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Effects of Monetary Policy on Output Growth and Inflation in Nigeria, 1986– 2020

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Abstract

This study assessed the effects of monetary policy on output growth and inflation rate between 1986 and 2020 in Nigeria. The study employed theoretical perspective of Keynesian Reformulated Quantity Theory of Money. Time series data on Monetary Policy Rate (MPR), Money Supply (M2) and Gross Fixed Capital Formation were obtained. The data were analysed using the Vector Error Correction Models. The study found that while monetary policy tools such as MPR and M2 have insignificant impact on inflation in the long run, their impacts were significant on real output growth. This suggests that inflationary pressure in Nigeria is not monetary driven in the long run. In terms of the short run, the study found that real output growth responds negatively to inflation rate, but positively to M2 and Monetary Policy Rate (MPR). Other findings from the study include (i) expansionary monetary policy characterised by lowering MPR and rising M2, fuels inflation in the short run, and this hurts real output growth, and (ii) MPR is driven by the lag values of real output growth, inflation rate, and money supply. For an effective monetary policy, the study suggests that efforts should be geared towards expanding financial inclusion and investment in Nigeria. The study also suggests the need for proper management of macroeconomic environment so as to stabilize inflation given that unstable macroeconomic environment also impacts negatively on real output growth.

Keywords: effects, inflation rate, monetary policy, Nigeria, output growth
JEL: E52

Introduction

In most countries of the world; be it in developed or developing economies, the attainment of a high level of economic growth has always been seen as the principal macroeconomic policy objective. Consequently, economic planners most especially those in developing countries have made series of painstaking efforts to formulate and implement policy with a view to achieving high level of economic growth. Conceptually, economic growth is the process by which a nation's wealth increases over time. It can best be described as a process of transformation and it is conventionally measured as the percentage increase in real Gross Domestic product (RGDP). Thus, for an economy to grow, it has to create the right conditions for growth (Levine & Zervos, 2006). Growth depends to a significant extent on the resources a country has. Apart from the resource endowment, growth is also a function of macroeconomic policy, technological progress, savings and the quality of human capital (Jhingan, 2006).

In developing countries such as Nigeria, maintenance of stability in the domestic level of prices and exchange rates is an important condition of economic growth (Ghatak and Sánchez-Fung, 2007; Uchendu, 2009). In Nigeria, however, the quest for economic development leads to inflationary pressures due to a variety of structural rigidities and imbalances (Uchendu, 2009). The inflationary increase in prices has been acknowledged to have adverse effects on the propensity to save and diverts investible resources into speculative and unproductive investments. Consequently, the monetary authority in Nigeria, just like those in other developing countries, is thus saddled with the responsibility of regulating the supply and direction of money and credit with the overall aim of maintaining price stability.

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The emphasis given to price stability in conduct of monetary policy is with a view to promoting sustainable growth and development as well as strengthening the purchasing power of the domestic currency of a nation (Okpanachi, 2008). Theory and empirical evidence in the literature suggest that sustainable long term growth is associated with lower price levels. To Mallick (2008) high inflation is damaging to long-run economic performance and welfare. Various channels of transmission of monetary changes have been distinguished in the literature. Their common feature is that policy-induced changes in the money supply lead to price, quantity and valuation effects of assets and liabilities which in turn affect investment spending and demand. It is against this backdrop this paper is designed to investigate the effect of monetary policy on output growth and inflation rate in Nigeria.

The paper is structured as follows. After the introductory section, the second section reviews some theoretical and empirical literature on the subject. The third section presents the research methods while the fourth presents and analyses annual series of monetary policy, growth proxies and inflation rate. The final section concludes and provides recommendations.

Research Objective

The main objective of this paper is to investigate the effect of monetary policy on inflation and output growth in Nigeria. Specifically, the study:

i. investigates the extent to which monetary policy proxied by money supply and monetary policy rate impact on output growth in Nigeria;

ii. Examines the impact of monetary policy proxied by money supply and monetary policy rate on inflation rate in the country

Review of Related Literature

This section involves two basic components; the review of relevant theories and subsequent empirical studies.

Theoretical Literature

Keynesian Reformulated Quantity Theory of Money

Monetary theory has evolved overtime. The evolution has drawn the attention of many researches with different views on the role and dimensions of money in attaining macro- economic objectives. Consequently, a number of scholars have investigated the relationship between monetary policy and other economic aggregates such as inflation and output. It is pertinent to state that each school of thought has its strength and weaknesses with different ideological, theoretical and empirical conclusions. The schools of thought include the Classical Monetary Theory and Keynesian Theory. The classical theories have two variants/approaches namely Transaction Approach (an approach that examines the link between the total quantity of money M and the total amount of spending on final goods and services produced in the economy) and the Cash Balances Approach also known as Cambridge Equation (an approach that emphasises that the value of money is determined by supply and demand of money).

This study is anchored on the Keynesian theory. Prior to the publication of Keynes's General Theory, the classical economists like Jean Baptist Say, Adam Smith, David Ricardo, Pigou and others were of the view that the economy automatically moves towards full employment through the workings of the price mechanism. Through the quantity theory of money, the classical economists attempt to show how money affects the economy using equation of exchange. In this equation of exchange, Fisher (1892) examined the link between the total quantity of money M and the total amount of spending on final goods and services produced in the economy P*Y, where P is the price level and

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Y is aggregate output, V is the velocity of money. The equation of exchange thus states that the quantity of money is the main determinant of the price level or the value of money. Any change in the quantity of money produces an exactly proportionate change in the price level. This means that when M changes, nominal income P*Y changes in the same direction.

However, Keynes, in his General Theory attacked the classical quantity theory for separating monetary theory from value theory. He then, presented a reformulated quantity theory of money which brought about a transition from a monetary theory of prices to a monetary theory of output (Jhingan, 2006). In this regard, Keynes integrated monetary theory with value theory and also linked the theory of interest into monetary theory. He disagrees with the older quantity theorists that there is a direct and proportional relationship between quantity of money and prices. According to Keynes, the effect of a change in the quantity of money on prices is indirect and non-proportional.

The Keynesian reformulated model assumes a closed economy and a perfect competitive market with fairly price-interest aggregate supply function. The economy is also assumed not to exist at employment equilibrium and also that it works only in the short run. Given these assumptions, the Keynesian chain of causation between changes in the quantity of money and in prices is an indirect one through the rate of interest. From the Keynesian mechanism, monetary policy works by influencing interest rate which influences investment decisions and consequently, output and income via the multiplier process. Thus, the Keynesian theory is a rejection of Say's Law and the notion that the economy is self-regulating.

The theory is rooted on one notion of price rigidity and possibility of an economy setting a less than full employment level of output, income and employment. The Keynesian macro economy brought into focus the issue of output rather than prices as being responsible for changing economic conditions. In other words, it was not interested in the quantity theory *per se*. In general, the Keynesian theory proposed that money and hence monetary policy has indirect effect on other economic variables by influencing the interest rate which affects investment and cash holding of economic agents. The position of Keynes is that unemployment arises from inadequate aggregate demand which can be increased by an increase in money supply which generates increased spending, increased employment and economic growth. In essence, the theory suggests that an increase in money supply can reduce unemployment but can also create inflation and so the monetary authorities should increase money supply with caution.

According to Dickens (2011), Keynes's theory of monetary policy is composed of three concepts—namely, the investment multiplier, the marginal efficiency of capital and the interest rate. Keynes avers that when the quantity of money increases, its first impact is on the rate of interest which tends to fall. Given the marginal efficiency of capital, a fall in the rate of interest will increase the volume of investment. The increased investment will raise effective demand through the investment multiplier effect thereby increasing income, output and employment (Jhingan, 2006 and Dickens 201). Jhingan (2006) noted that since the supply curve of factors of production is perfectly elastic in a situation of unemployment, wage and non-wage factors are available at constant rate of remuneration. There being constant returns to scale, prices do not rise with the increase in output so long as there is any unemployment. Under the circumstances, output and employment will increase in the same proportion as the effective demand, and the effective demand will increase in the same proportion as the quantity of money. However, Keynes as cited in Jhingan (2006:275) posits that:

once full employment is reached, output ceases to respond at all to changes in the supply of money and so in effective demand. The elasticity of supply of output in response to changes in the supply, which was infinite as long as there was unemployment falls to zero. The entire effect of changes in the supply of money is exerted on prices, which rise in exact proportion with the increase in effective demand.

Thus, so long as there is unemployment, output will change in the same proportion as the quantity of money, and there will be no change in prices; and when there is full employment, price will change in the same proportion as the quantity of money. Therefore, the Keynesian reformulated quantity theory of money suggests that with increase in the quantity of money, prices rise only when the level of full employment is reached and not before this. In the light of this, the goal of the monetary authority should be to use its influence over the interest rate to dislodge the economy from its long-period equilibrium position that is characterized by unemployment and propel it towards a long-period equilibrium position that is characterized by full employment.

Empirical Studies

A number of empirical works on the impact of monetary policy on economic growth have been developed over the years. Evidence from advanced economies abounds that monetary policy plays important role in economic growth. However, in developing countries like African countries, there is a paucity of knowledge on the nexus between monetary policy and economic growth. This, according to Ncube (1996) was due to the fact that Central Banks in developing countries are still trying to grapple with the intricacies of their functions with budding financial system on hand, and with emphasis on price stability as the sole monetary policy objective on the other hand.

Ming-Yua (2009) examined asymmetric effects of monetary and government spending policies on economic growth in Taiwan using quartile regression. Macroeconomic data for G7 countries during 1959-2005 were collated. A key feature of this study is analysis of the changing distribution of real GDP across countries and over time by quantile regression (QR) model and comparison of the results with OLS and LAD estimates. The empirical results of this model differ from those obtained by OLS and LAD estimates since the QR method processes more information from the sample distribution. The nonlinearities derived from conditional QR revealed considerable differences, including differences in sign and in the magnitude of the two government policies on real output across various business cycle stages.

Cecchetti and Kharroubi (2012) investigated the impact of the size and scope of the financial sector on economic growth in developed OECD countries between 1980 and 2009. The study employed econometric model. The study found that the relationship between the size of the financial sector and the growth of GDP shows the typical form of reverse (convex) U-curve, meaning that GDP rises to a certain extent with the growth of financial sector, but after certain limit (as in the case of the Laffer curve), oversized financial sector begins to “choke” economy and becomes an obstacle that slows the economic growth.

In a similar way, Starr (2005) used the Granger causality test to investigate the relationships between monetary-policy variables and both output and prices in the post-stabilization period, in four core CIS countries (Russia, Ukraine, Kazakhstan and Belarus) using quarterly data from 1995 to 2003. Results of the study provide little evidence of real effects of monetary policy in the four core CIS countries with the notable exception that interest rates have a

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significant impact on output in Russia. The findings complement the study of Uhlig (2005) whose findings show that contractionary monetary policy shocks have no clear effect on real GDP in the United States.

The research finding of Starr (2005) was also corroborated by those of Rafiq and Mallick (2008) who examined the effects of monetary policy on output in the three largest euro area economies (Germany, France and Italy) using the new VAR identification procedure. Quarterly observations from 1981- 2005 were used. Results suggest that monetary policy innovations are at their most potent only in Germany. Apart from Germany, it remains ambiguous as to whether a rise in interest rates concludes with a fall in output, thereby showing a lack of homogeneity in the responses. Furthermore, Berument and Dincer (2008) measured the effects of monetary policy for Turkey through structural VAR (SVAR) technique covering the period 1986-2000. Empirical results show that a tight monetary policy has a temporary effect on output, causing output to decline for three months in a statistically significant fashion.

Clausena and Hayo (2006) went further to investigate the asymmetric monetary transmission in Europe. The study employed a semi-structural modelling approach. the study found that the nature and the degree of asymmetry in the effects of monetary policy across the largest EMU countries depend heavily on the time horizon of the analysis.

Like the work of Berument and Dincer (2008), Bhuiyan (2008) examined the effects of monetary policy shock in Canada by using the overnight target rate as the monetary policy instrument using monthly data from 1994-2007. The study employed a semi-structural modelling approach and found that the transmission of the monetary policy shock to real output operates through both the interest rate and the exchange rate. Using money supply as a measure of monetary policy, Nouri and Samimi (2011) examined the impact of monetary policy on economic growth in Iran adopting ordinary least squares (OLS) technique and data covering the period 1974- 2008. A positive and significant relationship between money supply and economic growth was established in the study.

In contrast to earlier findings, Dakurah, Davies and Sampath (2001) employed cointegration and error correction models to study the causal relationship between the military burden and economic growth for 62 countries and found no common causal relationship between military spending and growth among these countries. Abu-Bader and Abu-Qarn (2003) used multivariate cointegration and variance decomposition techniques to investigate the causal relationship between government expenditure and economic growth for Egypt, Israel, and Syria, for the past three decades. They find that the military burden negatively affects economic growth for all the countries, and that civilian government expenditure cause positive economic growth in Israel and Egypt.

Applying a standard macro-model, Ibrahim and Andreas (2008) investigated the effect of Federal Reserve money supply policy between1969–2000. The study found that Federal Reserve's money supply had responded to changes in expected inflation and the output gap during the past four decades. Estimates of forward-looking money supply reaction functions reveal that money supply has always responded negatively to a widening output gap. Conversely, money supply responses to changes in expected inflation exhibit considerable differences between the pre-Volcker and Volcker–Greenspan era.

Edgar and Robert (2013) examined the impact of financial market development on the level of economic development in developing countries. The study employed the framework of Schreft and Smith (1998) model with an overlapping generation model with spatial separation and fiat money. The study found that the effects of monetary policy vary across the level of financial development. In economies with small stock markets, increasing the amount of liquidity will cause capital accumulation to decline. By comparison, in advanced economies, capital accumulation improves.

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Zhang and Liang (2007) investigated the determinants of swap spreads in the U.S. interest rate market using monthly data of 2-, 5-, 7-, 10-year maturity from June 30, 1998 to March 31, 2007. The study employed a multivariate Generalized Autoregressive Conditionally Heteroscedastic (GARCH) model with Error Corrections Terms (ECM). The study found that the movement of interest rate swap spread was negatively related to changes in the slope of yield curve of treasury securities which were consistent with their hypothesis. They also found out that changes in the IR swap spread would be related positively to changes in the implied stock market volatility; but they disproved their hypothesis that the changes in the swap spread would be related positively to changes in the default premium in corporate bond market. They however, found that swap spreads in the U.S. market showed negatively strong correlation with default premium with z-statistics of 2.01 or better. They also concluded that changes in the interest rate swap spread would be related negatively to the changes in the business cycle.

Abu-Bader and Abu-Qarn (2005) examined the relationship between financial development and economic growth in Egypt using annual data from 1960 to 2001. The data were analysed using VAR methodology on four variables namely: Gross Domestic Product to measure economic growth and ratio of money stock to nominal GDP, ratio of bank credit to the private sector to nominal GDP, ratio of credit issued to non-financial private firms to total domestic credit, representing proxies for financial development. Their findings show that the rise in private investment was facilitated by the financial liberalization in 1990 which led to the rebound in economic performance of Egypt in the 1990s. Their results infer that there is a direct linkage between financial development and financial liberalization.

Khabo (2002) evaluated the impact of monetary policy on a small and open economy in the case of South Africa for the period 1960-1997. He used M3 to measure monetary policy. The ordinary least square (OLS) method was employed, as well as the Augmented Dickey Fuller test to check for stationarity. Results of the study indicate that economic growth is significantly influenced by money supply.

In elevating this approach, Dele (2007) employed the geneneralized least squares (GLS) method in his study of monetary policy and economic performance of West African Monetary Zone Countries (Gambia, Ghana, Guinea, Nigeria and Sierra Leone) from 1991-2004. Using the variables money supply (M2), Minimum Rediscount Rate, banking system credit to private sector, banking system credit to central Government and exchange rate of the national currency to the US dollar, findings of the study indicate that monetary policy was a source of stagnation as it hurt real domestic output of these countries.

In contrast to the findings of Dele (2007) and Corazon (2014), Fasanya et al (2013) examined the impact of monetary policy on economic growth using time series data covering the period 1975-2010.The effects of stochastic shocks of each of the endogenous variables were explored using Error Correction Model (ECM). Findings of the study reveal a long run relationship among the variables. Also, the core finding of the study shows that inflation rate, exchange rate and external reserve are significant monetary policy instruments that drive growth in Nigeria.

A study by Chimobi and Uche (2010) examined the relationship between Money, Inflation and Output in Nigeria. The study adopted co-integration and granger-causality test analysis. The co-integrating result of the study showed that the variables used in the model exhibited no long run relationship among each other. Nevertheless, money supply was seen to granger cause both output and inflation. The result of the study suggested that monetary stability can contribute towards price stability in the Nigerian economy since the variation in price level is mainly caused by money supply and concluded that inflation in Nigeria is to an extent a monetary phenomenon.

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Adefeso and Mobolaji (2010) estimated the relative effectiveness of fiscal and monetary policy on economic growth in Nigeria using annual data from 1970-2007. The study employed the Error Correction Mechanism and Cointegration technique. The empirical result showed that the effect of monetary policy is stronger than fiscal policy and the exclusion of the degree of openness did not weaken this conclusion.

Amassoma et al. (2011) examined the effect of monetary policy on economic growth in Nigeria for the period 1986 to 2009 by adopting a simplified Ordinary Least Squared technique found that that money supply had a significant effect on economic growth while interest rate and exchange rate were observed to have positive but insignificant influence on economic growth. Onyeiwu (2012) examined the impact of monetary policy on the Nigerian economy using the Ordinary Least Squares Method (OLS) to analyse data between 1981 and 2008. The result of the analysis shows that monetary policy presented by money supply exerts a positive impact on GDP growth and Balance of Payment but negative impact on rate of inflation. Furthermore, the findings of the study support the money-prices-output hypothesis for Nigerian economy. Obviously, the empirical studies on monetary policy and real output growth in Nigeria is still scanty.

Research Methodology

The study is centred on examining the impact of monetary policy on inflation and output growth in Nigeria between 1986 and 2020. The data required include the real Gross Domestic Product (GDP) growth rate –a proxy for output growth, inflation rate proxied by headline inflation, and monetary policy instruments such as monetary policy rate (MPR) and broad money supply (M2). These data were collated from Annual Abstract of the National Bureau of Statistics and the Central Bank of Nigeria Statistical Bulletin.

Both descriptive and multivariate statistical tools were employed. The descriptive technique was used to describe the data background and patterns of movement. The study employs a system of restricted Vector Autoregressive Model (Vector Error Correction Model (VECM)) to investigate the extent to which the variables are related. The choice of the VEC model is informed by the possible issue of endogeneity (specification error), and the need to separate long run relationships from short run dynamics (Engle & Granger, 1987).

The VECM specifications employed in this study are presented in four (4) endogenous variables as stated below.

$$\Delta(rGrowth) = a_0 + a_1 \mathrm{rGrowth}\phi_{t-1} + \sum_{i=1}^{q1} a_{2i}\, \Delta(\mathrm{rGrowth}_{t-i}) + \sum_{i=1}^{r1} \psi_{1i}\, \Delta(\mathrm{Inflation}_{t-i}) + \sum_{i=1}^{z1} \Upsilon_{1i}\, \Delta(\mathrm{MPR}_{t-i}) + \sum_{i=1}^{j1} \Theta_{1i}\, \Delta(\mathrm{M2}_{t-i}) + \varepsilon_{1t} \quad .... \quad (1)$$

$$\Delta(\mathrm{Inflation}) = \psi_0 + \psi_1 \mathrm{Inflation}\psi_{t-1} + \sum_{i=1}^{q2} a_{3i}\, \Delta(\mathrm{rGrowth}_{t-i}) + \sum_{i=1}^{z2} \Upsilon_{2i}\, \Delta(\mathrm{MPR}_{t-i}) + \sum_{i=1}^{j2} \Theta_{2i}\, \Delta(\mathrm{M2}_{t-i}) + \varepsilon_{2t} \quad .... \quad (2)$$

$$\Delta(MPR) = \Upsilon_0 + \Upsilon_1 \mathrm{MPR}\phi_{t-1} + \sum_{i=1}^{q3} a_{3i}\, \Delta(\mathrm{rGrowth}_{t-i}) + \sum_{i=1}^{r3} \psi_{3i}\, \Delta(\mathrm{Inflation}_{t-i}) + \sum_{i=1}^{j3} \Theta_{3i}\, \Delta(\mathrm{M2}_{t-i}) + \varepsilon_{3t} \quad .... \quad (3)$$

$$\Delta(M2) = \eta_0 + \eta_1 M2\phi_{t-1} + \sum_{i=1}^{q4} a_{4i}\,\Delta(\text{rGrowth}_{t-i}) + \sum_{i=1}^{r4} \psi_{4i}\,\Delta(\text{Inflation}_{t-i}) + \sum_{i=1}^{j4} \Theta_{4i}\,\Delta(\text{MPR}_{t-i}) + \varepsilon_{4t} \quad \ldots. \quad (4)$$

Where

rGrowth = real gross domestic product growth rate (a proxy for output growth),

Inflation = Inflation rate

M2 = broad money supply (a proxy for monetary policy)

MPR = Monetary policy rate

From equation one through four, the variables in the left-hand side of each equation are expressed in their first difference, while those on the right-hand side an optimum lagged difference of the four variables and one period lagged error term (ECM) of the co-integrating equation. a_0 ... Θ_0 are the intercepts while the disturbance terms are denoted by ε_{1t} to ε_{4t}

The study also employed the Augmented Dickey-Fuller (ADF) test for stationarity as well as cointegration test.

Results and Discussion

To empirically establish the effect of monetary policy on inflation and output growth between 1986 and 2020 in Nigeria, the VEC models specified in the previous section were estimated using Eviews 9.0. Before the estimation, the study performed some descriptive analyses which are presented in Table 1 and Figure 1.

Descriptive Statistics

Table 1. Summary Statistics

	INFLATION	M2	MPR	RGDP_GROWTH
Mean	19.77234	8436.000	13.72857	0.045117
Median	12.00000	1985.192	13.50000	0.042100
Maximum	76.75887	35044.31	26.00000	0.146000
Minimum	0.223606	27.38980	6.000000	-0.043000
Std. Dev.	18.45628	11120.99	3.785310	0.040328
Skewness	1.763085	1.161022	0.756916	0.259718
Kurtosis	4.947486	3.000180	5.038268	2.903113
Jarque-Bera	23.66376	7.863173	9.400743	0.407167
Probability	0.000007	0.019613	0.009092	0.815802
Observations	35	35	35	35

Source: Author's computation from Appendix I

Table 1 contains summary statistics for variables used in the study. Generally, the results presented in the table show that data on all the study variables (except real output growth) are not normally distributed as evidenced by the probability values of the Jarque-Bera statistics which are substantially lower than the cutoff value of 0.05. A closer analysis of this statistics shows that the mean headline inflation between 1986 and 2020 is 19.77%, with a maximum of 76.76% recorded in 1994, and a minimum of 0.22% recorded in 1999.

Concerning monetary policy instruments, the study reveals that broad money stock and MPR averaged N8436.000 billion and 13.73% respectively. Their values range between minimum of N27.38980 billion and 6.0% and maximum of N35044.31 billion and 26% respectively. Additionally, the table shows that the average real output growth was about 0.045%, ranging from -0.043% to 0.15%.

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The trends of inflation, MPR, M2, and real GDP growth rate are cast in Figure 1 below:

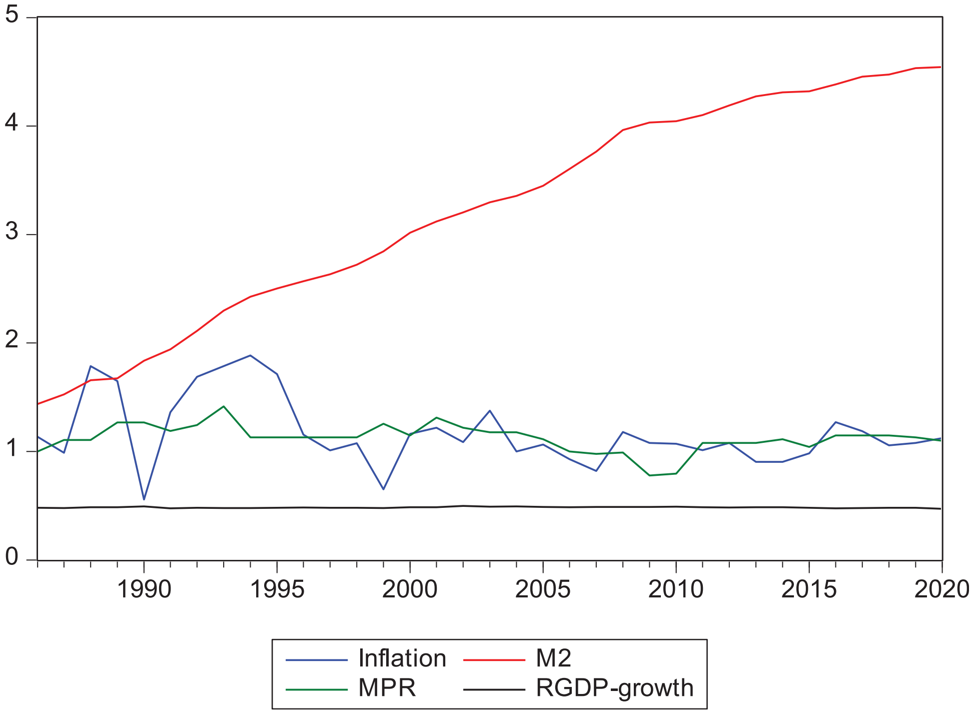

Figure 1. Trends of Study Variables

The pattern of the movement of the study variables are cast in a set of graph in Figure 1. As shown in the figure and Appendix I, all the variables (except real growth) understudy fluctuated but generally followed an upward trend.

Estimated Results

Lag Length Selection

The estimation of the VECM models specified in the preceding section involves three steps. First, we select the optimum lag length to run the specified models. This is presented in Table 2.

Table 2. Optimum Lag Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	131.7010	NA	5.12e-09	-7.739454	-7.558059	-7.678420
1	273.1470	240.0296*	2.58e-12*	-15.34224*	-14.43527*	-15.03707*
2	288.7972	22.76386	2.76e-12	-15.32104	-13.68849	-14.77174

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

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The decision of optimum lag length is based on 5 criteria (Sequential modified LR test statistic, Final prediction error, Akaike information criterion, Schwarz information criterion and Hannan-Quinn information criterion). Irrespective of the criterion, the decision of the optimum number of lags in a model is informed by the lowest statistics. As shown in the table, all the criteria selected maximum lag of 1. Therefore, the highest lag that will be employed in both the Johansen and VECM models is 1.

The second step involves test of cointegration using Johansen procedure. The Johansen test of cointegration is based on preconditions. One, the variables must be non-stationary at level but when we convert them into first difference, they should be stationary. Second, all the variables must be integrated of same order (that is at first difference). Consequently, the times series properties of the variables were investigated using the Augmented Dickey Fuller (ADF) so as to confirm their order of integration. The results are presented in Table 3.

Unit Root (Stationarity) Test

Table 3. Stationarity Test

Variable	ADF Statistics	Probability Value	Order of Integration
D(Inflation)	-8.472724	0.0000	1
D(MPR)	-7.147878	0.0000	1
D(M2)	-3.365405	0.0197	1
D(rGDP growth)	-7.429742	0.0000	1

Source: Extracted from Appendix III

Results in Table 3 suggest that all the variables in the study are non-stationary at level. However, after they are transformed into first difference, they became stationary, that is they are integrated at order one. Following this result, we proceed to estimate the long run cointegration using the Johansen procedure. The results from the Johansen test are presented in Table 4.

Cointegration Test

Table 4. Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.607250	60.52945	47.85613	0.0021
At most 1 *	0.383539	30.62279	29.79707	0.0401
At most 2	0.339935	15.14249	15.49471	0.0564
At most 3	0.056148	1.849135	3.841466	0.1739

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

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Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.607250	29.90665	27.58434	0.0247
At most 1*	0.583539	22.48031	21.13162	0.0367
At most 2	0.339935	13.29335	14.26460	0.0708
At most 3	0.056148	1.849135	3.841466	0.1739

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

In testing for the long run cointegration, the Trace statistic and the Max Eigen statistics are used. The decision rule is that the Trace statistic and/or the Max Eigen statistics should be higher than their corresponding critical values. As shown in the table, both Trace and the Max Eigen value tests show that there are 2 cointegrating equations in the system. This means that the null hypothesis of no cointegrating equation is rejected. In sum, the result suggests that the four variables included in the model have long run association (they are cointegrated).

The long run cointegrating equation is presented in Table 5.

Table 5. Long run Cointegrating Coefficients (standard error in parentheses)

Dependent Variable: real output growth

RGDP_GROWTH	INFLATION(-1)	M2(-1)	MPR(-1)
1.000000	0.019949 (3.41158)	0.009033 (3.73684)	0.056418 (3.00698)

Source: Extracted from Appendix V

Note: the coefficients are interpreted by reversing their signs

The results presented in Table 5 show that all the variables have negative and statistically significant impact on real output growth in the longrun. As shown in the table, a unit change inflation rate, for instance, will result in 0.0199% decrease in real output growth in the longrun. Similarly, a unit increase in money supply and MPR would lead to 0.01% and 0.057% decreases in real output growth in the longrun.

Estimated Vector Error Correction Mechanism

The third step is the estimation of VECM. The vector error correction model is designed to capture the short-run deviations that might have occurred in estimating the long-run co-integrating equations. It is designed for use with nonstationary series that are known to be cointegrated. The VEC specification restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships. Both the short-run non-causality test and the long-run causality test were conducted. The VECM in this study is estimated using optimum lag of 1 as indicated in Table 2. This is presented in Table 6.

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Table 6. Estimated VECM

Dependent Variable	$\boldsymbol{\phi_{t-1}}$	$\sum_{i=1}^{q1} \boldsymbol{a_{2i}\,\Delta(\mathrm{rGDP}_{t-i})}$	$\sum_{i=1}^{r1} \boldsymbol{\psi_{1i}\,\Delta(\mathrm{Inflation}_{t-i})}$	$\sum_{i=1}^{k1} \eta_{1i}\,\boldsymbol{\Delta(\mathrm{M2}_{t-i})}$	$\sum_{i=1}^{z1} \Upsilon_{1i}\,\boldsymbol{\Delta(\mathrm{MPR}_{t-i})}$	**R-Square**	**Eqn**
Δ(RGDP_GROWTH)	-0.132949 (0.0204)	-0.227052 [-1.19178]	-0.002997 [-1.53894]	0.004199 [0.22319]	- 0.012811 [-1.45337]	0.426037	5
Δ(Inflation)	-15.94211 (0.0756)	-2.259673 [-0.12554]	-0.309338 [-1.68137]	2.847463 [1.60218]	-0.180719 [-0.21700]	0.538881	6
$\Delta(M2)$	-0.945489 (0.2593)	-2.850589 [-1.68818]	-0.008562 [-0.49606]	0.493404 [2.95937]	0.090461 [1.15787]	0.374848	7
Δ(MPR)	-5.295130 (0.0003)	7.271021 [2.56327]	0.132039 [4.55397]	-1.072556 [-3.82941]	-0.082591 [-0.62928]	0.566598	8

( ) = p-values, [ ] = standard errors
Source: Extracted from Appendix V

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Table 6 contains the estimated VECM for real output growth, inflation, broad money supply (M2), and monetary policy rate (MPR) models specified in the preceding section. The models (1 through 4) are labeled 5 through 8 for easy exposition. The cointegration term also known as the error correction term is denoted by $\boldsymbol{\phi_{t-1}}$. It represents speed of adjustment to the long-term equilibrium. In principle, the speed of adjustment parameters should be negative and lie between (0, -1). When these two conditions are satisfied, then we can conclude that there is long-run causality running from the independent variables to the dependent variable. It also suggests that the model has the tendency of correcting its previous disequilibrium since any short-term deviation will converge to the long-run equilibrium.

As shown in the table, the ECM coefficient in real output growth model (equation 5) is negative (-0.132949) and significant at 5%. The negative and significant coefficient suggests that the output growth model tends to converge to its long-term equilibrium. This means that there is a long-run causality from one lagged period of inflation rate, M2, and MPR. In the case of short-run causality, the results in the table reveal that the model has negative response to its pass level, negative response to lag value of inflation rate but positive responses to lag values of M2 and MPR. Though, these responses are not significant as evidenced by the t-statistics which are substantially lower than 2.

Result in equation 6, however, suggests that there is no long-run causality between inflation and all other variables included in the model. In terms of short-run causality, the equation indicates though, inflation rate responds negatively to its past value, lag values of real output growth and MPR on one hand, and positively to money supply on the other hand, these responses are not very significant.

Similarly, equation 7 (money supply model) reveals that there is no long-run causality between money supply and all other variables included in the mode. Also, the short-run test reveals no causality between the dependent variable and all other variables except its pass level.

Finally, equation 8 suggests that there is a short-run causality running from lag real output growth, inflation rate, and money supply to MPR. However, no long run causality exists between MPR and all other variables in the model.

As shown in Appendix VI, the residuals for the models follow a normal distribution, and the statistics for the standardised residuals are insignificant, indicating that serial correlation (autocorrelation) is not evident. The relatively low R-squared values also suggest that the models are not highly fit.

Conclusion and Recommendations

This study has empirically assessed the effects of monetary policy on output growth and inflation between 1986 and 2020 in Nigeria. Following the analysis of data, the study concludes that the impact of monetary policy on inflation and output growth vary, depending on the monetary policy tools applied and the period (whether short-run or long-run) covered. In the long-run, the study concludes that while monetary policy tools such as MPR and M2 have insignificant impact on inflation, their impacts were significant on real output growth. This suggests that inflationary pressure in Nigerian is not monetary driven in the long-run. This is consistent with the observations of Baldini, Benes, Berg, Dao & Portillo (2012) and Chipote, & Makhetha-Kosi (2014) who noted that inflation in Nigeria is driven by declining productivity amidst rising population, deficit financing, and exchange rate pass-through.

In terms of the short-run, the study found that real output growth in Nigeria responds negatively to inflation rate, but positively to M2 and MPR. Just as with the long-run, the negative link between real output growth and inflation rate in the short-run is consistent with the theoretical postulation of the monetarist and supported by early research efforts such as Fischer (1993), Bruno & Easterly (1998), and Akinlo (2005). These authors, in their separate studies argue that high inflation rate is detrimental to growth as it adversely affects the volume of production through rising costs of inputs.

Other short-run conclusions drawn from the study include that expansionary monetary policy positively but insignificantly influences growth rate of the Nigerian economy, while fuelling inflationary pressure, and MPR is driven by the lag values of real output growth, inflation rate, and money supply.

In view of the above and in order to enhance the effectiveness of monetary policy, particularly in the shortrun, the study suggests the need for expanding financial inclusiveness in Nigeria. The study also suggests the need for proper management of macroeconomic environment so as to stabilize inflation given that unstable macroeconomic environment also impact negatively on real output growth.

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Appendix I: Descriptive Statistics

Year	Inflation	MPR	RGDP growth	M2
1986	13.67347	10.00	1.90%	27.3898
1987	9.694794	12.75	0.17%	33.6674
1988	61.21113	12.75	6.23%	45.4469
1989	44.67005	18.50	6.66%	47.055
1990	3.614035	18.50	11.63%	68.6625
1991	22.9597	15.50	-0.55%	87.4998
1992	48.80198	17.50	2.19%	129.08547
1993	61.26226	26.00	1.57%	198.4792
1994	76.75887	13.50	0.26%	266.94489
1995	51.59132	13.50	1.87%	318.76347
1996	14.31428	13.50	4.05%	370.33353
1997	10.21333	13.50	2.89%	429.73133
1998	11.91292	13.50	2.50%	525.6378
1999	0.223606	18.00	0.52%	699.7337
2000	14.5	14.00	5.52%	1036.0795
2001	16.5	20.50	6.67%	1315.8691
2002	12.2	16.50	14.60%	1599.4946
2003	23.8	15.00	9.50%	1985.1918
2004	10	15.00	10.44%	2263.5879
2005	11.6	13.00	7.01%	2814.8461
2006	8.5	10.00	6.73%	4027.9017
2007	6.6	9.50	7.32%	5809.8265
2008	15.1	9.75	7.20%	9166.8353
2009	12	6.00	8.35%	10780.627
2010	11.8	6.25	9.54%	11,101.46
2011	10.3	12.00	5.31%	12,628.32
2012	12	12.00	4.21%	15,503.41
2013	8	12.00	5.49%	18,743.07
2014	8	13.00	6.22%	20,415.61
2015	9.6	11.00	2.79%	20,885.52

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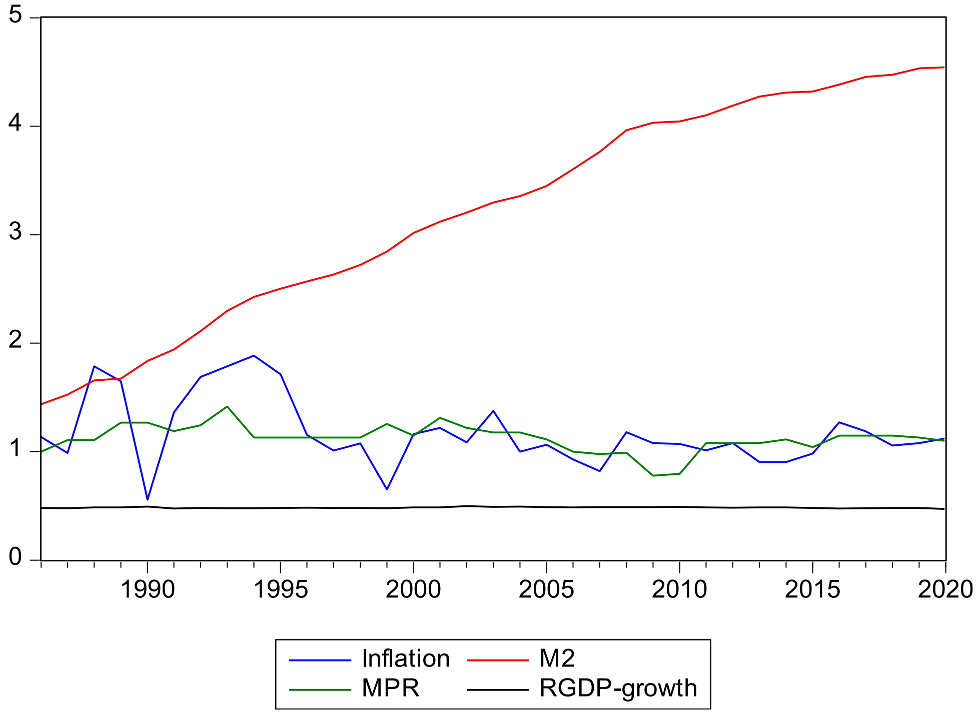
2016	18.6	14.00	-1.58%	24,259.00
2017	15.4	14.00	0.82%	28,604.47
2018	11.4	14.00	1.91%	29,774.43
2019	11.98	13.50	2.27%	34,251.70
2020	13.25	12.50	-4.30%	35,044.31

	INFLATION	M2	MPR	RGDP_GROWTH
Mean	19.77234	8436.000	13.72857	0.045117
Median	12.00000	1985.192	13.50000	0.042100
Maximum	76.75887	35044.31	26.00000	0.146000
Minimum	0.223606	27.38980	6.000000	-0.043000
Std. Dev.	18.45628	11120.99	3.785310	0.040328
Skewness	1.763085	1.161022	0.756916	0.259718
Kurtosis	4.947486	3.000180	5.038268	2.903113
Jarque-Bera	23.66376	7.863173	9.400743	0.407167
Probability	0.000007	0.019613	0.009092	0.815802
Sum	692.0317	295260.0	480.5000	1.579100
Sum Sq. Dev.	11581.57	4.20E+09	487.1714	0.055297
Observations	35	35	35	35



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Appendix II: Lag length Selection

VAR Lag Order Selection Criteria
Endogenous variables: RGDP_GROWTH INF M2
MPR
Exogenous variables: C
Date: 07/11/21 Time: 05:28
Sample: 1986 2020
Included observations: 33

Lag	LogL	LR	FPE	AIC	SC	HQ
0	131.7010	NA	5.12e-09	-7.739454	-7.558059	-7.678420
1	273.1470	240.0296*	2.58e-12*	-15.34224*	-14.43527*	-15.03707*
2	288.7972	22.76386	2.76e-12	-15.32104	-13.68849	-14.77174

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix III: Stationarity Tests

Null Hypothesis: D(INFLATION) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.472724	0.0000
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INFLATION,2)
Method: Least Squares
Date: 07/11/21 Time: 05:57
Sample (adjusted): 1988 2020
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INFLATION(-1))	-1.395752	0.164735	-8.472724	0.0000
C	0.003423	0.089987	0.038037	0.9699

R-squared	0.698406	Mean dependent var	0.005851
Adjusted R-squared	0.688677	S.D. dependent var	0.926462
S.E. of regression	0.516932	Akaike info criterion	1.576882

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Sum squared resid	8.283784	Schwarz criterion	1.667579
Log likelihood	-24.01855	Hannan-Quinn criter.	1.607398
F-statistic	71.78705	Durbin-Watson stat	2.170262
Prob(F-statistic)	0.000000		

Null Hypothesis: D(MPR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.147878	0.0000
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MPR,2)
Method: Least Squares
Date: 07/11/21 Time: 05:19
Sample (adjusted): 1988 2020
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MPR(-1))	-1.232178	0.172384	-7.147878	0.0000
C	0.000656	0.018554	0.035377	0.9720

R-squared	0.622376	Mean dependent var	-0.004210
Adjusted R-squared	0.610194	S.D. dependent var	0.170596
S.E. of regression	0.106511	Akaike info criterion	-1.582450
Sum squared resid	0.351681	Schwarz criterion	-1.491752
Log likelihood	28.11042	Hannan-Quinn criter.	-1.551933
F-statistic	51.09215	Durbin-Watson stat	2.099371
Prob(F-statistic)	0.000000		

Null Hypothesis: D(M2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.365405	0.0197
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

*MacKinnon (1996) one-sided p-values.

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Augmented Dickey-Fuller Test Equation
Dependent Variable: D(M2,2)
Method: Least Squares
Date: 07/11/21 Time: 05:19
Sample (adjusted): 1988 2020
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(M2(-1))	-0.572887	0.170228	-3.365405	0.0021
C	0.051352	0.018153	2.828772	0.0081

R-squared	0.267589	Mean dependent var	-0.002415
Adjusted R-squared	0.243963	S.D. dependent var	0.056950
S.E. of regression	0.049518	Akaike info criterion	-3.114262
Sum squared resid	0.076014	Schwarz criterion	-3.023564
Log likelihood	53.38532	Hannan-Quinn criter.	-3.083745
F-statistic	11.32595	Durbin-Watson stat	1.955601
Prob(F-statistic)	0.002051		

Null Hypothesis: D(RGDP_GROWTH) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.429742	0.0000
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RGDP_GROWTH,2)
Method: Least Squares
Date: 07/11/21 Time: 05:20
Sample (adjusted): 1988 2020
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RGDP_GROWTH(-1))	-1.327840	0.178720	-7.429742	0.0000
C	-0.000192	0.000911	-0.210880	0.8344

R-squared	0.640376	Mean dependent var	-0.000214
Adjusted R-squared	0.628775	S.D. dependent var	0.008589
S.E. of regression	0.005233	Akaike info criterion	-7.608941
Sum squared resid	0.000849	Schwarz criterion	-7.518244
Log likelihood	127.5475	Hannan-Quinn criter.	-7.578424
F-statistic	55.20107	Durbin-Watson stat	1.773216
Prob(F-statistic)	0.000000		

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Appendix IV: Longrun test

Date: 07/11/21 Time: 06:04
Sample (adjusted): 1989 2020
Included observations: 32 after adjustments
Trend assumption: Linear deterministic trend
Series: RGDP_GROWTH INFLATION M2
MPR
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.607250	60.52945	47.85613	0.0021
At most 1 *	0.383539	30.62279	29.79707	0.0401
At most 2	0.339935	15.14249	15.49471	0.0564
At most 3	0.056148	1.849135	3.841466	0.1739

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.607250	29.90665	27.58434	0.0247
At most 1*	0.583539	22.48031	21.13162	0.0367
At most 2	0.339935	13.29335	14.26460	0.0708
At most 3	0.056148	1.849135	3.841466	0.1739

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

RGDP_GROWTH	INFLATION	M2	MPR
-90.19164	-2.505875	-1.606409	-7.785469
52.77220	3.201673	-0.258446	-5.267135
207.9315	-0.455916	-0.384569	6.847300
-126.8574	0.577840	-0.196346	5.186194

Unrestricted Adjustment Coefficients (alpha):

D(RGDP_GROWTH)	0.000965	-0.001338	-0.000881	0.000533
D(INFLATION)	-0.011092	-0.191361	0.014896	-0.069199

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D(M2)	0.010417	-0.002244	0.021063	0.003525
D(MPR)	0.057060	0.006373	0.003847	-0.003787

1 Cointegrating Equation(s): Log likelihood 226.3290

Normalized cointegrating coefficients (standard error in parentheses)

RGDP_GROWTH	INFLATION	M2	MPR
1.000000	0.027784	0.017811	0.086321
	(0.00768)	(0.00315)	(0.02265)

Adjustment coefficients (standard error in parentheses)

D(RGDP_GROWTH)	-0.087016
	(0.06832)
D(INFLATION)	1.000373
	(8.19190)
D(M2)	-0.939557
	(0.77149)
D(MPR)	-5.146374
	(0.96350)

2 Cointegrating Equation(s): Log likelihood 234.0691

Normalized cointegrating coefficients (standard error in parentheses)

RGDP_GROWTH	INFLATION	M2	MPR
1.000000	0.000000	0.036997	0.243575
		(0.00825)	(0.06634)
0.000000	1.000000	-0.690524	-5.659897
		(0.24614)	(1.97876)

Adjustment coefficients (standard error in parentheses)

D(RGDP_GROWTH)	-0.157622	-0.006701
	(0.07333)	(0.00285)
D(INFLATION)	-9.098144	-0.584880
	(8.47977)	(0.32993)
D(M2)	-1.057980	-0.033289
	(0.89245)	(0.03472)
D(MPR)	-4.810071	-0.122583
	(1.10725)	(0.04308)

3 Cointegrating Equation(s): Log likelihood 240.7158

Normalized cointegrating coefficients (standard error in parentheses)

RGDP_GROWTH	INFLATION	M2	MPR
1.000000	0.000000	0.000000	0.039110
			(0.01346)
0.000000	1.000000	0.000000	-1.843631
			(0.81242)
0.000000	0.000000	1.000000	5.526624

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			(1.53470)

Adjustment coefficients (standard error in parentheses)

D(RGDP_GROWTH)	-0.340887	-0.006299	-0.000865
	(0.15733)	(0.00277)	(0.00113)
D(INFLATION)	-6.000762	-0.591671	0.061545
	(18.8699)	(0.33174)	(0.13557)
D(M2)	3.321760	-0.042892	-0.024255
	(1.69056)	(0.02972)	(0.01215)
D(MPR)	-4.010185	-0.124337	-0.094789
	(2.45844)	(0.04322)	(0.01766)

Appendix V: VECM

Vector Error Correction Estimates
Date: 07/15/21 Time: 05:42
Sample (adjusted): 1988 2020
Included observations: 33 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
RGDP_GROWTH(-1)	1.000000
INFLATION(-1)	0.019949
	(0.00585)
	[3.41158]
M2(-1)	0.009033
	(0.00242)
	[3.73684]
MPR(-1)	0.056418
	(0.01876)
	[3.00698]
C	-0.599404

Error Correction:	D(RGDP_GROWTH)	D(INFLATION)	D(M2)	D(MPR)
CointEq1	-0.132949	-15.94211	-0.945489	-5.295130
	(0.04407)	(8.88710)	(0.83371)	(1.40056)
	[-3.01712]	[-1.79385]	[-1.13407]	[-3.78073]
D(RGDP_GROWTH(-1))	-0.227052	-2.259673	-2.850589	7.271021
	(0.19051)	(17.9995)	(1.68856)	(2.83662)
	[-1.19178]	[-0.12554]	[-1.68818]	[2.56327]
D(INFLATION(-1))	-0.002997	-0.309338	-0.008562	0.132039
	(0.00195)	(0.18398)	(0.01726)	(0.02899)
	[-1.53894]	[-1.68137]	[-0.49606]	[4.55397]

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D(M2(-1))	0.004199	2.847463	0.493404	-1.072556
	(0.01881)	(1.77724)	(0.16673)	(0.28008)
	[0.22319]	[1.60218]	[2.95937]	[-3.82941]
D(MPR(-1))	- 0.012811	-0.180719	0.090461	-0.082591
	(0.00881)	(0.83281)	(0.07813)	(0.13125)
	[-1.45337]	[-0.21700]	[1.15787]	[-0.62928]
C	-0.000633	-0.264342	0.044804	0.100839
	(0.00198)	(0.18747)	(0.01759)	(0.02954)
	[-0.31911]	[-1.41004]	[2.54754]	[3.41312]
R-squared	0.426037	0.538881	0.374848	0.566598
Adj. R-squared	0.082710	0.216451	0.259079	0.486338
Sum sq. resids	0.000728	6.496152	0.057170	0.161339
S.E. equation	0.005192	0.490508	0.046015	0.077301
F-statistic	1.577076	2.767967	3.237900	7.059554
Log likelihood	130.0886	-20.00756	58.08581	40.96754
Akaike AIC	-7.520521	1.576216	-3.156716	-2.119245
Schwarz SC	-7.248429	1.848308	-2.884623	-1.847152
Mean dependent	-0.000197	0.004111	0.091437	-0.000261
S.D. dependent	0.005421	0.554132	0.053459	0.107857

Determinant resid covariance (dof adj.)	6.70E-11
Determinant resid covariance	3.00E-11
Log likelihood	212.4731
Akaike information criterion	-11.18019
Schwarz criterion	-9.910424

D(RGDP_GROWTH) = C(1)*(RGDP_GROWTH(-1) + 0.0199487643423*INFLATION(-1) + 0.00903270074874*M2(-1) + 0.0564183803931*MPR(-1) - 0.599404390421) + C(2)*D(RGDP_GROWTH(-1)) + C(3)*D(INFLATION(-1)) + C(4)*D(M2(-1)) + C(5)*D(MPR(-1)) + C(6)

D(INFLATION) = C(7)*(RGDP_GROWTH(-1) + 0.0199487643423*INFLATION(-1) + 0.00903270074874*M2(-1) + 0.0564183803931*MPR(-1) - 0.599404390421) + C(8)*D(RGDP_GROWTH(-1)) + C(9)*D(INFLATION(-1)) + C(10)*D(M2(-1)) + C(11)*D(MPR(-1)) + C(12)

D(M2) = C(13)*(RGDP_GROWTH(-1) + 0.0199487643423*INFLATION(-1) + 0.00903270074874*M2(-1) + 0.0564183803931*MPR(-1) - 0.599404390421) + C(14)*D(RGDP_GROWTH(-1)) + C(15)*D(INFLATION(-1)) + C(16)*D(M2(-1)) + C(17)*D(MPR(-1)) + C(18)

D(MPR) = C(19)*(RGDP_GROWTH(-1) + 0.0199487643423*INFLATION(-1) + 0.00903270074874*M2(-1) + 0.0564183803931*MPR(-1) - 0.599404390421) + C(20)*D(RGDP_GROWTH(-1)) + C(21)*D(INFLATION(-1)) + C(22)*D(M2(-1)) + C(23)*D(MPR(-1)) + C(24)

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Appendix VI: OLS

System: UNTITLED
Estimation Method: Least Squares
Date: 07/15/21 Time: 05:44
Sample: 1988 2020
Included observations: 33
Total system (balanced) observations 132

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.132949	0.044065	-3.017117	0.0204
C(2)	-0.227052	0.190515	-1.191782	0.2360
C(3)	-0.002997	0.001947	-1.538940	0.1267
C(4)	0.004199	0.018811	0.223193	0.8238
C(5)	0.012811	0.008815	1.453368	0.1490
C(6)	-0.000633	0.001984	-0.319114	0.7503
C(7)	-15.94211	8.887105	-1.793848	0.0756
C(8)	-2.259673	17.99948	-0.125541	0.9003
C(9)	-0.309338	0.183980	-1.681371	0.0956
C(10)	2.847463	1.777243	1.602180	0.1120
C(11)	-0.180719	0.832813	-0.216998	0.8286
C(12)	-0.264342	0.187472	-1.410037	0.1614
C(13)	-0.945489	0.833714	-1.134068	0.2593
C(14)	-2.850589	1.688561	-1.688176	0.0943
C(15)	-0.008562	0.017259	-0.496062	0.6209
C(16)	0.493404	0.166726	2.959366	0.0038
C(17)	0.090461	0.078128	1.157867	0.2495
C(18)	0.044804	0.017587	2.547542	0.0123
C(19)	-5.295130	1.400558	-3.780727	0.0003
C(20)	7.271021	2.836618	2.563271	0.0117
C(21)	0.132039	0.028994	4.553966	0.0000
C(22)	-1.072556	0.280084	-3.829414	0.0002
C(23)	-0.082591	0.131247	-0.629283	0.5305
C(24)	0.100839	0.029545	3.413116	0.0009

Determinant residual covariance	3.00E-11

Equation: D(RGDP_GROWTH) = C(1)*(RGDP_GROWTH(-1) +
0.0199487643423*INFLATION(-1) + 0.00903270074874*M2(-1) +
0.0564183803931*MPR(-1) - 0.599404390421) + C(2)
*D(RGDP_GROWTH(-1)) + C(3)*D(INFLATION(-1)) + C(4)*D(M2(-
1)) +
C(5)*D(MPR(-1)) + C(6)
Observations: 33

R-squared	0.426037	Mean dependent var	-0.000197
Adjusted R-squared	0.082710	S.D. dependent var	0.005421
S.E. of regression	0.005192	Sum squared resid	0.000728
Durbin-Watson stat	2.073658		

Equation: D(INFLATION) = C(7)*(RGDP_GROWTH(-1) +
0.0199487643423
*INFLATION(-1) + 0.00903270074874*M2(-1) + 0.0564183803931
*MPR(-1) - 0.599404390421) + C(8)*D(RGDP_GROWTH(-1)) +
C(9)
*D(INFLATION(-1)) + C(10)*D(M2(-1)) + C(11)*D(MPR(-1)) + C(12)

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Observations: 33

R-squared	0.538881	Mean dependent var	0.004111
Adjusted R-squared	0.216451	S.D. dependent var	0.554132
S.E. of regression	0.490508	Sum squared resid	6.496152
Durbin-Watson stat	2.000229		

Equation: D(M2) = C(13)*(RGDP_GROWTH(-1) + 0.0199487643423
*INFLATION(-1) + 0.00903270074874*M2(-1) + 0.0564183803931
*MPR(-1) - 0.599404390421) + C(14)*D(RGDP_GROWTH(-1)) +
C(15)
*D(INFLATION(-1)) + C(16)*D(M2(-1)) + C(17)*D(MPR(-1)) + C(18)
Observations: 33

R-squared	0.374848	Mean dependent var	0.091437
Adjusted R-squared	0.259079	S.D. dependent var	0.053459
S.E. of regression	0.046015	Sum squared resid	0.057170
Durbin-Watson stat	2.099818		

Equation: D(MPR) = C(19)*(RGDP_GROWTH(-1) + 0.0199487643423
*INFLATION(-1) + 0.00903270074874*M2(-1) + 0.0564183803931
*MPR(-1) - 0.599404390421) + C(20)*D(RGDP_GROWTH(-1)) +
C(21)
*D(INFLATION(-1)) + C(22)*D(M2(-1)) + C(23)*D(MPR(-1)) + C(24)
Observations: 33

R-squared	0.566598	Mean dependent var	-0.000261
Adjusted R-squared	0.486338	S.D. dependent var	0.107857
S.E. of regression	0.077301	Sum squared resid	0.161339
Durbin-Watson stat	2.307925		

Appendix VII: Diagnostic Tests

VEC Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 07/11/21 Time: 05:25
Sample: 1986 2020
Included observations: 32

Lags	LM-Stat	Prob
1	10.39692	0.8451
2	7.245472	0.9682
3	18.58023	0.2910

Probs from chi-square with 16 df.

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VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 07/11/21 Time: 05:26
Sample: 1986 2020
Included observations: 32

Component	Skewness	Chi-sq	df	Prob.
1	-0.083787	0.037442	1	0.8466
2	-0.161710	0.139468	1	0.7088
3	0.477908	1.218114	1	0.2697
4	0.342907	0.627120	1	0.4284
Joint		2.022143	4	0.7317

Component	Kurtosis	Chi-sq	df	Prob.
1	1.661972	2.387093	1	0.1223
2	2.445599	0.409813	1	0.5221
3	2.204442	0.843884	1	0.3583
4	2.266842	0.716693	1	0.3972
Joint		4.357483	4	0.3598

Component	Jarque-Bera	df	Prob.
1	2.424535	2	0.2975
2	0.549281	2	0.7598
3	2.061997	2	0.3567
4	1.343813	2	0.5107
Joint	6.379626	8	0.6048