Optimal Monetary Policy Instrument in Setting Monetary Policy Reaction Function in Nigeria

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Abstract: **This paper sets out to ascertain the performance of alternative monetary policy instruments in setting monetary policy reaction function in Nigeria and, in the process identify whether setting monetary policy reaction function using the interest rate as the policy instrument is superior to setting monetary policy reaction function using the money growth rate as the policy instrument in Nigeria. To achieve this objective, the performance of the alternative specifications in setting monetary policy reaction function is considered following three types of shocks the economy is historically susceptible to for comparative purpose. This is done using a calibrated small open-economy New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model of the Nigerian Economy. Within this framework, the alternative specifications are ranked based on the results of social welfare loss. The study shows that 1.3279 is the minimum welfare loss result of setting monetary policy reaction function using the interest rate as the policy instrument, compared with 1.02 minimum welfare loss result of setting monetary policy reaction function using the money growth rate as the policy instrument. The paper concludes that using the money growth rate option is welfare superior to using the interest rate option in Nigeria. Therefore, the result suggests that Central Bank of Nigeria (CBN) should consider using money growth rate in setting monetary policy reaction function, which is consistent with anti-inflationary policies.**

Keywords: **Monetary policy instruments, Welfare Loss, Small open economy, DSGE**

I. INTRODUCTION

For over a decade the central bank of Nigeria transited to ***indirect instruments*** in the conduct of monetary policy (2). The principal instrument used by the CBN in setting monetary policy reaction function is the Monetary Policy Rate (interest rate)(1, 3) The Monetary Policy Rate (MPR) serves as the nominal anchor that aimed at influencing the short-term overnight interest rates in the money market.

When assessing the ability of monetary policy framework to hit the announced targeted inflation rate consistently and in the process aid in reducing the output gap, then it becomes important to identify the right policy instrument to be used in setting the monetary policy reaction function (2).

Originally, the choice between setting monetary policy rule with the interest rate as the policy instrument and a policy rule with the monetary base (or some other monetary aggregate) as the policy instrument is essentially irrelevant(4). However, under certain circumstances, the choice matters a lot. For example, if there is too much uncertainty in measuring the real interest rate or determining the equilibrium real interest rate or if there are relatively big shocks to investment or net exports, the use of monetary aggregate in setting the reaction function is the most preferred while if there are big velocity shocks, then using the interest rate as the policy instrument is considered most optimal (5).

All the above-mentioned circumstances that necessitate making a choice among alternative monetary policy instruments in setting monetary policy reaction function are salient characteristics in the Nigerian economy.

While there is a consensus on the need to minimize social welfare loss, the main question is: How should the Central Bank of Nigeria (CBN) choose between the competing alternative instruments in setting the monetary policy reaction function. In order words, should the CBN set monetary policy reaction function using the interest rate as the policy instrument or monetary aggregate? The answer depends on which among the two alternatives guarantee minimum welfare loss. This leads us to discuss the effectiveness and optimality of alternative monetary policy instrument in setting monetary policy reaction function in Nigeria.

In this paper, this question is examined within the context of a small open economy New Keynesian policy model. Literature on optimal monetary policy in Nigeria within the context of the DSGE models is scarce. The pioneering works: includes (1,3,6,7) among others.

A common limitation in the previous studies of optimal monetary policy in Nigeria has been that, in all these studies, no attention has been paid to ascertain optimal monetary policy instrument in setting monetary policy reaction function in Nigeria, considering the salient peculiarities of the Nigerian economy. As such, there is an incentive to compare among the two alternative monetary policy instruments in setting monetary policy reaction function in Nigeria, in order to ascertain the option that ensures minimum welfare loss.

Following the introduction, the rest of the paper is organised as follows: In section II, relevant empirical literature is reviewed whereas section III, explicates the theoretical frameworks of the study. In section IV, the standard DSGE model used for the study is presented. While section V describes the alternative specifications for setting monetary

policy reaction functions in Nigeria. The model is simulated and the results are analysed and discussed in section VI. Finally, in section VII conclusions and policy recommendations are presented

II. EMPIRICAL LITERATURE

There exists a serious dearth of empirical literature comparing alternative monetary policy instruments in setting monetary policy reaction function as only a single work (9) was found to have conducted such a study.

The few empirical works studied alternative monetary policy instruments in setting monetary policy reaction function provided evidence that the two alternatives proved to be stable and capable of producing determinate equilibrium. In addition, both alternatives are capable to provide a similar outcome. However, literature emphasized the need to choose the right policy instrument in the conduct of monetary policy, because different policy instruments may not provide equivalent outcome under certain circumstance(5, 8).

(9) applies a sticky price, closed economy model using Chile's data to establish some basic equivalence among money growth rate rule, nominal interest rate rule and real interest rate rule in setting monetary policy reaction function. The study concludes that the models deliver almost same outcome, but recommended the use of nominal interest rate as the money growth rate is suffering from the well-known practical difficulty (velocity) in controlling monetary aggregate.

III. THEORETICAL FRAMEWORK AND MODEL DESCRIPTION

The theoretical underpinning for which the relationship between money, prices and output is explored emanates from the well-known quantity theory of money with an offshoot of the Money Growth Rate Rule. It serves as a means of keeping an economy on a controlled course of growth. The theory is based on the premise that by setting a constant money growth rate independent of current economic fluctuations monetary policy would be optimal (10). Also, the Taylor rule in line with rational expectation theory explains the theoretical underpinning of the relationship between interest rate, inflation and the output gap. The rule states that the public should expect changes in the nominal interest rate induced by the central bank, according to changes in inflation, output or other economic parameters(11)

The New Keynesian theory is the new consensus in monetary economics base on the notion that prices and aggregate demand are the key determinants for the real economy in the short run. The new neo-classical synthesis is micro-founded. It combines the features of the Keynesian model such as the application of pricing and output decision with the elements of the classical and RBC schools such as consumption, investment and supply factors decision.

Based on this general background, the study adopts this methodology as the theoretical benchmark of this study, in line with DSGE model estimation technique.

The paper adapts the model of (12)as it describes the Nigerian economy as a small open economy that trade with the rest of the world. Specifically, we modify the Euler equation of (12) by replacing the foreign output gap with domestic output gap and low of one price gap with real interest rate. In addition, we incorporate a different kind of the New Keynesian Philips Curve (NKPC) and Low of One Price (LOP) gap equations.

For the sake of simplicity, the model assumes complete asset markets and discrimination between domestic and foreign goods, but allows all goods to be traded internationally. In addition, the model assumes incomplete exchange rate pass-through.

This model is structured based on the behaviour of four economic agents (firm, household, the external sector and the monetary authority). These agents strive to maximize the respective utility subject to the given constraint.

The representative firm maximizes the expected discounted value of profits, under the constraint given by the demand curve and the monopolistic competition. Solving this problem leads to the New Keynesian Phillips curves as below

1 Domestic inflation
$$\pi_{h,t} = (1-\theta)\pi_{h,t-1} + \theta\pi_{h,t+1} + \frac{(1-\theta_h)(1-\theta_h\beta)}{\theta_h(1+\phi\beta)}\widetilde{mc}_t^r + mu_{pih}$$

2 Imported inflation
$$\pi_{h,f} = E_t\pi_{f,t+1} + \frac{(1-\theta_f)(1-\theta_f\beta)}{\theta_f(1+\phi\beta)}\psi_t + mu_{pif}$$

3 CPI inflation
$$\pi_t = (1-\theta)\pi_{h,t} + \theta\pi_{f,t}$$

Eq 3 is an identity equation that defines CPI inflation π_t as the sum of domestic inflation $\pi_{h,t}$ and imported inflation $\pi_{t,f}$

The representative household maximizes expected lifetime utility with respect to consumption and leisure, where consumption has a habit component .Solving the household maximization problem results to the New Keynesian dynamic IS curve as shown in equation 4below:

4 Consumption function
$$c_t = \vartheta c_{t-1} + y_{t+1}^* - \vartheta y_t^* + \frac{1}{\sigma}(1-\vartheta)\psi_{f,t} + (1-\theta)s_t + mu_c$$

IV. CALIBRATION OF PARAMETERS

Following the theoretical model, the structural parameters of the model are calibrated, in order to capture the salient features of the Nigerian business cycle. In line with New Keynesian DSGE model's tradition, parameters are borrowed from the literature on the economies of similar structure, or estimate from actual data for the Nigerian economy. However, where there is no literature available on some of the model parameters, unavoidably, values are assigned based on a subjective judgment by borrowing developed economies parameters values as a reference.

In addition, Bayesian estimation technique is adopted in estimating the model with the aid of Dynare software. Table 1 reports the calibrated parameters of the model

Table I calibrated parameters table

Calibrated parameter

Parameter Descriptions	Parameters	Values	Source
Discounted factor	β	0.99	(13)
Frisch elasticity of labour supply in SOE	φ	3.0	(13)
Frisch elasticity of labour supply in ROW	φ^*	3.0	(13)
Degree of habit formation in SOE	ϑ	0.72-0.94	(3, 6)
Import share of domestic economy	$\delta\varepsilon_B$	0.47	(14)
Calvo parameter for domestic producers	θ_h	0.64	(3)
Calvo parameter for retail importers	θ_f	0.91	(15)
Calvo parameter for foreign producers	θ_h	0.75	(16)
AR (1) persistence shock for domestic producers	ρ_{pih}	0.2	(16)
AR (1) persistence shock for domestic consumption	ρ_c	0.8	(16)

Monetary Policy

A. Monetary Policy reaction function

The choice among alternative monetary policy instrument should be guided by the criteria set by (5).

To be more consistent with the CBN behaviour, we adopt the assumed CBN interest rate rule in the form of a modified Taylor rule as in (3) and(1)as the baseline monetary policy reaction function:

5 Taylor rule/ Monetary policy rule
$$i_t = [\rho_i i_{t-1} + (1-\rho_i)](\phi_\pi \pi_t + \phi_x \tilde{x}_t + \phi_e\{e_t - e_{t-1}\}) + \varepsilon_t$$

The alternative monetary policy instrument in setting monetary policy reaction function in Nigeria is examined. In order to compare the above specification, i.e. Eq5, we specify the alternative below in form of a modified Taylor rule. In this setting, we use a money growth rate rule, where aggregate money supply is determined according to output and inflation deviations from their target values.

6 Taylor rule/ Monetary policy rule
$$m_t = [\rho_m m_{t-1} + (1-\rho_m)](\phi_\pi \pi_t + \phi_x \tilde{x}_t + \phi_e\{e_t - e_{t-1}\}) + \varepsilon_t$$

V. THE WELFARE LOSS

(17) emphasizes the importance of evaluation and analysis of the welfare properties of alternative monetary policy specifications. Welfare evaluation provides policymakers with a set of tools that allow them to compare alternative monetary policy specifications. Following (18), a second-order approximation to the utility losses of the representative domestic consumer (expressed as a fraction of steady-state consumption) is used as a measure of welfare evaluation, by configuring some inflation and output gap parameters in a special way:

7
$$L = -\frac{(1-\alpha)}{2}\left[\frac{\varepsilon}{\lambda} Var(\pi_{H,t}) + (1+\varphi) Var(\tilde{y}_t)\right]$$

VI. MODEL SIMULATION

A. Impulse Response Function

Impulse responses function analysis provides useful information about the dynamic behaviour of the Key monetary policy variables (inflation and output gap essentially) in response to the various shocks and the reaction of the monetary authority. The choice of optimal monetary policy instrument in setting monetary policy reaction function would be based on minimum volatility around the key monetary policy variable under different shocks.

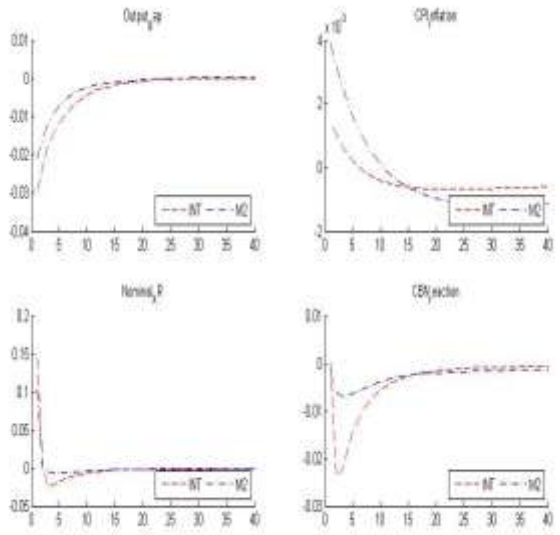
Domestic Productivity Shock

Figure 1 shows the response of inflation, output gap and the nominal exchange rate to a positive productivity shock under the two alternative specifications on one hand and the monetary authority reaction on the other hand. Following this shock output gap falls while the CPI inflation rise so does the nominal exchange rate (appreciation) under the two alternative specifications.

Figure 1 shows that all variables are more volatile under the option of an interest rate. If the central bank chooses to use the

interest rate option in setting monetary policy reaction function, the bank lowers the nominal interest rate to stabilize the domestic price and the output gap changes respectively. On the other hand, if the bank chooses to use the money growth rate option for setting monetary policy reaction function, the bank lowers the money growth rate to stabilize the domestic price and the output gap changes, respectively. Therefore, in response to a positive productivity shock, the money growth rate option for setting monetary policy reaction function is superior to that of interest rate.

Figure I positive productivity shock



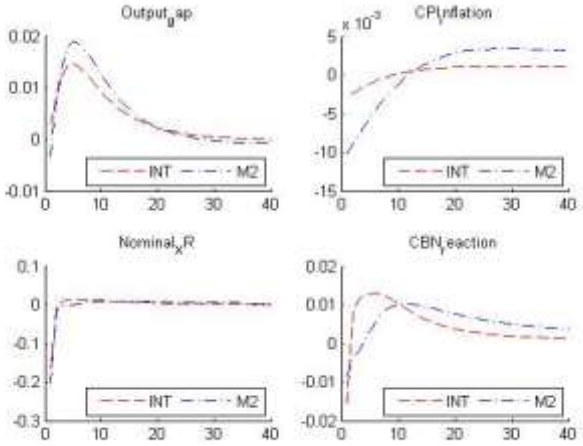
Authors' calculation

Domestic Consumption Shock

Figure 2 shows the response of inflation, output gap and the nominal exchange rate following a positive demand shock under the two alternative specifications on one hand and the reaction of monetary authority on the other hand. Following this shock output gap rises while CPI inflation falls as well as the nominal exchange rate (depreciates) under the two alternative specifications.

Figure 2 shows that all variables are more volatile under the money growth rate option. If the central bank chooses to use the interest rate option for setting monetary policy reaction function, the bank increases the nominal interest rate to stabilize the domestic price and output gap changes respectively. On the other hand, if the bank chooses to use the money growth rate option for setting monetary policy reaction function, the bank increases the money growth rate to stabilize the domestic price and output gap changes, respectively. Therefore, in response to positive domestic consumption shock interest rate option in setting monetary policy reaction function is superior to money growth rate option.

Figure II positive domestic consumption shock



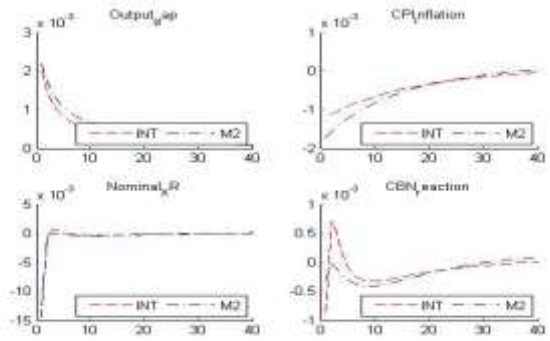
Authors' calculation

Positive Terms of Trade of Trade Shock

Figure 3 shows the response of inflation, output gap and the nominal exchange rate following positive terms of trade shock under the two alternative specifications on one hand and the reaction of monetary authority on the other hand. In response to this shock, output gap rises while CPI inflation and nominal exchange rate (depreciate) fall.

Figure 3 shows that CPI inflation and nominal exchange rate are more volatile under the money growth rate option while the output gap is more volatile under the option of using the interest rate. If the central bank chooses to use the interest rate option for setting monetary policy reaction function, the bank decreases the nominal interest rate to stabilize the domestic price and output gap changes respectively. On the other hand, if the bank chooses to use the money growth rate option for setting monetary policy reaction function, the bank decreases the money growth rate to stabilize the domestic price and output gap changes respectively. Therefore, in response to positive terms of trade shock, the choice of an optimal policy instrument is at the discretion of the policy maker as guided by a policy thrust.

Figure III Terms of Trade Shock



Author's calculation

B. Welfare Analysis of the Two alternative Frameworks

The variance of the key monetary policy variables and welfare losses under the two alternative specifications of monetary policy reaction function is reported in Tables 2.

The estimated welfare loss under interest rate specification is estimated at 1.3279 while the welfare loss under the alternative specification is estimated at 1.02; therefore, we can conclude that the monetary aggregate specification guarantees minimum welfare loss.

Using the interest rate rule in setting monetary policy reaction function in Nigeria has the maximum welfare loss because of the high variance associated with CPI inflation. Under such specification, this implies that:First, inflation rate in Nigeria is unacceptable as a result inflation forecasting and measuring the real interest becomes difficult if not impossible for the CBN. Second, exports shock is high; due to the over-dependence on volatile international oil market and.Third capital flight is frequent, due to over-reliance of international portfolio investors.

All the above mentioned put more pressure on domestic prices of goods. Therefore, under this circumstance using money growth rate in setting monetary policy reaction function is more optimal in Nigeria and is consistent with the central bank anti-inflationary policy (5)

Table II Welfare Loss of The Two Alternatives Instruments

Variables	INTR	MON
Inflation Variance	1.260	0.6099
Output gap Variance	0.0676	0.4101
Welfare loss	1.3279	1.02

Authors' calculation

VII. SUMMARY AND CONCLUSION

This study paper used a New Keynesian small open economy model to analyse the welfare implications of alternative monetary policy instruments in setting monetary policy rule in Nigeria. It examines the responses of CPI inflation, output gap and the nominal exchange rate along with the monetary authority reaction following different shock under interest rate specification and money growth rate specification for setting monetary policy reaction function.

The paper concluded that using an interest rate option guarantee lower volatility on key monetary policy variable under domestic consumption shock while with respect to productivity shock money growth rate is preferable. In the case of terms of trade shock the choice of optimal instrument is at the discretion of the central banker guided by a policy thrust. Monetary growth rate option in setting monetary policy reaction function is found to be welfare-superior in Nigeria.

The main conclusion of this paper is that the nature of shock theeconomy is historically susceptible to should dictate the choice of the policy instrument to be used in setting monetary policy reaction function. However, money growth rate is welfare superior because of the effects of the unacceptable rate of inflation, investment and export shock, which appear to be more endemic and outweighs the effects of velocity shock. Therefore, the alternative specification in setting monetary policy reaction function has good characteristics and the results are promising. It should be noted that both instruments and results have some limitations.

First, our analysis is based on simulation results that are obtained by making some assumptions and simplifications. The conclusions regarding instruments dominance, the ranking of alternative instruments, and welfare consequences depend on a specific parameterization and should not be taken as general propositions. However the parameters chosen fit the Nigerian economy, so the conclusions should have some empirical relevance.

A second limitation has to do with those aspects that the model omits such as oil sector, the informal sector and the fiscal authority. However, the model incorporates some key elements of the Nigerian economy and its findings are in accordance with its characteristics. However, further research is still needed. One direction for further research is to use a model that incorporates additional sectors.

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