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Monetary Policy-making in Nigeria: Does Evidence Support Augmented Taylor Rule?

Abstract: This paper relies on the augmented Taylor rule to evaluate the reaction function of the historical path of nominal monetary policy rate in Nigeria in the period 1996:Q1-2014:Q4. The main technique of analysis is the GMM econometric approach and the reaction function is augmented with the real exchange rate. Evidence from the study suggests that the real output and exchange rate are both significant in explaining the path of monetary policy rate while the inflation variable was not statistically significant. Monetary policy reacts negatively to lagged real exchange rate and current real exchange rate but positively to lagged real output gap. We conclude that lag of real exchange rate has a greater effect on the policy rate consequently inflation targeting is not a primary objective of the CBN. Based on economic theory, the study recommends the adoption of Taylor rule because findings from such rule based approach can be used stabilize output and inflation in Nigeria.

1.0 Introduction

This paper relies on the augmented Taylor rule to evaluate the reaction function of the historical path of nominal monetary policy rate in Nigeria. The Taylor rule and its variants by some other scholars (McCallum, (1987); Ball, (1999); Svensson (2000); Smets and Wouters, (2007)) engendered different ways by which monetary authorities derive the policy rate through the reaction function. The original Taylor rule (Taylor, 1993) which is still applicable in monetary policy modelling was used to describe the behaviour of the U.S. Federal Reserve between 1987 and 1992. It stipulates that the instrument of the monetary authority reacts to two key goal variables: deviations of contemporaneous inflation from a pre-set target rate and deviations of contemporaneous real output from its potential level.

The conduct of monetary policy in Nigeria dates back to 1959 but the use of market control mechanism started after the Structural Adjustment Program in 1986 (Tella, 2011). This ushers in the use of indirect control mechanism by the Central Bank of Nigeria (CBN) for monetary and macroeconomic management in Nigeria. The issue of whether monetary policy is best conducted by monetary policymakers using rules already known in advance or by

discretion is seemingly an empirical question for most developing nations due to the dearth of research in these nations. Kydland and Prescott (1977) are of the view that discretion may result either in consistent but sub-optimal planning or in economic instability while Patra and Kapur (2012) argue in favour of monetary policy rule. They opine that if predictability of the relationship between goals and instruments exists or at least variability is systematic, it is then possible to incorporate feedback into a rule.

In Nigeria, before 2007, the use of discretion or rule based approach by the CBN was not supported by a definite policy pronouncement. The choice of either of the two options in determining the policy rate requires full autonomy of the bank which was not granted until the promulgation of the CBN Act 2007 that repealed the 1999 Act. The 2007 Act provides that the CBN shall be a full autonomous body in the discharge of its functions (CBN, 2016). In view of the improved legal framework the CBN, now has a right to operate on full discretion and or use interest rate or monetary aggregate rule in forecasting monetary policy rate in Nigeria.

Studies on how best to determine optimal policy rate is still evolving especially in developing nations. However findings from a study by Asso, Khan and Lesson (2010) suggest that on this issue, views still differ about how the Taylor rule can best be applied in practice for macroeconomic management. It is not a gainsaying to express the opinion that the Taylor rule had contributed to the advancement of practice of central banking in developed nations by provoking the thought of other scholars who have made complimentary contributions after his work. We say this on the opinion of Asso *et al.* (2010) who itemised some of the uses of Taylor rule as follows; first it can be applied in inflation targeting regimes, second it considers real economic activity to achieve price stability in the medium term. Others are; interpreting the output gap as a harbinger of future inflationary pressure leads to a single

mandate focused on current and future inflation and finally the use of Taylor rule to evaluate historical monetary policy is very desirable for future projections of the monetary policy rate.

The use of a rule based approach for determining the policy rate has been subjected to empirical investigation in many advanced countries. For example, Lee *et al.* (2011) provides a good illustration of Taylor rule on Australia and United Kingdom (UK) using linear regression models to provide a useful and detailed characterisation of monetary policy in the two countries. They found that monetary policy reacts differently to inflation and its gap in the two countries. Kharel, Martin and Milas (2011) also experiment with exchange rates as additional explanatory variables to help explain UK interest rate movements while Sergi and Hsing (2010) considered the influence the real exchange rate may have had on Australian monetary policy and found that policy rate reacted positively to real effective exchange rate.

A study that denies the Taylor rule is Rowe and Tulk (2003) who evaluate the rule in a model-free environment in Canada using historical data during the bank's inflation-targeting regime. They found that the Bank would not improve its policy of targeting inflation by paying more attention to the advice provided by the rule.

Evidence from emerging and developing economies considered different modelling methods like forward and backward looking models in an augmented Taylor rule. We found from the empirical literature that Patra and Kapur (2012) using a forward looking model evaluates the operational performance of the McCallum rule, the Taylor rule and hybrid rules for India in 1996–2011 and found that this approach can attain the setting of a nominal output growth objective for monetary policy with an interest rate instrument.

Sghaier and Abida (2013) just like Patra and Kapur considered a forward looking model and found that the Central Bank of Tunisia followed the Taylor rule in its interest rate setting

behaviour. The response coefficient of expected inflation is greater than that of the output gap. This result is consistent with the fact that inflation is the primary objective of monetary policy in that country. In the Latin America, De-Losso (2012) used a different econometric approach in a study that characterizes the monetary policy in Brazil through a forward-looking Taylor-rule-type reaction function using the Generalised Method of Moments (GMM) to estimate interest rate response. The results show that the interest rate response to inflation was greater than one-to-one before stabilization and smaller than that afterwards, hence inverting the Taylor's principle. In MENA countries, (Turkey, Israel, Jordan and Morocco) Helmi (2011) also used GMM estimator in their study and found that all the central banks in the sample uses interest rate smoothing in managing their monetary policy and that the simple Taylor rule can be applied on these countries but it requires some modification such as adding the exchange rate and the foreign interest rate.

Studies on a rule based approach for determining the CBN reaction function is evolving in Nigeria but findings on this issue are diverse. Agu, (2007) used a monthly data for the period 1999-2005 based on Vector Error Correction approach and found that inflation rate is an important variable in the CBN reaction function. Iklaga, (2008) conducted a study on the same issue for the period 1999Q1-2007Q4 by forecasting the policy rate. He found that inflation and output are significant in determining the policy rate. Siri, (2009) used a combination of three econometric methods (Ordinary Least Squares Two Stage Least Squares and Non Linear Least Squares) for the period 1980Q1-2007Q4 and found that while output gap has no influence on the interest rate, inflation rate influence policy rate

Other studies reviewed are those conducted by CBN, (2013) and Abubakar and Yaba, (2014). The CBN, (2013) study is based on the New Keynesian Framework and analysis was by Bayesian econometric technique that covers a period of 1985Q1-2009Q4. The study found

that the coefficient values of the monetary policy reaction function are not exact to Taylor rule but very close to it. Abubakar and Yaba, (2014) investigated the CBN reaction function based on McCallum Rule using ARDL econometric technique for the period 1989Q1-2013Q4. They found that McCallum policy rule can serve as a potent rule for Nigerian monetary policy.

In this paper, unlike the others on Nigeria, we apply the Generalised Method of Moments (GMM) as proposed by Hansen (1982) to determine the relevance of augmented Taylor rule for monetary policy making in Nigeria. The remainder of the paper is structured as follows. Section 2 discusses the theoretical framework. Section 3 presents the data and methodology Section 4 is based on the discussion of findings and section 5 concludes the paper

2. Theoretical Review: Taylor's Rule

The theoretical thinking of the Taylor rule is derived from whether a central bank should use policy rules or discretion when determining the policy rate. Opinion is diverse on this but a recommendation from the literature is that policy rules are superior to discretion because discretion results in either consistent but sub-optimal planning or in economic instability (Calvo, 1978). The policy rule specified by Taylor is stated in the form:

$$i_t = r^* + \pi_t + \alpha(\pi_t - \pi^*) + \beta \tilde{y}_t \quad . . . \quad (2.1)$$

Where i is the nominal Federal funds rate, r^* is the equilibrium real Federal funds rate, π_t is the rate of inflation in the previous four quarters, π^* is the target inflation rate, \tilde{y} is the per cent deviation of real GDP from its target level and α and β are parameter values of inflation and output gap respectively. Federal funds rate rises if inflation rises above its target value, π^* or real GDP rise above its target level. When both inflation and GDP are on target, the nominal Federal funds rate will be equal to the sum of the equilibrium real value r^* and target

inflation π^* . For an improved explanation or interpretation of equation (2.1) the nominal interest rate rule can be rewritten in the form:

$$i_t = \delta + (1 + \alpha)\pi_t + \beta\tilde{y}_t \quad (2.2)$$

Where; $\delta = r^* - \alpha\pi^*$. The parameter values in (2.1) reflect the preferences of the monetary authority, and a stability condition of α greater than zero is frequently assumed. It is easy to see that if α was less than zero, rising inflation would, all other things being equal, cause the real interest rate to fall, which provides a stimulus for increased output.

Taylor (1993) for the use of the rule in the US sets both the inflation target π^* and the equilibrium real rate r^* equal to 2 and assigns an equal weight of 0.5 to the inflation and output gap terms. Using these values, he shows that this simple rule tracks the actual path of the Federal funds rate reasonably well. But the weight for inflation and output gaps or optimal value of these two parameters would ultimately depend on the structure of the model being considered. A widespread modification to the Taylor rule is to include terms representing interest rate smoothing behaviour by central banks. According to Clarida, *et al.* (2000) such characterization of the policy rate which incorporates gradual adjustments of the interest rate is represented in the form:

$$i_t = \rho_1 i_{t-1} + (1 - \rho_1) i_t^* \quad (2.3)$$

The monetary authority set the nominal policy rate i_t as the weighted average of the previous period of the policy rate i_{t-1} , the Taylor rule is represented by i_t^* while ρ is the parameter estimate of the lag of policy rate.

3.0 Methodology

3.1 Data and its Sources

Our data set ranges from 1996:1- 2014:4 obtained from the CBN statistical bulletin and annual statement of accounts. The choice of the period is based on the availability of real

exchange rate data from 1996. The variables of the study are monetary policy rate (MPR) being the proxy for monetary policy. Other variables are real gross domestic product (RGDP) proxy by real output gap, inflation rate (IR) proxy by the headline consumer price index and the real exchange rate (RER).

3.2 Empirical Model

The empirical model for this paper are the current, forward and backward looking Taylor rule that also incorporate real exchange rate as the policy reaction function which estimates the effect of inflation and real output on the policy rate. Following the work of Taylor (1993), Clarida, *et al.* (2000) and Sergi and Hsing (2010) we model the current, forward and backward-looking equations as follows: Equation (3.1) incorporates the current real exchange rate, current real output gap and inflation variable. The augmented Taylor rule is expressed in the form:

$$i_t = \alpha + \rho i_{t-1} + \gamma_\pi (\pi_t - \pi_t^*) + \gamma_y y_t + \gamma_e e_t + \varepsilon_t \quad (3.1)$$

Where i_t is the policy rate at time t , i_{t-1} is the lagged policy rate at the prior period, π_t is the current inflation rate, π_t^* is the target inflation rate at time t , y_t is the current output gap at time t and e_t is the current real exchange rate. Other notations are α , which is the intercept, ρ and γ are parameter estimates while ε_t is the error term with a zero mean and constant variance that is independently, and identically distributed (iid). The lagged interest rate term that is included is meant to take into account the interest rate smoothing by the policymaker.

Equation (3.2) is a forward looking Taylor rule expressed in the form:

$$i_t = \alpha + \rho i_{t-1} + \gamma_\pi (\pi_{t+1} - \pi_t^*) + \gamma_y y_{t+1} + \gamma_e (e_{t+1} - e_t) + \varepsilon_t \quad (3.2)$$

Where i_t is the policy rate at time t , i_{t-1} is the policy rate at the prior period, π_{t+1} is the inflation rate at the next period, π_t^* is the target inflation at time t , y_{t+1} is the output gap at time $t+1$, e_{t+1} is the real exchange rate in the prior period e_t is the current real exchange rate. Other notations are α , which is the intercept, ρ and γ are parameter estimates while ε_t is the error

term with a zero mean and constant variance that is independently, and identically distributed (iid). Equation (3.3) is a backward looking Taylor rule incorporating the difference between the lag real exchange rate and the current exchange rate.

$$i_t = \alpha + \rho i_{t-1} + \gamma_\pi (\pi_{t-1} - \pi_t^*) + \gamma_y y_{t-1} + \gamma_e (e_{t-1} - e_t) + \varepsilon_t \quad (3.3)$$

Where i_t is the policy rate at time t , i_{t-1} is the policy rate at the prior period, π_{t-1} is the inflation rate at the next period, π^* is the target inflation at time t , y_{t-1} is the output gap at time $t-1$, e_{t-1} is the real exchange rate in the prior period e_t is the current real exchange rate. Other notations are α , which is the intercept, ρ and γ are parameter estimates while ε_t is the error term with a zero mean and constant variance that is independently, and identically distributed (iid).

3.2 Analytical Procedure

The output gap y_t estimate was derived based on Hodrick-Prescott (HP) Filter with the value of smoothing parameter equal to 1600. Unlike Taylor (1993) who used year-over-year change in the price deflator as proxy for inflation, we experiment with quarter on quarter Consumer Price Index (CPI) headline inflation as the inflation rate. The target inflation is the target inflation rate prescribed by the CBN. The unit root test of the study variables was by the Augmented Dickey Fuller (ADF) and lag length choice was automatic based on Schwarz information criteria. The test equation included both the intercept and trend and intercept.

The regression analysis was based on Generalised Method of Moments (GMM) “continuous updating approach developed by Hansen, Heaton, and Yaron (1996) and studied in Stock and Wright (2000). The econometric method can correct for unknown forms of autocorrelation and heteroskedasticity which cannot be achieved if the Ordinary Least Squares (OLS) or the Two Stage Least Squares (2SLS) were used. The instruments used for analysis are assumed to be uncorrelated to the error term but strongly correlated with the right hand side variables.

The instruments used are also more than the number of estimated coefficients for the model to be over-identified. The post estimation tests include the model misspecification test, over-identification test by means of J-test and Stock- Yogo weak instrument test, which attests to the reliability of our results. All of these are discussed in the next part of the paper.

4.0 Discussion of Results

4.1 Results of Unit Root Test

In Table 1, the study reports the Augmented Dickey Fuller (ADF) method of testing unit root. The analysis, included the intercept, trend and intercept in the test equation. The rgdpgap, infgap and tinf variables are 1(0) and are significant at 5% level after including the linear time trend while mpr and lnrrer are 1(1) and are significant at 1% level.

4.2 Empirical Findings

This paper assesses the augmented Taylor rule based on GMM estimators in three approaches as indicated in Table 2 for the period 1996:Q1-2014Q4. The results show that the three approaches used show substantially different results. What is common to the three methods is that the estimated coefficient value of the response variable (MPR) adjusts gradually over time to its target. The results also indicate a negligible difference between forward and backward looking method at 1% level of significance. The inference from the results is that adjustment of the policy rate based on augmented Taylor rule has been gradual over time by the CBN.

The second issue on Table 2 is to affirm whether the CBN set the nominal interest rate in response to the expected level of inflation. We found that inflation variable across the three methods is not statistically significant for it to explain changes in the policy rate. Taylor (1993) says that a central bank monetary policy rate response to inflation must be greater than 1 because the real interest rate must increase more than the expected increase in inflation for it to stabilize inflation expectations and lower aggregate demand. On the other side of the

argument, an inflation coefficient that is less than 1 is likely to cause an increase in inflation because it presupposes a smaller interest rate in response to a higher expected inflation which might likely lead to a rise in expected inflation.

Unfortunately the result indicates that inflation expectations are not significant in explaining changes in the monetary policy rate. The inference from this evidence suggests that stabilizing inflation is not a primary objective of the CBN as widely claimed the monetary authority.

The paper included the real output gap in the Taylor rule equation as posited by Taylor. The result indicates that the variable is significant in the backward model at 10% level while it is not in both the current and forward models. Taylor proposes a coefficient value of 0.5 for the real output gap. The estimated coefficient though weakly significant satisfies the Taylor rule in the backward model. The inclusion of the real output gap has been justified for a number of reasons based on economic theory. The output gap represents an indicator which can be used by the monetary policymaker to stabilize output and also used as a proxy for expected inflation. The inference from the result is that the output gap has a significant weight in the reaction function and can be used to determine changes in the current monetary policy rate based on the backward model.

The real exchange rate included in the CBN reaction function shows evidence that it is strongly significant compared to real output gap and inflation variables in the backward model. The relationship between the policy rate and exchange rate is indirect in the three options although the forward model is not significant. In the backward model a per cent increase in the real exchange rate causes the monetary policy rate to decline by 3.88 percentage points. This infers that movement of the exchange rate can be used to explain the path of monetary policy rate in Nigeria during the period under study.

4.3 Result of Diagnostic Tests

The bases for determining whether the models of the study are mis-specified and or over-identified are based on the results of J-statistic and Probability of J-statistic reported in Table 3. We fail to reject the models because J-statistic of $4.0093 < \text{probability of } \chi^2_{0.050} = 15.5$ for current model; $5.9897 < \text{probability of } \chi^2_{0.050} = 9.49$ for forward model and $8.3899 < \text{probability of } \chi^2_{0.050} = 15.5$. Therefore we conclude that our models are not misspecified.

In respect of over-identifying restrictions, for GMM analysis, the order condition of identification of the equations is where $L \geq K$. In Table 3 the instrument rank for each of the models is greater than number of parameters which are 5 in each of the models. Hence we conclude that all our equations met the over identifying conditions.

The validity of instruments used in the GMM regression analysis is tested based on Cragg-Donald F. statistic test. The results are reported in Table 4. The F-statistic at 72.66 for current model and 103.5 for backward model allow us to reject the Null hypothesis of weak instruments where F-statistic $72.66 > 16.88$ Stock-Yogo critical value at 5% level of significance even if when the model is over-identified. In respect of the backward model we also reject the Null hypothesis of weak instruments because the F-statistic $103.5 > 19.86$ Stock-Yogo at 5% level of significance while the forward model F. statistic $13.38 > 9.48$ Stock-Yogo at 10% level of significance. The inference from the results is that the instruments used for the study are strong in spite of the fact that the parameters are over-identified.

5.0 Conclusion and Recommendation

This paper considers whether the augmented Taylor rule is applicable in Nigeria based on a data set for the period 1996Q1-2014Q4. Unlike others studies conducted on Taylor rule as a reaction function on Nigeria, we employ the GMM econometric technique and augmented the

Taylor rule with real exchange rate. We considered three model options which are current period, forward looking and backward looking. We found that the backward looking model performs better in an augmented Taylor rule compared to the other two models. Further to this the real output gap and exchange rate variables significantly affected the policy rate. Apart from the inflation variable, real output variable conform to the Taylor rule while the lagged exchange rate variable is inversely related to the policy rate. The parameter value has the higher weight compared to real output gap. We found no evidence to support the fact that inflation variable affects the policy rate.

We conclude that lag of real exchange rate has a greater effect on the policy rate compared to other variables of the study consequently the result suggests that inflation stability is not a primary objective of the CBN as widely claimed. Based on economic theory, the study recommends the adoption of Taylor rule because findings from such rule based approach can be used stabilize both output and inflation in Nigeria. This study can be further extended to include asset prices in the central bank reaction function.

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Appendix

Table 1: Result of Unit Root Tests

Variable	Model Specification		
	Order of Integration	1(0)	1(1)
mpr	Intercept	-1.4663	-7.5093*
	Trend and Intercept	-1.7885	-7.4562*
Rgdpgap	Intercept	-3.2275**	-8.9705*
	Trend and Intercept	-3.2017**	-8.9154*
lnrer	Intercept	-2.2291	-7.5813*
	Trend and Intercept	-0.9731	-8.1662*
infgap	Intercept	-7.1807*	-10.4818*
	Trend and Intercept	-6.5427*	-10.4988*
Tinf	Intercept	-4.4156*	-8.6928*
	Trend and Intercept	-3.9773**	-9.0129*

Source: Author (2016)

Critical values: Intercept – 1% (*) -3.5203; 5% {**} -2.9006; 10% [***] -2.5889.

Critical values: Trend and Intercept - 1% (*) -4.0869; 5% {**} -2.9030; 10% [***] -2.5889.

Table 2: Regression Results

	Current model	Forward model	Backward model
Variable	coefficient	coefficient	coefficient
c	2.7344* (0.6254)	1.2689*** (0.6499)	1.1966*** (0.7114)
mpr(-1)	0.8661* (0.0319)	0.9067* (0.0448)	0.9068* (0.0477)
infgap	0.0060 (0.0244)	-0.0015 (0.0025)	-0.0002 (0.0021)
lnrgdpgap	0.3167 (0.2400)	0.2359 (0.2744)	0.5220*** (0.3023)
lnrer	-0.2911*** (0.1623)	-1.0091 (0.6534)	-3.8784* (1.2237)

Source: Author (2016)

Standard errors are in parenthesis

(*) [**] {***} indicate 1%, 5% and 10% level of significance

Table 3: Model Specification/ over-identification Test Results

Model	J-statistic	Prob (J-statistic)	Instrument Rank
Current	4.0093	0.6754	11
Forward	5.9897	0.1999	9
Backward	8.3899	0.2109	11

Source: Author (2016)

Table 4: Weak Instrument Test Results

Model	Cragg Donald F.Statistic	Stock-Yogo Critical values (RelativeBias)
Current	72.66	5% -16.88; 10% - 9.92; 20% - 6.16
Forward	13.38	5% - 15.72; 10% - 9.48; 20% - 6.08
Backward	103.5	5% -19.86; 10% - 11.29%; 20% -5.07

Source: Author (2016)