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## **Monetary Policy and Industrial Outputs in Nigeria: The Relevance of Rational Expectation Hypothesis**

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**ABSTRACT** - This study investigates the validity or otherwise of the policy ineffectiveness proposition in Nigeria. We adopted the rational expectation theoretical framework and specified a traditional new classical macroeconomic model with price flexibility, market clearing and agent expectation formed rationally. This model was estimated using the Two Stage Least Square (TSL) technique. The findings from the empirical analysis showed that monetary policy affected the real industrial output only by inducing surprises and since there was no systematic (that is predictable) way to manipulate those surprises. In other words systematic monetary policy may not be effective in influencing industrial output in Nigeria. The finding is consistent with other studies in this area and also in tune with general characteristics of industrial sector where the level of modernity could be compared to the economic environment of developed countries where the hypothesis has been confirmed. The implication of these results on industrial development is to appreciate that monetary policy cannot be used to influence the cyclical movement of real industrial production in Nigeria. The fact that surprise monetary policy appears more potent in accompanying this, discretionary monetary policy pursued to stimulate the real industrial output will be of no effect. Hence monetary policy can do no better than to use a constant growth rate rule such as the one Friedman recommends, since that will reduce the skepticism of the economic agents on the commitment of monetary authority to "announced" policy stance.

**Keywords:** Rational Expectations, Real Outputs, Monetary policy, JEL Classifications.

## **INTRODUCTION**

The focus of this paper is on the relevance of the rational expectation hypothesis as a theoretical framework for monetary policy formulation in contemporary Nigeria. There are several reasons for this focus. First, the empirical support for the Rational Expectation (Ratex) hypothesis has largely come from advanced countries with differences in both economic and institutional framework from Nigeria, a developing economy. Second, the existing evidence on Nigeria is at best ambiguous. Whereas some came down against the Ratex hypothesis (see Anyanwu 1993&1994) others found a rather weak support (see Uba 1989, Odedokun 1988 Nwaobi 1999). Apart from general methodological 'flaws relating to model specification inherent in these studies, the studies were based on the implicit assumption of homogeneity in the observed relationship between the industrial and aggregate economy-a very restrictive assumption. There are considerable variations between the industrial and agricultural sectors in relation to structural features and institutional aspects, which have direct bearing upon the real effects of monetary policy. This fundamental limitation makes results from these studies misleading and doubtful. This consideration among others points to the need to undertake further econometric investigation of the relevance of Ratex hypothesis in Nigeria. Third, the previous studies covered the period to about 1992. A fresh look now has the advantage of utilizing more time series data, which makes the present efforts more robust and incisive, thus building a sound empirical foundation for future

## **THE RATIONAL EXPECTATION PROPOSITION**

The theoretical works of Lucas (1972), Sargent and Wallace (1973) and Barro (1976) suggest that in an economy in which agents have rational expectation, anticipated changes in the money supply will have no effect on real output, but are simply translated into price level changes. Unanticipated changes in the money supply on the other hand will have real effects because agents cannot distinguish between current, relative and absolute demand shifts. Lucas (1972) posits that the economy is conceived as consisting of a large number of physically separate markets in each of which demand is subject to market specific or relative shifts and to a common or aggregate demand shifts. The latter is usually made a function of change in the money supply. The typical economic agent is assumed to be sufficiently rational and well informed to be able to anticipate and distinguish between shifts in relative demand and shifts in the money supply that are predictable on the basis of information available at the beginning of each trading period.

However, any unpredictable or random movements in relative demand cannot be immediately distinguished from similar movements in the money

supply. The possibility exists that a positive random movement in money supply will confuse the typical supplier into believing that there has been a random relative demand shift in his favour. This is inevitable if agent employs the optimal method of forming an estimate of the random movement in the money supply based on limited information, provided the random relative demand shifts have a significant variance. Thus a positive random movement in the money supply will lead the typical supplier into thinking that there has been a random relative demand increase in his market and hence a random increase in the money supply will produce a rise in aggregate output. Predicted movements in the money supply will on the other hand produce no such movement in output since they do not affect the typical suppliers view of their relative prices. This theoretical exposition is usually called rational expectation (RATEX) hypothesis.

## **REVIEW OF RELATED STUDIES**

Sergeant and Wallace (1975) first attempted a direct test of the monetary policy ineffectiveness proposition. They distinguished between unanticipated (surprise) inflation and actual inflation as a cause of macroeconomic fluctuations in the United States. The outcome of their findings provided support for Ratex hypothesis.

Barro (1977) pioneered the second round of testing this rational expectation hypothesis. He replaced unanticipated inflation with unanticipated money growth explained fluctuation in the real variables in the US economy. A similar result was obtained when Barro (1978) replaced unemployment with output. In a similar but expanded model of Barro's approach, Attfield (1981) subjected the Ratex hypothesis to empirical investigation based on annual quarterly data from UK economy. Attfield specified output equation in which the natural level of output was made a function of two variables time and a measure of inflation variability. Attfield found estimate, from his output equation to be consistent and robust and provided strong support for Ratex hypothesis in the U.K. economy.

Mishkin (1982) rejected the results from earlier studies and demonstrated that anticipated changes in the monetary growth did exert real effects. He opined that Barro results depend on the length of the lag allowed for in modeling the influence of money on output. Makin (1982) in own study tested the hypothesis with output equation including both anticipated and unanticipated monetary growth. The results of his study suggested that anticipated money growth dominated the monetary growth surprises in effect on real economic activity.

Darrat (1985) challenged Mishkin (1982)'s results. He investigated the hypothesis for Canadian economy. Darrat criticized Mishkin's a priori choice of four lags as unduly restrictive leading to specification bias if in actual fact the lag length for some variables is different from four lags. He buttressed his criticism



with Mishkin (1982) own criticism that "it is the specification of these lags that give rise to the in-conclusive empirical evidence from previous tests of the rational expectation hypothesis. Darrat (1985) then modified Mishkin's model to avoid this bias by allowing the data to determine the relevant macro variables. Darrat's results showed that only the unanticipated component of inflation exerted a significant positive impact on real output whereas the impact of anticipated inflation on real output evidence presented in his study strongly supported the Ratem hypothesis that only unanticipated inflation induced significant positive deviations of real output from trend. In another earlier study, The results of Alogoskoufis (1982) for Greece economy, Hanson (1980), and Chopra and Montiel (1986) for Latin America economies and Moosa (1993, 1997) for Indian economy provided supports for the hypothesis in those countries. Other studies such as; Mohabbet et al 1991, Hafer & Kutan 1997 Khatri-Cletri et al 1990, Kulscar 1991 and Humphrey (1992) also generally supported the short-run output determination (Ratem) hypothesis in developing countries.

Uba (1989) using the Barro model with annual data on Nigerian economy (1965 to 1985), found supports for monetary neutrality on real output. In another important earlier study for Nigeria based on annual and disaggregated data for 1968 to 1987, Odedokun (1988) investigated the RATEX hypothesis. The data sets included inflation rate and four categories of real output, namely manufacturing output, real estate and construction output, real GDP less primary production and overall real GDP. Odedokun admitted that his results were not robust and hardly conclusive but certain fairly reliable findings worthy of note emerged from his study. One of them was that anticipated monetary growth significantly influenced real variables when aggregate output (GDP) was used. Another was that unanticipated monetary growth only affected inflation. However, evidence from his study also showed that unanticipated monetary growth exerted significant influence on manufacturing output.

Uba and Odedokun used either one or two lags on annual data and five lags on quarterly data without any explanation for using the highly restrictive lag structure in their studies. This might have biased the result and even be the cause of the weak support of the hypothesis in their study. This is corroborated by Darrat (1985) criticism of Mishkin (1982) that the inappropriate specifications of lag structure in the existing studies contributed to the outcomes of these studies.

Anyanwu (1993) using a modified Barro's model where both monetary and fiscal policy variables were used, came out with the following result for 1970-1988 period annual data, that in both open and closed Nigerian economy that rational expectation received supports for only price level and not output. However, for the period of 1970 to 1992 in another study of Anyanwu (1994), both in open and closed Nigerian economy monetary neutrality did not receive any support for

both output and price level. Surprisingly, in spite of the obvious limitation of earlier studies, Anyanwu's model fall foul of (same pit falls of Odedokun and Uba) arbitrary choice of lags. Anyanwu used 6 lags for quarterly data and 2 lags for annual data without providing enough justification for such restrictive model. In a similar study but with different approach, Ogungbenro et al (1995) examined the effects of monetary policy on unemployment. They modified Barro (1977) and Wogin (1980) models to specify unemployment as a function of money supply, government expenditure, and export earnings. They used OLS estimation technique on annual data (1960 to 1993) for Nigerian economy. The results of their findings showed that monetary policy affected unemployment. This result is not without fault in two ways; first, using rational expectation model without the underlying assumption made the outcome of their study to be doubtful. Second, the choice of their lag length on the variables was too arbitrary. They chose three lags on money supply and one lag on all other variable without providing justification for such restriction, thus, the outcome of their findings maybe misleading and difficult to interpret.

Nwaobi (1999) re-investigated the claims of earlier studies on Nigerian economy. He specified an open-economy rational expectation model where imported intermediate goods were accorded important role. He proxied monetary policy by foreign income, and money supply. The resulting output equation was estimated using Cochrane-Orcutt iterative procedure. The findings from his study provided evidence in support of rational expectation hypothesis in Nigeria. He concluded that only unanticipated components of externally induced price changes caused domestic output to deviate.

One major observation from this review is that issue of policy ineffectiveness hypothesis is yet to be settled on empirical level in Nigeria. The doubts over the outcome of some of these studies due to their methodology make further empirical investigation imperative. The subsequent sections of this study provided evidence at filling this empirical gap in the existing literature with data from Nigeria.

## **DATA DEFINITIONS AND SOURCES**

The study relied on secondary quarterly time series data. Empirical investigation was carried out based on 120 quarterly observations covering the period 1970 to 1999. Eight variables were considered: Growth in money supply (M) real (Industrial) output (Y), foreign reserve (F) Exchange rate (E), Export Earnings (X) Treasury bill rate @ inflationary rate (CCPINF) and inflation uncertainty VINP.

Monetary policy was defined as discretionary changes in money supply ( $M_1$  and  $M_2$ ). Both  $M_1$  and  $M_2$  were considered to check which of the two definitions of money was more robust and relevant in effects on real industrial output in Nigeria. The output was proxied by industrial production indices instead

of the Gross Domestic Product (GDP) used by the previous studies (e.g. Uba 1989, Anyanwu 1993, 1994). This become necessary in order to check whether the emerging modern sector (industrial) would provide the appropriate condition necessary for the validity of the Ratex hypothesis in Nigeria. Inflation rate was computed as percentage changes in composite consumer Price indices, while Inflation uncertainty was computed as the variance of inflation in preceding five quarters. Data on the entire variable were obtained from various issues of two publication of CBN namely: Statistical Bulletin and Annual reports and Statement of accounts.

## **THE MODEL**

The theoretical framework for analyzing the potency of monetary policy on the real variables such as industrial output is explicitly embedded in the Rational Expectations Model. The standard fashion of this model as developed by Muth (1961), modified by Barro (1977) is always the starting point of empirical analysis of this nature. Therefore, this study adopted the Barro's two-step procedure to specify the money growth equation to describe how agents form their expectation about future money growth. The predicted and residual values from this equation were taken as systematic and surprise components these were utilized in the second step as regressors in output equation. The detail analysis of each equation is presented below.

### **Money growth equation**

The technique employed in specifying the money growth equation drew essentially from Darrat (1985) VAR procedure. However, the nominal variable (inflation rate) was replaced with money supply growth in our model. Instead of Darrat's Theils minimum variance for selecting the appropriate model, we relied on Akaike's Final Prediction Error (FPE) Criterion in conjunction with multivariate Granger – Causality tests. The objective was to determine simultaneously the relevant macro-variables and their appropriate lag lengths. This method is appealing because it balances the risk due to the bias when a lower order is selected and the risk due to the increase of variance when a higher order is selected. Specifically this method allows a variable to depend on a subset of the variables under consideration and allow each variable to enter the operation with a different number of lags. This means that not only is there a reduction in the number of parameter to be estimated but at the same time the influence of each variable may be felt at different time lags. The macro-variables considered for inclusion in the money growth equation were: the treasury bill rate, foreign reserves, export earnings, exchange rate and inflation rate. This set of macro-variables was chosen because information on them are readily available at low cost and the agents might utilize them to predict monetary policy actions.



The first step in our specification of the systematic money growth equation was the choice of own lag lengths for the nominal variables to ensure white-noise residuals. The choice was determined by varying the lag in the auto-regression:-

$$M_t = a_0 + a_1(L) M_t + U_t \dots\dots\dots(1)$$

Where  $a_1(L) = \sum_{k=1}^n a_{1k} L^k$ , and  $L$  in the lag operator  $k=1$  and  $L^k M_k = M_{t-k}$ ,  $n$  is the maximum lag order specified a priori to be twelve (12) quarters and  $U_t$  is a white-noise stochastic term. The lag length that yielded the minimum FPE was selected as the appropriate order of  $a_1(L)$ .

After determining the appropriate lag order of  $a_1(L)$ , whether other variables should also enter the systematic money equation was determined by estimating the following model.

$$M_t = a_0 + a_1(L) M_t + a_2(L) Z_t + U_t \dots\dots\dots(2)$$

Where  $Z_t$  is the vector of the relevant macro-variables, each considered one at a time and  $a_2(L)$  is a distributed lag polynomial defined in similar fashion to  $a_1(L)$ . With the lag in  $a_1(L)$  fixed at its previously chosen order, the lags in  $a_2(L)$  were varied from 1 to 12:

The lag length that provided the minimum FPE was selected as the appropriate lag order for the macro-variables. Then f-test on the joint significance of the estimated coefficient of the macro variables was performed. If the coefficients as a group are significant non-zero, the variable is said to contain valuable information for predicting money growth and thus retained for further consideration. The above steps were followed for each of proposed macro-variable and those remaining for consideration were ranked according to the minimum FPE from equation (2). Then the money growth equation:

$$M_t = a_1(L) M_t + a_2(L) Z_{it} + a_3(L) Z_{ut} + U_t \dots\dots\dots(3)$$

is estimated where  $Z_{it}$  is the macro-variable with least FPE from equation (2) regression and  $Z_{ut}$  are the remaining macro-variables, again considered one at a time as the case in bivariate equation (2). This process continued until all proposed variables, were either discarded or included in the money growth equation.

### The output equation.

The output supply model for testing the rational expectation hypothesis is of the form.



$$Y_t = Y^* + \hat{\alpha}(P_t - P^e_{t-1}) \dots\dots\dots(4)$$

Where  $Y_t$  is the level of output in period  $t$ ;  $Y^*$  is the constant "natural level of output associated with the vertical Classical aggregate supply curve;  $P_t$  is the price level in period  $t$  and  $P^e_{t-1}$  is the price level in period  $t-1$ .

This says that there will be a fixed level of output except to the extent that actors makes errors about prices. If equation (4) is modified by adding only a random supply disturbance  $e^s_t$ .

$$Y_t = Y^* + \hat{\alpha}(P_t - P^e_{t-1}) + e^s_t \dots\dots\dots(5)$$

Here and elsewhere, we assume that the random error  $e^s_t$  takes an average (or expected) value of zero, and is serially uncorrelated. Formally,  $E(e_t)$  and  $E(e_t e_s) = 0$  ( $t \neq s$ ). The price level proportional to money growth  $M_t$ , plus a random demand disturbance  $e^d_t$ .

$$P_t = \hat{\alpha}M_t + e^d_t \dots\dots\dots(6)$$

Supposing the monetary authorities keep the money growth constant, except that they try to stabilize the economy by changing the money growth rate response deviations of the last periods output from the natural rate that achieve this with random error  $e^m_t$ .

$$M_t = \beta_0 + \beta_1(Y^* - Y_{t-1}) + e^m_t \dots\dots\dots(7)$$

With rational expectations, actors will expect the price level to be proportional to the systematic component of the money growth (where we have used the assumption that  $E(e_t) = 0$

$$P^e_t = \hat{\alpha}(\beta_0 + \beta_1(Y^* - Y_{t-1})) \dots\dots\dots(8)$$

The actual price level will also depend on the error in equation (7) and the demand disturbance.

$$P_t = \hat{\alpha}(\beta_0 + \beta_1(Y^* - Y_{t-1})) + \hat{\alpha}e^m_t + e^d_t \dots\dots\dots(9)$$

Subtract equation (8) from (9)

$$P_t - P^e_t = \hat{\alpha}e^m_t + e^d_t \dots\dots\dots(10)$$

Tat is error in price expectation just depends on the disturbance. Substituting this back into equation (5) results in the following:

$$Y - Y^* = \hat{\alpha}e^m_t + \hat{\alpha}e^d_t + e^s_t \dots\dots\dots(11)$$

This says that the deviation of current real output from the natural rate only depends upon the disturbances and not on the systematic component of policy. This is essentially the analysis of sergeant and Wallace (1975) which led to the conclusion that only unanticipated policy matters.

One important observation about this analysis is that if deviations from the natural rate (of output) were random, then stabilization policy would not be relevant. It is persistent deviations that have to be explained and of course corrected for. This is done by including one period lag of the output variable in output equation (11). It becomes:

$$Y_t - Y^*_t = f(Y_{t-1}, u_t) \dots\dots\dots(12)$$

Where  $u_t = \hat{\alpha}e^m_t + \hat{\alpha}e^d_t + e^s_t$ .

$$Y_t = b_0 + b_1 Z_t + \sum_{n=1}^n b_2 M_t + U_t \dots\dots\dots(13)$$

Where M represent either the unanticipated ( $M^u$ ) or the anticipated ( $M^e$ ) components of money growth as specific in the earlier section. In addition to these policy variables, the equation included time trend (T) to capture effects of secular growth in natural rate of output and (VINF), a measure of the impact of inflation variability on the real industrial production. This was done because of the possibility that the efficiency of the economy and hence the national level of output might be reduced by highly uncertain inflation rate. For this study, the output equation simultaneously included both systematic and surprise's components of money growths to bring out the relative significance of each component and as such be able to see which of the two components overwhelm the other. The final versions of the models were:-

$$Y_{1t} = \beta_{10} + \beta_{11} T + \sum_{j=0}^n \beta_{12} VINF + \beta_{13} Y_{t-1} + \sum_{j=0}^n \beta_{14j} M^e + E_{1t} \dots\dots\dots(14a)$$

$$Y_{2t} = \beta_{20} + \beta_{21} T + \sum_{j=0}^n \beta_{22} VINF + \beta_{23} Y_{t-1} + \sum_{j=0}^n \beta_{24j} M^u + E_{2t} \dots\dots\dots(14b)$$

$$Y_{3t} = \beta_{30} + \beta_{31} T + \sum_{j=0}^n \beta_{32} VINF + \beta_{33} Y_{t-1} + \sum_{j=0}^n \beta_{34j} M^e + \sum_{j=0}^n \beta_{35j} M^u + E_{3t} \dots\dots\dots(14c)$$



Where $Y_t$	=	the level of industrial output
VINF	=	Inflation Uncertainty
$M^u$	=	surprise components of money growth
$M^e$	=	systematic components of money growth
$n$	=	maximum lag order
$T$	=	time trend.

The predicted values of the final versions of equation (3) represent the systematic (anticipated) component of monetary policy variable, while the residuals (i.e actual – predicted) values of the same equation represent the surprise (unanticipated components of the policy variable). The theoretical framework of the equation 14 (a-c) was not specific on the lag lengths “n” on the money growth components; therefore, a decision had to be made on the appropriate size on “n”. Mishkin (1982), Ceceshetti (1986) and others have warned that inappropriate choice of lag has implication on the robustness of the model. Therefore, the size of “n” was determined empirically, using FPE criterion procedure. The approach performed well in selecting the appropriate lag structure in comparison to other statistical criteria. In these cases, the hypothesis would be supported if the coefficient on MU (as a group) in equation (14b, c) are significantly greater than zero, i.e  $B_{24j}$  and  $B_{35j} > 0$ . The coefficients on  $M^e$ 's were expected not be collectively greater than zero i.e  $B_{13j}, B_{34j} < 0$ .

## THE EMPIRICAL RESULTS

### Estimated money growth equations

Applications of the techniques described in section (3) on the quarterly Nigerian data from 1970(1) through 1999(4) yielded the following specifications for the money growths.

$$M^1_{1t} = a_0 + a_1(L)^4 M^1_{1t} + a_2(L)^9 X^1_t + a_3(L)^2 R^1_t + a_4(L)^7 F^1_t + E_{1t} \dots\dots\dots(15.1)$$

$$M^1_{2t} = a_0 + a_1(L)^7 M^1_{2t} + a_2(L)^8 X^1_t + a_3(L)^2 R^1_t + a_4(L)^7 F^1_t + E_{2t} \dots\dots\dots(15.2)$$

Where  $M^1_{1t}$  and  $M^1_{2t}$  represent the growth rate of narrow and broad money definitions respectively, the super scripts on the lag polynomial indicate the appropriate lag structures. Therefore the significant predictions of the Nigerian monetary growth over the estimation period were:- seven quarterly lags on broad money  $M_2$  and four lags on Narrow money ( $M_1$ ),  $X^1_t$ , the growth rate of export earnings with eight and nine lags on  $M^1_{2t}$  and  $M^1_{1t}$  equation respectively.  $R^1_t$  the three month treasury bill rate with two lags and  $F^1_t$  the growth rate of foreign reserves with seven lags on both ( $M^1_1$  and  $M^1_2$ ) money growth equations.

From all indication that Mishkin (1982) Odedokun (1988) Uba (1989) and Anyanwu (1993, 1994) restricted lags on all the variables would have led to specification bias. The empirical results from estimating equations (15.1) and (15.2) were given in Table 1 and 2 respectively. In each of these models the explanatory power  $R^2$  was moderately high, 50% and 44%. The significance of the  $r^2$  in each case as indicated at 5% level are  $F(22,87) = 3.60$  and  $F(24,86) = 2.60$  for  $M^1$  and  $M^1_{2t}$  respectively. In addition, the Durbin-Watson statistics were within the accepted range (2.039 and 1.863). This suggests absence of auto correlation among the residuals in both models. The conventional (SE) and heteroskedastic consistent standard error (HCSE) of the two models were similar; hence, heteroskedastic in the errors was not indicated.

**Table 1: Quarterly estimates of (M1) monetary growth equation**

CONSTANT=-0.026(1.999)	$M_{t-1} = -1.159(1.661)$ $M_{t-2} = 0.025(0.270)$ $M_{t-3} = 0.1081(1.170)$ $M_{t-4} = -0.379(4.223)$	$X_{t-1} = 0.012(0.451)$ $X_{t-2} = 0.030(1.054)$ $X_{t-3} = 0.049(1.647)$ $X_{t-4} = 0.672(2.197)$ $X_{t-5} = 0.071(2.386)$ $X_{t-6} = 0.049(1.553)$ $X_{t-7} = 0.006(0.192)$ $X_{t-8} = 0.071(2.312)$ $X_{t-9} = 0.017(0.583)$	$R_{t-1} = -0.088(1.255)$ $R_{t-2} = 0.024(0.351)$	$F_{t-1} = -0.0140(0.766)$ $F_{t-2} = -0.004(0.280)$ $F_{t-3} = 0.005(0.267)$ $F_{t-4} = 0.046(2.578)$ $F_{t-5} = -0.039(1.909)$ $F_{t-6} = -0.016(0.796)$ $F_{t-7} = -0.043(2.348)$
S.E = 0.069 $R^2 = 0.501$ $F(22,87) = 3.60(0.000)$ DW = 2.039				
SUM OF COEFFICIENTS	0.136	0.977	-0.063	1.922

**Table 2: Quarterly estimates of (M2) monetary growth equation**

CONSTANT=-0.0249(1.915)	$M_{t-1} = -0.054(0.052)$ $M_{t-2} = -0.094(0.885)$ $M_{t-3} = -0.054(0.493)$ $M_{t-4} = -0.303(3.187)$ $M_{t-5} = -0.057(0.570)$ $M_{t-6} = -0.046(0.463)$ $M_{t-7} = -0.122(1.178)$	$X_{t-1} = 0.007(0.319)$ $X_{t-2} = 0.272(1.00)$ $X_{t-3} = 0.617(2.656)$ $X_{t-4} = 0.050(2.162)$ $X_{t-5} = 0.043(1.859)$ $X_{t-6} = 0.037(1.530)$ $X_{t-7} = 0.006(0.263)$ $X_{t-8} = 0.042(1.880)$	$R_{t-1} = 0.066(1.221)$ $R_{t-2} = 0.060(1.113)$	$F_{t-1} = -0.008(0.576)$ $F_{t-2} = -0.012(0.898)$ $F_{t-3} = -0.009(0.673)$ $F_{t-4} = -0.023(1.764)$ $F_{t-5} = -0.037(2.451)$ $F_{t-6} = -0.001(0.051)$ $F_{t-7} = -0.030(2.129)$
$R^2 = 0.445$ S.E = 0.052 $F(22,79) = 2.60(0.000)$ DW = 1.863				
SUM OF COEFFICIENTS:	0.286	1.007	-0.01	1.141

**Notes:** Absolute value of t-statistics in parenthesis after the coefficient estimates.  $R^2$  is the coefficient of multiple determination adjustment for degree of freedom. SE is the standard error of the regression while DW is the Durbin Watson statistic.



**Table 3: Diagnostic tests on M1 and M2 monetary growth models**

TEST CONDUCTED ON	MODEL 1.1 ( $M_1$ )	MODEL 1.2 ( $M_2$ )
LM TEST FOR 5TH ORDER SERIAL CORRELATION IN RESIDUAL	CHI <sup>2</sup> (5) = 2.661 F(5,74) = 0.40(0.850)	CHI <sup>2</sup> (5) = 5.592 F (5,73) = 0.84(0.527)
LM TEST FOR 11TH ORDER SERIAL CORRELATION IN RESIDUAL	CHI <sup>2</sup> (11) = 4.114 F(11,57) = 0.25(0.993)	CHI <sup>2</sup> (11) = 3.829 F (11,56) = 0.22(0.995)
LM AUTOREGRESSIVE HETEROSCEDASTICITY (ARCH (M))	CHI <sup>2</sup> (6) = 7.128 F (6,67) = 0.90(0.503)	CHI <sup>2</sup> (6) = 5.575 F(6,66) = 0.67(0.674)
HETEROSCEDASTICITY ERRORS	F(38,43) = 0.297 (0.999)	F(38,44) = 0.367(0.999)
CHI-SQUARE NORMALITY CHI <sup>2</sup> (2) = 3.422	CHI <sup>2</sup> (2) = 2.634	
Parameter Constancy test over: 1991(1) – 1999(4)		
Forecast Chi2 (36) /36	2.82	2.85
CHOW TEST (36,51)	1.60 [0.0709]	1.52[0.0969]

**Notes:** The values in parenthesis are probabilities values.

A set of diagnostic tests was also conducted to confirm the evidence of absence of serial correlations among the residuals. The results of these tests are presented in Table 3. It showed that there was no evidence of residual serial correlation heteroskedastic and non-normality in error distribution of this model and that the coefficient remained stable throughout the entire period.

## EVALUATION OF EMPIRICAL RESULTS

In this second step of our empirical analysis the contemporaneous and lag values of the systematic ( $M^e_1$  and  $M^e_2$ ) and surprise ( $M^u_1$  and  $M^u_2$ ) components of money growth were used in estimating the real industrial output equation (14a-c). The full estimates of the output equations are presented in Tables A1 to A4 in the appendix for M1 and M2 and at both eleven and 19 lag structures. The summary of the sum of coefficients and their respective F-statistics are presented in Table 6.

**Table 6: Analysis of the effects of the sum of coefficients on monetary growth components on the real industrial output.**

		SUM OF COEFFICIENTS			
		Single estimation with (11lags) (i)	Joint estimation with(11lags) (ii)	Single estimation with (19lags) (iii)	Joint estimation with(16lags) (iv)
Equation with m1 monetary growth	Systematic (fitted) value (fit m1)	0.063	-0.235	0.427	1.287
	Surprise (residual) values (res m1)	-1.794*	-1.792*	-3.417*	-5.243*
Equation with m2 monetary growth	Systematic (fitted) value (fitm2)	-0.624	-0.360	-0.326	0.653
	Surprise (residual) values (resm2)	-2.860*	-3.063*	-9.410*	-6.567*

**Notes:** The value of t-statistics appears in parenthesis after the coefficient estimate. The sum of coefficients represents the addition of the parametric estimate of the contemporaneous and lagged variables.

Based on estimated in table 6, the first proposition examined is that whether systematic components had real effects or not. The estimates in show that the sums of the coefficient on systematic components were less than the critical value at 5% level of significance. Also the null hypothesis that contemporaneous and lagged values of systematic ( $M^e_1$  and  $M^e_2$ ) had no significant effect on real industrial output could not be rejected as indicated by the F-statistics. In marked contrast, its counterpart null hypothesis that only surprise components had real effects could not be rejected. This confirms the rational expectation theoretical argument that only surprise monetary policy explained industrial output fluctuation and the impact of such surprise (shocks to) monetary policy exceedingly overwhelms that of its systematic counterpart. There is also evidence to show that M1 versus M2 model did not lead to different conclusion. For instance neither M1 nor M2 model led to rejection of the hypothesis. Though using M2 led to some improvement in parameter estimates. This superiority of M2 over M1 indicates the relative strength of M2, as lead indicator of real economic activity in Nigeria.

In the light of these results, the findings are in line with our “a priori” expectation that deviation of real industrial output from the trend only depends on the random (unpredictable) component of monetary policy variable. Also that the inconclusive evidences reported in earlier studies such as Odedokun (1988) and Anyanwu (1993 & 1994) may likely be due to the assumption upon which their models were based. Such assumption includes the restrictive lag structure and the lumping of formal (industrial) and informal (agriculture) sectors in evaluating the real effects of monetary policy when rational expectation conditions are assumed.

## **CONCLUSION AND POLICY IMPLICATIONS**

This study provided further empirical evidence on the real effects of monetary policy when expectations were formed rationally. In this paper efforts were made to correct for those shortcomings identified in earlier studies the main finding from this study is that surprise monetary policy exerted a more significantly negative impact on the real industrial output. The systematic policy had no impact on the real industrial output determination when expectations were formed rationally.

The conclusion of this paper is that, monetary policy affected the real industrial output only by inducing surprises and since there was no systematic (that is predictable) way to manipulate those surprises. In other words systematic monetary policy was is not effective in influencing industrial output in Nigeria. This result provided strong support for the Rational Expectation hypothesis in Niat industrial sector in Nigeria was similar in nature and structure to the advanced economies where such evidence had already been provided.

The implication of these results on industrial development is to appreciate that monetary policy cannot be used to influence the cyclical movement of real



industrial production in Nigeria. The fact that surprise monetary policy appears more potent in accompanying this, discretionary monetary policy pursue to stimulate the real industrial output will be of no effect. Hence monetary policy can do no better than to use a constant growth rate rule such as the one Friedman recommends, since that will reduce the skepticism of the economic agents on the commitment of monetary authority to “announced” policy stance.

Above all, monetary authority needs to recognize the limits of the policy tools at its command in view of structural peculiarity of Nigerian economy. Even with the best of intentions, some policies have the potential to end up doing more harms than good. To continue applying such policy just to be seen as doing something would be very unproductive. Though, monetary policy has important role to play in the economy, it is not a tool the monetary authority should be using directly to stimulate industrial growth. Indeed, the Nigerian experience with such approach over the years has not worked satisfactory, on the contrary it has always been damaging. We therefore concluded that the best contribution monetary policy can make to industrial growth in Nigeria is to ensure macroeconomic stability. However, this again depends so much on how the monetary authorities tackle the issue of policy credibility.

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## Appendix

TABLE A1: QUARTERLY ESTIMATES OF THE LOG OF REAL INDUSTRIAL OUTPUT 1970(1)- 1997(4) WITH (19) AND (16) LAGS ON M1 MONETARY GROWTH

	I	II	III	IV	V
	FITMI	RESMI		FITMI	RESMI
INTERCEPT	0.486(2.211)	0.747(2.539)	0.531(1.848)		
TREND	0.009(2.840)	-0.012(2.886)	-0.010(2.582)		
VINF	0.025(1.143)	0.015(0.724)	0.023(0.803)		
LR <sub>Y</sub> <sub>t-1</sub>	0.876(17.306)	0.816(12.690)	0.846(13.727)		
LAGO	-0.002(0.008)	0.213(0.998)		-0.019(0.540)	0.014(0.057)
1	0.129(0.402)	0.007(0.033)		-0.025(0.063)	-0.247(0.890)
2	0.407(1.265)	-0.045(2.140)		0.602(0.145)	-0.581(2.273)
3	0.274(0.887)	-0.770(3.661)		-0.122(0.314)	-0.212(0.680)
4	0.373(1.018)	-0.041(0.190)		0.322(0.623)	-0.212(0.680)
5	0.195(0.530)	-0.505(2.381)		-0.083(0.165)	-0.580(2.017)
6	-0.084(0.231)	-0.026(0.118)		0.038(0.800)	-0.206(0.711)
7	0.185(0.506)	-0.067(0.309)		0.970(0.215)	-0.154(0.504)
8	-0.247(0.672)	-0.048(0.219)		-0.422(0.813)	-0.292(0.824)
9	0.090(0.250)	-0.221(1.026)		-0.813(0.358)	-0.209(0.591)
10	-0.321(0.884)	0.368(1.69)		-0.325(0.679)	-0.631(1.852)
11	-0.400(1.212)	0.021(0.091)		0.205(0.443)	-0.510(0.146)
12	-0.312(0.861)	-0.456(1.947)		0.951(1.907)	-0.352(0.958)
13	-0.066(0.181)	0.170(0.699)		0.331(0.829)	0.286(0.789)
14	-0.019(0.054)	-0.340(1.462)		0.234(0.613)	-0.316(0.940)
15	0.053(0.148)	-0.311(1.183)		0.216(0.587)	-0.329(0.929)
16	0.146(0.477)	-0.077(0.328)		-0.011(0.028)	-0.448(1.407)
17	-0.430(1.340)	0.052(0.219)			
18	-0.032(0.098)	-0.270(1.159)			
19	-0.138(0.422)	0.071(0.299)			
R <sup>2</sup>	0.85	0.86	0.86		
F-STATISTIC	94.04(0.000)	36.24(0.000)	35.83(0.000)		
DW	2.112	2.100	2.379		
SUM OF COEFFICIENTS	0.427(1.75)	-3.147(1.75)		1.287(1.69)	-5.423(1.69)a

**Notes:** The value of t-statistics appears in parenthesis after the coefficient estimate. The sum of coefficients represents the addition of the parametric estimate of the contemporaneous and lagged variables.



**TABLE A2: QUARTERLY ESTIMATES OF THE LOG OF REAL INDUSTRIAL OUTPUT 1970(1) – 1997(4) WITH (19) AND (16) LAGS ON M2 NONETARY GROWTH.**

	I	II	III	IV	V
	FTM2	RESM2		FTM2	RESM2
INTERCEPT	0.388(1.680)	1.361(3.450)	0.788(2.309)	-0.532(1.108)	0.386(1.152)
TREND	-0.007(2.136)	-0.021(3.669)	-0.014(2.957)	-0.128(0.259)	-0.352(1.041)
VINF	0.015(0.712)	-0.012(0.582)	0.023(1.317)	-0.238(0.467)	-0.340(1.007)
LRY t-1	0.899(18.098)	0.697(8.294)	0.790(11.098)	-0.083(0.175)	-1.014(2.949)
LAGO	-0.329(0.771)	0.368(1.259)		-0.473(0.901)	-0.329(0.909)
1	0.077(0.017)	-0.148(0.501)		-0.106(0.205)	0.527(1.528)
2	0.072(0.163)	-0.196(0.670)		0.314(0.596)	-0.431(1.069)
3	0.264(0.619)	0.264(0.619)		0.314(0.596)	-0.431(1.069)
4	0.390(0.818)	-0.479(1.567)		-0.811(1.442)	-0.838(1.982)
5	0.056(0.120)	-0.511(1.651)		-0.255(0.442)	-0.361(0.890)
6	0.039(0.083)	-0.462(1.614)		-0.751(1.342)	-0.876(2.144)
7	-0.104(0.225)	-0.462(1.614)		-0.019(0.036)	-0.463(1.041)
8	-0.574(1.308)	-0.462(1.926)		1.187(2.175)	-0.181(0.182)
9	0.245(0.531)	-0.424(1.294)		0.209(0.426)	0.083(0.182)
10	-0.342(0.746)	-0.883(2.682)		0.315(0.656)	-0.288(0.659)
11	-0.259(0.571)	-0.550(1.603)		0.067(0.146)	-0.607(1.359)
12	0.715(1.590)	-0.752(2.106)		0.327(0.741)	-0.509(1.171)
13	-0.390(0.852)	-0.392(1.068)			
14	-0.064(0.129)	-0.608(1.705)			
15	-0.930(0.208)	-0.738(1.844)			
16	0.511(1.186)	-0.383(1.089)			
17	-0.428(0.944)	-0.200(0.565)			
18	-0.029(0.026)	-0.737(2.207)			
19	-0.014(0.032)	-0.114(0.331)			
R <sup>2</sup>	0.85	0.86			
F-STATISTIC	47.67(0.000)	61.48(0.000)			
DW	1.986	1.993			
SUM OF COEFFICIENTS	0.326(1.75)	-9.410(1.75)*	2.180	0.653(1.69)	-6.567(1.69)

**Notes:** The value of t-statistics appears in parenthesis after the coefficient estimate. The sum of coefficients represents the addition of the parametric estimate of the contemporaneous and lagged variables.

**TABLE A3: QUARTERLY ESTIMATES OF THE LOG OF REAL INDUSTRIAL OUTPUT 1970(1) – 1997(4) WITH ELEVEN LAGS ON MONETARY GROWTH**

	I	II	III	IV	V
	FITMI	RESMI		FITMI	RESMI
INTERCEPT	0.293(1.619)	0.328(1.876)	0.312(1.475)	-0.029(0.079)	0.140(0.604)
TREND	-0.005(2.103)	-0.006(2.376)	-0.006(2.047)	0.072(0.205)	-0.112(0.458)
VINF	-0.011(0.732)	0.009(0.665)	0.005(0.282)	0.126(0.370)	-0.472(1.96)
LRY	0.933(22.811)	0.914(22.876)	0.917(19.387)	0.041(0.126)	-0.644(2.598)
LAGO	0.048(0.168)	0.150(0.740)		0.005(0.013)	-0.083(0.305)
1	0.059(0.208)	-0.118(0.576)		0.009(0.024)	-0.323(1.242)
2	0.425(1.501)	-0.494(2.415)		0.029(0.068)	-0.0217(0.082)
3	0.159(0.598)	-0.645(3.167)		0.073(0.179)	0.019(0.069)
4	0.069(0.224)	-0.108(0.521)		0.021(0.069)	0.110(0.361)
5	0.014(0.043)	-0.319(1.571)		0.044(0.132)	-0.158(0.535)
6	-0.231(0.739)	-0.008(0.036)		0.162(0.480)	-0.278(1.919)
7	0.074(0.235)	0.028(0.139)		0.010(0.028)	0.032(0.102)
8	-0.052(0.186)	0.087(0.423)			
9	0.030(0.104)	-0.185(0.905)			
10	-0.219(0.748)	-0.272(1.315)			
11	-0.313(1.056)	0.090(0.421)			
R <sup>2</sup>	0.85	0.85			
F-STATISTIC	90.4(0.00)	108.99(0.000)	0.85		
DW	2.089	2.322	51.92(0.00)		
SUM OF COEFFICIENTS	0.063(1.88)	-1.794(1.68)	2.343	-0.235(1.68)	-1.792(1.68)*

**Notes:** The value of t-statistics appears in parenthesis after the coefficient estimate. The sum of coefficients represents the addition of the parametric estimate of the contemporaneous and lagged variables.

**TABLE A4: QUARTERLY ESTIMATES OF THE LOG OF REAL INDUSTRIAL OUTPUT 1970(1) – 1997(4) WITH ELEVEN LAGS ON M2 MONETARY GROWTH.**

	I	II	III	IV	V
	FITM2	RESM2		FITM2	RESM2
INTERCEPT	0.33(1.717)	0.442(2.547)	0.499(2.213)	-0.419(0.938)	0.321(1.122)
TREND	-0.005(2.029)	-0.007(2.832)	-0.008(2.643)	-0.067(0.149)	-0.207(0.646)
VINF	0.922(2.889)	0.895(21.781)	0.882(18.035)	-0.024(0.052)	-0.265(0.849)
LRYt-1	-0.007(0.557)	0.006(0.494)	-0.004(0.336)	0.185(0.417)	-0.881(0.803)
LAGO	-0.489(0.634)	0.322(1.155)		0.173(0.358)	-0.140(0.414)
1	-0.239(0.634)	-0.219(0.769)		-0.162(0.336)	-0.279(0.845)
2	0.007(0.019)	-0.329(1.168)		0.304(0.645)	-0.368(1.076)
3	0.423(1.145)	-0.868(3.855)		0.199(0.405)	-0.122(0.326)
4	0.250(0.636)	-0.287(1.003)		0.236(0.563)	-0.300(0.326)
5	0.040(0.100)	-0.288(1.006)		0.138(0.316)	-0.032(0.083)
6	-0.096(0.291)	-0.029(1.002)		-0.324(0.741)	-0.654(1.672)
7	0.071(0.176)	-0.025(1.088)		-0.127(0.267)	-0.177(0.435)
8	0.272(0.681)	0.179(0.615)			
9	0.139(0.337)	-0.080(0.272)			
10	0.116(0.284)	-0.576(1.954)			
11	-0.200(0.484)	-0.042(0.140)			
R <sup>2</sup>	0.84	0.85			
F-STATISTIC	86.62(0.000)	102.6(0.000)	0.85		
DW	2.005	2.189	99.93(0.000)		
SUM OF COEFFICIENTS	-0.624(1.88)	-2.869(1.88)	2.180	-0.360(1.68)*	

**Notes:** The value of t-statistics appears in parenthesis after the coefficient estimate. The sum of coefficients represents the addition of the parametric estimate of the contemporaneous and lagged variables.