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ARTICLE

Optimal Monetary Policy in a simple backward and forward looking Models

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Abstract

The growing dynamics of macroeconomic and political environment across the globe particularly in developing countries where high inflation appears persistent, and trade -off between low stable inflation and full employment are becoming more challenging for monetary and fiscal authorities and has increase the needs to review the optimal monetary policy choice by the central banks. The present study investigates the optimal monetary policy choice in a backward and forward looking model. In particular, the study adopt an explorative review where both theoretical and empirical literature on the subject were reviewed and synthesized. The findings from literature revealed that there is no consensus on whether the optimal monetary policy should be backward looking or forward looking as both have their own unique advantages. The study concludes that a hybrid of both forward and backward-looking model where more weights is assigned to forward looking variables will improve the responsiveness of monetary policy decision on real macroeconomic variables like inflation, employment and economic growth.

Keywords*: optimal monetary policy, Taylor rule, interest rate, inflation rate*

JEL Classification: *G20, G21, G53*

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1. Introduction

There is growing debate in monetary and fiscal policy literature as to how should the central banks and fiscal authorities respond to variabilities in macroeconomics goals of price stability, full employment, stable economic growth among others. In particular, should central banks follow their discretion or should they follow some set of implicit/explicit rule in setting policy variables? Again, if the central bank must follow some set of implicit/explicit rule in policy formulation, should the model be ***backward looking*** or should it be **forward looking** or even a combination of both. This issue is what this synthesis is all about.

It is well accepted that monetary policy plays an essential role in providing a stable macroeconomic background to facilitate the efficient allocation of resources. To

demonstrate that such an economic environment can be achieved by adopting an optimal monetary policy framework. Researchers across the globe have proposed several alternative models (**Caglayan, Jehan & Mouratidis, 2016**). Majority of these models aims to provide monetary authorities with framework/guideline that should be followed (though not explicitly) in setting the policy rate while incorporating macroeconomic variables expectation. This is because macroeconomic expectation plays a prominent role in monetary policy formulation and macroeconomic modelling. For instance, stock prices depend not only on present performance of firms and interest rates, but also on the expectations about future performance and interest rates. Private fixed investment is affected not only by present profitability of a firm, but also by expectations for future profitability (**Joseph et al, 2021**). Money demand are not only impacted the present or past demand but also future expectation like seasonal transaction, political environment among others. Despite this recognition, there is little consensus on how expectations should be incorporated in macro-econometric models.

While some econometric models use very simple mechanisms of expectation formation premised on past and present information which is referred to as adaptive expectations or "backward-looking models". Nonetheless, it is easy to imagine that future events affect present activity. Suppose for instance that a government announces that it will have a tight fiscal policy several years in the future. If private economic agents expect this policy to be adopted, and change their economic behavior accordingly, there may be changes in economic variables, such as long-term interest rates, even though there is no actual reduction in fiscal expenditure and even though the policy is only announced (**Salunkhe, & Patnaik, 2019**). This mechanism of expectation formation is called rational expectations. The models that incorporate such expectations are called "forward looking models" and are distinguished from "backward-looking models," in which expectations are based on current and past information, as are adaptive expectations (**Udom and Yaaba, 2015**).

The debates in literature as to whether backward looking models or forward-looking models provide optimal monetary policy framework was reinvigorated by the work of John Taylor in 1993 now known as "Taylor Rule". The Taylor Rule suggests that the central banks should raise rates when inflation is above target or when gross domestic product (GDP) growth is too high and above potential. It also suggests that the central bank should lower rates when inflation is below the target level or when GDP growth is too slow and below potential (**Taylor, 1993**). Taylor rule model is categorized under the adaptive expectation models (backward looking) which focuses their attention on present and past deviation in inflation and output in the economy in while making decision about the next policy rate by the monetary authorities. His writing was largely appreciated and criticized in economic literature and since his publication several variants of Taylor rule was developed by policy maker across the globe and academician to help provide insight on the weakness of Taylor rule (**Salunkhe, B., & Patnaik, 2019**). The goal of Taylor rule is to reduce uncertainty in the economy and reduce the activities of arbitragers who aims to take advantage of information asymmetric and policy lacuna in the economy thereby sabotaging the effort of the monetary authorities. By adopting a consistent and known framework by economic agent in policy rate decision arbitrage activities will reduce and economic activities will be more predictable.

While some of the variants of Taylor rules are backward looking others are forward looking such that prevailing/ short interest or policy rate are determined based on the lag and current value of macroeconomic values or based on some future forecast. At best, the existing frameworks can be classified into two groups. The first group includes the models that relate the responsiveness of the interest rate to backward-looking aspects of macroeconomic indicators (**Khaysy & Gang, 2017; Samuel, 2016**). The second category of studies including **Bernanke and Mihov (1998); Benjamin and friedman (2016); and Caglayan et al. (2016)** has presented an empirical framework for studying optimal monetary by considering only forward-looking aspects of the underlying variables. Still, there are those who of the view that the optimal monetary policy should be able to integrate both backward looking and forward looking model.

Several forward looking models based their reasoning from the work of Keynes. For instance, several decades ago, Keynes (1923, p. 148) said "If we wait until a price movement is actually afoot before applying remedial measures, we may be too late". Similarly, another well-known economist Donald Kohn (1995 cited in **Chinaemerem & Akujuobi, 2017**) said, "Policymakers cannot avoid looking into the future." The words of **Alan Greenspan (1994)** can be summarized as that the one of main challenges to monetary policymakers is that they interpret current data regarding macroeconomic indicators and financial markets by considering expected future inflationary forces and take courses of actions to encounter those forces in advance. At the empirical level, numerous empiricists have also documented that to design effective monetary policies, the G-7 countries and

several other developed economies considerably consider anticipated future changes rather than lagged values of realized macroeconomic outcomes (**Clarida, Gali, and Gertler, 1999**).

Given that monetary policy environment is dynamic and evolving as even recognized by Taylor in his famous book "Discretion Versus Policy Rules in Practice.", there is need to always review and update models that guide the monetary authority in reaching decision on what the anchor lending rate should be. To this end, the present study will aim to provide a synthesized review of literature on whether optimal monetary policy should be backward or forward looking.

2. Optimal Monetary Policy Framework

2.1 Conceptual Clarification

Monetary Policy: Monetary policy is the process by which the monetary authority of a country controls the supply of money, often targeting a rate of interest for the purpose of promoting economic growth and stability (**Benjamin & Friedman, 2016**). The official goals usually include relatively stable prices and low unemployment. Monetary economics provides insight into how to craft optimal monetary policy. Monetary policy is referred to as either being expansionary or contractionary, where an expansionary policy increases the total supply of money in the economy more rapidly than usual and contractionary policy expands the money supply more slowly than usual or even shrinks it. Expansionary policy is traditionally used to try to combat unemployment in a recession by lowering interest rates in the hope that easy credit will entice businesses into expanding. Contractionary policy is intended to slow inflation in order to avoid the resulting distortions and deterioration of asset values (**Benjamin & Friedman, 2016**).

Monetary policy differs from fiscal policy, which refers to taxation, government spending, and Government borrowing associated borrowing. Monetary policy, to a great extent, is the management of expectations (**Lars, 2016**). Monetary policy rests on the relationship between the rates of interest in an economy, that is, the price at which money can be borrowed and the total supply of money. The instruments/tools of monetary policy can be divided into two: the Direct and indirect instruments. The direct monetary control tools are the reserve requirement, interest rate policy, sectoral allocation of credit, maximum credit expansion, stabilization of securities and loans to indigenous borrowers. While the indirect monetary policies include Open Market Operation (OMO), discount rate mechanism, liquidity ratio, selective credit control and cash reserve requirement. The ultimate objective of monetary policy is to control inflation and stabilize domestic prices (viz low interest rates and exchange rate stability) using contractionary and/or expansionary monetary policy.

A monetary policy is referred to as contractionary if it reduces the size of the money supply or increases it only slowly or if it raises the interest rate. An expansionary monetary policy increases the size of the money supply more rapidly, or decreases the interest rate (**Benjamin & Friedman, 2016**). Furthermore, monetary policies are described as follows: accommodative, if the interest rate set by the central monetary authority is intended to create economic growth; neutral, if it is intended neither to create growth nor combat inflation; or tight if intended to reduce inflation.

Inflation Rate: Inflation refers to the persistent and sustained rise in the general level of prices of goods and services in an economy. Manifesting visibly is the decline in the value of money. The effects of high inflation on the economy are generally considered to be predominantly harmful that is why the achievement of price stability has always been one of the fundamental objectives of microeconomic policy in both developed and less developed countries (**Orubu, 2016**). **Igbatayo and Agbada (2017)** defined it as the continuous and sustained rise in general price level of goods and services in a nation's economy. It refers to a situation where the volume of money chasing the available goods and services in an economy is too much, consequently resulting in a persistent rise in general price level.

Maku and Adelowokan (2017) defined it as inflation as the persistent increase in the price level, or a persistent decline in the purchasing power of money, and this is caused by an increase in available currency and credit beyond the proportion of goods and services. According to **Jhingan (2015)** inflation is a persistent and appreciable rise in the general level of prices. Note every rise in the price level in termed inflation. Therefore, for a rise in the general price level to be considered inflation, such as rise must be constant, enduring and sustained. The rise in the price should affect almost every commodity and should not be temporal. But **Danjuma, Jibrin and Blessing (2018)** are more explicit referring to inflation as a continuing rise in prices as measured by an index such as the consumer price index (CIP) or by the implicit price deflator for Gross National Product (**Jhingan, 2015**).

2.2 Theoretical Framework on Optimal Monetary Policy

Discussion on the optimal monetary policy framework will be grouped into two framework; the backward looking models and Forward looking Models.

2.2.1 Backward Looking Models

There are various methodologies of incorporating expectation into economics modelling. In traditional macro-econometric models, adaptive expectations and static expectations are popular. They are called backward looking expectations, since they make the *ad hoc* assumption that expectations are based solely on present and past information.

2.2.1.1 Taylor Rule

The Taylor rule, proposed by **Taylor (1993)**, is a reduced form approximation of the responses of policy interest rate to changes in output, inflation, or other economic variables. Particularly, the rule describes how the central bank raises the policy rate by half percentage point, for every one-percentage point rise in inflation. The goal of the rule is to encourage price stability by decreasing uncertainty and growing the credibility of the central bank's future actions (**Estrella & Fuhre, 2003; Ibrahim & Abubakar, 2018**). It avoids the inefficiencies of time non-consistency in the exercise of discretionary monetary policy (**Taylor, 1999**). According to Taylor's original rule, interest rate responds to the difference between actual and potential GDP, and also to the difference between actual and targeted inflation rates:

$$r = p + .5y + .5(p - 2) + 2 \text{ (the "Taylor rule")} \quad (1)$$

where

r = the nominal policy rate
p = the rate of inflation
y = the percent deviation of real GDP from a target

The rule is therefore based on three factors: actual versus targeted inflation levels; actual and potential GDP; and the short-run interest rate consistent with potential GDP. Taylor's rule is therefore a guideline for central banks on how to adjust interest rates in order to change economic conditions. Notwithstanding its limitations and critics, Taylor's rule has become established in central banking for adjusting and setting cautious rates for economic stabilization, while sustaining long-run growth (**Bakare, 2011; Akinbobola, 2017; Ajide & Lawanson, 2017**). He recommends the real interest rate should be 1.5 times the inflation rate. This is based on the assumption of an equilibrium rate that factors the real inflation rate against the expected inflation rate. Taylor calls this the equilibrium, a 2% steady state, equal to a rate of about 2%. But that's only part of the equation—output must be factored in as well (**Akinbobola, 2017; Ajide & Lawanson, 2017; Adefeso & Mobolaji, 2016**).

Taylor rule has been criticized by some central banks and academician. One of the issues identified from Taylor rule is that central banks often "target" for real GDP is potential output, the amount the economy can sustainably produce when capital and labor are fully employed. With that assumption, the variable *y* in the Taylor rule can be interpreted as the excess of actual GDP over potential output, also known as the *output gap*. To put the equation into words, Taylor rule predicts that federal reserve (US central bank) will raise the federal funds rate (tighten monetary policy) by one-half percentage point: (1) for each percentage point that inflation rises relative to the Fed's target, assumed to be 2 percent; or (2) for each percentage point that that output rises relative to its potential. The Taylor rule also predicts that when inflation is at target and output is at potential (the output gap is zero), the federal reserve will set the real federal funds rate at 2 percent—about its historical average. However, Taylor rule will fail when there is significant elasticity of interest rate or when interest rate is close to liquidity trap, zero bound among others.

2.2.1.2 McCallum Rule

McCallum (1999) is of the view that central banks should follow a rule in designing monetary policy. McCallum suggests that central banks should target nominal GDP growth rate through the use of monetary base as an operating instrument. He proposed a rule that can be represented mathematically as:

$$\Delta mb_t = \Delta y_t^p - \Delta vmb_t + \delta(\Delta y_{t-1}\ p - \Delta y_{t-1}) \quad (2)$$

Where mb is the monetary base, y p denotes the desired rate of growth defined as the sum of the rate of inflation and average real GDP in the long-run, v represents the average growth rate of velocity over the previous four periods 2, y is nominal GDP, δ indicates the monetary adjustment factor and Δ is a differenced term. All variables are in logarithms form. According to him, equation (2) shows that the growth rate of base money is influenced by the changes in the desired level of output and the growth rate of the velocity of money, which can be taken to mean the effect of innovations on money supply. McCallum strategy implies forecasting the future average growth rate of velocity so as to stabilize the price level against possible money demand shock.

According to **Tekam (2018)**, given a neutral long-run monetary policy, if the growth rate of velocity is steady and nominal GDP grows at the desired rate, then inflationary trend will compellingly follow suit. In this case, monetary policy is also determined by the level of adjustment of the growth rate of monetary base by the

central bank. The central bank is expected to adjust the growth rate of money supply in response to deviation in either output and/or inflation from the desired level. If the growth rate of GDP, for instance, falls below the target, the growth rate of monetary base is adjusted upward and the reverse also applies. According to McCallum (1999) the formulation process of equation (2) strictly meets some critical requirements. First, the behaviors of the variables considered in the rule are determined by the activities of the central banks. Second, the influence of the innovations in the financial system on the model is moderate. Third, the relative importance of either the money stock or interest rate depends on their relative impact on the ultimate goal of monetary policy.

2.2.2 Forward Looking Model

Several literatures have contributed to forward looking models (rational expectation) in the context of central bank decision making process.

forward-looking models incorporate rational expectations, and economic agents know the correct future values of every variable. Technically, forward-looking models are solved this way: All variables are assumed to have long-run equilibrium values (steady-state values); they are assumed to revert to equilibrium values eventually; the present value of all variables is solved by working backward from the equilibrium values (**Neuenkirch, 2014; Caglayan et al., 2016**).

The existence of long-run equilibrium is a necessary condition for a forward-looking model. (Unless we know our destination, we cannot find a path to reach it.) It is also a necessary condition for a forward looking model that all variables revert to their steady-state values. Assuming rational expectations does not guarantee that all variables will revert to their steady-state values. A monetary policy rule should be so chosen as to prevent the models from exploding. If a steady state exists and the reversion condition holds, a forward-looking model reverts to long-run equilibrium after variables depart from their steady-state values in the short run as a result of a temporary shock. Thus, a forward-looking model connects the short-run disequilibrium to the long-run equilibrium.

Another feature of forward-looking models is that a central bank's behavior is formalized as a monetary policy rule. Traditional policy simulations using a macro-econometric model take as given each period's policy. In such simulations, attention is not necessarily paid to interactions between the model's endogenous variables and policies. For instance, policies are kept fixed even though an economic situation changes. Suppose that a central bank implements a tight monetary policy against high inflation. If it continues the same policy even after the high inflation disappears, an economy is driven into a deflationary situation. From the viewpoint of the central bank's goal, deflation is not thought of as preferable.

$$y_t = y^* - \alpha(rl_t - rl^*) + €_t, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\pi_t = \pi t\text{-}1 + \beta(y_t - y^*) + \eta_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$i_t = \pi_t + rs + \delta(y_t - y^*) + \Omega(\pi_t - \pi^*) \quad \ldots\ldots\ldots\ldots (5)$$

$$rs_t = i_t - \pi_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where y_t = output gap (%) (negative); rl_t = real long-term interest rate (%); y*= steady-state output gap (%) (negative); rl* = equilibrium real long-term interest rate (%); π_t = inflation rate (%); i_t: monetary policy rate (%); other variables are structural parameters (positive) while η_t and $€_t$ error terms.

Equation (3) is the IS balance in a reduced form. The y_t is not the output itself but the output gap, which is determined by the difference between the real long-term interest rate (rl_t) and its equilibrium value (rl). When the real long-term interest rate rises, the output gap expands, as consumption is postponed to the future and private fixed investment is reduced. The $€_t$ summarizes the demand movements caused by non-interest rate factors, such as an increase in fiscal expenditure, an increase in net exports accompanied with improvements in overseas economies, and an increase in private fixed investment expanded by expectations for an increase in future revenue.

Equation (4) is the Phillips curve with the Non-Acceleration Inflation Rate of Unemployment (NAIRU). The inflation rate rises above the previous period's level when the output gap closes beyond its equilibrium level (y*). From the viewpoint of the expectation-augmented Phillips curve, the first term on the right-hand side corresponds to the expected rate of inflation of private economic agents. Equation (6) determines the real short-term interest rate and is obtained by combining the two assumptions of Fisher's identity ($\pi^*_{t+1} = \pi_t$) and the static expectations for the future inflation rate ($i_t = rs_t + \pi^*_{t+1}$). These assumptions are combined to say that players are irrational in the short-term money market. Suppose that it is certain that an economy will be boosted ($y_{t+1} > y^*$). From equation (6), the ex-post inflation rate is surely above the ex-ante inflation rate ($\pi_{t+1} + \pi^*_{t+1} = \pi_t$). This implies that, since the short-term interest rate is set too low, the ex-post real short-term interest rate ($i_t - \pi_{t+1}$) is below the ex-ante real short-term interest rate (rs_t).

Here, private economic agents have rational expectations for real short-term interest rates, which in

turn means that they have similar rational expectations for real long-term interest rates.

2.3 Empirical Literature

Several empirical efforts have been made to investigate optimal monetary policy option in literature using either backward looking approach of Taylor or forward looking approach. Some of the literatures includes **Caglayan et al. (2016), Neuenkirch (2014), Ibrahim and Abubakar, (2018), Odior (2018), Ogunsakin (2021)**.

For instance, **Caglayan, Jehan, and Mouratidis (2016)** examined the optimal monetary policy rules for an open economy: evidence from Canada and the UK. The study developed a frward looking model from insight on backward looking model using quarterly data with regards to Canada, and the UK from 1983q1-2007q4. The findings revealed that the open economy policy rule receives support from the data and that the monetary policy makers in the UK and Canada have asymmetric preferences for forward looking models and inflation are estimated rather than target based on the past value.

For instance, **Oye, Alege, and Olomola, (2018)**, also examined the desirability of the Taylor-type rule for the Nigerian economy. The study computed optimal monetary and fiscal rules using a Linear-Quadratic approximation of the equilibrium conditions in a New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model. The parameters of the DSGE model were calibrated to suit the Nigerian economy. The main findings of the study showed that the optimized monetary rule obeys the Taylor principle while the optimized fiscal rule ensures a passive and countercyclical fiscal path. The implication of the finding shows that in the presence of a government that commits to a fiscal balance rule, it is desirable for the central bank to stabilize inflation while the government should avoid the procyclical bias. **Udom and Yaaba (2015)**, attempted to investigate the optimal monetary policy instrument for Nigeria between 1981Q1 to 2013Q2 using a bounds testing approach to cointegration. The result indicates the superiority of monetary instrument, followed by combined instrument and then interest rate instrument. The study therefore suggests that the CBN should lay more emphasis on monetary instrument particularly if output growth or stability is the primary goal of monetary policy.

Odior (2018) in his study "Inflation Targeting in an Emerging Market: VAR and Impulse Response Function (IRF) Approach" examined inflation targeting in developing countries using Nigeria as a case study. The VAR and IRF were used to estimate the data collected on consumer price index, broad money supply, exchange rate, gross domestic product and government expenditure over the period 1970 – 2010. The model ascertained the extent in which policy target of these macroeconomics variables does lead to changes in inflation. The results show that, money supply and past level of inflation have the potentials of causing significant changes in inflation in Nigeria.

Riti and Kamah (2015) carried out a study titled "inflation targeting and economic growth in Nigeria: A Vector Auto Regressive (VAR) Approach". The study examines the achievement of sustainable growth through inflation targeting in Nigeria using the VAR model. Annual time series data were used covering a span of 1981 – 2010. The variables used include; Consumer Price Index (CPI), Gross Domestic Product (GDP), Exchange Rate (EXR), US Consumer Price Index (CPI, as a proxy for foreign price), Money Supply (M2), and Interest Rate (INTR). The study found out that exchange rate contributes significantly to inflationary pressures in Nigeria – which is a reflection of the import dependent nature of the Nigerian economy. The study recommends amongst others that the objective of monetary policy should be made clear thereby improving planning in the private and public sectors. Also, the CBN should critically and carefully evaluate policy options before implementing them.

Bassey and Essien (2016) analysed the issues, problems, and prospects of inflation targeting framework for monetary policy in Nigeria. According to them, recent policy indication shows that the Central Bank of Nigeria (CBN) may have soft-pedalled in the pursuit of full-fledged Inflation Targeting for the country. The paper thus attempted to critically analyze the basic issues, problems and prospects germane to the adoption of Inflation Targeting as a monetary policy framework for Nigeria. They examined the basic features and performances of inflation targeting countries globally and adduced that Inflation Targeting is not "a cure-all medicine" and that it may not significantly reduce the real costs of disinflation in Nigeria in terms of a decline in output and an increase in unemployment.

Olusegun (2021), examined inflation targeting in Nigeria and South Africa, using fully modified least square to estimate a modified Taylor rule for the period 1970 to 2016. The study unravels evidence of a significant response of inflation and squared inflation to policy interest rates in South Africa, but not in Nigeria. Overall, South Africa's central bank places much emphasis on inflation targeting in setting interest rates, which Nigeria does not. Further, for South Africa, output gap is significant, while it is not significant for Nigeria. The study also reveals that exchange rate, openness to trade and international reserves play significant roles in central bank policy in both countries. In other words, there is need for central banks to adopt an eclectic approach,

setting the monetary policy rule to adjust to any observed disequilibrium between output gap, inflation, exchange rate, foreign reserves and openness to trade.

Agu (2011) specifies two simple models of monetary policy reaction functions for Nigeria: The first, a tracking model based on the revealed processes at the Central Bank of Nigeria (CBN), and an alternate model which closely follows the Taylor rule. The results confirm the primacy of inflation and credit to the private sector in the CBN's monetary policy reaction function, which is consistent with the literature. Apart from these, however, none of the key macroeconomic variables that CBN indicates in its policy documents actually seem to have been considered in setting the interest rate policy. Empirical estimates could also not confirm interest rate smoothing, or the relevance of fiscal dominance in the reaction function. However, inflation and credit to the private sector do matter to the bank – although the first only retroactively. It is therefore apt to infer that the CBN acts consistent with its price stability and private sector-led growth objectives, but accommodates discrepancies in its goals and outcomes and, possibly without intending to do so, follows the Taylor rule.

Guangling and Thabang (2020), investigated the optimal design and effectiveness of monetary and macro prudential policies in promoting macroeconomic (price) and financial stability for the South African economy. They developed a New Keynesian dynamic stochastic general equilibrium model featuring a housing market, a banking sector and the role of macro prudential and monetary policies. Based on the parameter estimates from the estimation, we conduct an optimal rule analysis and an efficient policy frontier analysis, and compare the dynamics of the model under different policy regimes. We find that a policy regime that combines a standard monetary policy rule and a macro prudential policy rule delivers a more stable economic system with price and financial stability. A policy regime that combines an augmented monetary policy (policy rate reacts to financial conditions) with macro prudential policy is better at attenuating the effects of financial shocks, but at a much higher cost of price instability. Our findings suggest that monetary policy should focus solely on its primary objective of price stability and let macro prudential policy facilitate financial stability on its own.

Ibrahim and Abubakar, (2018), examined 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.

Kithsiri (2014), provided welfare maximizing optimal monetary and fiscal policy rules for Sri Lanka, in a New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model, closely following **Schmitt-Grohe and Uribe (2007)**. A standard Taylor rule type monetary policy reaction function where the nominal interest rate responds to inflation deviations and output gap, and a fairly simple fiscal policy reaction function in which tax revenue depends on the level of total government liabilities are used. The deep structural parameters of the model are calibrated to the Sri Lankan economy. To conduct welfare analysis, equilibrium solutions to the model are approximated up to second order accuracy. The optimal solution coefficients for the policy reaction functions are determined such that the welfare associated with the optimal policy rules delivers virtually the same level of welfare associated with the Ramsey optimal allocation. The monetary and fiscal policy rules that are optimal within a group of implementable and simple rules are then proposed for the Sri Lankan economy.

Ogunsakin (2021) examined that the asymmetric effects of monetary policy mix on real output both at aggregate and disaggregate levels in Nigeria were scrutinized using data sourced from the Central Bank of Nigeria Statistical Bulletin and Bureau of Statistics. Data for the study was analysed with the nonlinear Autoregressive Distributed Lag (ARDL) and Structural Vector Autoregressive Model (SVAR). The study decomposed money supply (MS) and monetary policy rate (MPR) into positive and negative in order to capture expansionary and contractionary

monetary policies. The real output was proxied by Gdpgr. Results from long-run nonlinear ARDL showed long-run co-movement between monetary policy variables and real output both at aggregate and sectoral levels. Results obtained from further empirical estimations showed that the response of real output to shocks emanating from both positive and negative monetary policies was significant with different magnitudes. While the response of output growth rate to shocks from positive monetary policy was significant but negative, its response to shocks from negative monetary policy was positive and significant. It was equally noted in the analysis that positive monetary policy shocks to domestic interest reduces the exchange and output growth rate both at aggregate and sectoral levels. However, the effects of negative monetary policy were wider than that of positive effects. This shows that negative monetary policy would be more efficacious when output is desired to be increased. Results from variance decomposition revealed that, among variables employed in the study, money supply and monetary policy rate explained much of the variations in Nigeria's real output. Based on these findings, the study, therefore, concludes that the effects of monetary policy on real output are asymmetric and not symmetric.

3. Summary of Literature

A variable is forward-looking if it depends on expectations of future variables and has endogenous one-period-ahead forecast errors. Conversely, a variable is backward-looking if it depends on its past values. An extension of this idea to monetary policy rules would then suggest that interest rate rules are forward-looking if they contain some measures of expected inflation and/or output gap, and backward-looking if the indicator variables enter as lagged representations.

Several articles have been reviewed and from majority of the review, the following conclusion and summary can be drawn. First, it was discovered that most central bank mix both description with rule based models in determining the policy rate because of the sophistication and dynamics of the today economic environment like changing technology, political situation, insecurity, among others. It was also discovered that most central bank often employ several models in forecasting the future inflation, employ different variants of Taylor rule for inflation targeting central banks or different version McCallum models for central banks that employs monetary targeting as the monetary policy framework.
We also discovered that central bank adjusts interest rates by considering both lead (forward) and lagged (backward) aspects of the underlying macroeconomic variables (inflation, output, interest rate, exchange rate, etc). It was also discovered that monetary policymakers assign relatively more weight to the future expected inflation, future exchange rates, and the prior period output when setting the interest rate. There is also significant evidence of the presence of asymmetric preferences regarding interest rate setting over monetary targeting.

Specifically, it was discovered that both the output and inflation volatility are negatively related to interest rate setting. This suggests that the central banks often respond more to output contractions than it does to the output expansion. Also, most central banks often give preference to price stability over output growth and employment while setting interest rates.

4. Recommendation and Policy Implication

From the discussion above it is clear there is no consensus as to the general acceptable method the policy makers – monetary authorities or fiscal authorities should follow in their efforts address macroeconomic fluctuations in the economy. However, one thing is clear from the discussion, macroeconomic models aiming to influence the aggregate variables should first and foremost decides on which variables the central bank should target in its operational framework. The central bank should first decide on the choice of monetary framework whether the central bank is adopting inflation targeting, monetary targeting, exchange rate targeting, or even Nominal GDP targeting. The choice of the monetary framework also depends on the peculiarity of nation in terms of development of the financial system, the financial deepening of the country, the level of cooperation between monetary and fiscal authorities, and nature of money demand in the country.

Decision on whether to adopt any of the monetary policy framework as mentioned above will also influence whether a country central bank should put more weights on backward looking variables or forward-looking variables. It will also influence the choice of model. For instance, a country whose monetary policy framework is that of inflation targeting as common across the globe will surely look for modified version of the Taylor rule which will guide as a benchmark while making decision on the anchor interest rate.

Above all, central banks will be better off if they can employ a hybrid of backward- and forward-looking models in which case they include ultimate target variables in both their lag and leads in the models. Similarly, because expectation plays an important role and future events tends to influence the present decision

more than the past, it is important that forward looking variables takes more weights in the models.

Lastly, central bank models should not be static like a robot kind of but should by dynamic such that more weight should be assign to either output or inflation at different period depending on future forecast and the events of the moment. For instance, in an election year, the central bank of course should give more weights to inflation knowing that electioneering events often leads to increase aggregate expenditure which has tendencies of instigating inflationary pressure on the economy.

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