percentage increase in the price level. The trend increase in the price level caused by appreciation of the real exchange rate, was approximated by the $\Delta\bar{z}$ in the Phillips curve.

Expectations are properly captured to model both forward-looking and backward looking agents in the economy using model consistent expectations, Eπ. Economic agents who are assumed to be fully forward-looking comprise 1− b_2 of the population and b_2 agents follow the rule of thumb of past inflation. Another way of thinking about this parameter is the persistence of inflation—the more persistent inflation, the higher is b_2. The coefficient b_3 captures for the influence of the output gap on inflation (the slope of the Phillips curve), measuring the level of trade-off between output and inflation.

Import prices are often lagged and are calculated simply as the sum of foreign inflation and change in the nominal exchange rate:

$$\pi_t^{imp} = d_1\pi_{t-1}^{imp}(1-d_1)(\Delta s_t + \pi_t^*) + \emptyset_t. \quad (3)$$

This is important as it represents the direct exchange rate channel and reflects the speed of the exchange-rate pass-through.

3.1.3 Uncovered Interest Rate Parity

The relationship with the world is captured by the uncovered interest rate parity condition that relates the behaviour of domestic and foreign interest rates and the nominal exchange rate, while the nominal exchange rate may exhibit some persistence:

$$\Delta s_{t+1} = e_1\Delta s_t + (1-e_1)(i_t - i_t^* - prem_t) + v_t, \quad (4)$$

where, Δs is the change of the nominal exchange rate; i is the domestic nominal interest rate; i* is the foreign nominal interest rate; $prem$ is the risk premium; and ν is an exchange rate shock. The coefficient e_1 determines the level of exchange rate persistence—the higher its value the less sensitive is the exchange rate to changes in interest rates. It could be that the country has a deep FOREX market and thus a more stable exchange rate (Bulíř, 2005) or that the central bank intervenes heavily in the FOREX market (the more heavily the central bank intervenes, the higher the value of e_1).

The long-term version of the uncovered interest rate parity is better expressed in real variables, binding together the trend values for real exchange rate appreciation (either due to the Balassa-Samuelson effect or some "convergence inflation" as in Čihák and Holub (2003)) and the trend values of domestic and foreign real interest rates:

$$\Delta\bar{z}_{t+1} = \bar{r}_t - \bar{r}_t^* - prem_t. \quad (5)$$

The steady-state values for Δz , r and r* are set as parameters in this model, requiring prior assessment of these trend values, while the risk premium is calculated endogenously, assuring the existence of a consistent steady state. We assume that the Nigerian economy would have an equilibrium real depreciation to the tune of about 2 per cent annually. Alternatively, the central bank uses FOREX interventions actively in the Retail Dutch Auction System (RDAS) market (and the exchange rate channel) to meet the inflation target.

3.1.4 Policy Rule

Notwithstanding the level of attention given to modelling the impact of monetary policy on macroeconomic aggregates, macroeconomists are also interested in modelling the central banks' reaction to developments in the economy. These responses which are prompted by various economic realisations in addition to the particular objective of price stability are captured in econometric models commonly referred to as "monetary policy reaction functions". The analysis of the monetary authorities' reactions, although a sensibly researched topic (Khoury, 1990), was sparsely undertaken until recent interest was (mainly) motivated by Taylor (1993). The Taylor rule was formulated explicitly for determining the short-term interest rate of the central bank and states that "keep the real-short-term interest rate constant as a neutral policy stance, and make a surcharge (discount) when the output gap is positive (negative) and/or inflation is above (below) a target rate".

The model is closed by a policy reaction function of the monetary authority (a Taylor rule, Taylor, 1993). For simplicity, we take the three-month interest rate (91 day Treasury Bills) to be the instrument of monetary policy, and the authority is assumed to respond to deviations of next-period inflation from its target and to the output gap. The last-period policy stance may also affect the current policy stance:

$$i_t = f_1 i_{t-1} + (1 - f_1)(i_t^n + f_2(E_t\pi_{t+1} - \pi^T) + f_3 y_t) + \varepsilon_t, \quad (6)$$

Where, i is the domestic short-term nominal interest rate and ε is a policy shock. The monetary authority is fully forward-looking and uses model-consistent inflation expectations, $E_t\pi_{t+1}$. The policy-neutral rate, i^n, is such that keeps the output gap unchanged. We calculate it as a sum of the trend real interest rate and model-consistent inflation expectations:

$$i_t^n = \bar{r} + E_t\pi_{t+1}. \qquad (7)$$

For the sake of simplicity and representative of the current interest rate structure in Nigeria, only the three-month interest rate is used, neglecting and no long-term interest rates.

3.2 Model Calibration

The baseline version of the model is based on "reasonable" values for all the parameters, however, the model exhibits comparatively low persistence. The model expresses each variable in terms of its deviation from equilibrium, though attempt is not made to elucidate on movements in equilibrium real exchange rate, real interest rate, real output and the inflation target. The calibration process was split in two parts. First, the calibration of the trend variables which determines the steady-state levels of the model, and second the calibration of individual equations parameters, determining the business-cycle properties of the model.

3.2.1 Assumptions and Calibration on Equilibrium Values

The calibration of the long-term parameters ensures that the model converges. These adjustments are made for the trend values of the domestic and foreign real interest rates, real exchange rate, and risk premium as the values are imposed via parameters. In addition, the targets for domestic and foreign inflation are set as parameter, since the choice of an inflation target predetermines that the forecasted inflation converges to the target. The model structure above (from equations (1) to (7)), determines some important long-run relationships. The nominal interest rate converges to the neutral rate that in turn equals to the sum of the trend real interest rate and inflation target in the long-run trends "steady-state" of inflation expectations equal the inflation target. The steady-state change in nominal exchange rate comes out as the sum of steady-state inflation differential vis-à-vis the world and steady-state real exchange rate appreciation. The risk premium is calculated

endogenously given the parameterization of domestic and foreign real interest rate and the change in the real exchange rate. On the one hand, this is one way to keep the model simple. On the other hand, this simplification also keeps the trend values in (5) on a consistent path. The results of the model depend on the assumed equilibrium values. Six long-run parameters are set in the model:

a. Inflation target – A fundamental assumption is that the CBN sets interest rate similar to an inflation targeting regime. This assumption is based on the trend of actual inflation up till 2005 as described in Berg et al. (2006). The assumed target is 9.9 per cent, which is the higher end of the single digit target as prescribed under the West African Monetary Zone convergence criteria on inflation, a target the country has subscribed to meet since 2004.
b. Foreign long-run inflation (or foreign inflation target) – this is based on an assumed target for inflation by the Federal Reserve Bank of the United States, given the trend of inflation over a similar period as above. The assumed target is 3 per cent.
c. Domestic trend real interest rate – the level is assumed to be 5 per cent amounting to a risk premium of about 5 per cent.
d. Foreign trend real interest rate – this is set at 4.75 per cent
e. Equilibrium real exchange rate appreciation/depreciation – It is assumed that the national currency is under valued by about 3 per cent in the model. This assumption is based on the level of intervention of the monetary authority in the foreign exchange market over the recent past. However, the level of intervention has reduced over time, especially in the last two years under consideration (2006-2007), as the inter bank foreign exchange market and other autonomous sources have become the main supplier of foreign exchange in the market.
f. Potential output growth – this level of potential growth of the economy is set by a trend estimated at an average of 7.6 per cent. Though oil GDP has decelerated over the recent past, growth in the non-oil sector should make up for the potential output growth in the Nigerian economy.

3.2.2 Business Cycle Properties

The business cycle properties are as follows:

a. **Output gap persistence** - varies between 0.1 (extremely low persistence) to 0.95 (high persistence). An OLS regression of a log of output on its lagged value and a trend was used to estimate the parameter values.

b. **Pass-through from monetary conditions to real economy.** The value varies between −0.1 (low impact) to −0.5 (high impact) in the model calibration. The higher the parameter the more responsive is the output gap to changes in monetary policy. This implies policy reactions need to be less pronounced as the parameter in adjusted upward. An expert assessment was applied to obtain the value.

c. **Impact of foreign demand on the output gap** typically varies from 0.1 to 0.5 and is based on the export-to-GDP ratio.

d. **Ratio of domestically produced goods in the consumer basket** – varies between 0.95 (closed economy) to 0.3 (fairly open economy). Based on the share of imported goods in the CPI basket, the parameter is set at 0.65.

e. **Inflation persistence** – determines the share of forward-looking versus backward-looking agents on the goods markets. The value which varies between 0.4 (low persistence) and 0.9 (high persistence), is set in favour of backward-looking agents as pertains in the Nigerian economy and more pronounced policy reactions are required for a given disinflation goal. An OLS regression of the rate of inflation (quarter-on-quarter) on its lagged value and complement with expert assessment.

f. **Exchange rate persistence measures FOREX market flexibility**. The value varies between zero (forward-looking FOREX market) to 0.9 (either backward-looking FOREX agents or a central bank intervening on the FOREX market). Though interventions stabilize the exchange rate it does not violate the steady-state consistency of the model — e.g., the exchange rate will never appreciate as long as

there is positive inflation differential on the FOREX market (r − r*). Expert Assessment is applied.

g. **Policy rate persistence in the Taylor rule.** The value varies between zero (no persistence in policy setting) to 0.8 ("wait-and-see" policy). Taylor-rule is applied via an OLS regression of the policy rate on its lagged value and complement with expert assessment.

h. **Weight put by the policy maker on deviations of inflation from the target** in the policy rule. Expert assessment used to determine the value.

i. **Weight put by the policy maker on output gap in the policy rule.** The linear homogeneity condition: 3 f >0, otherwise the model becomes explosive and is adjusted vis-à-vis an expect assessment.

3.3 Data Source and Methodology

3.3.1 Data Source

Quarterly time series data covering 1999Q1 to 2007Q4 have been used for the simulation. Basically, data for the simulation and analysis are Gross Domestic Product (GDP) at 1990 constant basic prices, the Composite Consumer Price Index (CPI) 2003 base year, Monetary Policy Rate (MPR)/Minimum Rediscount Rate (MRR) of the Central Bank of Nigeria and the 91-day Treasury bill rate for the Domestic economy. On the other hand, data for the foreign economy was based on the United States economy which is the dominant trading partner of Nigeria and was obtained from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). Data for the Nigerian economy were sourced from various editions of the Central Bank of Nigeria, Annual Reports and Statistical Bulletin, and Statistical Bulletin of the National Bureau for Statistics. The CPI and GDP are seasonally adjusted using the Census X12 methodology. Lambda is set at 1600 for the Hodrick-Prescott filtering process.

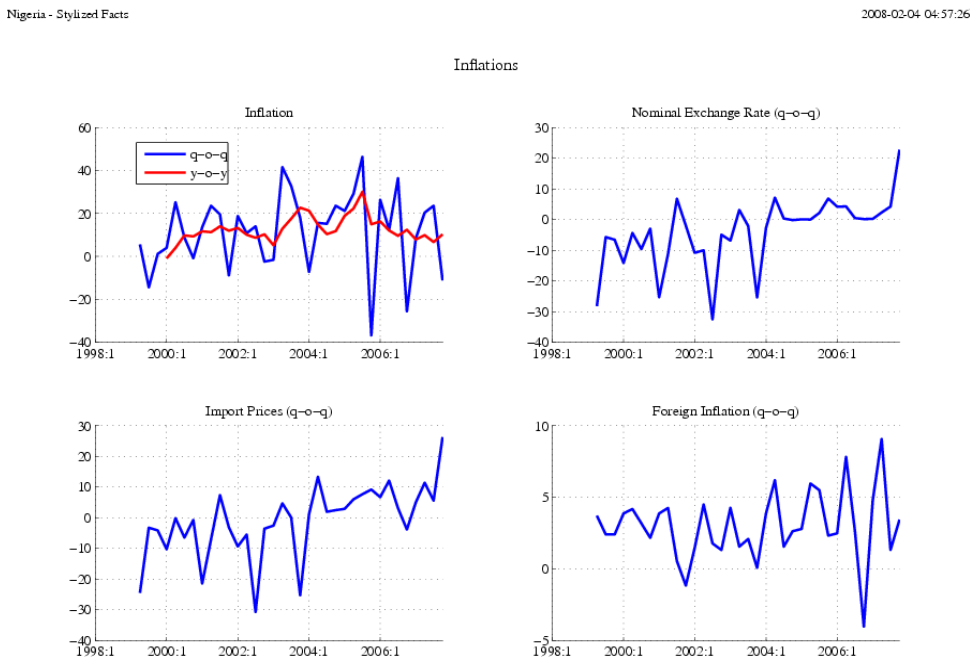
A historical database, which provides initial conditions, is necessary to run the model forward. As a minimum, the database has values for all variables that appeared with a lag in

the model structure. Thus, for a forecast starting in the first quarter of 2007, we needed initial conditions for the fourth quarter of 2006 for all variables with the lag of order one.

The output gap and inflation gaps are all generated automatically via the read function applied in the Matlad software used for the modelling. Similarly, other gaps in exchange rate and interest rates are also generated automatically. Other variables and the level of discretion considered by the MPC for decision making on the MPR were not included in the modelling process.

Stylized Facts

Inflation



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Trends

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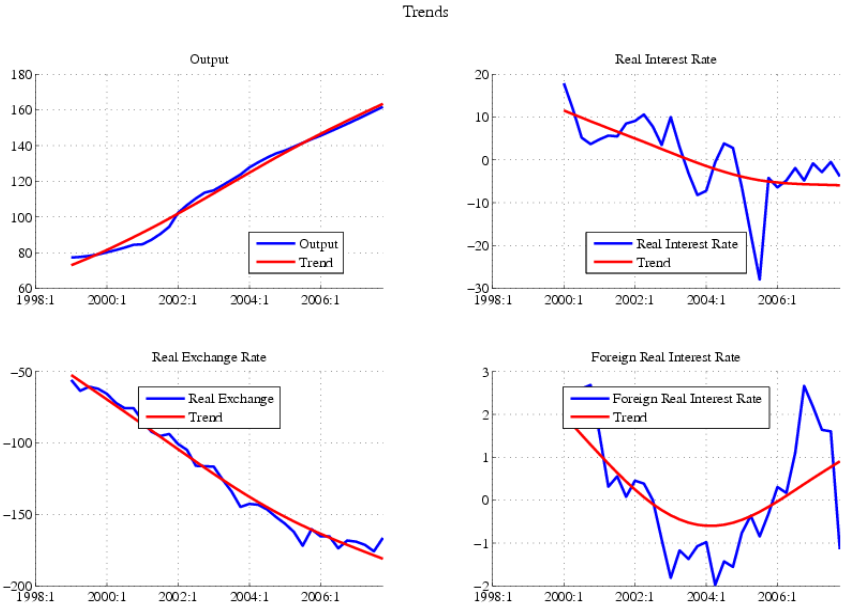

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Gaps

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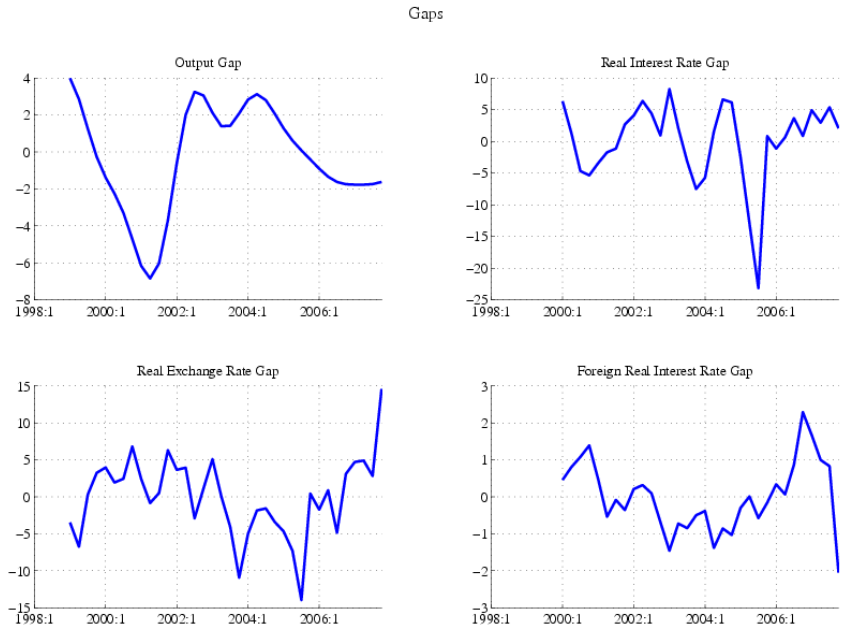

3

The model is applied in preparing a baseline forecast. Since the model is a simplified representation of the economy, it is best used to frame discussions on the baseline forecast. Above are the basic model properties depicting projection of various economic indicators and how they response to shocks in the economy. From the above the transmission process from policy rate decisions to impact on inflation would be approximately 2 years of pass-through in the first instance. Shocks to the various indicators have different effects on each other. However, an interest rate shock to the economy is more pronounced on output, as the output gap is impacted significantly.

4 Conclusions and Recommendation

4.1 Conclusions

The paper described a gap model for the conduct of monetary policy in Nigeria. Theoretically, similar approaches are applied by several inflation targeting central banks around the world to produce macroeconomic forecasts. Such a framework is useful in determining the path of monetary policy by central banks and can be used to anchor agents' expectations. The model structure is consistent with the conduct of monetary policy in Nigeria, particularly if the central bank decides to transit to an explicit inflation targeting framework. Notwithstanding, the model is equally useful in a monetary targeting framework, as Taylor (1999) notes the similarity how the two strategies (monetary targeting and inflation targeting) react to shocks suggests that both have a role as consistency check on the other when deciding how monetary policies respond to shocks in order to maintain price stability. That is, they give two reinforcing recommendations for monetary policy. It therefore implies that, in an event money supply policies become unreliable, perhaps because the money multiplier relationship in the monetary programme is unstable, interest rate policies can be brought to fore as suggested by Taylor.

The model is centred on the nominal interest rate as the policy instrument with the key principle that the role of monetary policy is to anchor inflationary expectations. Most channels through which monetary policy acts in a small open economy with a managed floating exchange rate are captured by the model. The most important use of the model is to help structure discussions on monetary policy and provide a veritable approach for

assessing risks and alternative scenarios. It should be noted that the specification and parameterization of the model was not completely data-driven. However, it provides a framework within which all available information, that is, both judgmental and econometric, can be used to evaluate economic behaviour. The resulting model is merely an abstraction of the economy, but captures the key features that matter for monetary policy.

The model has numerous limitations. For one, emphasis is placed on its simplicity as its supply side does not contain stock-and-flow relationships. For example, there is no treatment of the current account as well as the impact of fiscal operations on aggregate demand. The cost of simplicity also presents an issue of the model been susceptible to the "Lucas Critique", since it lacks the required microeconomic foundation; however, this is less emphasised than macro-econometric models for monetary policy. Other limitations exist based on the fact that certain economic features are not explicitly modelled, including credibility and optimality of policy.

It should be noted however that some limitations of the models can be addressed with minor modifications. Simple extensions could integrate more complicated expectation dynamics, modules for monetary aggregates, administered price increases, as well as fiscal operations of Government.

4.2 Recommendations

Due to time constraints the study could not be extended to cover other indicators the CBN used in taking decisions on its key policy rate in the considered period. However, the lapse provides opportunity for further research. As model-building projects could help in developing of institutional knowledge, the process should evolve over time. Models that embody the basic economic principles run the risk of being inconsistent across time in ways that sometimes defy logic and reason. Notwithstanding, models do not have to be perfect to be useful. A very useful strategy is to start simple initially and then to extend the model as suggested by experience.

It is encouraging to note that the recently amended CBN Act, 2007 makes explicit provisions for the conduct of monetary policy in Nigeria. Though monetary policy communication

process may still require fine tuning to minimise information asymmetry and foster greater policy outcomes, such issues as transparency, accountability and effective communication will become more relevant if an explicit inflation targeting regime is implemented. The Bank will be required to make public its inflation target, its operating instrument and may publicly need to explain the reasons for its inability to meet target if such a situation arises. For policymakers facing real-time policy decisions, the usefulness of the model is more pronounced in such instances.

With the introduction of the Monetary Policy Rate (MPR) by the CBN as the major indicator for signalling its monetary policy stance, the need for a model that describes the policy intention of the Bank would assist economist and economic agents in predicting the future path of monetary policy. In sum, a small open economy model has the obvious advantage of providing a simple and clear structure for thinking about monetary policy. This is not only important for the internal discussions of the central bank, but also for its communications with the public. While this would be useful for establishing the monetary stance of the central bank by economic agents, it would also help at ensuring a smooth transmission between policy decisions and their impact on financial markets in particular. In view of this, knowledge on how monetary authorities view economic developments to take decisions on the policy interest rate is therefore essential.

References

Ajayi, S. I. (1978); *Money in a Developing Economy A Portfolio Approach to Money Supply Determination in Nigeria*, Ibadan University Press, Ibadan.

……; Money, Prices and Interest Rates: The Nigeria Paradigm, Nigerian Journal of Economic and Social Studies vol. 20.

Akhtar, M. A. (1997); *Understanding Open Market Operations,* Public Information Department, Federal Reserve Bank of New York.

Berg, A., P. Karam, and D. Laxton (2006a), "A Practical Model-Based Approach to Monetary Policy Analysis-Overview," IMF Working Paper (Washington: International Monetary Fund).

----------, 2006b), "A Practical Model-Based Approach to Monetary Policy Analysis-Overview," IMF Working Paper (Washington: International Monetary Fund).

Carstenseny, K. (2003); "Estimating the ECB policy reaction function" Kiel Institute for World Economics, Duesternbrooker Weg.

Central Bank of Nigeria: Annual Report and Statement of Accounts, Various Issues.

---------- (2004); *Monetary, Credit, Foreign trade and Exchange Policy Guidelines for Fiscal 2004/2005*, *(Monetary Policy Circular No. 37)* January.

---------- CBN Statistical Bullentin (Various issues).

Choi, W. G. (1999); "Estimating the discount rate policy reaction function of the monetary authority", Journal of Applied Econometrics, 14, 379-401.

Clarida, R.; Galí, J. and Gertler, M. (1999); "The Science of Monetary Policy: A New Keynesian Perspective." Journal of Economic Literature, 37(4), pp. 1661-707.

……. (2000); "Monetary policy rules and macroeconomic stability: evidence and some theory", Quarterly Journal of Economics, 115, 147-180.

Doguwa, S. I. (2002); "Estimating Taylor-Type Monetary Policy Reaction Functions for Nigeria: 1985-2001", Journal of Monetary and Economic Integration, West African Monetary Institute, Vol. 2, Number 1, 13 – 36.

Nnanna, O. J. (2003); "Relationship Between Monetary and Fiscal Policies in Economic Management", Paper presented at the One-Day Seminar organised by the Nigerian Economic Society held at Muson Cetre, Lagos, May.

Wrightsman, D. (1976); *An Introduction to Monetary Theory and Policy,* New York, The Free Press.

Bernanke, B. S. and I. Mihov (1997) "What does the Bundesbank target?" European Economic Review, 41, 1025-1053.

Edwards, S. and M. Khan. 1985. "Interest rate determination in developing countries: A conceptual framework", IMF Staff Papers, Vol. 32, No. 3.

Hall, Robert E., and N. Gregory Mankiw (1994) “Nominal Income Targeting”, in Monetary Policy, ed. by N. Gregory Mankiw (Chicago: University of Chicago Press).

Hausman, J. A. 1978. “Specification tests in econometrics”, Econometrica, vol. 46, 1251-72.

José M. Salgado S., Garcia G. P., and Medeiros M. C. (2001); “Monetary Policy During Brazil´s Real Plan: Estimating the Central Bank´s Reaction Function” Department of Economics, Pontifical Catholic University of Rio de Janeiro.

José R. Sánchez-Fung, (2000); “Estimating a Taylor-type monetary policy reaction function for the case of a small developing economy.

Judd, J. P. and Rudebusch G. D., (1998); “Taylor’s Rule and the Fed: 1970–1997 FRBSF Economic Review 1998, Number 3

Laxton, Douglas and Alasdair Scott, (2000); “On Developing a Structured Forecasting and Policy Analysis System Designed to Support Inflation-Forecasting-Targeting,” in Inflation Targeting Experiences: England, Finland, Poland, Mexico, Brazil, Chile, (Ankara: The Central Bank of Turkey), pp. 6-63.

McCallum, B. T. (2000) “Alternative Monetary Policy Rules: A Comparison with Historical Settings for the United States, the United Kingdom, and Japan” a Paper prepared for the Economic Quarterly of the Federal Reserve Bank of Richmond.

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

Michael, B. and Lisenda, L. (2000…..) L Monetary Policy after Financial Liberalisation: A Central Bank Reaction Function for Botswana by Centre for Research in Economic Development and International Trade, University of Nottingham CREDIT Research Paper, No. 01/17

Mihailov, A. (2005); “Has More Independence Affected Bank of England’s Reaction Function Under Inflation Targeting?” Lessons from Taylor Rule Empirics.

Poole, William (1970), “Optimal Choice of Monetary Policy Instrument in a Simple Stochastic Macro Model”, Quarterly Journal of Economics (May).

Runchana, P. (2002);”Inflation Dynamics and Reaction Function In High-Inflation Environment: An Implication for Turkey” Research Department Working Paper No: 10, The Central Bank of the Republic of Turkey

Shortland, A. and Stasavage, D. (2004); “What Determines Monetary Policy in the Franc Zone? Estimating a Reaction Function for the BCEAO”

Taylor, J. B. (2000) “Using Monetary Policy Rules in Emerging Market Economies”, a revised version of a paper presented at the 75th Anniversary Conference, “Stabilization and Monetary Policy: The International Experience”, November 14-15, 2000, at the Bank of Mexico.

_____, (1999) “A Historical Analysis of Monetary Policy Rules”, in Monetary Policy Rules, ed. by John B. Taylor (Chicago: University of Chicago Press for NBER)

_____, (1993) “Discretion Versus Policy Rules in Practice”, Carnegie Rochester Conference Series on Public Policy, Vol. 39

_____, (1993) “*Macroeconomic Policy in the World Economy: From Econometric Design to Practical Operation*. New York: W.W. Norton

Yash P. Mehra, (1999); “A Forward-Looking Monetary Policy Reaction Function” Federal Reserve Bank of Richmond Economic Quarterly Volume 85/2.

Annex 1: The Structure and Key Features of the 'Core-Model'

This annex explains the functional specifications and key features of the 'core-model' that form the main transmission mechanism channels of the Nigerian economy. The model captures the essential macroeconomic relations, primarily the impact of monetary policy on the economy and inflation. Because of transmission lags inherent in monetary policy decisions, the model helps to provide a comprehensive view on future economic developments in the economy, as well as the steps to be taken in a given situation to enable future developments to correspond with the targeted objectives. The key characteristics of the model include the ability of monetary policy to influence the real economy in the short-run; the absence of a trade-off between inflation and output in the long-run (i.e., inflation is a monetary phenomenon); and a monetary policy conducted using a forward-looking policy rate that requires the Bank to adjust its policy instrument so as to bring inflation expectations and, therefore, inflation itself in line with the inflation objective.

The medium-term 'core-model' is a highly aggregated model that consists of a monetary policy reaction function, shocks and a number of equations having the nature of various transformations, identities and simple autoregressive relations. However, this box feature shall concentrate only on the behavioural part of the model, which describes the general view about the macroeconomic relationships in Nigeria. Notations used below are explained in detail at the end of the box.

*(1) l_y_gap = A1*l_y_gap{-1} – A3*rmci + A2*l_us_y_gap{-1} + shock_ademand*

(2) dl_cpi = 1/2(dl_cpi {-1} + E_dl_cpi) + B3*costpush + shock_asupply*

(3) Cost push = C1 (-l_zsarx_gap) + (1-C1)(l_y_gap)*

(4) dl_lssar – dl_lssar_tar = alpha/(1-alpha)(4*(E_l_lssar – l_lssar) + is – sa_is – prem + shock_forex) + beta/(1-beta)*(l_lssar_tar – l_lssar)*

*(5) is = D3*is {-1} + (1-D3)*(is_tnd + D1*(d4l_cpi {+3} – dl_cpi_tar {+3} +D2*l_y_gap) + shock_mpolicy)*

***Equation (1)** describes the behaviour of aggregate demand in the economy, represented by the output gap. It states that aggregate demand is influenced by its past level (representing inertia or persistence), monetary conditions (an overall indicator of the monetary policy stance, defined as RMCI, which is a weighted average of the deviations of the real interest rate and real exchange rate from their trends); US (foreign) aggregate demand, which enters the model with a lag; as well as a shock or innovation to domestic aggregate demand, picking up non-modelled effects.*

***Equation (2)** represents the expectations-augmented Phillips Curve, a price setting equation that represents the supply side of the economy. According to this equation, inflation depends*

on its lagged and expected value as well as cost-push factors (a combination of the output gap and import prices). It can be recognised that modifications were done to the traditional Phillips Curve equation where, rather than relying solely on the conventional output gap measure, the equation incorporates other variables, such as import prices, to better explain the inflation dynamics in Nigeria.

Equation (3) *represents cost-push factors, proxied by movements in the real exchange rate gap (to account for import costs) and the output gap. Import costs represent imported inflation (i.e., from US), while the aggregate demand/output gap represents domestic demand pressures on inflation.*

Equation (4) *is the Uncovered Interest Rate Parity (UIP) condition where the exchange rate depends on the differential between domestic interest rates and foreign interest rates, including a risk premium, which investors require in deciding to allocate capital. However, the standard textbook UIP equation has been modified to suit the Nigerian economic condition.*

Equation (5) *is a monetary policy rule, describing how the Bank sets interest rates in order to balance the short-run trade off between stabilising inflation around the objective and supporting developments in the real economy.*

Notations

l_y_gap = output gap (deviation of actual non-mining GDP from its trend)
rmci = real monetary conditions index (weighted average of the deviations of the real interest rate and real exchange rate from their trends)

dl_cpi = quarterly inflation, annualised

dl_lssar = quarterly change in nominal exchange rate

dl_cpi_tar = inflation target

costpush = import prices (represented by real exchange rate gap) and output gap

is = nominal interest rate

l_zsarx_gap = deviation of real exchange rate from its trend

is_tnd = interest rate trend

l_us_y_gap = US output gap (deviation of actual output from its trend level)

us_is = US interest rate (treasury bills)

E_dl_cpi = expected inflation

l_lssar = nominal naira/dollar exchange rate

E_l_lssar = expected nominal rand/Pula exchange rate

dl_lssar_tar = quarterly change in the nominal exchange rate target

prem = risk premium

d4l_cpi = annual inflation

shock_ademand = aggregate demand shock

shock_asupply = aggregate supply shock

shock_forex = foreign exchange shock

shock_mpolicy = monetary policy shock

alpha = indicates the extent of development in the financial markets

beta = represents the extent of intervention in the determination of the exchange rate by the monetary authority

N.B: *The shocks/innovations are exogenous and represent non-modelled effects.*