EMPIRICAL INVESTIGATION OF MONEY SUPPLY, INFLATION AND ECONOMIC GROWTH NEXUS IN NIGERIA

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ABSTRACT
The main goal of monetary policy is to guarantee that the money supply is at a dimension that is steady with the development focus of real income, to such an extent, that non-inflationary development is certain and price stability, guaranteed. Since the discovery of the COVID-19 Pandemic, the money supply has risen consistently, averaging 9.16% between 2020Q1 and 2022Q2. Inflation, on the other hand, has risen by 15.70% while growth averaged a meagre 1.24%. As a result, this study aims to analyse the relationship among select macroeconomic variables. The Toda Yamamoto Vector Autoregressive and Granger Causality approaches are adopted for this study and cover the period 2006Q1 to 2022Q2. There is evidence of joint causality to money supply growth and lending rate. Impulse response functions reveal that increasing growth in money supply causes a marginal rise in inflation while having no contemporaneous effect on real GDP growth. However, over the forecast horizon, increasing levels of money supply growth cause a persistent decline in real GDP growth, insinuating that the levels of growth in the Nigerian economy are motivated by other factors. The Central Bank is encouraged to manage the level of money supply effectively to sustain real GDP growth.

Keywords: Economic Growth, Granger causality, Inflation, Money Supply, Toda Yamamoto
JEL Codes: C3, E5, E13, E31, O4

1. INTRODUCTION
Monetary policy is one of the key drivers of economic growth through its impact on economic variables (Makhetha-Kosi, 2014). It ensures that money supply is at a level that is consistent with the growth target of real income such that non-inflationary growth is attained. Monetary policy influences consumer spending, investment decisions and aggregate demand through changes in money supply and interest rates. Makhetha-Kosi (2014) notes that there are two crucial links that must exist so that changes in real money stock will affect changes in output. First, interest rates must be responsive to changes in the money stock. Second, changes in interest rates must bring about changes in aggregate demand. The existence of these two links will enable changes in money stock to convey changes to output levels in an economy. In this case, the soundness of any economy revolves around its economic and financial performance. Monetary policy alludes to the procedure by which monetary authorities influence money supply, regularly focusing on a rate of interest for the purpose of encouraging economic growth and price stability.

According to Precious & Makhetha-Kosi (2014), the main goal of monetary policy is to guarantee that money supply is at a dimension that is steady with the development focus of real income, to such an extent, that non-inflationary development will be certain. The amount of money that circulates in an economy attracts interest rates which impact consumers spending.

Between 2006 and 2022, money supply grew consistently but at a faster rate between 2006Q1 and 2008Q2. This was followed by a contemporaneous rise in the rate of inflation between 2007Q3 and 2009Q1. Real GDP was also observed to rise, though cyclically, between 2006Q1 and 2022Q2. However, GDP grew at a slower pace between 2015Q1 and 2022Q2. The rate of inflation declined between 2009Q3 and 2014Q4 as money supply growth moderated between the same periods. The observed decline in money supply between 2016Q4 and 2017Q2 saw inflation decline between 2017Q1 and 2018Q2. However, the actions of the monetary authorities to increase the money supply between 2017Q3 and 2022Q2 could have been instrumental in the rise in inflation within the same period. These effects could be observed to reduce the rate of growth in real GDP over the study period and more so between 2020Q1 and 2022Q2. Since the discovery of the COVID-19 Pandemic, the money supply has risen consistently, averaging 9.16% between 2020Q1 and 2022Q2. Inflation, on the other hand, has risen by 15.70% while growth averaged a meagre 1.24%.

Literature has exposed two existing cases concerning the capability of monetary policy influencing economic growth – the Keynesian and Monetarist theories. With the current state of most economies where prices of goods remain on the increase, policymakers are encouraged to pay critical attention to monetary policies to sustain and maintain price stability (Wauk & Adjorlolo, 2019). Specifically, monetary policy impacts money supply in an economy, which influences interest and inflation rates (Hall, 2022). Central banks typically conduct monetary policy via variations in price or quantity variables. In terms of price, monetary authorities set short-term interest rates in the interbank market for bank reserves or clear bank balances with the central bank (He, 2018). In terms of quantity, the level of money supply and its consistency with the absorptive capacity of the economy is varied (Omanukwue, 2010).

Money supply and inflation rates are one of the most important key determinants of economic growth Omanukwue (2010). According to the Monetarists, money supply leads to inflation by raising the general price level in a manner that could stimulate economic growth. Nevertheless, the rise in the money supply could affect economic growth negatively. A somewhat new thinking is the possibility of an asymmetric relationship or effect from money supply and (Hicham, 2020). Various studies have highlighted possible relationships between money stock, interest rate and economic growth across varying time horizons, economies, and methodologies. While Hassan, Sanchez, & Yu (Forthcoming), Tegegne (2021), Doan Van (2020), and Dingela & Khobai (2017) find that money supply has a positive impact on inflation, Buthelezi (2023), Amassoma, Sunday, & Onyedikachi (2018); Precious & Makhetha-Kosi (2014); and Amisano & Fagan (2010), promote a negative impact of money supply on inflation and economic growth. In Nigeria, Omanukwue (2010) and Onwumere, Ibe, Ozoh, & Mounanu (2012) find conflicting results but note the importance of relevance among the variables.

With the significance of inflation on economic growth and money supply on inflation and economic growth, the role of monetary authorities via the quantity variation of monetary policy could be considered in the drive to stabilise prices and promote growth. As highlighted above, studies on the relation among these variables were conducted prior to the COVID-19 pandemic. With the insurgence of the Pandemic, a lot has changed in the dynamics among financial variables, especially with the rising levels of inflation and the different strategies being implemented by monetary authorities across the globe to fight inflation. In addition, most of the papers on the relationship between money supply, inflation and economic growth explored the relationship in a distinct linear form using either economic growth or inflation as dependent variables. Given the different and conflicting results of the possible effect/impact or relationship among the variables, this study assessed the dynamics of the relationship among

the variables, using recent quarterly variables, and having considered possible breaks in the series. It also ascertained the viability of monetary policy (captured using a broader form of money supply) in stimulating economic activity in Nigeria.

The paper employs the Toda Yamamoto Vector Autoregressive and Granger Causality approach over the 2006Q1 and 2022Q2 period. Following this introduction, section 2 provides some theoretical foundation and empirical literature. Section 3 presents the methodology. In section 4, the results and findings are discussed, and section 5 concludes the paper highlighting some policy implications and recommendations.

2. LITERATURE REVIEW

2.1 Theoretical Literature

Classical economists hold that 'Inflation is always and everywhere a monetary phenomenon'. This is because of the assumption that a rise in the quantum or variation in money supply determines the value of money but not necessarily changes in output (Omanukwue, 2010). The Quantity Theory of Money (QTM) is hinged on the Irvin Fisher equation of exchange that states that the quantum of money multiplied by the velocity of money is equal to the price level multiplied by the number of goods sold. Mathematically,

$$MV = PQ \quad (1)$$

Where $M =$ quantity of money

$V =$ velocity of money

$P =$ price level

$Q =$ real goods and services

The QTM suggests that as the stock of money increases, the overall price level of goods and services in the economy increases. Additionally, the QTM states that the rise in price level is proportional to the increase in the money supply. Hence, if the money supply increases by 8%, the price level will increase by 8%, while other factors remain the same. The QTM suggests that the growth rate of money supply determines the growth rate of the price level in the long run. The QTM assumes that:

i. velocity of money is constant because technical and institutional factors that could necessitate a faster movement in the velocity of money evolves slowly.
ii. Factors affecting real output are exogenous to the quantity theory, that is, monetary factors do not influence developments in the real economy.
iii. Causality runs from money to prices, that is, prices vary proportionally in response to changes in the quantum of money, with velocity and real output invariant.

Certain weaknesses have been identified as the non-recognition of money as a resource that could spur production, and changes in the quantum of money supply in circulation are the effects of variation in business cycle, rather than the cause as opined by the monetarists.

Modern QTM holds that the velocity of money is not constant. Thus, it assumes that financial and institutional structures have evolved over the years and specifies the velocity of money as a function of the nominal interest rate and changing money supply, that is,

$$v = mlr(int) \quad (2)$$

Thus, combining equations 2.1 and 2.2, and assuming some level of endogeneity of output and money supply, the following model would be estimated:

$$y = msg, mlr, inf \quad (3)$$

This study differs from other known studies on this topic in that it relies on recent data having a higher frequency and capturing the effect of COVID-19 as captured by a break in the series. It also endogenises money supply, capturing the effect of changing money supply in the QTM.

2.2 Empirical Literature

Generally, the aim of monetary policies across most nations includes price stability, enhancing employment, maintaining equilibrium in the balance of payments, promotion of output growth, and stability in the country's financial system among others. Amankwah, Prince, & Nubuor (2019) note that to achieve price stability and enhance growth, authorities must improve the efficiency of the economy, as it prevents distortions in savings and investment decisions. Based on a monetary aggregate, the transmission mechanism depends, fundamentally, on its impact on relative prices, particularly, interest rate, exchange rate, and inflation (Andres, Mestre, & Valles, 2014), the most conventional monetary policy channel being the interest rate (Mishkin, 1995).

The impact of money supply on inflation and economic growth has received major attention in macroeconomics. However, there is no consensus on the impact of money supply on inflation and growth both empirically and theoretically (Buthelezi, 2023). Some studies find that money supply has a positive impact on inflation (Hassan, Sanchez, & Yu, Forthcoming; Amaral, Dyhoum, Abdou, & Aljohani, 2022; Tegegne, 2021; Doan Van, 2020; and Dingela & Khobai, 2017). Others find a negative impact of money supply on inflation and economic growth (Buthelezi, 2023; Amassoma, Sunday, & Onyedikachi, 2018; Precious & Makhetha-Kosi, 2014; and Amisano & Fagan, 2010). Onwumere, Ibe, Ozoh, & Mounanu (2012) find a positive relationship between money supply and economic growth. At a theoretical level, the QTM advocates that money supply is a key factor in determining inflation (Friedman, 1989). Friedman's money supply theory outlines that change in money supply are the primary determinants of the pace of economic growth (Friedman, 1989).

Employing varied techniques such as the TVP-VAR and Markov switching dynamic regression in South Africa, Buthelezi (2023) notes that money eventually moves economic growth above equilibrium after a few years. Also, the estimated money supply reflected that there would be an increase in the inflation rate. Chaitip, Chokethamorn, Chaiboonsri, & Khounkhalax (2015) note that money supply is associated with economic growth-wide phenomena of countries in the ASEAN economic community in the long-run.

Across Asia, particularly in Pakistan and India, Pradhan, Nishigaki, & Hall (2017) find that broad money supply, inflation and economic growth Granger cause each other and exhibit the presence of a long-run equilibrium relationship. Hassan, Sanchez, & Yu (Forthcoming) document the relationship between financial development and economic growth and find a positive association between financial development and economic growth in OIC developing countries.

Some studies emphasise the existence of nonlinear relation between money supply, inflation, and economic growth. Asab (2019), using data from Qatar, reports a significant positive relationship between inflation and economic growth below the money supply threshold and a nonsignificant association after the threshold. In Ghana, Sare, Ibrahim, & Musah (2019) find that the inflation-growth nexus is mediated by the level of broad money supply. While inflation negatively affects overall growth, evidence suggests that inflation significantly inhibits economic growth when the broad money supply exceeds a certain threshold of MS/GDP. In Sierra Leone, Turay, Seraj, & Ozdeser (2023) establish the effect of asymmetric relationship between money supply and economic growth in Sierra Leone and conclude that while positive changes in money supply have an insignificant effect on economic growth, negative changes improve economic growth.

Studying the behaviour of the Central Bank of Nigeria, Ayinde, Bankole, & Adeniyi (2020) find that money supply is endogenous in Nigeria. Omanukwue (2010) establishes the existence of 'weakening' unidirectional causality from money supply to core consumer prices in Nigeria. Likewise, Pedro & Adesina-Uthman (2022) disaggregating the components of inflation, emphasise the importance of money supply in controlling inflation rate in Nigeria. Furthermore, monetary aggregates still contain significant, albeit weakening information about developments in core prices. Onwumere, Ibe, Ozoh, & Mounanu (2012) find that broad money velocity and market liquidity promote economic growth. Fasoranti & Alimi (2014) find short-run interaction between real GDP and money supply with a bidirectional causality between the variables. Adebisi (2020) notes that the impact of domestic monetary shocks on inflation in the Nigerian economy are moderate. In addition, inflation appears to be most sensitive to domestic supply. Money supply, interest rate shocks and nominal exchange rate shocks.

This study thus captures the behaviour of these variables in Nigeria highlighting the behaviour of real GDP post COVID-19 and employing the broadest form of money supply.

3. METHODOLOGY

3.1 Data and Variables

The study utilised quarterly data from 2006Q1 to 2022Q2. The set of variables include real money supply growth (MSG), growth rate of real gross domestic product (RGDPG), maximum lending rate (INT), and inflation rate (INF). Money supply growth was proxied by growth in M_3, measured as the change in money supply over its position in the preceding December. In addition, the study investigates whether inflation is a significant factor that affects the relationship between money supply growth and economic growth in Nigeria. Real money balances are computed by deflating the money supply by CPI. The interest rate was proxied by maximum lending rate as it represents the true reflection of transactions. The intuition behind adopting maximum lending rate is due to its ability to reflect the true cost of fund or borrowing because the monetary policy rate is simply an anchor rate that signals the direction of policy.

All data employed in the analysis were sourced from the statistical databases of the Central Bank of Nigeria and the National Bureau of Statistics. The selection of the study period was based on the unavailability of data for some of the variables employed in the study.

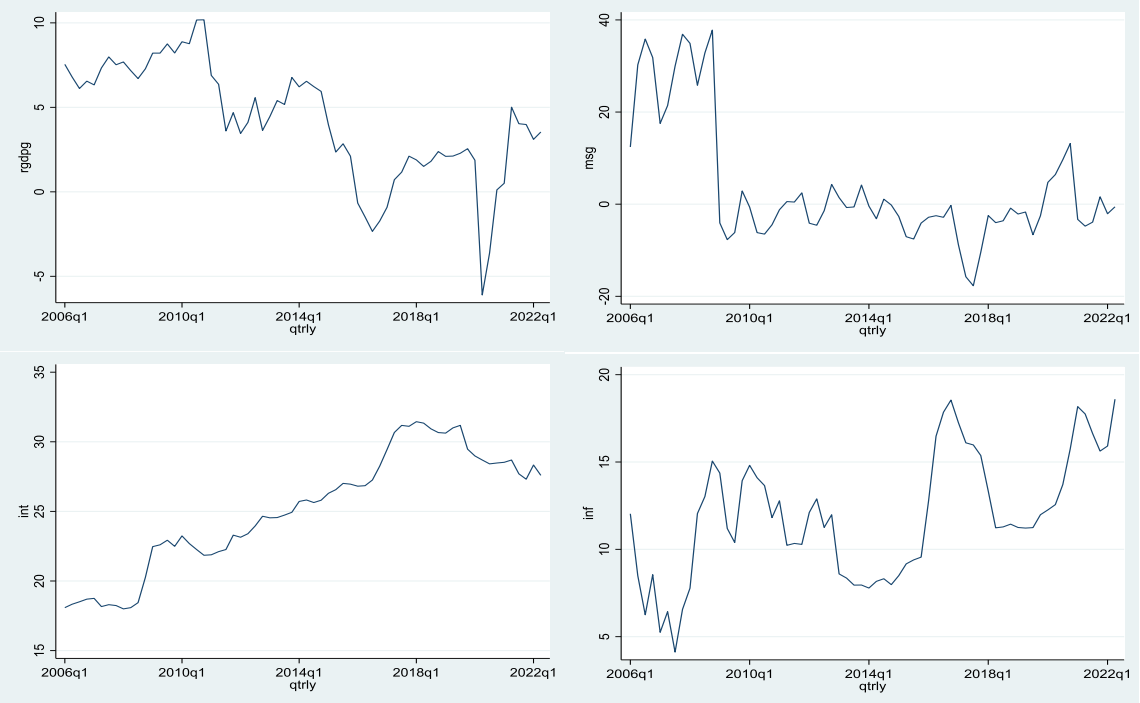
3.2 Pre-Estimation Analysis

Graphical Presentation

The graphical plots (Figure 1) highlight the nature of the variables in their level form. An inspection of the graphs shows some evidence of volatility in the growth in money supply and real GDP series. Real GDP increased volatility in the latter part of the series (2014-2022) and maintained a decline for the most part of the study period, with a possibility of significant breaks in 2010Q4, 2017Q3 and 2020Q1.

As shown in the graph, all the variables, except MSG, exhibit a trend. They show that while RGDPG is downward sloping, INF and INT are upward sloping. Furthermore, interest rate and inflation maintained an upward trajectory, while RGDPG declined during the period. Some of the variables exhibit breaks, particularly, RGDPG, INF, and MSG. An inspection of the graphs shows that all the variables are likely to be non-stationary. In Nigeria, MSG declined drastically prior to 2010 and remained around the zero mark for the remaining duration of the study.

Figure 1: Graphical Plot of real GDP growth, money supply growth, interest rate and inflation rate.



Source: Authors' computation

3.3 Descriptive Statistics

Descriptive statistics presented in Table 1 shows that money supply growth remained below 5% averaging 3.44% in Nigeria and spreading between -17.71% and 37.79% within the study period. This indicates that though monetary authorities increased the level of money supply in the economy to high levels (37.79%), on average, the level of growth in money supply has remained around the zero band and same did not change drastically as monetary authorities aim to stabilise prices. In addition, the level of growth may have been subdued in the drive to sustain prices. Evidence reveals that there are higher deviations in the data on growth in money supply as the points are further from the mean as evidenced by the standard deviation. Growth

in real GDP averaged 4.22% with minimal variation in the series. There were episodes of decline in RGDPG, evidenced by the minimum level of growth recorded in Nigeria (-6.10%).

Maximum lending rates averaged 25.10% between 2006Q1 and 2022Q2 with wide variability in the series as shown by the standard deviation of 4.2 points. Inflation averaged 11.87%. Higher variations were also observed in the MSG variable, signifying greater levels of variability in the data.

In terms of skewness, inflation and money supply growth are positively skewed while growth in real GDP and interest rate are negatively skewed, highlighting that large distribution of the real GDP growth and interest rate are centred around the left of the normal curve. Kurtosis suggests that only MSG is leptokurtic, having a greater likelihood of extreme events as compared to a normal distribution, while INT and INF are platykurtic. The results of normality, represented by the Jarque Bera statistic, show evidence of normality in all the variables except in the MSG series, that is, MSG is not from a normal distribution.

Table 1: Descriptive Statistics

Variables	Mean	Std. Dev.	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera
RGDPG	4.2223	3.4318	- 6.1040	10.1804	- 0.5894	3.0809	3.8398
MSG	3.4434	13.4179	- 17.7089	37.7895	1.3801	3.8878	23.1180***
INT	25.1000	4.1979	17.9982	31.4445	- 0.2353	1.9603	3.5821
INF	11.8748	3.5092	4.1165	18.5956	0.0667	2.2899	1.4356

*Note: **RGDPG**, **INF**, **MSG**, and **INT**, represents growth in real GDP, inflation, growth in money supply, inflation, and maximum lending rate for Nigeria over 66 observations. *** denotes the 1% level of statistical significance.*

Source: Authors' computation

3.4 Unit Root Tests

Table 2 presents the results of the ADF and KPSS tests. The results of the ADF test reveals that none of the variables are stationary at levels, though money supply seems to exhibit some level of stationarity at the 5% level of statistical significance when measured under one of the levels. Money supply growth and real GDP growth are only stationary around a constant and trend, possibly because of structural breaks or nonlinearities in these variables. Thus, using the ADF test, the conclusion is made that all the variables are difference stationary. Nigeria's real GDP growth, inflation and interest rate are difference stationary and thus have a unit root.

The results of the KPSS test of stationarity are slightly different from those of the ADF, with respect to the MSG and INF variables, as they report stationarity around some trend. RGDPG and INT are difference stationary and thus have a unit root. In summary, the results reveal that the variables in the model are integrated at orders I(0) and I(1). To ascertain the relationship and impact analysis among the variables in the model, the Toda-Yamamoto Vector Autoregressive (VAR) and Granger Causality approaches are employed.

Table 2: Results of Unit Root Tests

p-values			*RGDPG*	*MSG*	*INT*	*INF*
Level	***ADF***	**Intercept**	0.2672	0.1548	0.4785	0.2943
		Intercept & Trend	0.2508	0.1993	0.9163	0.2766
		None	0.1194	0.0187	0.9034	0.7311
	KPSS	**Intercept**	p>all	0.05<p<0.01	p>all	0.10<p<0.05
		Intercept & Trend	p<all	0.05<p<0.01	0.05<p<0.01	p<all
			RGDPG	***MSG***	***INT***	***INF***
First Difference	***ADF***	**Intercept**	0.0000		0.0000	0.0000
		Intercept & Trend	0.0000		0.0001	0.0000
		None	0.0000		0.0000	0.0000
	KPSS	**Intercept**	p<all		p<all	
		Intercept & Trend	p<all		p<all	
Decision $I(d)$ (ADF)			I(1)	I(0)	I(1)	I(1)
Decision $I(d)$ (KPSS)			I(1)	I(0)	I(1)	I(0)

Source: Authors' computation

To ascertain the validity of the breaks in the series, the Breakpoint unit root tests were carried out and the Chow test was utilised to validate the Break dates as detailed in Table 3. The results, presented in Table 3, reveal the existence of significant breaks in the real GDP growth variables in 2020Q2. To capture the effects of this break (COVID-19), dummy variables were generated in line with the break dates and inserted as endogenous variables in the TY-VAR system.

Table 3: Results of Breakpoint unit root Test

Null Hypothesis:		**The select variable has a unit root**							
		RGDPG		**MSG**		**INT**		**INF**	
		Break date	**p-values**	**Break date**	**p-values**	**Break date**	**p-values**	**Break date**	**p-values**
Level	**Intercept**	2014Q1	0.3349	2008Q4	<0.01	2008Q3	.6871	2015Q4	0.6385
	Intercept & Trend	2020Q2	0.5919	2008Q4	<0.01	2019Q3	0.4925	2012Q2	0.8435
First difference	**Intercept**	2020Q2	<0.01			2009Q1	<0.01	2016Q2	<0.01
	Intercept & Trend	2020Q2	<0.01			2019Q3	0.4925	2016Q2	<0.01

Source: Authors' computation

Also, the Chow test confirms the validity of the breakpoint unit root test for real GDP growth at the 2020Q2 break date given by the rejection of the null of no breaks at the specified breakpoints as presented in Table 4.

Table 4: Results of Chow Test

Chow Breakpoint:	2020Q2
Null Hypothesis:	No breaks at specified breakpoints
Sample:	2006Q1 – 2022Q2
F-statistic	4.5666***
Note: *** denotes a 1% level of statistical significance. Number of observations = 66.	

Source: Authors' computation

The results of the unit root tests suggest that the variables could be characterised by sudden changes or asymmetries and thus require some further analysis to discover the true nature of the variables. However, the relationship among the variables was examined with the inclusion of dummy variables to capture the significant break in the growth of real GDP, and assessed in a system using the TY-VAR.

3.5 Model Specification

The suitability of an approach depends on the underlying test equation and the order of cointegration of the series under consideration (Salisu, 2015). The result of the unit root test suggest that the Autoregressive Dynamic Lag (ARDL) bound approach or the Toda-Yamamoto VAR (TY-VAR) approach could be employed. Though insensitive to whether the variables are I(0) or I(1), the ARDL bound estimation reveals the existence of the linear relationship among the non-stationary or mixed form of variables. It does not, however, disclose the direction of the relationship among the considered variables. Therefore, to understand the cause and effect direction among the variables presented in this study, the Modified Wald test (MWALD) as suggested by (Toda & Yamamoto, 1995) is employed.

The MWALD test emerged as a major improvement over the traditional Granger causality test as the latter test failed to consider the possibility of a non-stationarity or any cointegrating relationship, if at all, among the variables (Wolde-Rufael, 2006). The Toda and Yamamoto (1995) exercise applies a standard VAR model while variables are in levels rather than first differences (unlike Granger causality test) implying that the risk of wrongly identifying the order of integration of the series is minimised (Mavrotas & Kelly, 2001).

Considering the impact/effect of money supply on inflation and economic growth, the authors attempt to explain the relationship between the variables using the function specified as follows:

$$RGDPG = f(MSG, INT, INF) \quad (4)$$

Where RGDPG, MSG, INT, and INF are real GDP growth, money supply growth, interest rate and inflation rate for Nigeria over the 2006Q1 to 2022Q2 period.

To determine the evidence of some relationship among the variables, causality and impact analysis based on the categorisation of the variables into a system, were determined based on the TY-VAR approach.

The model representing the relationship between the dependent and independent variables is presented as follow:

$$\mathrm{RGDPG_t} = \alpha_0 + \alpha_1 \mathrm{MSG_t} + \alpha_2 \mathrm{INT_t} + \alpha_3 \ln \mathrm{INF_t} + \varepsilon_t \quad (5)$$

All the variables are expressed in percentages. Equation 5, as emphasised by theory and previous studies, particularly in line with the quantity theory of money, reveals that monetary tightening, in terms of quantity rather than price, a contractionary monetary policy – refers to a decline or reduction in money supply growth is assumed to be positively related to growth in real GDP ($\alpha_1 > 0$). Though the relationship between money supply and economic growth is indirect, its link exists via the interest rate channel, where a contractionary monetary policy would cause the interest rate to rise, which in turn raises the cost of capital (lending rates), thereby causing a decline in aggregate demand and a fall in output and vice versa. In addition, contractionary monetary policy (decline in MSG) is expected to reduce inflation and a decline in INF would decrease growth in real GDP. Thus, we expect a negative relationship between INF and RGDPG and INT and RGDPG.

Examining the relationship among the variables (that is, persistence or otherwise) of money supply in containing inflationary pressures and promoting growth, the variables are subjected to the TY model. The generalised TY-VAR model is specified in the set of equations below.

$$RGDPG_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i}\, RGDPG_{t-i} + \sum_{j=k+1}^{k+d_{max}} \alpha_2\, RGDPG_{t-j} + \sum_{i=1}^{k} \beta_{1i}\, MSG_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{2i}\, MSG_{t-j} + \sum_{i=1}^{k} \gamma_{1i}\, INT_{t-i} + \sum_{j=k+1}^{k+d_{max}} \gamma_{2i}\, INT_{t-j} + \sum_{i=1}^{k} \delta_{1i}\, INF_{t-i} + \sum_{j=k+1}^{k+d_{max}} \delta_{2i}\, INF_{t-j} + \mu_{1t}$$

$$MSG_t = \alpha_0 + \sum_{i=1}^{k} \beta_{1i}\, MSG_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{2i}\, MSG_{t-j} + \sum_{i=1}^{k} \alpha_{1i}\, RGDPG_{t-i} + \sum_{j=k+1}^{k+d_{max}} \alpha_2\, RGDPG_{t-j} + \sum_{i=1}^{k} \gamma_{1i}\, INT_{t-i} + \sum_{j=k+1}^{k+d_{max}} \gamma_{2i}\, INT_{t-j} + \sum_{i=1}^{k} \delta_{1i}\, INF_{t-i} + \sum_{j=k+1}^{k+d_{max}} \delta_{2i}\, INF_{t-j} + \mu_{2t}$$

$$INT_t = \alpha_0 + \sum_{i=1}^{k} \gamma_{1i}\, INT_{t-i} + \sum_{j=k+1}^{k+d_{max}} \gamma_{2i}\, INT_{t-j} + \sum_{i=1}^{k} \alpha_{1i}\, RGDPG_{t-i} + \sum_{j=k+1}^{k+d_{max}} \alpha_2\, RGDPG_{t-j} + \sum_{i=1}^{k} \beta_{1i}\, MSG_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{2i}\, MSG_{t-j} + \sum_{i=1}^{k} \delta_{1i}\, INF_{t-i} + \sum_{j=k+1}^{k+d_{max}} \delta_{2i}\, INF_{t-j} + \mu_{3t}$$

$$INF_t = \alpha_0 + \sum_{i=1}^{k} \delta_{1i}\, INF_{t-i} + \sum_{j=k+1}^{k+d_{max}} \delta_{2i}\, INF_{t-j} + \sum_{i=1}^{k} \alpha_{1i}\, RGDPG_{t-i} + \sum_{j=k+1}^{k+d_{max}} \alpha_2\, RGDPG_{t-j} + \sum_{i=1}^{k} \beta_{1i}\, MSG_{t-i} + \sum_{j=k+1}^{k+d_{max}} \beta_{2i}\, MSG_{t-j} + \sum_{i=1}^{k} \gamma_{1i}\, INT_{t-i} + \sum_{j=k+1}^{k+d_{max}} \gamma_{2i}\, INT_{t-j} + \mu_{4t}$$

Where k = the optimal lag length, which is determined using the Schwartz Information Criteria (SC), and

d_{max} = the maximum order of integration.

To this end, generalised impulse responses, which are invariant to the ordering of the variables in the VAR have been used.

3.6 Lag Order Selection Criteria for the VAR

The optimal lag length of 1 is selected based on the result of the SC presented in Table 5. The SC was chosen to identify the optimal lag as it accommodates for a small sample, which is the case in this study, having utilised a total of 66 observations.

Table 5: Lag Order Selection Criteria and F-Bound Test Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-667.896	NA	62631.6	22.39652	22.53614	22.45114
1	-453.075	393.8377	83.03076	15.76917	16.46728*	16.04224*
2	-436.83	27.61625	82.98195	15.76101	17.01761	16.25254
3	-425.749	17.36086	99.6204	15.92496	17.74006	16.63495
4	-409.134	23.81427	101.1617	15.90447	18.27806	16.83292
5	-395.962	17.1236	118.0116	15.99874	18.93082	17.14564
6	-352.28	50.96267*	51.43759*	15.07600*	18.56657	16.44135

Note: * indicates lag order selected by the criterion. LR refers to sequential modified LR test statistic (each test at 5% level), FPE (Final prediction error), AIC (Akaike information criterion), SC (Schwarz information criterion), and HQ (Hannan-Quinn information criterion). Number of observation**s** = 66

Source: Authors' computation

4 RESULTS AND DISCUSSION OF FINDINGS

4.1 Granger Causality Test

Table 6 relays the results of the Granger Causality/Block Exogeneity test, which shows the existence of a bidirectional causality between money supply growth and maximum lending rate at the 5% and 1% levels of statistical significance. There exists a unidirectional causation from inflation to money supply growth and from inflation to maximum lending rate. Thus,

highlighting the importance that the level of inflation plays in the Nigerian economy. There is evidence of joint causality to money supply growth and maximum lending rate, emphasising the role of all these macroeconomic variables in the movements in money supply. Nevertheless, it is observed that money supply does not considerably have enough power to predict growth in the Nigerian economy as established by (Amassoma, Sunday, & Onyedikachi, 2018).

Table 6: Toda-Yamamoto Granger Causality Test Results

Dependent Variable	Direction of Causality				
	RGDP	***MSG***	***INT***	***INF***	***All***
RGDP	-	1.952306	0.0365	0.0056	2.0355
MSG	1.7453	-	17.3129***	5.8925**	24.2095***
INT	0.3977	4.5916**	-	3.6471*	9.3233**
INF	1.1252	0.1140	0.0454	-	0.6785
Note: ***, **, and * denote the 1%, 5% and 10% levels of statistical significance. Number of observations = 66.					

Source: Authors' computation

4.2 Impulse Response Functions

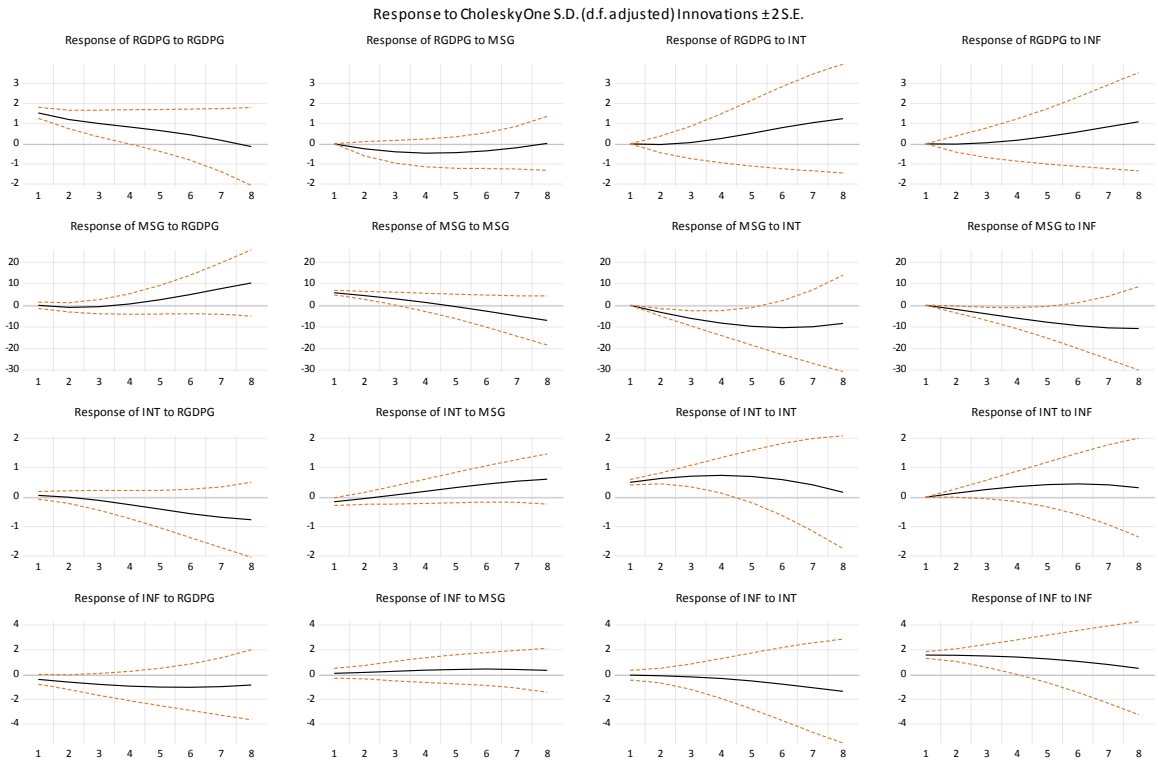
The effect of changes in the variables in this model cause a minor and seeming persistent change in the levels of other variables. While changes in real GDP growth cause increased positive performance in economic activities in the first 7 quarters following the change, the effects of changes in real GDP on money supply growth and maximum lending rate are delayed. In addition, better economic performance, as measured by the rise in real GDP growth, causes increasing levels of growth in money and declining interest rates.

Over the forecast horizon, an initial increase in money supply growth leads to a contemporaneous decline in maximum lending rate, which is expected as the supply of money outpaces the demand for money by businesses and households. Nevertheless, following the second quarter, maximum lending rate increases persistently. Increasing levels of growth in money supply is observed to cause a marginal rise in the level of inflation, which is in line with Keynes' thesis that inflation is always and everywhere a monetary phenomenon. It is observed that economic growth does not respond to growth in money supply contemporaneously. In the following quarter after the shock, however, the response of real GDP growth to a rise in money supply growth is negative.

The effect of changes in maximum lending rate and inflation rate on real GDP growth is delayed until the third and fourth quarters when real GDP growth is observed to rise persistently. Though increasing levels of inflation cause a decline in growth of money supply and rising interest rates, which are expected to cause a decline in economic growth, the opposite is observed. That is, despite experiencing rising lending rates and declining growth in money supply because of rising prices, growth in real GDP is seen to remain constant in the first three quarters following the inflationary shock and rise consistently over the eight quarters observed. Thus, insinuating that the levels of real GDP growth in the Nigerian economy are motivated by other non-monetary factors, such as the state of infrastructure, insecurity, institutional quality and informal sector size, among others.

As observed, increasing levels of growth in money supply causes inflation rise to rise minimally or moderately, which is further translated into a delayed rise in real GDP growth as evidenced by the graphs in figure 2. These could be likened to the outcome of the study by Starr (2005) who observed weak evidence of the real effects of monetary policy.

Figure 2: Impulse response Functions among the variables

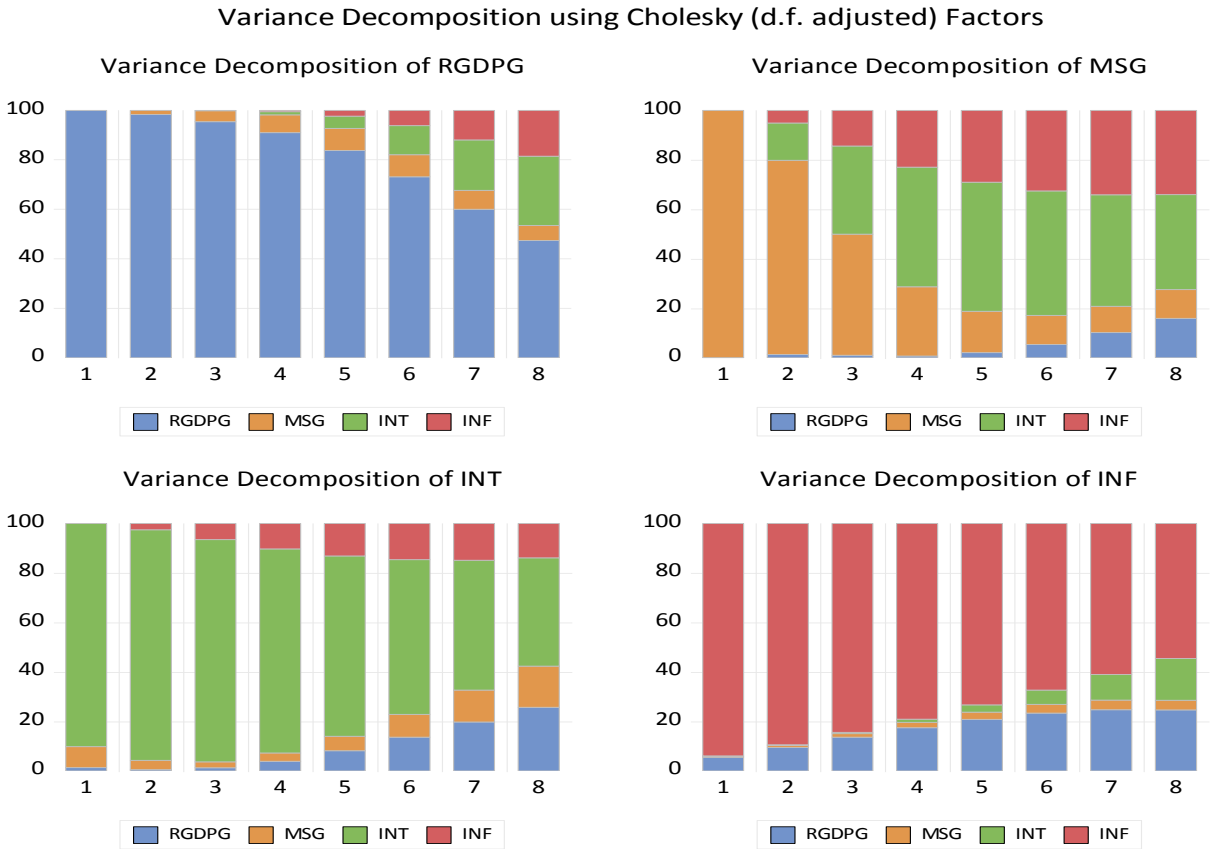


Source: Authors' computation

4.3 Variance Decomposition

The results of the variance decomposition reveal that none of the variables contribute significantly to explaining other variables in the model. Real GDP growth is explained by itself in the first quarter, which declines from the second quarter. Though the contribution of money supply growth to real GDP growth increases from the second quarter, it declines over the horizon with an increase in the contribution of maximum lending rate to the overall behaviour of real GDP growth. All the variables included in the model, except inflation rate, contribute to the performance of the maximum lending rate in the first quarter. Though the contribution of money supply growth declines between the second and third quarters, it increases alongside inflation rate in affecting the composition of the maximum lending rate. The contribution of all the variables to inflation rate increases over time, being driven by largely by real GDP growth. Contribution to money supply growth is largely driven by maximum lending rate and inflation rate. Also remarkable is that the forecast error variance of money supply growth could be explained by exogenous shocks to the other variables as observed in the second chart on Figure 3.

Figure 3: Variance Decomposition among the variables



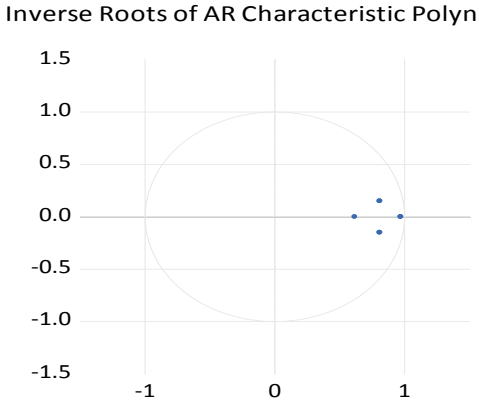
Source: Authors' computation

4.4 Post-Estimation Diagnostics

4.4.1 Stability Tests

The result of stability shows that the model is stable as all the unit roots of the characteristic polynomial lie within the unit circle as shown in Figure 3.

Figure 4: Stability Test Results



Source: Authors' computation

Table 7: Stability Test Result

Roots of Characteristic Polynomial	
Endogenous variables	RGDPG, MSG, INT, INT
Exogenous variables:	C
Lag Specification	1 1
Root	Modulus
0.971022	0.9710
0.810011 - 0.149999i	0.8238
0.810011 + 0.149999i	0.8238
0.615121	0.6151
No root lies outside the unit circle	
VAR satisfies the stability condition.	

Source: Authors' computation

4.4.2 Autocorrelation and Heteroskedasticity Tests

The result of the VAR Residual Portmanteau and heteroskedasticity tests reveal that the models are okay as there exists no evidence of residual autocorrelation and heteroskedasticity at the 5% level of statistical significance.

Table 8: VAR Residual Portmanteau Tests for Autocorrelations

Null hypothesis:		**No residual autocorrelations up to lag h**			
Sample:		2006Q1 – 2022Q2			
Included obs:		64			
Lags	**Q-Stat**	**Prob**	**Adj Q-Stat**	**Prob**	**df**
1	6.6858	NA	6.7919	NA	NA
2	23.5564	0.0997	24.2067	0.0851	16

Source: Authors' computation

Table 9: VAR Residual Heteroskedasticity Tests (Level and Squares)

Joint Tests		
Chi-sq	**df**	**Prob**
217.7371	220	0.5305

Source: Authors' computation

5 CONCLUSION AND POLICY RECOMMENDATIONS

The paper examines the relationship among specific macroeconomic variables in Nigeria utilising quarterly data from 2006Q1 to 2022Q2, having captured the effect of a break in the real GDP series following the COVID-19 Pandemic. The Toda Yamamoto VAR/Granger causality approach was employed. The results reveal the presence of both bidirectional and unidirectional causality between money supply growth, lending rate and inflation. Specifically, money supply growth determined and was determined by lending rates, while a unidirectional causality was established from inflation to lending rate. Impulse response functions reveal that increasing levels of growth in money supply cause a marginal rise in the level of inflation as observed by Amaral, Dyhoum, Abdou, & Aljohani (2022) for the case of the US, and a contemporaneous decline in real GDP growth. Consequently, an increase in money supply growth causes some decline in real GDP growth. This implies that the higher the levels of liquidity, the lower the levels of economic growth. Though increasing levels of inflation cause a decline in growth of money supply and rising interest rates, which are expected to cause a decline in economic growth, the opposite is observed. Results from the variance decomposition suggest that money supply growth does not contribute immensely to the behaviour of other variables in the model, except in relation to maximum lending rates. The Central Bank is encouraged to constrain liquidity, to some certain threshold, in a bid to promote real growth as well as liaise with other authorities to control the overall effect of various factors on the level of economic growth.

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