

Monetary Policy in Nigeria: Any Role for McCallum Rule?

Mika'ilu Abubakar¹, Baba N. Yaaba^{2,*}

¹Department of Economics, Usmanu Danfodiyo University, Sokoto, P.M.B. 2346, Nigeria

²Department of Statistics, Central Bank of Nigeria, P. M.B. 0187, Abuja, Nigeria

Abstract The unending debate among policy makers, researchers and market analysts on the suitability of monetary policy rule over discretion prompted the development of models to determine and predict the possible future path of monetary policy. Proponents of rule favour commitment to a specific rule while opponents, although agree with the proponents to some extent but to a large extent prefer discretion, with the notion that central banks cannot outsource critical issues of monetary policy decision making to a simple mechanics of rule. This study determined the applicability of McCallum rule, within the context of bounds test, to Nigeria's monetary policy framework, using data from 1989Q1 to 2013Q2. With a positive monetary response factor and potential output as well as negative velocity, monetary base can be varied to enhance output growth at low inflation rate, thus guarantees output stability perhaps in the long-run, hence supports the application of the rule by the Central Bank of Nigeria (CBN). The study, however, suggested the introduction of additional monetary variable to the rule to make it more robust as well as constant monitoring of velocity of monetary base considering the observed volatility of the variable during the studied period.

Keywords McCallum rule, Taylor rule, Monetary policy, GDP

1. Introduction

The unending debate amongst policy makers, academics and market players as to whether monetary policy framework should be based on rule rather than discretion of policy makers have prompted the search and subsequent development of models to determine and predicts the possible future path of monetary policy, using developments in the domestic as well as external sectors of the economy. Advocates of rule believe that, without commitment to a specific rule, there is the possibility of heavy reliance on a particular policy that strives to achieve a particular objective at the expense of others and that the credibility of monetary policy will be in doubt. They also believe that policy rule increases accountability and holds policy makers responsible for underperformance.

Although, policy makers seems to agree with the numerous advantages of rules as opined by its advocates and most importantly its ability to facilitate communication with the public, on the policy intentions of the monetary authority, hence enables fair judgement of their performance vis-à-vis the policy objectives. This notwithstanding, however, they, to a large extent, tend to favour discretion, with the notion

that central banks cannot outsource such critical and complex issues of monetary policy to a simple mechanics of rule. Their scepticism with regard to rule is also in connection to the ambiguity enshrined in the linkage between policy instruments and the ultimate policy goals. Therefore, policy makers will prefer, in a worst case scenario, a blend of both rule and discretion believing that the two are complimentary.

The complementarity of rule and discretion, however, poses the challenge of policy mix. Without any identifiable quantitative challenges with discretion, there is need to determine not only how to decide on the rule but also how to measure performance over time. Popular contributions in this regard are McCallum (1987) and Taylor (1993). Taylor rule gained more prominence because of its simplicity as well as its performance in the United States in the 1990s.

McCallum (1987) rule targets nominal gross domestic product (GDP) through money supply. The rule states the need to adjust monetary policy in terms of deviations of GDP from target. For instance, if GDP falls below the desired target, the central bank is expected to increase money supply to stimulate the economy so as to facilitate increase in GDP to the desired level. While Taylor (1993) is of the view that central bankers increase the nominal interest rate, if output is above the potential (output gap) and/or inflation is above the target (inflation gap). In a nutshell, therefore, McCallum rule is a nominal GDP target rule using monetary base as the major policy instrument, while Taylor rule disregards

* Corresponding author:

yaabakatcha@yahoo.com (Baba N. Yaaba)

Published online at <http://journal.sapub.org/economics>

Copyright © 2014 Scientific & Academic Publishing. All Rights Reserved

monetary target in preference for interest rate.

However, since monetary targeting is still in vogue in Nigeria, it would not be out of place to think that McCallum rule is suitable for Nigeria. This study is, therefore, an attempt to examine the relevance of McCallum rule to the Central Bank of Nigeria (CBN) monetary policy framework.

To achieve this, the paper is structured into five sections. Following this introduction is section two which appraises the principles behind McCallum rule, as well as relevant empirical literature. Section three, explains the data sources and methodology, while section four presents the empirical results and the last section concludes the study.

2. Review of McCallum Rule

2.1. Theoretical Review

McCallum (1987, 1993)¹ is of the view that central banks should follow a rule in designing monetary policy. McCallum suggest 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:

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

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 periods², 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 (1) 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 Shuzhang (2010), 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 (1988) the formulation process of

equation (1) 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 policy³.

2.2. Empirical Review

Dean and Stark (1995) use macroeconomic models of Keynes, PSTAR⁴ and rational expectations to appraise McCallum rule for the US between 1963 and 1993. They submitted that, McCallum rule on the average seems more appealing than any other monetary policy rule, as the average level of real output was closer to the potential level, while prices were lower in the simulation than the historical data suggested. They, however, suggest the use of growth rate of nominal GDP instead of levels but agreed that the rule overall enhances downward trend in inflationary spiral.

Stark and Dean (1998) further expanded the set of economic models based on which McCallum rule was originally tested. They employed Keynesian version, reduced-form model and structural VAR framework as well as impulse response to test the stability of the model using quarterly US data from 1959Q1 to 1993Q2. Their results identified some problems of instability with the original McCallum specification which focused on nominal GDP. The rule according to them performed better, in term of dynamic stability and short term variability measures when growth rate of real GDP is used as against level. They submitted that if the rule is modified to use growth rate of real GDP instead of level, it will serve as a useful tool of monetary policy formulation.

Arturo and Mishkin (1996) examine the role of monetary aggregates in the conduct of monetary policy in the United States and Germany for the period 1959 to 1995 using a multivariate VAR concept. They assess monetary aggregates from the perspectives of information variable, indicator of policy action and instrument of policy rule. Their final results confirmed neither the informative nor indicative role of monetary aggregates. It also didn't provide any strong evidence in support of the potency of monetary aggregates as instrument of policy rule for both countries.

Esanov et al. (2004) use an eclectic approach to review the rule-based behavior of the Central Bank of Russia with regard to the conduct of monetary policy from 1993 to 2002. They assess the reaction of the bank to exchange rate, inflation and output gap. Their results show that between 1993 and 2002, the bank used monetary aggregates as an instrument of monetary policy which conforms to the McCallum proposition.

Vdovichenko and Victoria (2004) investigate the policy rule type adopted by the Bank of Russia between 1993 and

1 McCallum revised the earlier version of the rule using nominal GDP growth as the target.

2 McCallum used annual data which yields four years, but according to Michael and Kapur (2012) average growth rate of velocity for quarterly data is sixteen quarters = $(1/16)*[(x_{t-1} - b_{t-1}) - (x_{t-17} - b_{t-17})]$

3 Inflation or output.

4 PSTAR was developed by Herb Taylor of the Federal Reserve Bank of Philadelphia in the late 80s to support monetary policy formulations.

2003. With special focus on econometric modelling of monetary policy rules of various types, they employed different econometric techniques, such as generalized method of moments (GMM), ordinary least squares (OLS) and two-stage least squares (TSLS) with modifications in term of adopting two set of simultaneous equations that describes the dynamics of intervention in the foreign exchange market and sterilisation of excess liquidity. The results show a stabilizing pattern in the management of base money and that the format of interest rate policy was more of adaptive in nature. The results also reveal that the Bank was more interested in exchange rate regulation as against the inflation officially pronounced by the Bank.

Kong (2007) reviews the conduct and characteristics of Chinese monetary policy from the first quarter of 1994 to the fourth quarter of 2006 by estimating the monetary policy reaction function via a quantity theory of money like model. He finds that although all the estimated rules describe Chinese monetary policy stance to some extent but Taylor rules performs better than McCallum rules in evaluating Chinese monetary policy stance during the period.

Shuzhang *et al.* (2008) uses a counterfactual simulation method to assess the possibility of McCallum rule policy framework for China based on two distinct macroeconomic models from 1994Q1 to 2009Q1. The results show that McCallum rule is capable of stabilizing growth rate of China and that monetary base rule can be used as a benchmark for monetary policy decisions in China.

Tuuli *et al.* (2008) examine the applicability of McCallum monetary policy rule based on money supply with inflation objective for mainland China for the period 1996 to 2008. They examined the informative content of the concept of excess money compared to rule-based values for forecasting inflation. The results confirmed the usefulness of monetary aggregates in forecasting both consumer and corporate goods prices. They, however, argued that results for consumer prices depend on the time horizon of the forecast. They concluded that the movement in the Chinese monetary base tracked fairly well the McCallum rule and that it can be used to detect shocks to Chinese monetary policy.

Diez de los Rios (2008) also supported the proposal of McCallum (1987) which suggest the need for a monetary rule that will guide policymakers to the possibility of fluctuations in exchange rates. He estimates monetary policy reaction function using an affine term structure framework for Canada, Germany and the U.K for the period January 1979 to December 2005. The results suggest that, unlike the earlier results, the monetary authorities of the studied countries react to movements in nominal exchange rate.

Ghatak and Moore (2008) examine the monetary policy reaction function based on both Taylor and McCallum rules for the transition economies of the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Bulgaria and Romania between 1994 and 2006 using vector

autoregression. The results show that while monetary aggregate in Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia, react to inflation variants in the long-run, the deviation of exchange rates from the potential level can be attributed to the vagaries of short-term interest rates. They submitted that the Taylor rule is far more applicable to exchange rate targeting, whereas McCallum rule is suitable for inflation targeting.

Shuzhang (2010) evaluates the relevance of McCallum rule to the Chinese monetary policy guideline. He applied a structural VAR to China's quarterly data from the first quarter of 1994 to the first quarter of 2009. The results strongly support the use of the rule as a medium to long-term policy framework for monetary policy formulation as it is capable of stabilizing the economy, reduce policy uncertainties, increase credibility as well as improve transparency of monetary policy.

Michael and Kapur (2012) examine the operational performance of McCallum rule, Taylor rule and their respective hybrid versions for India using quarterly data from 1996 to 2011. The results reveal that, the forward-looking nominal output objective formulations of both rules and their hybrid versions, using interest rate as an operating instrument, performed better than the backward-looking specifications. They, therefore, argued in favour of the adoption of the forward-looking formulations of the rules for India.

Giray (2012) estimates a reaction function of the Central Bank of the Republic of Turkey (CBRT) based on Taylor rule, as well as what he referred to as 'Hybrid McCallum-Taylor rule'. The data covered the period 2003Q1 to 2012:Q1. He used Generalized Methods of Moments (GMM) and Limited Information Maximum Likelihood (LIML) methods to estimate the reaction function covering the period of inflation targeting in Turkey, with nominal interest rate as the instrument of monetary policy. The results reveal that Taylor rule specifications are more applicable to the monetary policy guideline of the Central Bank of Republic of Turkey (CBRT).

3. Methodology and Data Sources

Equation (1) implies that, if output gap is negative⁵, the base money should be adjusted downward to reduce the rate of overheating in the system. Similarly, negative inflation gap⁶ should also attract reduction in the money supply.

From equation (1), therefore:

$$\Delta mb_t = \log mb_t - \log mb_{t-1} \quad (2)$$

$$\Delta y_t^p = \text{desired growth rate of nominal GDP} \quad (3)$$

$$\Delta vmb_t = \left(\frac{1}{16}\right) * [(y_{t-1} - mb_{t-1}) - (y_{t-17} - mb_{t-17})] \quad (4)$$

Alternatively, velocity (v) can be obtained from Fisher

5 Growth rate of nominal output exceeds target or the desired level.

6 Inflation rate exceeds target or the desired level.

equation as:

$$MV = PT \tag{5}$$

Where M is the money supply, V is the velocity of circulation, P is the price level and T is the level of transaction. Making V the subject, we have:

$$V = \frac{PT}{M} \tag{6}$$

Given that;

$$PT = GDP \tag{7}$$

Where GDP represents nominal gross domestic product. Then equation (6) becomes:

$$V = \frac{GDP}{M} \tag{8}$$

In case of inflation targeting central bank, Δy_t^p is the sum of inflation target and long-run average real GDP growth rate.

Following, Baoli (2010), equation (1) can be modified to avoid the possibility of interpreting McCallum rule as mainly a price stability reaction.

$$\Delta mb_t = \Delta y_t^p - \Delta vmb_t + \varphi(if_{t-1}^p - if_{t-1}) + \delta(\Delta y_{t-1}^p - \Delta y_{t-1}) \tag{9}$$

Where if^p and if are inflation target and inflation respectively. Although, Central Bank of Nigeria (CBN) is not an inflation targeter but it has long been striving to achieve single digit inflation, hence if^p will be proxied by the upper bound of single digit (i.e. 9.99), while Hodrick-Prescott (HP) filter (1997) will be applied to GDP growth rate to derive the potential GDP as well as the corresponding GDP gap.

If $if_{t-1}^p - if_{t-1}$ is represented as f_g and $\Delta y_{t-1}^p - \Delta y_{t-1}$ is denoted as y_g , then equation (9) can be reformulated as:

$$\Delta mb_t = \Delta y_t^p - \Delta vmb_t + \varphi f_{g,t} + \delta y_{g,t} \tag{10}$$

The study adopts autoregressive distributed lag (ARDL) approach developed by Pesaran *et al* (2001) to estimate equation (10). The choice of the ARDL is based on several considerations. First, the model can be applied irrespective of whether the underlying regressors are stationary at I(0) or I(1) or a mixture of both. In other words, the model does not require stationarity of the data. Second, it yield high quality results even if the sample size is small (i.e. it has a small sample property). Third, it provides unbiased estimate of the long-run model as well as valid t-statistics even when some of the regressors are endogenous (Harris and Sollis, 2003).

Following Pesaran *et al.* (2001) the ARDL version of equation (10) becomes:

$$\begin{aligned} \Delta mb_t = & \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta mb_{t-i} + \sum_{i=1}^p \beta_{2i} \Delta Ly_{t-i}^p \\ & + \sum_{i=1}^p \beta_{3i} \Delta Lvmb_{t-i} + \sum_{i=1}^p \beta_{4i} \Delta f_{g,t-i} \\ & + \sum_{i=1}^p \beta_{5i} \Delta y_{g,t-i} + \alpha mb_{t-1} + \beta Ly_{t-1}^p \\ & + \gamma Lvmb_{t-1} + \varphi f_{g,t-1} + \delta y_{g,t-1} + \mu_t \end{aligned} \tag{11}$$

Note that β_4 and β_5 in equation (11) replaced φ and δ as represented in equation (10).

The general error correction representation of equation (11) is formed as:

$$\begin{aligned} \Delta mb_t = & \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta mb_{t-i} + \sum_{i=1}^p \beta_{2i} \Delta Ly_{t-i}^p \\ & + \sum_{i=1}^p \beta_{3i} \Delta Lvmb_{t-i} + \sum_{i=1}^p \beta_{4i} \Delta f_{g,t-i} \\ & + \sum_{i=1}^p \beta_{5i} \Delta y_{g,t-i} + \beta_6 ECM_{t-1} \end{aligned} \tag{12}$$

Where ECM is error correction representation of equation (11).

Table 1. Summary Statistics of the Variables used for the Estimation

	<i>mb</i>	<i>ly^p</i>	<i>lvmb</i>	<i>f_g</i>	<i>y_g</i>
Mean	0.06	13.90	0.10	12.31	0.00
Median	0.05	14.06	0.12	3.68	0.03
Maximum	0.32	16.20	0.74	79.58	0.22
Minimum	-0.08	9.09	-0.57	-11.42	-0.61
Std. Dev.	0.06	1.71	0.32	20.86	0.11
Skewness	0.77	-0.61	-0.17	1.40	-2.49
Kurtosis	4.87	2.63	2.37	3.86	12.50
Jarque-Bera	23.75	6.69	2.07	34.98	470.34
Probability	0.00	0.04	0.36	0.00	0.00
Sum	5.84	1362.65	9.71	1206.82	0.02
Sum Sq. Dev.	0.40	284.90	9.66	42228.06	1.25
Observations	98	98	98	98	98

Two stages are involved in the estimation of equation (11). The null hypothesis of the non-existence of the long-run relationship among the variables is first defined by $H_0: \alpha = \beta = \gamma = \phi = \delta = 0$. H_0 is tested against the alternative of H_1 not H_0 by conducting F-test or Wald test. Rejection of the null hypothesis confirms the existence of a long-run relationship among the variables irrespective of their order of integration. If the calculated F-statistics is above the upper level of the critical band as tabulated in Pesaran *et al.* (2001), the null hypothesis is rejected, implying that there is co-integration, if it lies below the lower level; the null cannot be rejected, signifying lack of co-integration. The result is inconclusive, if the F-statistics falls within the band.

Quarterly data spanning from the first quarter of 1989 to the second quarter of 2013 were used for the estimation. The data is obtained from the Statistical Bulletin of the Central Bank of Nigeria (CBN) and the Annual Abstract of Statistics of the National Bureau of Statistics (NBS).

4. Analysis of Results

4.1. Statistical Properties of the Data

To determine the statistical properties of the data used for the estimation, summary statistics and correlation coefficients of the variables were calculated. Unit root tests were also conducted on the data to determine their level of stationarity and the results are reported in Table 1 to 3. The summary statistics of the variables used for the estimation are reported in Table 1. The table indicates that there are ninety eight observations in all. While the growth rate of monetary base (*mb*) recorded a mean observation of 0.06,

the potential growth (ly^p) stood at 13.90. The mean observation of the output gap (y_g) is almost zero. While f_g has the minimum value of -11.42, the minimum value of ly^p is 9.09. The log of velocity recorded a minimum of -0.57 and maximum of 0.74 showing that the variable was volatile during the sample period.

Table 2 reports the correlation coefficients of the variables. Ly^p and $lvmb$ are highly correlated with mb , at 0.98 and -0.64, respectively. While ly^p is positively correlated with mb , $lvmb$, f_g and y_g are negatively correlated with mb . This further support the direction (signs) of the relationships as obtained in the long-run result for the respective variables reported in Table 4. The less strong relationship among variables other than the dependent variable (mb) pre-supposes lack of autocorrelation.

Table 2. Correlation Coefficient of the Variables used for the Estimation

	<i>mb</i>	ly^p	<i>lvmb</i>	f_g	y_g
<i>mb</i>	1.00	0.98	-0.64	-0.53	-0.01
ly^p		1.00	-0.53	-0.55	0.00
<i>lvmb</i>			1.00	0.35	0.27
f_g				1.00	0.01
y_g					1.00

The study utilised both Augmented Dickey Fuller (ADF) (based on Akaike Information Criterion, Swatzch Bayesian Criterion and Hannan Quinn Criterion) and Phillips Perron (PP) tests to examine the presence of unit root in the series. The results as reported in Table 3 indicates that all the variables are I(1) and significant at 1.0 per cent. This shows that there are no I(2) series among the variables, hence lend support to the use of bounds test approach to cointegration.

Table 3. Unit Root Test of the Variables Used for the Estimation

	Augmented Dickey-Fuller						Phillips Perron	
	AIC		SBC		HQC		Level	First Diff.
	Level	First Diff.	Level	First Diff.	Level	First Diff.		
<i>mb</i>	-4.034615*	-4.251144*	-1.466259	-10.64303*	-1.466259	-10.64303*	-1.403762	-10.6417*
ly^p	0.533817	-4.927804*	0.533817	-3.899503**	0.533817	-4.927804*	-9.524635*	-17.93502*
<i>lvmb</i>	-1.629941	-4.062739*	-1.629941	-4.062739*	-1.629941	-4.062739*	-1.628464	-10.60287*
f_g	-2.80102***	-6.988856*	-2.80102***	-6.988856*	-2.80102***	-6.988856*	-2.55098	-6.956577*
y_g	-5.055164*	-5.319986*	-4.714329*	-16.58742*	-4.714329*	-16.58742*	-34.99266*	-47.77007*

Note: *, ** and *** implies significant at 1%, 5% and 10%, respectively.

4.2. Analysis of the Empirical Results

To affirm the validity of McCallum rule as modeled in equation (11), change in monetary base will be a direct function of change in output gap. This is referred to as the monetary response factor and it is one of the most critical terms in McCallum rule as it is essential for the stabilization of output and to some extent price level (Shuzhang et al, 2008). This is so, because, the gap of nominal income growth term (δ)⁷ is defined as the trend growth of gross domestic product (GDP) minus actual growth of GDP such that as growth in actual output fall short of its potential, monetary policy becomes expansionary so as to close the gap. The accommodative monetary policy stance of the monetary authority is adjudged by the positive response of the growth rate of base money. Hence, output gap is *a priori* expected to return positive sign. Positive output gap, in this case, portrays that the economy still has spare capacity to produce more, hence, serves as a signal to the central bank that more money is needed in circulation to enhance the productive capacity of the economy.

The long-run result presented in Table 4, in consonance with the principles of McCallum rule, indicates that both potential output and the corresponding output gap are directly a function of monetary base. In other words, both the monetary response factor as well as the potential output yielded positive signs in agreement with the workings of the McCallum rule.

The negative relationship between monetary base and velocity (the second most critical term in the rule) is in line with the principles of the rule as portrayed in equation (10). McCallum's view is unlike the plausible argument of the monetarists on either constant velocity or a perfect elasticity of velocity (V), as enshrined in the quantity theory of money (QTM) in the original Fisher equation⁸, or k as in the later modification of the equation by the Cambridge school⁹, led by A. C. Pigou, to variations in money supply (M), such that as M increases, velocity responds positively and proportionately. The following submissions strongly support the inverse relationship between money supply and velocity as contained in the McCallum rule.

Increase in M conceivably implies more money in the hands of economic agents (households, firms and financial institutions), out of which some portion could end-up as cash balances arising from the desire for hoarding, following any of the motives for holding money as propounded by Keynes. This, therefore, hinders a proportionate response of V to increase in M . It is this gap, arising from the non-proportionate response of V or k to changes in M that Keynes argued are taken care of by other factors outside the QTM such as production and trade.

According to Hussman (2011), upward adjustment of money supply tends to effectively lower short-term interest

rate. Fall in interest rate, in-turn push upward the preference for liquidity, thereby reduces velocity. He, therefore, concludes that changes in the monetary base are made to have an inverse changes in the velocity. This is also the basis for the structuralists proposition of the inverse relationship between M and V .

The expected future role of money tends to influence the behavior of rational economic agents, such that as money is perceived to lose its purchasing power in future, rational economic agents invest more in assets that are likely to maintain relatively stable value over time, hence reduce cash balances and increase velocity even at a period of declining M .

The assumption that changes in the amount of money in circulation do not either alter velocity or positively affects it is only a critical assumption in the QTM but does not form part of the building blocks of the McCallum rule. This is evident from the formulation of equation (10) where velocity is *a priori* assigned negative sign. The cases of the US in the 1940s and after the recent global economic crisis are consistent with this result. The money stock in the US increased sharply during the Second World War but the velocity trended downward. Similarly, both narrow and broad money increased sharply in the US after the most recent global financial crisis but velocity responded in a different direction (Lothian, 2009 and Shahani, 2012).

The negative coefficient of velocity represented in Table 4 and strongly supported by Figures 1 and 2, indicates not only that V is neither constant nor stable in Nigeria but varies inversely with M within the studied period. Probable reasons could be that as M increases, interest rate falls, thus encourages hoarding or huge cash balances in the hands of economic agents, hence decline in velocity. This happens, because, cash balances are, as stated earlier, sensitive to interest rate.

Viewed from another perspective and in line with Shuzhang et al. (2008), the negative sign of the velocity of monetary base probably mirrors the influence of shocks arising from financial innovations due to improvements in technology and regulation. With this in mind, it behoves that any permanent shock to money demand would hardly impact heavily on prices. In other words, the efficacy of the influence of money demand on prices neutralises as velocity becomes a reflection of technological and regulatory changes.

With positive monetary response factor and negative coefficient of velocity particularly in the long-run, McCallum rule seems potent to serve as a tool to ensure the attainment of potential output at the desired level of inflation in Nigeria. In other words, the direct relationship of β and δ to mb as well as the negative influence of mb on γ make McCallum rule a good choice of monetary policy rule for Nigeria.

7 Represented as y_g in equations (10) and (11).

8 $M = \frac{PT}{v}$

9 The Cambridge school later modified the equation as: $M = kPT$

Table 4. The Estimated Long-Run Results, ARDL (1,0,0,0,0)

Dependent Variable: <i>mb</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
β_0	0.1732	0.0697	2.4850	0.0148
β	0.1262	0.0282	4.4785	0.0000
γ	-0.1380	0.0342	-4.0298	0.0001
ϕ	-0.0002	0.0003	-0.5767	0.5655
δ	0.0000	0.0000	2.2302	0.0282

$R^2 = 0.99$ Adjusted $R^2 = 0.99$ F-Stats = 3.69, (5, 67), 0.0000. DW Stats = 2.2617
 Prob(F-statistic) = 0.0000 AIC = -2.805436, SBC = -2.646175, HQC = -2.741039

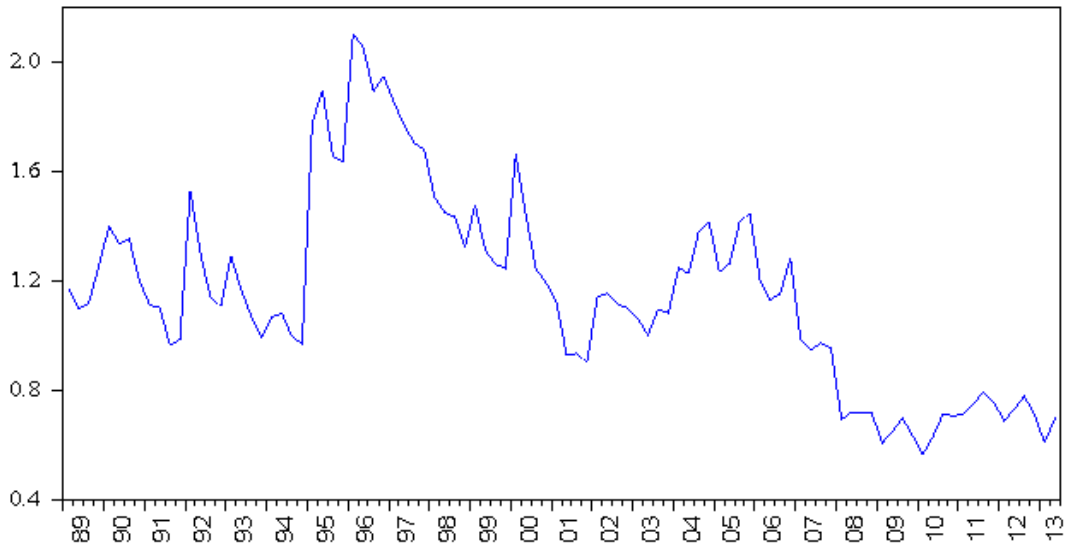


Figure 1. Velocity of Monetary Base, 1989Q1 to 2013Q2

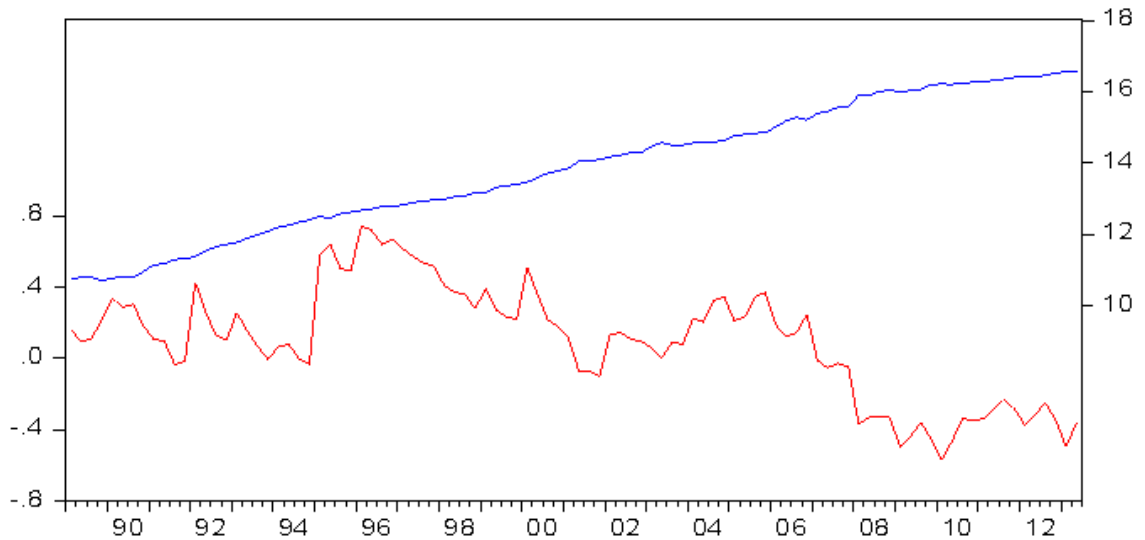


Figure 2. Monetary Base Vs its Velocity in Nigeria, 1989Q1 to 2013Q2

Table 5. Error Correction Estimate of the ARDL Model

Dependent Variable: Δmb				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
β_0	0.0104	0.0172	0.6067	0.5456
$\beta_1(-4)$	0.2247	0.0956	2.3498	0.0211
$\beta_2(-1)$	3.8310	1.6841	2.2748	0.0254
$\beta_2(-2)$	-3.0884	1.4287	-2.1617	0.0334
$\beta_3(-2)$	0.0709	0.0474	1.4969	0.1381
$\beta_4(-1)$	-0.0023	0.0009	-2.5195	0.0136
$\beta_6(-1)$	-0.2152	0.1119	-1.9227	0.0578

$R^2 = 0.21$ Adjusted $R^2 = 0.16$ AIC = -2.788622, SIC = -2.596996, HQC = -2.711653
 Prob(F-Statistic) = 0.001824 Durbin - Watson Stat = 1.915805

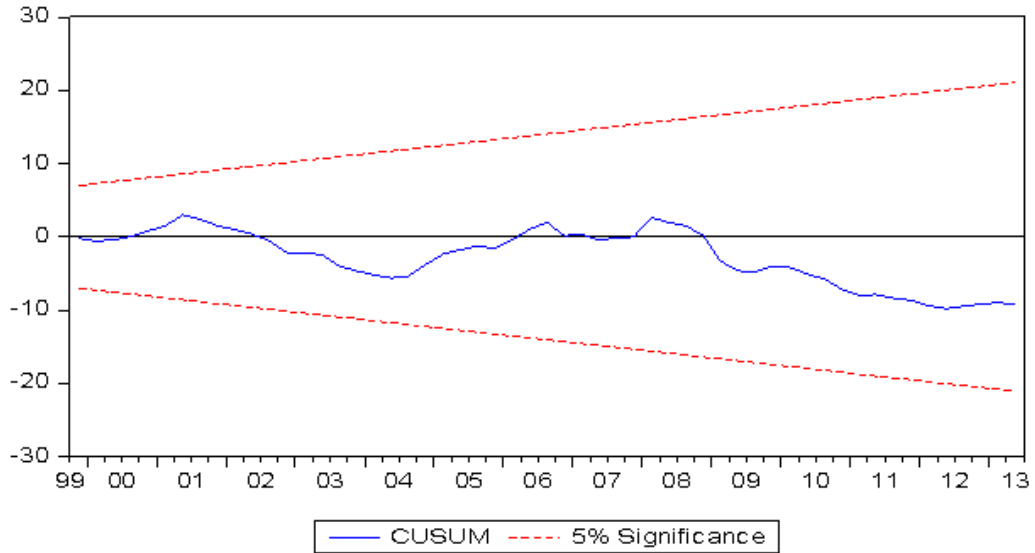


Figure 3. Cumulative Sum of Residual Test

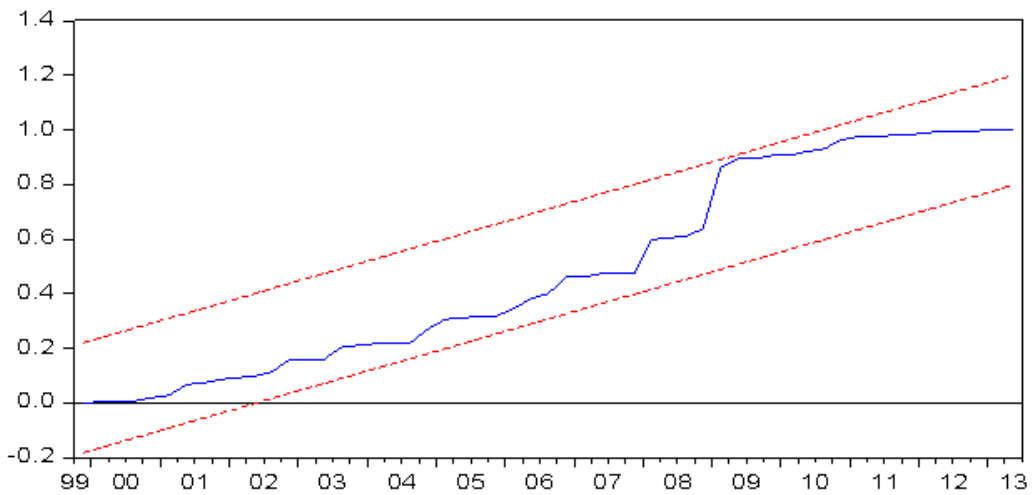


Figure 4. Cumulative Sum of Squares Recursive of Recursive Residual Test

The CBN can vary mb in a way that will push output to its equilibrium without necessarily being inflationary, since γ moves in opposite direction with mb . If δ is positive (i.e. output falls below its potential), the CBN can increase mb to stimulate the economy so as to vary δ to attain the desired β and since γ is inversely related to mb , it follows that increase in mb will not positively impact on φ , as γ will fall at any rise in mb . In a nutshell, therefore, mb can be adjusted to vary δ to attain the desired level of β without positive effect on φ .

The third most critical variable in the rule, however, yielded a negative coefficient, although statistically insignificant from zero. The inflation gap (φ) is expected, in line with equation (10) to be positively related to mb . This is, nonetheless, less worrisome since γ is negative and statistically significant.

Overall, the results suggest a potent role for McCallum rule in Nigeria's monetary policy framework. This is, because, in addition to the positive and statistically significant¹⁰ relationships between both potential output and the corresponding output gap to the monetary base, the velocity of circulation established a statistically significant inverse relationship with base money growth. Thus boosts the suitability of the rule to a populous economy which defies all measures to achieve its potentials.

The coefficient of the ECM reported in Table 5 is negative and statistically significant, providing additional support to the cointegrating relationships among the variables in the model (Sung-Hoon and Byoung-Ky, 2008). The ECM shows that restoration of disequilibrium in case of distortion is moderate. About 21.0 per cent of disequilibrium is restored on quarterly basis.

The commonly used techniques of cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) were adopted to test the stability of the equation and of the estimated parameters. The equation parameters are stable, if the whole sum of recursive errors lies within the two critical lines. Both Figures 3 and 4 show that the parameters of the analysed equation are stable, since the recursive errors lie within the two critical lines of CUSUM and CUSUMSQ tests.

5. Conclusions and Policy Options

The unending debate on the possibility of rule based monetary policy framework have ignited search for rule, the result of which is the emergence of McCallum rule amongst others. This paper attempts to test the applicability of McCallum rule to the Nigeria's monetary policy framework within the context of bounds tests approach to cointegration developed by Pesaran *et al* (2001), using data from the first quarter of 1989 to the second quarter of 2013. The study

utilized cumulative sum of recursive residual and cumulative sum of squares recursive residual to test the stability of the estimated parameters.

While the coefficients of output gap¹¹ and the velocity of monetary base, which are the first two most critical terms in the rule are properly signed, that of inflation gap is not. The potential output and the corresponding output gaps are positively signed, while the velocity of circulation of the monetary base is negatively signed and statistically significant in line with the workings of the rule.

Over all, the results show that McCallum rule can serve as a potent monetary policy rule for the Nigeria's monetary policy framework. Considering the positive monetary response factor (δ) as reported in Table 4, as well as the negative velocity and positively signed potential output, McCallum rule provides promising signal for the possibility of variations in mb to enhance output growth at desirable level of prices, hence guarantees output stability perhaps in the long-run.

However, since the idea of monetary policy rule (both non-activist rule-such as that of Friedman Milton and activist versions- such as McCallum and/or Taylor rules) seems not appealing to monetary authorities, the study suggests that the CBN should adopt the rule as a consultative yardstick or illustrative benchmark to guide the monetary policy committee (MPC) in taking discretionary monetary policy decisions. In other words, the McCallum framework should be officially commissioned and results made available to MPC members at least one week before MPC meetings. This will serve as additional information to committee members.

Furthermore, additional factors can be introduced to the rule. The current structure of the rule relies extremely on mb which is just one of the numerous instruments of monetary policy. Therefore, some other monetary policy variables can be introduced to the rule to make it more robust.

It is, however, important to note the need for caution when using the rule as a benchmark or a guide, considering high volatility of velocity. The velocity of monetary base ranges between 0.6 and 2.1 during the studied period which mirrors the non-predictable nature of the behavior of economic agents. Macroeconomics has, however, not provided adequate theory capable of predicting human behavior, hence, velocity should be properly monitored so as to continuously update policy makers on the dynamic responses of humans to variations in policies.

REFERENCES

- [1] Arturo, E. and Mishkin, F. S. 1996, Is there a role for monetary aggregates in the conduct of monetary policy? NBER Working Paper No. 5845.
- [2] Baoli, L., 2010, The McCallum rule for Chinese monetary policy, Proceedings of the 7th International Conference on

¹⁰ They are not as strong as suggested by McCallum as he alluded a base money response of between 0.25 to 0.50 for industrialized and emerging economies (Michael and Muneesh, 2012).

¹¹ As well as potential output.

- Innovation and Management, School of Management, Anhui Science and Technology University, Anhui, P. R. China, pp. 881-884.
- [3] Dean, C. and Stark, T., 1995, Evaluating McCallum's rule for monetary policy, *Business Review*, January/February 1995.
- [4] Diez de los Rios, A., 2008, McCallum rules, exchange rates and the term structure of interest rates, Bank of Canada, Working Paper/Document de travail, 2008-43.
- [5] Esanov, A., Christian, M. and Lúcio, V. S., 2004, Monetary policy rules for Russia, BOFIT Discussion Papers, No. 2004-11.
- [6] Ghatak, S. and Moore, T., 2008, Monetary Policy Rules for Transition Economies: An Empirical Analysis, Faculty of Arts and Social Sciences, Kingston University, Discussion Paper 37.
- [7] Giray, G., 2012, Inflation targeting and monetary policy rules: Further evidence from the case of Turkey, *Journal of Applied Finance & Banking*, 2(5), 127-136.
- [8] Harris, R. and R. Sollis (2003). "Applied Time Series Modeling and Forecasting. West Essex Wiley.
- [9] Hodrick, R. and Prescott, E., 1997, Post-war U.S. business cycles: An empirical investigation, *Journal of Money, Credit and Banking*, 29(1), 1-16.
- [10] Hussman, J. P., 2011, Sixteen Cent: Pushing the Unstable Limits of Monetary Policy, *Weekly Market Comment*. Available at www.hussmanfunds.com/wmc/wmc110124.htm.
- [11] Kong, D., 2007, Monetary policy rule for China: 1994 – 2006. East Asia Economic Research Group Discussion Paper No. 14, School of Economics, University of Queensland.
- [12] Lothian, J. R., 2009, U. S. Monetary Policy and the Financial Crisis", Federal Reserve Bank of Atlanta, CenFis Working Paper No 09-01.
- [13] McCallum, B. T., 1987, The Case for rules in the Conduct of Monetary Policy: A Concrete Example", *Weltwirtschaftliches Archiv*, 123, 415-429.
- [14] McCallum, B. T., 1988, Robustness Properties of a Rule for Monetary Policy. Carnegie-Rochester Conference Series for Public Policy 29(1988), 173 – 203.
- [15] McCallum, B. T., 1993, Unit Root in Macroeconomics Time Series: Some Critical Issues. *Economic Quarterly*, Federal Reserve Bank of Richmond, Issue Spring, 13 – 44.
- [16] McCallum, B. T., 2002, Recent Developments in Monetary Policy Analysis: The Role of Theory and Evidence, *Economic Quarterly*, Winter Issue, Federal Reserve Bank of Richmond, 67-96.
- [17] Michael, D. P. and Kapur, M., 2012, Alternative monetary policy for India, IMF Working Paper No. 12/118.
- [18] Pesaran, M. H., Shin, Y. and Smith, R. J., 2001, Bound testing approaches to the analysis of level relationship. *Journal of Applied Econometrics*, John Wiley and Sons Ltd.
- [19] Shahani, S., 2012, Velocity of Money and Quantitative Easing, available at saeedshahani.com/2012/09/14/velocity-money-quantitative-easing.
- [20] Shuzhang, S., Gan, C. and Hu, B., 2008, Evaluating McCallum rule as a policy guideline for China, Lincoln University Working Paper No. 64 3 325811.
- [21] Shuzhang, S. (2010): "Identifying the monetary policy transmission mechanism and evaluating the McCallum rule as a monetary policy guideline for China", A Thesis submitted to Lincoln University in partial fulfilment of the requirements for the Degree of Doctor of Philosophy.
- [22] Stark, T. and Dean, C., 1998, Evaluating McCallum's rule when monetary policy matters, *Journal of Macroeconomics*, 20(3), 451-485.
- [23] Sung-Hoon, S. and Byoung-Ky, C., 2008, The monetary exchange rate model and stock prices: Using bounds testing approach, *Journal of Korea Trade*, 12(2), 31-54.
- [24] Taylor, J. B., 1993, Discretion versus Policy Rule in Practice, *Carnegie-Conference Series on Public Policy*, 39: 195-214, Dec., 1993, North-Holland.
- [25] Tuuli, K., Aaron, M. and Riikka, N., 2008, McCallum rule and Chinese monetary policy, BOFIT Discussion paper 15/2008.
- [26] Vdovichenko A. and Victoria, V., 2004, Monetary policy rules and their application in Russia, Economics Education and Research Consortium, Working Paper Series, No 04/09.