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Money Growth Bias and Output Variability in Nigeria: An Empirical Perspective

Mustapha Saidi Atanda
University of Benin, Benin-City, Nigeria.

Musa Samuel Olayinka Ganiyu Osobase Anthony Onagiese
University of Lagos, Akoka, Lagos Nigeria.

Abstract
The application of the Kydland-Prescott and Barro-Gordon framework on money growth bias and economic growth proxied with output growth focuses on monetary authorities' desire to stimulate output above its natural growth rate. This paper shows that output stabilization target by the monetary authority often generates money growth bias in Nigeria. However, maintaining stable domestic price around the public expectation increases output above the full employment but at the cost of high output volatility. This is in line with Rogoff (1985) proposition on delegation approach as a solution to dynamic inconsistency problem. The paper adopts Autoregressive Distributed Lag (ARDL), Autoregressive Moving Average (ARMA), Generalized Autoregressive Conditional Heteroscedasticity GARCH (1, 1) and the threshold GARCH (1, 1) modeling framework as well as Cointegration Analysis (Bound testing and Johansen-Juseluis procedure). The annual data used in the estimations were sourced from the Central Bank of Nigeria (1970 - 2010).
Keywords: money growth bias, output growth, money growth expectation, co-integration, unit roots test, autoregressive distributed lag model, autoregressive moving average model and bound testing.

1. Introduction

The time variant dramatic behavior of growth of money in most developing countries particularly Nigeria in the last decade remains litigious. Researchers in this area had pointed out that this inflationary behavior resulted from efforts of policy makers to raise output above its balance growth path. Most cited work on the subject matter in literature includes the work of Friedman (1977), Kydland and Prescott (1977) and Baro and Gordon (1983). The potential of money growth bias and output growth had been discussed extensively among macroeconomists since the past four decades (Friedman, 1977)[1]; there are huge differences among scholars on the impact of average rate of money growth, money growth bias on economic growth at the theoretical point[2]. The explanatory power of the Friedman, Kydland and Prescott, Barro and Gordon postulations hereafter (FKPBG hypothesis) had been challenged on various grounds namely theoretical, empirical and expressional.

In assessing central bank activities, it is noticed that central bank do not attempt to increase output above potential level because of the cost of maintaining the growth of money attached to such reaction (Blinder, 1998). Perhaps, the major problem of policy makers is described as judging the available resources or capacity in the economy so as to minimize inflationary pressure that may arise from reversal act. Empirical support to this claim i.e. FKPBG hypothesis was the formal econometric framework made in Ireland (1999) reported that money growth and unemployment in the United States in the long run is in line with the FKPBG results while the short run dynamic behavior contradicts the claim. Since the dynamic short term does not support the claim of the FKPBG in this context, the short term measurement is quite important for policy decision than the long term[3]

[1] Milton Friedman discussed extensively the potential of inflation uncertainty to lower output growth in his Noble lecture in 1977. Friedman argues that, an increase in the average rate of inflation results in more uncertainty about future inflation; distorts effectiveness of the price mechanism in efficient resources allocation and increases economic inefficiency and thus, reduce output growth.

[2] Friedman shows this, with his mechanical device of output and money growth:

$$M_t V_t = P_t Y_t \qquad (i)$$

$$M_{t-1} V_{t-1} = P_{t-1} Y_{t-1} \qquad (ii)$$

If we assume that $P_t = P_{t-1}$ *and* $V_t = V_{t-1}$, then,

$$\frac{M_t - M_{t-1}}{M_{t-1}} = \frac{Y_t - Y_{t-1}}{Y_{t-1}} \qquad (iii)$$

Equation (iii) is a demand rule which characterized the reaction of the monetary authority; if the policy maker wishes to stabilize the price level, then, it must set money growth to equate output growth, that is, real output growth. This is known as the Friedman Policy Rule (FPR).

[3] Following Keynesian supposition that the concept of long run does not exist, this cited claim is justified.

it is justified to say that short term econometric evidence disagree with the supplication of the FKPBG on inflationary burst experienced in the 1970s. McCallum (1997) presents that FKPBG study on the incentive structure of the central bank to stimulate the economy excessively can lead to increased money growth. The FKPBG explanation to this fact is that the central bank could perfectly well refrain from playing the inflationary game the public expects it to do, by so doing the public money growth expectation will be high and thus higher than the actual money growth. For this reason, money growth bias must arise. Under discretion, policy makers try to create money growth surprises in order to increase output above its potential level, simultaneously, the public knows about it and raises its expectation about money growth; this systematically neutralizes the impact of the surprises of increase money growth made by the policy makers and thus the effect of inflation on output, which makes the goal of the policy maker unrealizable. Intuitively, monetary policy under discretion results in suboptimal money growth bias rather than raising expected utility and output growth[1].

The expected utility is maximized under commitment, that is, the policy maker will be better off if it were possible to commit themselves to zero money growth, this guarantees more credibility to the policy maker as the public believes and understands that the policy maker has no intention to set money growth above zero, they set their expectation about future money growth to zero and that reduces inflation cost to the policy maker. In this sense, the cost of inflation is zero and the bias proportion of money growth is also zero. However, considering the situation whereby the policy maker set to change their behavior by setting low positive money growth, based on credibility of the central bank the public still believes that they are committed to zero inflation and thus does not change their expectation. This change in behavior results in low marginal cost of managing money growth and increase expected utility above what is achieved under the discretion rule and the money growth bias proportion is strictly minimized. Thus, expected utility under commitment is greater than that realized under discretion[2].

In a situation whereby the policy makers' forum is more of political authorities than monetary stance whose believe is highly positive correlated with his electoral concerns; the electoral concerns breed short horizons and a strong commitment to employment or increase output growth and economic activity, the standard inflation bias story seems reasonably realistic. As is currently the case to many central banks of present days, independence is an instrument which gives them the opportunity to focus solely on price stability, with this autonomy it is obvious that they will notice the suboptimal behavior of trying to trade off money growth for employment and output above their potential levels. Going by this central bank autonomy, money growth bias is then a shadow of the past (Cukierman, 2003 and Gerlach, 2003). Instinctively, the explanation to this assertion is given by the bias proportion mechanism which is different across countries and of which is verified empirically.
The main objective of this paper is to demonstrate the impact assessment of the money growth bias - which is as a result of dynamic policy inconsistencies – on economic growth in Nigeria. The organization of this paper is as follows, section two dwells on past literatures on the subject matter while section three demonstrates the theoretical framework adopting the augmented traditional Phillips curve which is in form of aggregate supply form[3] , in analyzing the model we shall establish the equilibrium rate of money growth, at this point the uncertainty is assumed to be zero and expected money growth is equal to the actual value, more so, the other case will be examined. Section four derives the main testable implication of the theory, in order to this; the paper makes use of the time series econometrics to estimate the impact assessment of money growth bias on economic growth in Nigeria. Section five presents the findings, some implications for re-building the credibility of the central banks as policy making institutions.

2. Review of Relevant Literatures

Rogoff (1985) suggests the credibility – flexibility trade off by assigning the work of a central bank to a conservative person, who has no business with the public this type of method is what he called "Delegation". Tabellini and Alesina (1993) and Walsh (1995) propose optimal incentive contracts for central bankers and Svensson (1997a) points out that such optimal contract can be implemented by means of a simple inflation target. Friedman (1968) and others have emphasized that monetary policy operates with long and variable lags. The money growth bias mechanism presented in the theoretical structure are based on two fundamental assumptions: first, when current policy makers are uncertain about the real state of the economy at the initial time the policy was initiated to its expected impact on the economy during and after implementation, and second, the policy makers possess expansionary policy in the sense they are more concerned about downward deviation of output from its natural level than about upward deviations. Due to the stated nomenclature monetary policy is chosen so as to make probability of making wrong on the side of policy choices made at the given time.

[1] Egwaikhide, F. (2012); Lecture Note on Advanced Macroeconomics for PhD Economics Class of 2011/2012 session, University of Ibadan, Nigeria.
[2] Committed to zero inflation yields best result and maximize utility compare to discretionary policy rule.
[3] See Section three of this paper for clearer exposition on the aggregate supply function.

Recently writers have put forward claims that money growth bias could arise as a consequence of asymmetric policy reactions on the part of central banks. Cukierman (1999) examines the KPBG set-up in which the loss function of the policy makers involves inflation and output/employment. However, in contrast to the benchmark, he assumes that policy makers care more about output only when it is below its natural level as it is a measure of economic growth. In the KPBG explanation, there is a single perturbation in the model to the natural rate of output. There is some probability that the shock will be sufficiently large to reduce output below the natural level, the public attaches a positive probability to central bank engaging in expansionary monetary policy in order to increase output to the targeted level. Since the asymmetric loss function implies that the central bank takes no action in the opposite case in which there is positive shock that pushes output above the natural level, an inflation bias result.

Jordan (1998) assumes a central bank is unable to control money growth, perfectly. He reports that since contractionary monetary control errors lead to recessions, the central bank has an incentive not to aim for a too low steady state inflation rate. Thus, a positive inflation bias arises as a consequence of the assumption that policy makers attach greater losses to recessions than to expansions. Similarly, Nobay and Peel (1998) here consider an asymmetric loss function for the central bank, that is, asymmetric in both inflation and output. They find out that asymmetry of the loss function impact on the steady state inflation rate on both sides. Egwaikhide *et al.* (1994) reported that the Nigerian inflation is influenced by monetary and structural factors and that the exchange rate (official and parallel) increases the general price level using the modern econometric technique of cointegration and error correction modeling (ECM). Ruge Murcia (1999) studies the case in which policy makers' loss function is asymmetric around the optimal inflation rate. While the nature of the asymmetry is not determined in the theoretical analysis, he estimates US data for the period of 1952 -1999 and finds that the Federal Reserve appears to have been more concern about inflation falling below than rising above the desired level.

3. Theoretical Framework of the Model

3.1 The Basic Structure

In a situation whereby the policy maker believes that changes in aggregate demand affects real output, they may increase money supply in other to raise output above the natural level and are faced with money growth that they believe is too high; they may actually not want to undergo recession in order to reduce this, the expansionary policy adopted to raise output above its natural level if not permanent at least temporary leads to increased money growth. This suggests that the trade-off between money growth (inflation) and output is not as simple as it is presented in the traditional Phillip curve. This spurs the re-consideration of the augmented Phillip trade-off version; this will be described below and thus, form the bed rock of the theoretical framework.

Consider an economy, such that there is information asymmetry between policy maker and the public. Other underlying assumptions of the economy were as follows.

Assumptions of the Economy

(a) The aggregate supply function for the economy is of the augmented Lucas supply type; which is specified as:

$$Y_t = Y_p + \phi(\pi_t - \pi_t^e) + v_t \qquad (1)$$

$$\phi > 0 \quad and \quad v_t \approx (0, \sigma^2)$$

All the variables are discrete in nature. Y_t is the output at time t, say current period, Y_p represents the natural level of output while π_t and π_t^e actual inflation rate at time t, and expected inflation rate that stands for the public's opinion about inflation. v_t is the white noise error term that does correlates with the coefficient of the inflation bias component, ϕ. ϕ stands for the weight placed on inflation or simply put the inflation surprise to changes in real output.

(b) The social welfare function is captured with a loss function which is assumed to be quadratic in both output and inflation respectively.

$$S_w = \frac{1}{2}(Y_t - Y_T)^2 + \frac{1}{2}\psi(\pi_t - \pi_T)^2 \qquad (2)$$

$$\psi > 0$$

Here, inflation is positively related with its cost, that is, an increase in inflation is associated with an increase in its cost. A simpler way to capture its negative impact algebraically is to assume a quadratic social welfare function. The parameter ψ reflects the relative importance of output and inflation in

social welfare Y_T denotes the target output and π_T is the optimal inflation rate.

(c) The policy makers respond asymmetrically to supply disturbance. This is under the assumption that it places greater weight to output being below than above its optimal level.
(d) Inflation bias mechanism, ϕ, is not proportional to the variance of supply shock[1]. In other words, it is not been affected by the supply shock which is represented by the white noise term.
(e) The policy makers' aim at creating expansionary policy to raise output above its natural level, that is, promote output growth.

For the analyses of the theoretical framework, interested readers can as well consult the appendix section of the paper.

3.2 Theoretical Foundation

The second scenario mimic the practical behavior of the policy maker vis a vis the central bank. Therefore, the theoretical basis for this study is formulated on the basis of Cukierman and Gerlach (2003) and this shows the connection between money growth bias and economic growth.
Recall equation (18) from the derivation in appendix 3.

$$\pi_t^e = \pi_T + \frac{\phi}{\psi}(Y_T - Y_P)$$

Re-arrange the above expression, it follows that;

$$(Y_T - Y_p) = -\frac{\psi}{\phi}(\pi_T - \pi_t^e) \qquad (19)$$

The theoretical structure reveals a negative relationship between inflation bias and output growth. The right hand side of equation (19) is the difference between the optimal output and its natural level, this measures output growth. The decision is that a positive difference depicts output growth at the particular time; however, growth reverse. The left hand side of the equation represents money growth bias, which is simply the deviation of the expected money growth from the actual money growth, which is the deviation between the policy maker decision and public's opinion. The greater the magnitude the larger the bias proportion experience in the inflation rate. Lastly, the coefficient of money growth bias determines the impact of money growth bias on output growth vis-à-vis economic growth. Thus, the a-priori expectation from the literature (kydland and Prescott (1977) and Baro Gordon (1983), Cukierman (1999)) of negative impact between money growth bias and output growth is supported by this model. Instinctively, if the actual money growth is greater than the expected, policy makers tend to place more emphases on inflation – price stabilization by increasing the marginal cost – than output stabilization and thus economic growth declines. This means that as money growth bias grows positive, output growth declines and thus growth of the economy.

4. Methodology Design

The Autoregressive Distributed Lag (ARDL) bounds testing model for testing the existence of a cointegration relationship was developed by Pesaran *et al* (2001). The bound testing and Johansen and Juselius (1990) methods are adopted in this study because of its clear edge over other techniques of estimating the single cointegration relationship (Engle and Granger 1987; Engle and Yoo (1987); Stock and Watson (1988); Phillips and Ouliaris (1990)). The obvious problem other methods encounter is that of endogeneity problems and the inability to test hypothesis on the estimated coefficients in the long run, this is much associated with the Engle and Granger (1987) procedure. Secondly, in modeling money growth bias and economic growth relationship, the paper presents the Autoregressive Distribution Lag (ARDL) Model in order to reduce the long run estimation problem of heteroscedasticity and autocorrelation[2] that may occur in the results. The structure of the model is as

$$E(\beta) = \beta + v \qquad (i)$$

[1] $E(E(\beta) - \beta)^2 = E(v^2) \quad = \sigma^2 \; cons\tan t \qquad (ii)$

$\phi \neq \sigma^2$ *which is* $cons\tan t.$

[2] Transforming the initial model through first differencing of the variables gives:

$$(Y_T - Y_p) = \chi(\pi_T - \pi_t^e) \qquad (i)$$

Taking the first difference;

$$\Delta Y_t^* = \chi(\Delta\pi_t^*) \quad + \Delta\varepsilon_t \qquad (ii)$$

follows:

$$(Y_T - Y_p) = \chi(\pi_T - \pi_t^e) + \varepsilon_t \qquad (20)$$

Where χ is negative in nature and represents the impact of the inflation bias on output growth. Assume that:

$$y_t = (Y_T - Y_p)$$

$$\pi_t = (\pi_T - \pi_t^e)$$

$$y_t = \chi \pi_t + \varepsilon_t \qquad (21)$$

Estimate the standard deviation from each sample, that is, θ_y *and* θ_π respectively, and divide both output and money supply series by each standard deviation (Greene, 1997), thus, equation (21) is re-presented as follows:

$$y_t^* = \chi \pi_t^* + \varepsilon_t \qquad (22)$$

Where:

$$y_t^* = \frac{(Y_T - Y_p)}{\theta_y} \quad and \quad \pi_t^* = \frac{(\pi_T - \pi_t^e)}{\theta_\pi}$$ respectively.

After performing the unit root test to ascertain the order of integration of each series in the model basically inflation bias and output growth, the Autoregressive Distributed Lag (ARDL) Model can then be specified considering the integration order of each series in the specification:

$$y_t^* = \chi_0 + \chi_1 \sum_{i=1}^{p} y_{t-i}^* + \chi_2 \pi_t^* + \chi_j \sum_{J=2}^{p} \pi_{t-j}^* + \chi_i \pi_{t-1}^* + \Delta\varepsilon_t \qquad (23)$$

The Autoregressive Distributed lag Model (ARDL) is represented by equation (23) which gives the final form of the impact assessment model of inflation bias and output relationship. This equation takes care of the problem of heteroscedasticity and autocorrelation mishaps. Data on actual output, actual money supply and output growth were sourced from the Central Bank of Nigeria (CBN) statistical bulletin of different editions, while money growth bias, expected money growth and potential output were computed using Autoregressive Moving Average (ARMA) modeling and structural breaks models, the money growth bias is simply the difference between actual and expected money growth, all these estimations were derived from the actual data sets from CBN. The data series ranges from 1970 to 2012.

4.1 Empirical Implementation of Techniques

The paper employs uni-variate time series econometric methodology to estimate the expected money growth, the particular type of the univariate technique used is the Autoregressive Moving Average ARMA(4,3) this model was selected based on the Schwarz Bayesian Criterion (SIC) ; this generates the in – sample forecast of the annual money growth series which span from 1970 to 2010. The generated in-sample series represent the forecast money growth series which is then use as a proxy for expected money growth (Sims, 1988) and stands as public opinion about money growth in Nigeria. Ideally one would need to estimate the standard deviation of the supply shock to test the theory, which is the disturbance to the Phillips trade off equation. But for simplicity, the standard deviation of each of the series is used to measure the relative shock arising from the divergence of opinions between the policy makers and the general public; that is, the discretionary rule. Each variable was then divided by its estimated standard deviation to eradicate the co-existence of heteroscedasticity and autocorrelation problems that may arise from estimations due to absence of anti-cyclical policy. Stabilization policy may also weaken this relation in the presence of imperfect knowledge of both the policy makers and the public; also, policy makers at times are concerned about inflation, the stabilization of shocks to output is partial if not zero in the absence of uncertainty.

Cursory look at the adjusted series[1] the growth rate of output is relatively stable from the seventies to early nineties; there has been little or no contribution to growth from the fiscal side such that the monetary authority had no noticeable influence on stimulating investment through interest rate channel to kindle output. The deviation between the actual money growth and the expected money growth was quite worrisome as the bias proportion is very high, mostly on the positive range of the chart; this implies that the nation experienced high inflation during this period much of this inflation comes from the injection made from the fiscal authorities which make it quite unclear to predict the public opinion. At this period (1970 – 1990) the economy was faced with political heat from the military and sorts of policies were imposed on the nation from the podium of

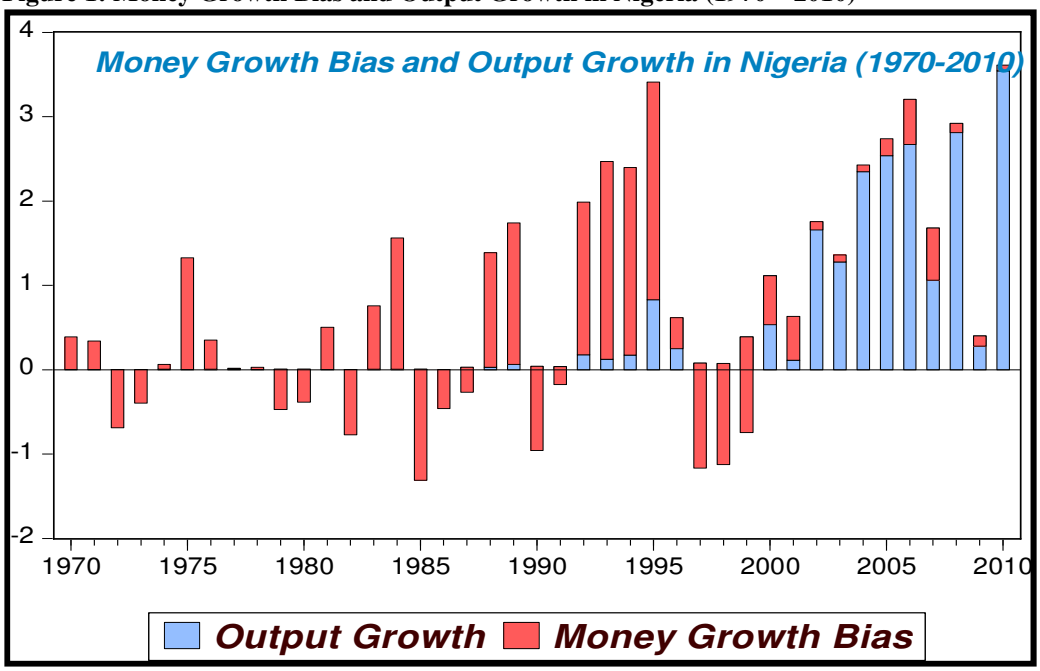
This act resolves the autocorrelation problem in the initial equation.

[1] Adjusted series here refers to the series generated after considering the impact of policy shocks and random disturbance in the system.

international organizations basically the nation's creditors. There was information asymmetric around as at that time and increased money growth dominates the environment, thus, purchasing power of the naira was relatively lower compare to the late nineties.

As from 2000 the nation's took a new look, the military handed over the government to the civilian and sorts of stabilization policies of the new government stimulates output growth. The monetary authority was on the verge of creating an environment of low inflation and thus, the bias proportion realized from money growth was relatively low and one can see that output growth outweighs the bars of money growth bias (see figure 1).

Figure 1: Money Growth Bias and Output Growth in Nigeria (1970 – 2010)



Source: Author's computation

4.2 Analyses and Interpretation of Results

The stationary tests used here to ascertain the stationary position of variables are the Augmented Dickey Fuller (ADF) and Dickey Fuller Generalized Least Square (DF-GLS) procedures. The former considers the influence of the long memory of the series itself while the later takes care of de-trending of the series. Estimating these two tests, it is observed that variables in this study were stationary not at their initial levels but at their first difference I (1) (see table 1).

In order to establish the existence of a long run relationship among variables in the model, the study makes use of the Bounds testing approach and the Johansen Cointegration test procedure. The bounds test for examining the evidence for a long term relationship can be conducted using the F-test (Narayan and Narayan, 2005). To implement the bound test procedure, it is pertinent to presents its structural model as a conditional autoregressive distributed lag (ARDL) model as follows:

$$y_t^* = \chi_0 + \chi_1 y_{t-1}^* + \chi_2 \pi_{t-1}^* + \chi_j \sum_{J=0}^{p} \pi_{t-j}^* + \chi_i \sum_{i=1}^{p} y_{t-i}^* + \varepsilon_t \qquad (24)$$

Table 1: Test for Stationarity of Series

	Test for Stationarity of series		
Variables	***ADF Test (t-values)***	***DF-GLS Test (t-values)***	***I(d)***
Economic Growth	-16.1424	-3.8006	I(1)
Money Growth bias	-6.8193	-6.9109	I(1)
	Critical Values for each test		
1%	-3.6104	-2.6443	
5%	-2.9389	-1.9524	

Definitions:
ADF Test = Augmented Dickey Fuller Test
DF_GLS Test = Dickey Fuller Generalized Least Square Test
I (d) = Order of Integration

Source: Author's Computation

The cointegration test under the bounds framework involves the comparison of the F-statistics against the critical values generated for specific sample size. The result in Panel A of table 2 shows that when economic growth is taken as the dependent variable for Nigeria, the computed F-statistic denoted by F (E/M) is 11.129 higher than the upper bound critical values of 5.304 and 7.172 at both 5% and 1% levels; however, if money growth is the dependent variable over the same period, the computed F-statistic F (M/E) gives 1.682 which is lower than the lower bound critical values at 5% and 1% levels respectively. This suggests that the null hypothesis of no cointegration is rejected for Nigeria when economic growth is the dependent variable.

Panel B of table 2 presents the Johansen Cointegration test; the result shows that the cointegrating vectors were significant at 5% as the trace and eigenvalue statistics are greater than the 95% critical values. The diagnostic test also supported this result as it is shown by the Mackinnon-Haug-Michelis probability values. Thus, the null hypothesis of no cointegration cannot be accepted. Therefore, the variables are cointegrated, and have a long run relationship.

Table 2: Testing for Cointegration Analysis

Panel A: Bound Test for Cointegration				
Computed F-Stats	F(E/M)[1]		F(M/E)[2]	
37	11.129		1.682	
Critical Values at various confident levels 95% and 99%				
T	I (0)	I (1)	I (0)	I (1)
35	4.036	5.304	5.604	7.172
40	3.958	5.226	5.376	7.092
Critical Values for the Bound test: Unrestricted Intercept and Trend				
Panel B: Johansen Cointegration				
Hypotheses	Eigen value	Trace Stats	C.V. (0.05)	Prob.**
None*	0.538	45.468	15.494	0.000
At most 1*	0.344	16.071	3.841	0.000
** denotes rejection of the hypothesis at 0.05 level*				
*** Mackinnon-Haug-Michelis (1999) P-Values*				

Source: Author's Computation

4.3 Measurements of Long and Short Run Dynamics

The long run results are presented in Table 3 below. The results were generated using the Unrestricted ARDL (1, 0, 1), and the estimated elasticity for inflation bias is negative and quite significant. The result suggests that a 100 percent increase in money growth bias results in 0.5 percent decline in output growth and by extension economic growth, even after lagging by one period the result shows a similar direction of influence and magnitude. This implies that as the bias proportion of money growth rises; the lower is the weigh place on output growth in Nigeria. Secondly, output stabilization was not the utmost aim of the Central Bank under this period, what constitutes their policy portfolio was to reduce the threats of inflation through money growth to the barest minimum if not totally eradicating it. Therefore, the money growth surprise to output is relatively lower due to the huge concentration on taming inflation in the country; this argument is seen geometrically in figure 1. Though in the chart the post – 2000 period reflect output variability period as output growth outweighs money growth significantly but fluctuates across time. The diagnostic tests of the long run dynamic model all supported the reliability of the model, the previous inflation rate has also significant impact on output stabilization in recent time, thereby, contending the significant tradeoff between inflation and output in our dear country Nigeria; the Breusch – Godfrey (BG) LM test suggests the acceptance of the null hypothesis of no serial correlation. It is also evident that the p-value is very high. The Jaque-Bera normality test ascertains that the errors are normally distributed with zero mean and constant variance while the F- statistics indicate the predictive accuracy of the model. Based on all these statistical indicators, hence, the model is good for policy analyses on money growth bias and output growth and by extension economic growth in Nigeria.

[1] F(E/M): Output growth is taken as the dependent variable.
[2] F(M/E): money growth bias is used as the dependent variable in the estimation.

Table 3: Long Run Relationship using the Unrestricted ARDL (1, 0, 1)

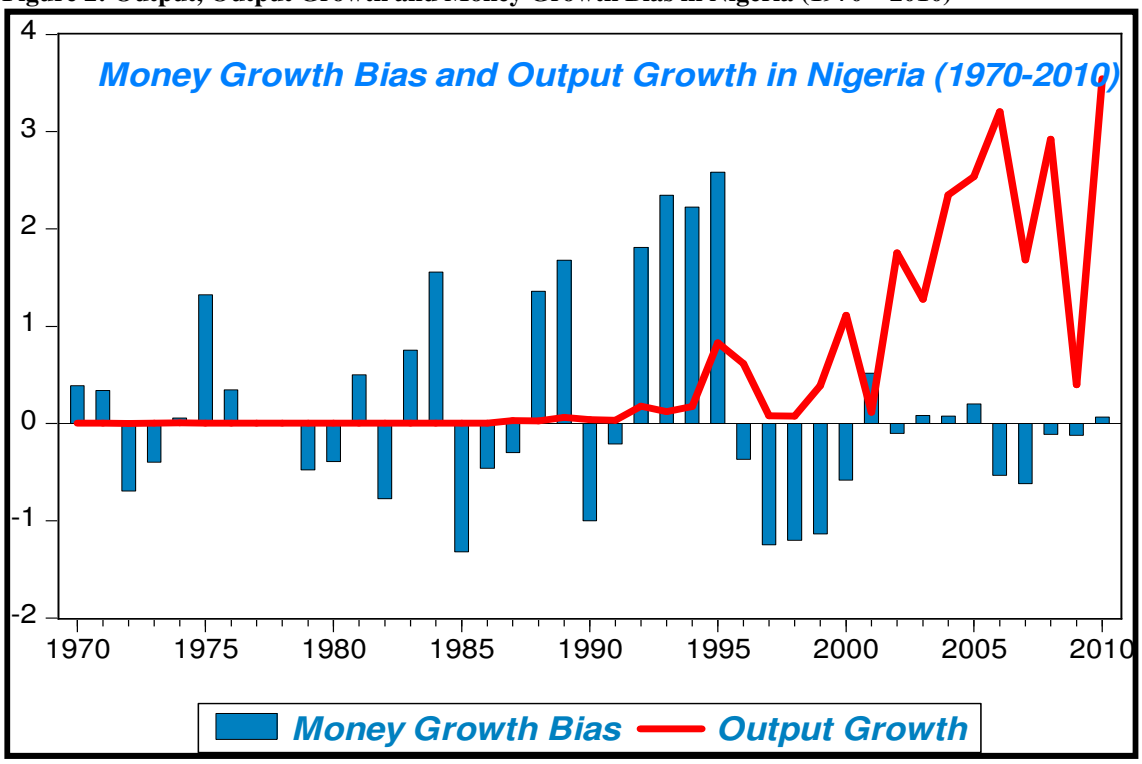
Estimated Long Run Dynamic Model Using Unrestricted ARDL Approach			
Regressand: Output Growth			
Regressors	***Coefficient***	***T - Statistics [P-Value]***	***Decision***
Constant term ©	0.2346	1.5315 [0.1344]	*Insignificant*
Lagged Value of Output Growth (OTPTGRT (-1)	**0.7086**	4.7480 [0.0000]	***Significant***
Inflation Bias (Inflbias)	**-0.0054**	[3.0013] [0.0093]	***Significant***
Lagged Value of Inflation Bias (INFLBIAS (-1)	**-0.0041**	[2.0278] [0.0172]	***Significant***
	Diagnostic Statistics		
R- Squared	0.3916		
Adjusted R-Squared	0.3409		
Durbin Watson Statistic	2.4843		
Chi - Square (B-G test, prob.)	5.6106 [0.9107]		
F-test [prob.]	7.7265 [0.0004]		
Note:			
1. Values in parentheses are the probability values			
2. T- Statistics in Parentheses are negative values			

Source: Author's Computation

In order to validate the short run dynamics, the study employs the Error Correction Model (ECM). The parsimonious modeling reveals that there is an instantaneous adjustment to equilibrium in the short run for the two variables. This implies that in an attempt for the monetary authority to stabilize aggregate price considering the public expectations, both the supply and velocity shocks in the system will automatically generates output growth but distort the output equilibrium which leads to output volatility. The GARCH (1, 1) estimate shows that there is present of volatility clustering in the output growth series which validates the above expression of output volatility (See appendix 1). The threshold GARCH (1, 1) result indicates a positive coefficient but statistically insignificant, this supports the claim that there are no asymmetries in the information available for this series. Specifically, news does not have effect on the volatility of the output growth series; what really matters is the approach used by the monetary authority. The result here is in line with Rogoff (1985) delegation approach of monetary policy[1]. Therefore, policy should be directed to control output volatility as the monetary authority tries to reduce actual inflation through money growth bias and inflation bias to foster their credibility.

[1] Delegating monetary policy authority to an individual who is having anti-inflation objective will results in low inflation and increased output variability, this is what Rogoff called the second best approach.

Figure 2: Output, Output Growth and Money Growth Bias in Nigeria (1970 – 2010)



Source: Author's computation

Conclusion

This paper examines relationship between money growth bias and output growth. The analysis reported that the pre – millennium era is characterized with high inflation and low or zero output growth especially in the military regime. Imported inflation increases domestic price as local manufacturers were awesomely discouraged. Export was relatively low during this period. There is reverse of policy stance in the post-millennium era; actual inflation was tame from its incessant fluctuations and decline towards the public inflation expectation which reduces the money growth bias proportion (see Figure 2). Discretionary policy of the monetary authority in recent time has led to an average money growth bias as it is shown by figure 2 this lowers expected utility, though it stimulates output growth but its fruitless efforts to control output variability had make the control error unavoidable, thus, effective policy towards money growth management should also consider the resultant effect of this policy rule on output volatility that alter economic stabilization in both short, medium and long run. Further research interest in this area should focus on money growth bias, volatility and economic performance in Nigeria.

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Appendix

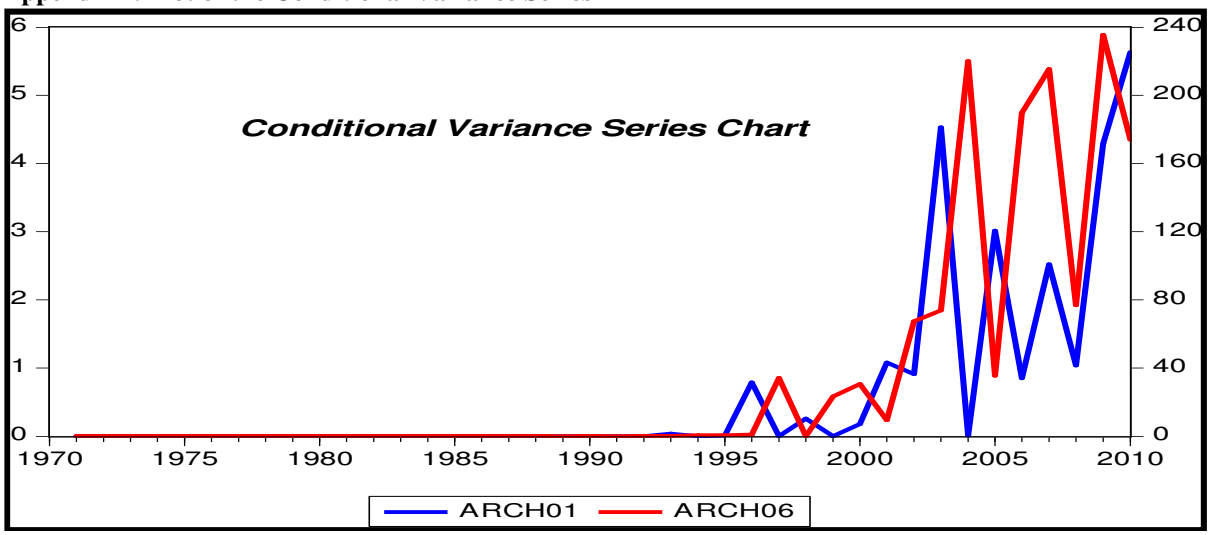
Appendix 1: GARCH and Threshold GARCH (1, 1) Models

GARCH MODELS: GARCH (1, 1) and T-GARCH (1, 1)
Dependent Variable Otptgrt: Sample (1970 -2012)

Parameter	Estimate	Std. error	t-statistic
Constatnt	*0.0005*	*0.0019*	*0.7710*
Output Growth (-1)	*1.0457*	*0.2094*	*0.0000*
Variance Equation			
Constatnt	*0.0000*	*0.0000*	*0.6785*
ARCH (1)	*2.2981*	*1.3074*	*0.0788*
GARCH (1)	*0.6633*	*0.2583*	*0.0102*
R - Squared	*0.2983*		
S.E. of Regression	*0.8557*		
T-GARCH (1, 1) Model			
Constant	*0.0000*	*0.0000*	*0.7985*
ARCH (1)	*0.3506*	*0.6635*	*0.5972*
Resid (-1)^2(Resid (-1) less than zero)*	*5.3632*	*3.357*	*0.1101*
GARCH (1)	*0.658*	*0.2652*	*0.0131*
R-Squared	*0.2119*		
S.E. of Regression	*0.9069*		

Source: Author's Computation

Appendix 2: Plot of the Conditional Variance Series



Source: Author's Computation

Appendix 3: Analyzing the model

In order to analyze this model, the structure of the model is divided into two (2) scenarios:
The first scenario:
A case of binding commitment between the policy maker's objective and public's opinion. In this scene, the policy maker make binding commitment with the public on what inflation will be before actual inflation is determined; such that the public observes that the policy makers is duly committed to the inflation direction they choose. Thus, the expected inflation is the same as the actual inflation ($\pi_t = \pi_t^e$).

Recall equation (1):

$$Y_t = Y_p + \phi(\pi_t - \pi_t^e) + v_t \qquad (3)$$

$$\pi_t = \pi_t^e$$

$$Y_t = Y_p + v_t \qquad (4)$$

Taking expectations of both sides:

$$E(Y_t) = Y_p + E(v_t) \qquad (5)$$ [1]

$$E(Y_t) = Y_p$$

Similarly, if output is measured without bias, then the above equation can be re-written as follows:

$$Y_t = Y_p \qquad (6)$$

Equation (6) suggests that output at a particular time is equal to its natural rate, that is, it is the same as its equilibrium rate or full employment. The problem of the policy maker is to choose inflation that satisfies at least this condition – output is equal to its natural level or full employment. In order to perform this, there is need to minimize the social welfare (loss function) equation and this is done below.

Solving the social welfare function, by recalling equation (2):

$$S_w = \frac{1}{2}(Y_t - Y_T)^2 + \frac{1}{2}\psi(\pi_t - \pi_T)^2 \qquad (7)$$

$$\text{Recall from equation (6) } Y_t = Y_p = Y_T;$$

$$S_w = \frac{1}{2}(Y_T - Y_T)^2 + \frac{1}{2}\psi(\pi_t - \pi_T)^2$$

$$\underset{\pi}{Min}\ S_w = \frac{1}{2}\psi(\pi_t - \pi_T)^2 \qquad (8)$$

Take the first order derivative of equation (8) with respect to π_t [2]; since actual output is equal to the full employment output which is the optimal output for the economy; there is a corner solution for the social welfare function and absolute importance is diverted to inflation to minimize output and therefore, ψ is close to one, $\psi \approx 1$.

$$\pi_t = \pi_T \qquad (9)$$

Inflation, that is actual inflation, π_t, represents the optimal inflation rate for the economy in this case, π_T. In general, under the first scenario, the actual, expected and optimal inflation rates are equal respectively.

The second scenario:

The second scene is basically a situation where the policy maker chooses inflation and taken public expectation about inflation as given. This is peculiar to real life situation, that is, similar to the central bank behavior in practice. In such case, the expected inflation is formed by the public before the money growth or actual inflation is determined or otherwise, or both are determined concurrently.

In this scene, $\pi_t \neq \pi_t^e$ thus equation (1) becomes;

$$Y_t = Y_p + \phi(\pi_t - \pi_t^e) + v_t \qquad (10)$$

Recall the social welfare equation:

$$S_w = \frac{1}{2}(Y_t - Y_T)^2 + \frac{1}{2}\psi(\pi_t - \pi_T)^2 \qquad (11)$$

Substitute equation (10) in (11);

$$S_w = \frac{1}{2}(Y_p + \phi(\pi_t - \pi_t^e) + v_t - Y_T)^2 + \frac{1}{2}\psi(\pi_t - \pi_T)^2 \qquad (12)$$

$$\underset{\pi}{Min}\quad S_w = \frac{1}{2}(Y_p + \phi(\pi_t - \pi_t^e) + v_t - Y_T)^2 + \frac{1}{2}\psi(\pi_t - \pi_T)^2$$

Take the first order derivative of the minimization problem and set the equation to zero, the below equation follows:

---

[1] The expectation of the random term is equal to zero, $E(v_t) = 0$.

[2] $\frac{d S_w}{d \pi_t} = \psi(\pi_t - \pi_T) = 0$ The derivative process takes the form of chain rule and this solution is set to zero to satisfy the first order condition, which suggests that actual inflation rate chosen by the policy maker, is the optimal inflation rate.

$$\frac{d S_w}{d \pi_t} = (Y_p + \phi (\pi_t - \pi_t^e) + v_t - Y_T)\phi + \psi(\pi_t - \pi_T) = 0 \qquad (13)$$

Re-arrange the expression and solve for π_t, the following expression is derived:

$$\pi_t = \frac{\phi^2 \pi_t^e + \psi \pi_T + \phi v_t - \phi(Y_p - Y_T)}{(\psi + \phi^2)} \qquad (14)$$

Add $\phi^2 \pi_T - \phi^2 \pi_T$ to the numerator of equation (14):

$$\pi_t = \frac{\phi^2 \pi_t^e + \psi \pi_T + \phi^2 \pi_T - \phi^2 \pi_T + \phi v_t - \phi(Y_p - Y_T)}{(\psi + \phi^2)}$$

$$\pi_t = \frac{(\psi + \phi^2)\, \pi_T + \phi^2 (\pi_t^e - \pi_T) - \phi (Y_p - Y_T) + \phi v_t}{(\psi + \phi^2)} \qquad (15)$$

Multiply equation (15) by $(\psi + \phi^2)$;

$$\pi_t (\psi + \phi^2) = (\psi + \phi^2)\, \pi_T + \phi^2 (\pi_t^e - \pi_T) - \phi (Y_p - Y_T) + \phi v_t \qquad (16)$$

Expand the expression in equation (16) and solve for π_t:

$$\pi_t = \pi_T - \frac{\phi}{\psi}(Y_p - Y_T) + \frac{\phi v_t}{\psi} \qquad (17)$$

Taking expectations of equation (17); to ascertain the expected inflation:

$$\pi_t^e = \pi_T - \frac{\phi}{\psi}(Y_p - Y_T)$$

$$\pi_t^e = \pi_T + \frac{\phi}{\psi}(Y_T - Y_P) \equiv \pi^{EQ} \qquad (18)$$

Equation (17) shows that actual inflation is affected by the random variable, thus from the theoretical structure policy inconsistency has a significant role in determining actual inflation rate. Although the optimal inflation is greater than the actual which deduce that the policy maker have some prescribe benefit for choosing low positive inflation, that is, sub-optimal inflation rate under the discretionary policy rule.

While equation (18) presents that the expected inflation rate is identically related to the equilibrium rate. This suggests that the public opinion about inflation is greater than the optimal (target) choice of inflation. Intuitively, higher inflation expectation by the public neutralizes the effect of increase inflation policy made by the policy maker to stimulate output above the natural level, Y_P. The impact of output growth above the natural level is strictly measured by the ratio of the inflation surprise, ϕ, and the weight place on inflation and output in the social welfare function, ψ.

Box 1: Summary of Results under both Scenarios

Scene 1:

Inflation Actual, expected and Target Inflation rates are equal.

Output Actual, natural and Target Outputs levels are equal.

Scene 2:

Inflation: Actual is greater than expected and the later is greater than optimal choice of inflation, if and only if optimal choice output is greater than its natural level. Although there is still an inflation bias even if the target and natural levels of output are equal provided policy makers have a precautionary demand for expansion but deem insignificant in this model.

Output: Both actual and optimal choices of outputs are greater than the natural rate and these show that theoretically output increases above its natural level as marginal cost of inflation rises.

Source: Author's compilation

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