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Impact of monetary policy on disaggregate inflation in Nigeria: A *structural var approach*

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Abstract
This paper examined the impact of monetary policy on disaggregate inflation in Nigeria over the period January 2002 – June 2020. The paper also investigated the impact of oil price shocks on macroeconomic variables in Nigeria. Using a linear Structural VAR approach, we found evidence that a decline of the monetary policy rate does not reduce inflation. In addition, exchange rate seems to have a significant impact on core inflation. That is, a shock to exchange rate decreases core inflation in the long-run, although there is no impact in the short-run. However, in the case of food inflation, an exchange rate shock increases food inflation in the long-run, likely due to the impact on food import. The study further establishes that oil price shock is key in explaining fluctuations in macroeconomic variables in Nigeria.

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1. Introduction

The efficacy of monetary policy is to ensure price stability and sustainable economic development. The traditional monetary transmission mechanism transpires through interest rate channels, which affect interest rates, costs of borrowing, levels of physical investment, and aggregate demand. Aggregate demand may be impacted through friction in the credit markets known as credit view. Achieving a stable rate of overall inflation largely depends on how it affects firm's pricing decisions in different sectors. The effects of monetary policy on disaggregate inflation are expected to differ from those on aggregate inflation due to the different channels of monetary transmission mechanisms, degrees of price stickiness, etc. Altissimo *et al*. (2009) [1]; Bils and Klenow (2004) [6]; Baumeister *et al*. (2013) [3]; and Clark (2006) [10] show that there are important differences in the dynamics of inflation at the aggregate and sectoral level. Thus, the measure of aggregate inflation may hide the dynamics of disaggregate inflation. Accordingly, Balke and Wynne (2007) [2] argue that the aggregate price index alone may not be the most appropriate guide for formulating monetary policy. Instead, Aoki (2001) argues that stabilizing the relative prices of different commodities around their optimal value is one of the most effective goals for a central bank. Therefore, it is critical that monetary authorities recognize how the prices of various commodities in different sectors respond to monetary policy action. This paper x-rays the effects of monetary policy on disaggregate inflation in Nigeria from 2006 to 2019. It is fundamental to note that empirical evidence on the effects of monetary policy on disaggregate inflation is inclusive.

Thus, the present study extends the literature on the effect of monetary policy on disaggregate price levels in three directions. First, we analyze the effects in a large emerging market economy (EME) such as Nigeria as most studies in the extant literature have focused on advanced economies (AEs) (Bernanke *et al*., 2005; Ellis *et al*., 2014). However, it is well established that the conduct and effects of monetary policy in EMEs differ widely from those in AEs (Frankel, 2010; Lahiri and Patel, 2016) [15, 19]. In general, EMEs suffer from less developed political and institutional systems (Fraga *et al*., 2003). Moreover, their financial markets are still developing, coupled with some challenges that present a mere enabling environment for monetary authority to control.

It is pertinent to note that studies have also revealed that empirical evidence on the effects of monetary policy on disaggregate inflation is indecisive hence still a work in progress. For illustration, Lastrapes (2006), Balke and Wynne (2007) [2], Baumeister *et al* (2013) [4] infers that monetary policy plays a differential effect on relative commodity prices at the disaggregate level. In contrast, Boivin *et al*. (2009) [7] expressed that monetary policy plays little or insignificant role in explaining the discrepancies in individual prices (see also De Graeve and Walentin, 2011) [12]. The rest of the paper is structured as follows. Section two presents the stylized facts on monetary policy and price developments in Nigeria, while section three dwells on the theoretical and empirical literature. Section four deals with the methodological and data issues while the discussion of empirical results is in Section five. Section six concludes the paper and proffer policy recommendations.

2. Literature Review

2.1. The Quantity Theory of Money

Classical monetary economists explained the relationship between money supply and price level using the Quantity Theory of Money (QTM). QTM postulates that the quantity of money in circulation determines the changes in the general price level. This simple relationship is illustrated as

$$P = VM/Y \quad (1)$$

Where P is the price level, V is the velocity of money, M and Y represent money supply and is real output respectively.

The Quantity Theory of Money has five basic postulations; first, a direct and proportionate relationship exists between money supply and price level such that a percentage change in money supply will lead to a proportional percentage change in price level. The assumption is directly linked to the classical hypothesis of transactional use of money. That is, since people hold money for the purchasing power (i. e the real value of money), the price level must be proportionate to nominal money supply to maintain real balances (Humphrey 1974) [16].

Second, the theory assumes a unidirectional causal relationship between M and P, meaning that changes in money supply precede changes in price level. According to Humphrey (1974) [16], a change in money supply affects prices through two transmission mechanisms; the direct expenditure and indirect interest rates. The former suggests that a rise in money supply affects prices through its effect on the demand for goods, while the latter suggests that a rise in money supply will first trigger a fall in interest rates, and spur investment, before there is a rise in the price level.

Third, the theory postulates that money supply has no effect on other macroeconomic variables such as output and employment in the long run. However, in the short run, money supply may exert temporary effects on them.

Fourth, general price level responds principally to changes in money supply and not to non-money factors or real sector activities.

Finally, the nominal stock of money is exogenously determined by the central banks. That is, the nominal stock of money is not determined by the demand for money, rather by the central bank's balance sheet.

The classical Quantity Theory has been critiqued overtime on the basis of unrealistic assumptions; for instance, the modern Keynesians refute the assumption of full employment, and the Post-Keynesians critiqued the assumption of constant velocity of money, constant demand for real balances. Thus, other theories have been proposed to explain the link between money supply and prices.

2.2. Keynes' Reformulated Theory of Money

The Keynesian theory of money argues against some of the basic assumptions of the classical theory. Most importantly, it argues against the direct transmission mechanism between money supply and price level. The theory however, suggests that changes in money supply affects prices via the interest rates channel. Thus, a rise in money supply is assumed to lead to a fall in interest rate and consequently increase investment, which will in turn will raise effective demand and consequently increase prices. The theory also suggests that an increase in money supply will not only raise prices, but will also raise income, output and employment (Humphrey, 1974) [16].

These arguments are founded on five assumptions; first, the theory assumes perfect elasticity of factors of production and constant wages; second, the assumption of homogeneity of factors of production; third, the assumption of constant returns to scale; forth, non-proportionality between prices and output; and finally, quantity demanded and quantity of money change in the same proportion when there is unemployment of resources.

In essence, the Keynesian theory of money postulates that in the short-run when unemployment exists, changes in output will be proportionate with changes in money supply while prices will remain unchanged. However, in the long run, when resources are fully employed, changes in money supply will lead to proportionate changes in prices.

In addition to examining the nexus between inflation and monetary policy, this study also examines the various channels of monetary policy transmission with the aim of deriving recommendation for effective monetary policy implementation. Thus, some theoretical monetary policy transmission mechanisms are discussed below.

2.3. Monetary Policy Transmission Mechanisms

The transmission channels of monetary policy are the mechanisms through which monetary policy decisions are reflected in the price levels and inflation. Based on Mishkin (1996) [20], we provide an overview of the theoretical monetary policy transmission channels.

2.3.1. The Interest Rate Channel

The interest rate channel is a key monetary policy transmission channel under the Keynesian ISLM model. The model is expressed as follows:

$$M \uparrow \rightarrow i \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow \quad (2)$$

The above illustrates an expansionary monetary policy ($M \uparrow$), where there is a decline in real interest rates ($i \downarrow$), which in turn lowers the cost of capital and raises investment spending ($I \uparrow$). This rise in investment spending raises aggregate demand, and this causes a rise in national output ($Y \uparrow$).

It is important to note the following assumptions of the interest rate channel; real interest rate rather than nominal interest rate affect investment decisions; real long-term interest rates affect investment spending instead of short term interest rates; prices are sticky, implying that an expansionary monetary policy, which reduces short term nominal interest

rates, will also reduce short term real interest rates as well as long term real interest rate.

2.3.2. The Exchange rate Channel

The exchange rate channel plays a significant role in the transmission of monetary policy decisions to the real economy (Taylor 1993) [23]. A basic representation of this channel is given as follows;

$$M \uparrow \rightarrow i \downarrow \rightarrow E \downarrow \rightarrow NX \uparrow \rightarrow Y \uparrow \quad (3)$$

Where M, i and Y are as previously defined, E represents the domestic exchange rate and NX represents net exports.

The relationship described in equation (2) explains how a reduction of domestic real interest rates will affect national output via its effect on the domestic exchange rate. The relationship is such that a fall in domestic interest rates $(i \downarrow)$ will trigger a depreciation of the domestic interest rate $(E \downarrow)$. This will consequently make domestic goods more attractive than foreign goods and cause a decrease in imports, leading to a rise in net exports$(NX \uparrow)$. Finally, a rise in net exports will lead to a rise in aggregate demand$(Y \uparrow)$.

2.3.3. The Bank Lending Channel

The Bank lending channel emphasizes the key role of banks in providing credit to the private sector. This channel is expressed as;

$$M \uparrow \rightarrow bank\ deposits \uparrow \rightarrow bank\ loans \uparrow \rightarrow I \uparrow \rightarrow Y \uparrow \quad (4)$$

The above equation is an expression of the impact of an expansionary monetary policy on investment and output through its impact on the bank deposits and bank loans. Edwards and Mishkin (1995) [13] and Miskin (1996) argue that this channel has become less potent in developed countries with more advanced financial systems and it has a larger effect on smaller firms than larger ones with access to the capital market.

2.4. Empirical Literature Review

Empirical literature is awash with studies on the effectiveness of conventional monetary tools in achieving monetary policy objectives. These studies are usually centred around the impact of money supply on output, inflation and unemployment and the mechanism through which the impact is transmitted.

A wide strand of literature has examined the impact of conventional monetary policy on aggregate inflation or consumer price index across developed and emerging markets (e.g. Vogel (1974); Dwyer and Hafer (1988); Poole (1994); Graude and Polan (2005); Akram (2009); Anzuini *et al* (2010); Hammoudeh *et al*, (2015) etc.). However, the impact on disaggregate inflation has received less attention, particularly in emerging market economies. Aoki (2001), Dash and Kumar (2020) [18] assert that the response of the aggregate inflation to monetary policy is expected to differ from the response of various components of inflation due to different monetary policy transmission mechanisms and degrees of price stickiness. Thus, the present study seeks to revisit the efficiency of money policy in reducing inflation in Nigeria with emphasis on the components of inflation (i.e., Core and Food inflation).

Based on research techniques, we observed three broad themes in the literature; first, macroeconomic models, essentially modelling the money supply, inflation nexus using simple regression model. The second is the use of Dynamic Stochastic General Equilibrium Model (DSGE Models), and the third is the use of different variants of Vector Autoregressive (VAR) Models. The studies discussed in this section fall into one or more of these categories highlighted herein.

3. Methodology

3.1. Data Measurement and Variable Description

The study employed monthly data obtained from the Central Bank of Nigeria for the period 01-01-2002 to 06-01-2020, making cumulatively 224 observations. Monthly series are preferred as it increases the data points and provides greater degrees of freedom. In this study oil prices are used in real terms, taking the ratio of the average world nominal oil price in US dollars to the US Consumer Price Index extracted from CBN Database. The definition of oil prices adopted for the study is symmetric oil price growth rates as well as asymmetric definition of oil price changes.

The study examines the impact of oil price volatility on Gross Domestic Product, Exchange Rate and Inflation rate in Nigeria using a Structural Autoregressive (SVAR) Model.

3.2. Model Specification

3.2.1. Specification of Linear SVAR Model

Generally, an SVAR Model is specified as:

$$Y_t = m + A_1 y_{t-1} + A_2 y_{t-2} + \cdots A_p y_{t-p} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Equation (1) specifies VAR (p) process, where A_i $(i = 1, 2, \ldots\ldots, p)$ are k x k matrices of coefficients, m is a k x 1 vector of constants and ε_t is a vector of white noise process. The easiest way to appreciate the feature of VAR is to specify a sample VAR. consider a simple VAR where k= 2 and p=1. This gives:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} m_1 \\ m_2 \end{pmatrix} + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \quad (2)$$

$$y_t = v + A y_{t-1} + U_t \ldots\ldots\ldots\ldots (3)$$

More explicitly, this can be written as:

$$y_t = m_1 + a_{11} y_{1,t-1} + a_{12} y_{2,t-1} + \varepsilon_{1t} \quad (4)$$

$$y_t = m_2 + a_{21} y_{1,t-1} + a_{22} y_{2,t-1} + \varepsilon_{2t} \quad (5)$$

Thus, each variable in VAR is expressed as a linear combination of lagged values of itself and lagged values of all other variables in the group. The behavior of y depends on the properties of the A matrix. If the Eigen values and Eigen vectors of A matrix are:

$$a = \begin{pmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{pmatrix} \qquad C = \begin{pmatrix} \vdots & \vdots \\ c_1 & c_2 \\ \vdots & \vdots \end{pmatrix}$$

Provided the Eigen values are distinct, the Eigen vectors will be linearly independent and C will be nonsingular. It then follows that;

$$C^{-1} AC = and\ A = C\, C^{-1} \ldots\ldots\ldots\ldots\ldots \quad (6)$$

Defining a new vector Z_t as:

$$Z_t = C^{-1}y_t \; or \; y_t = CZ_t \quad (7)$$

The process of pre-multiplying (2) by C^{-1} and simplifying gives:

$$Z_t = m^* + Z_{t-1} + \eta_t \quad (8)$$

Where $m^* = C^{-1}m \; and \; \eta_t = C^{-1}\varepsilon_t$.

Thus,

$$Z_{1t} = m_1^* + \lambda_1 Z_{1,t-1} + \eta_{1t} \quad (9)$$

$$Z_{2t} = m_2^* + \lambda_2 Z_{2,t-1} + \eta_{2t} \quad (10)$$

Each Z variable follows a separate AR (1) process and is stationary I (0), if the Eigen value has modulus less than 1; is a random walk with drift I (1), if the Eigen value is 1; and is explosive, if the Eigen value exceeds 1 in numerical value. Finally, it is important to look for the cointegrating relation. Using equation (4) such relation can readily be found. The second bottom row in equation (4) gives:

$$Z_{2t} = c^{(2)}y_t \ldots\ldots\ldots\ldots \quad (11)$$

Where $c^{(2)}$ is the bottom row in C^{-1}. Thus, $z_2$is the linear combination of I(1) variables but is itself a stationary I(0) variable. The co-integrating vector annihilates the I(1) component in y_t.

The model of this study is specified as:

$$\begin{aligned}\Delta GDP_t = {} & \sum_{i=1}^{L} \alpha_{11}^{i}\Delta GDP_{t-i} + \alpha_{12}^{0}\Delta EXR_t \\ & + \sum_{i=1}^{L} \alpha_{12}^{i}\Delta EXR_{t-i} + \alpha_{13}^{0}\Delta CPI_t \\ & + \sum_{i=1}^{L} \alpha_{13}^{i}\Delta CPI_{t-1} \\ & + \sum_{i=1}^{L} +\alpha_{15}^{0}\Delta COP_t + \sum_{i=1}^{L} \alpha_{15}^{i}\Delta COP_{t-i} + \varepsilon_{1t}\end{aligned}$$

$$\begin{aligned}\Delta EXR_t = \sum_{i=1}^{L} \alpha_{21}^{i} = {} & \Delta EXR_{t-i} + \alpha_{22}^{0}\Delta GDP_t \\ & + \sum_{i=1}^{L} \alpha_{22}^{i}\Delta GDP_{t-i} + \alpha_{23}^{0}\Delta CPI_t \\ & + \sum_{i=1}^{L} \alpha_{23}^{i}\Delta CPI_{t-i} + \alpha_{25}^{0}COP_t \sum_{i=1}^{L} \alpha_{25}^{i}\Delta COP_{t-i} + \varepsilon_{2t}\end{aligned}$$

$$\begin{aligned}\Delta CPI_t = \sum_{i=1}^{L} \alpha_{31}^{i}\Delta CPI_{t-i} + {} & \alpha_{32}^{0}\Delta GDP_t \\ & + \sum_{i=1}^{L} \alpha_{32}^{i}\Delta GDP_{t-i} + \alpha_{33}^{0}\Delta EXR_t + \sum_{i=1}^{L} \alpha_{33}^{i}\Delta EXR_{t-i} \\ & + \sum +\alpha_{35}^{0}\Delta COP_t + \sum_{i=1}^{L} \alpha_{35}^{i}\Delta COP_{t-i} + \varepsilon_{3t}\end{aligned}$$

$$\begin{aligned}\Delta COP_t = \sum_{i=1}^{L} \alpha_{51}^{i}\Delta COP_{t-i} + \alpha_{52}^{0}\Delta GDP_t + \sum_{i=1}^{L} \alpha_{52}^{0}\Delta GDP_{t-i} + \alpha_{53}^{0}\Delta EXR_t \\ + \sum_{i=1}^{L} \alpha_{53}^{i}\Delta EXR_{t-i} + \alpha_{54}^{0}\Delta CPI_t + \sum_{i=1}^{L} \alpha_{54}^{i}\Delta CPI_{t-i} + \varepsilon_{4t}\end{aligned}$$

Where:
GDP is Real Gross Domestic Product; CPI is Consumer Price Index; and COP is Crude Oil Prices. The variables are time series variables and the data sourced from CBN bulletin and OPEC bulletin respectively. The VAR model is adopted for this study because of the forecasting power relative to large structural models. Also, as a common virtue of VAR, the variables are all endogenous, hence, bypasses the decision as to what contemporaneous variables are exogenous.
The study is also interested in capturing the effect of oil prices changes in Nigeria. An exogenous variable, x_t will be incorporated in the VAR model to show this effect. Therefore, the model will be re-specified as;

$$y_t = m + Ay_{t-1} + Bx_t + \varepsilon_t$$

x_t is a difference between the actual oil production level and the potential oil production level. It is an exogenous variable in the VAR specification representing the activities of the Niger-Delta militants.

3.3. Stationarity Tests

The properties of the time series data will be tested in order to determine the order of integration to show the stationarity of the series. For this, the study will employ two-unit root tests; the Augmented Dickey Fuller (ADF) test and the Philips-Perron (PP) unit root tests. If the series is correlated at higher order lags, the assumption of the white noise disturbance is violated. The ADF test takes the unit root as the null hypothesis H_0: P =1. Since explosive series do not make much economic sense, this null hypothesis is tested against the one-sided alternative H_1: p <1. The null hypothesis of a unit root is rejected against the one-sided alternative if the t- statistics is less than the critical value.

3.4. Estimation of SVAR Models

VAR models can be estimated by standard methods. Unrestricted least squares (LS), generalized least squares (GLS), bias-corrected least squares and maximum likelihood (ML) methods are the common classical method of estimation. For the purpose of this research, we intend to fit our data with the aforementioned methods of estimation. The data generating process will govern the selection of the most appropriate method of estimation of the models. It must be maintained that, in this research, we intend to use a stationary process so that the data generating process of the variables used in the study are subjected to standard transformation process.

3.5. Lag Selection Criteria

In this study, we will be guided by two methods of determining the optimal size of lags to be included. Sequential testing procedure and information criteria will be used. In Sequential testing procedure, we further utilize the 'Top-down sequential testing' through Wald or LR tests for parameter restriction while the 'Bottom-up sequential testing', we utilize Portmanteau and LM tests to decide the optimal number of lags. The information criteria to be used, on the other hand, are the Akaike Information Criterion (AIC), Hannan-Quinn Criterion (HQC), and Schwarz Information Criterion (SIC).

3.6. Models Diagnostics

There are set of tools for checking whether a given SVAR model represents the variables adequately. In this empirical work, our diagnostics will be deduced from the followings

standard SVAR models checks:

Tests for Autocorrelation
A basic assumption for the SVAR model is that the reduced-form innovation process is white noise. In other words, the innovations are assumed to exhibit no serial correlation. The lag order of the model is typically chosen such that this condition is at least approximately satisfied. For a given SVAR model, it may still be desirable to check for residual autocorrelation. In that case, the Portmanteau and Breusch-Godfrey LM tests can be used.

Test for Normality
Although normality of the innovations of a SVAR model and, hence, normality of the observed variables is not required for the validity of most asymptotic procedures related to VAR modeling, arguably, normality can still be a property of interest. For example, it facilitates predictive inference as discussed earlier. Moreover, knowing that the distribution of the observations is far from normal is useful for assessing possible efficiency gains from using other estimation procedures.

Residual ARCH Tests
Conditional heteroskedasticity in the VAR innovations does not invalidate the consistency of standard estimators of the VAR slope parameters, as long as the unconditional error variances remain finite. However, it undermines the efficiency of the estimator and affects how we conduct inference about the parameters of interest. Hence, knowing whether the innovations are conditionally heteroskedastic or not is quite important.

Time Invariance
An important assumption underlying a standard VAR analysis is the time invariance of the model. As defined earlier, stationarity requires time invariance and unconditional moments. That assumption is not only violated if the stability condition is unsatisfied but may also be violated if the parameters change over time. A wide range of procedures for checking the stability or time invariance of a given model exist. Chow test via LR statistic will be utilized to check whether the parameters of the VAR models are fixed.

3.7. Tools of Structural Analysis of SVAR Models
Standard SVAR tools of analysis will be used to draw structural inference for the research. In this work, we intend utilize *'impulse response function', 'forecast error variance decomposition', 'Granger Causality', 'in-sample forecast' and 'out-of-sample forecast', 'forecast scenario', and policy counterfactuals.*
Impulse Response Analysis will be used to trace the effect of mutually (un) correlated shocks on the macroeconomic variables of interest and therefore help in identification of dynamic response of the variables to one standard deviation shocks.
Forecast Error Variance Decomposition helps to decompose the contribution of shocks in explaining fluctuations in the macroeconomic variables. The weights of each shock can be decomposed via prediction mean squared error at various horizons.
We intend to produce forecast scenario to scrutinize the model's predictive power via conditional and unconditional forecast. Thus, the sensitivity of reduced-form SVAR forecasts to hypothetical future events will be evaluated using forecast scenario.

3.8. Identifying Oil Shock using Sign Restriction
In this study, we propose to employ sign restriction as the scheme for the identification of structural shocks in the SVAR. The rationale for opting for this identification is traced to the skepticisms raised by empirical macroeconomists in employing short run and long run restrictions. Following study of fiscal shocks (e.g., Canova and Pappa 2007; Mountford and Uhlig 2009; Pappa 2009) [8, 21, 22], technology shocks (e.g., Dedola and Neri 2007) [11], and various other shocks in open economies (e.g., Canova and De Nicolo 2002; Scholl and Uhlig 2008) [9], in oil markets (e.g., Baumeister and Peersman 2010; Kilian and Murphy 2011a,b) [17], and in labor markets (e.g., Fujita 2011), we develop and adopt the restrictions as revealed in the table below;

Table 1: Identification of Structural Shocks

Structural Shocks	Core $_{inf}$	EXCR $_{oil}$	Food $_{inf}$	RGDP
Contractionary	< 0	-	≤ 0	< 0
Monetary Policy Shock	> 0	-	> 0	-
Exchange Rate Shock	> 0	-	> 0	-
Oil Price Shock				

***Source*:** Authors' Computation 2022

From the restrictions imposed in the table, the shape of the impulse response function will be used to identifying the restrictions that meet the economic theory. The fraction of the initial candidate models that satisfy the identifying restriction may be viewed as an indicator of how informative the identifying restrictions are about the structural parameters.

4. Empirical Results
4.1. Monetary Policy Shocks and Disaggregated Price Response: Evidence from Sign-Identified SVAR
In this section, the main empirical objectives of the study will be achieved. The objectives are established on the basis of the methodological contribution and empirical application.
The first objective to be achieved is connected to quantifying the response of disaggregated prices: core, headline and food inflation to monetary policy shock. Thus, the research employs econometric model of shock identification via sign and zero restriction as introduced by Faust (1998) [14], and popularized by Uhlig (2005). This is a contribution to the methodology, as little or no empirical studies in Nigeria so far uses a combination of zero and sign restriction to identify the response of macroeconomic variables in Nigeria due to monetary policy shock. The second objective is related to oil and exchange rate shock and response of key macroeconomic variable in Nigeria, namely real GDP. The study develops exogenous variables in the VAR framework to account for the role of oil price changes.
The study, as explained earlier, adopts the combination of zero and sign restriction to identify three structural shocks. To recast the identification scheme, the study recalls the information in table 2.

Table 2: Identification of Structural Shocks

Structural Shocks	Core $_{inf}$	EXCR $_{oil}$	Food $_{inf}$	RGDP
Contractionary Monetary Policy Shock	< 0	-	≤ 0	< 0
Exchange Rate Shock		-	> 0	-
Oil Price Shock	$>$	-	> 0	-

***Source*:** Authors' Computation 2022

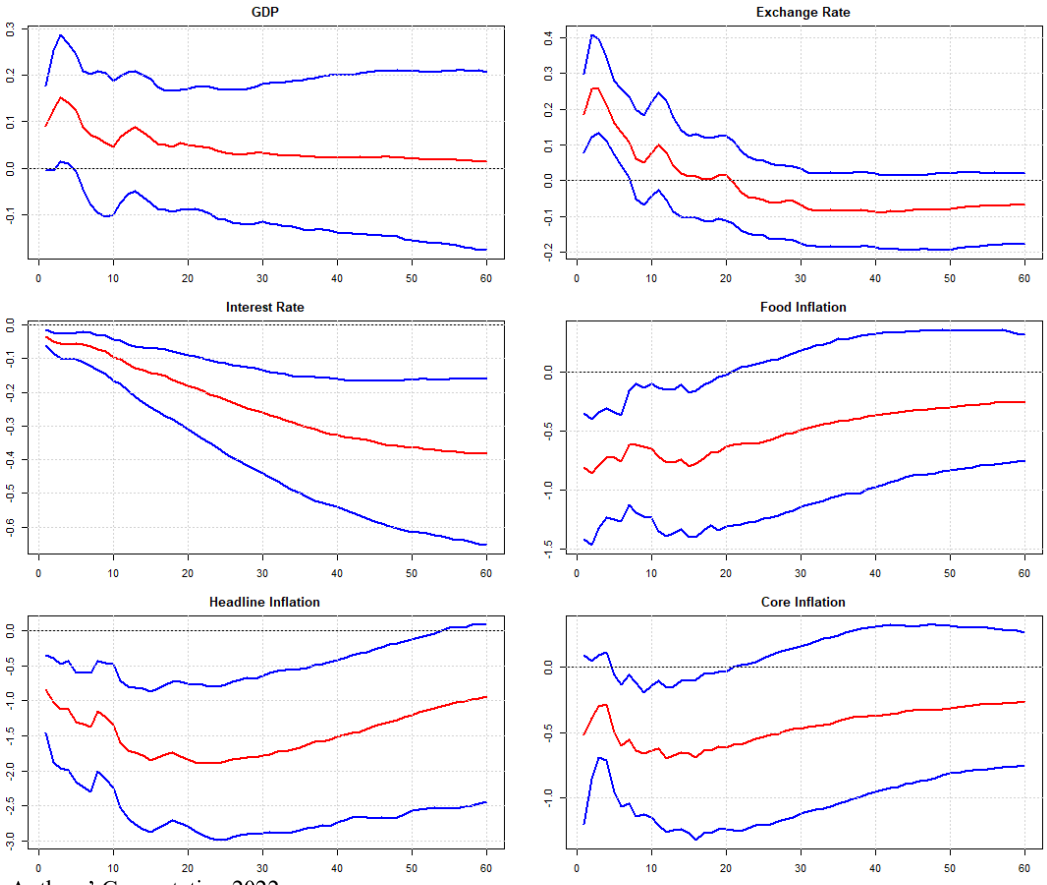
Therefore, the study intends to examine the response and reaction of the Nigeria's macroeconomic variables, namely,

food inflation, core inflation to contractionary monetary policy shocks. The study further re-assesses the response of real GDP to oil and exchange rate shocks. Following Uhlig (2005), the study utilizes rejection method as preached by the author.

4.2. Monetary Policy Shock: Contractionary Monetary Policy

The study aims to explore responses of the macroeconomic variables in Nigeria to unanticipated changes in monetary policy stance. We examine the shape and changes in the structural impulse response in the figure below. The monetary policy shock can be stimulated via several episodes, one of which is a surprise movement in the monetary policy rate. The lines below extract the posterior impulse responses and plots the resulting responses to monetary policy shock. The important macroeconomic variables to be analyzed via its responses is the real GDP because it gives some understanding about the fluctuation in the level of economic activities.

Interestingly, structural shock hitting the economy are described in figure 7 where the reaction of the real GDP, real interest rate, exchange rate, GDP deflator, consumer price index and oil production gap is depicted.



***Source*:** Authors' Computation 2022

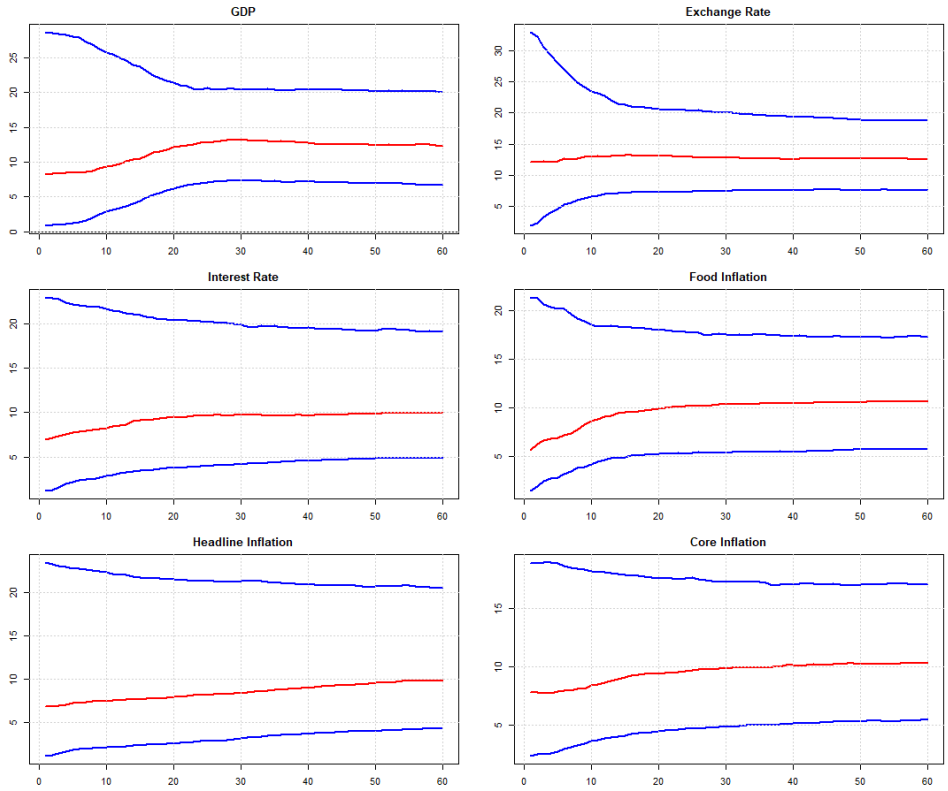
Fig 1: Structural Impulse Response to Monetary Policy Shock

From the top left corner of figure 1, we can see that real GDP remain positive throughout the shock scenario, with some fluctuations around the mean value. It is also observed from the figure that there is wide error band around the response of the real GDP which may suggests that the real GDP exhibit uncertainty in its path. The uncertainty in the response of real GDP increases as the time horizon goes further into the future. Thus, with monetary policy shock which is induced as a result of increase in monetary policy rate, Nigeria's real GDP will exhibit positive response. This can be traced to the rise in the price of oil following positive demand shock.

Exchange rate behaves abnormally by reacting, first as appreciation, then consistently depreciates throughout the shock horizon. Put differently, the exchange rate appreciates immediately with oil demand shock and then reacts negatively, approaches zero horizon, and further plunge into depreciation of the country's currency.

Core inflation and GDP deflator react quite in opposite directions. While core inflation consistently and persistently falls, the GDP deflator rises following contractionary monetary policy shock. This scenario underscores the importance and dominance of monetary policy shock over fiscal policy in dynamic interaction of the macroeconomic variables in Nigeria.

Figure 2 illustrates the estimates of forecast error variance decomposition of the structural shock from oil demand. Thus, from the dynamic response of the real GDP in the figure, the study can deduce that real GDP's contribution to the fluctuation of the Nigeria's economy is big-impact movement. The size of the fluctuation in real GDP determines the performance of the economy. Also, as reveal from the figure, exchange rate seems to be important in responding to oil demand shock with almost equal strength as the real GDP. It can be traced to the fact that the Nigeria's economy is best described as a Small-Open Economy (SOE). Thus, exchange rate, which is seen as externally determined, will play significant role in dynamic interaction and reaction of key macroeconomic variables in the Nigerian economy.

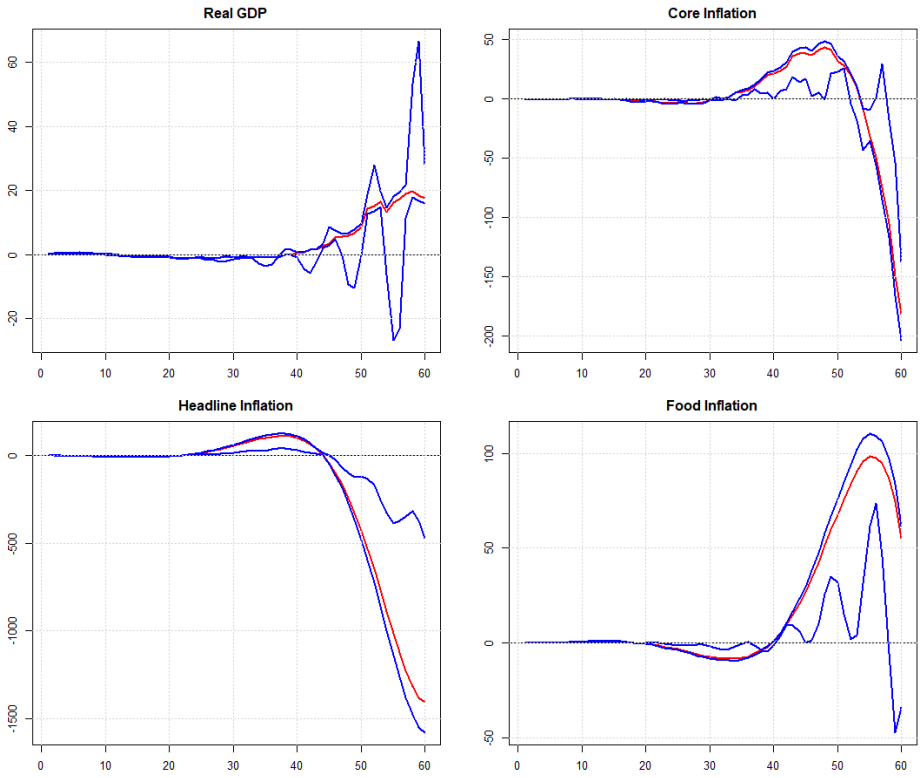


***Source*:** Authors' Computation 2022

Fig 2: Forecast Error Variance Decomposition

4.1 Exchange Rate Shock

In this analysis, the study evaluates shape of the orthogonalized impulse response of the endogenous variables in the system. The model is estimated using the same settings as in Uhlig (2005), i.e. 12 lags, no constant, and 60 steps for the impulse response functions. The algorithms use 200 draws from the posterior and 200 sub-draws for each posterior draw to generate the impulse vectors and the candidate impulse responses to which the rejection algorithm will be applied.



***Source*:** Authors' Computation 2022

Fig 3: Structural Impulse Response to Exchange Rate Shock

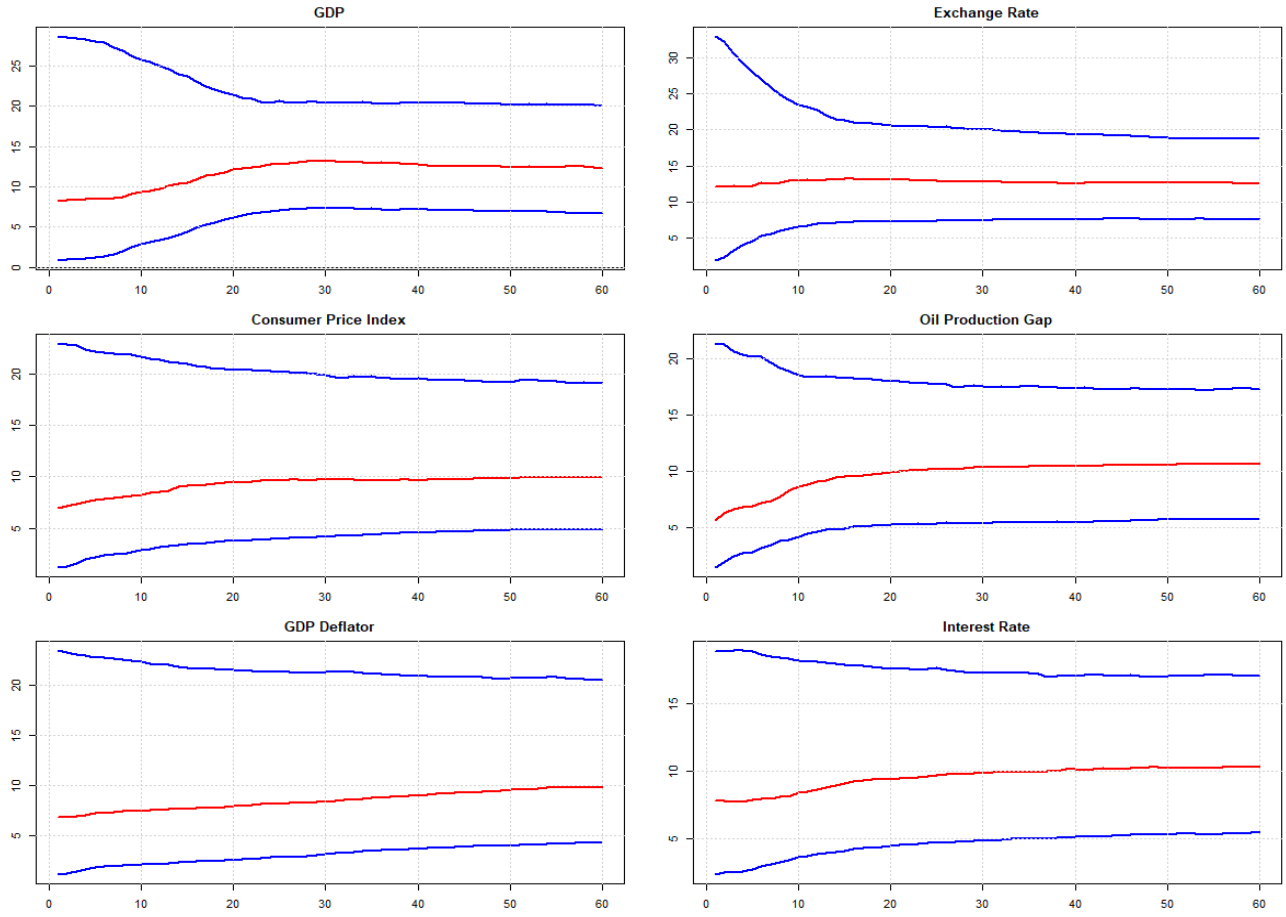
From the plots of the responses of the key macroeconomic variables, the study can infer about the dynamic response of each of the six-component vector of endogenous variables. The red-line shows the point estimates of the responses while blue-line is error band which is fixed at 68% standard error.

From the top left corner of figure 3, the response of real GDP to a one-unit standard deviation increase in the global oil supply indicates that Nigeria's real GDP reacts negatively with initial shock transmission into the economy. The persistence decline in real GDP continues rather slowly as the time horizon goes deeper into the future. The shape of the impulse response of the real GDP further declines until it approaches zero at the 60th horizon before the impact of the shock dies out of the economy. Empirically, the study can establish that fall in oil price due to increase in its supply will generate fall in revenue into the economy. This will translate into lower real GDP in Nigeria.

The unrestricted sign attached to real exchange rate shows that the response of the exchange rate to increase in oil supply is persistent depreciation of Nigeria's currency. From the top right corner of figure 8, it shows that there is immediate short-lived positive reaction of the Nigeria's currency with increase in the global supply of oil at the international market which gradually becomes negative induced-movement. The persistent depreciation continues until it reaches zero at 20th horizon and becomes negative throughout the shock scenario. The consumer price index is negative and remains in the region for the entire period of the shock. This behavior of the consumer price index can be explained in terms of high degree of openness nature of the Nigeria's economy. The fall in price resulting from increase in oil supply makes the Nigeria's economy more vulnerable and, therefore, the immediate negative reaction of the consumer price index.

The response of the oil production gap to a one-unit increase in the supply of oil is depicted to be positive. The supply shock in oil widens the oil production gap in the economy as the activities of the Niger-Delta increases. Their disruption of oil production increases as a result of the increase in the supply of oil at the global market.

The response of GDP deflator and real interest rate shows that while the former increases positively to the shock, the latter shows a negative reaction. These responses can be attributed to the fact that the economy is heavily influenced by external shocks (trade and financial shocks).



***Source*:** Authors' Computation 2022

Fig 4: Forecast Error Variance Decomposition

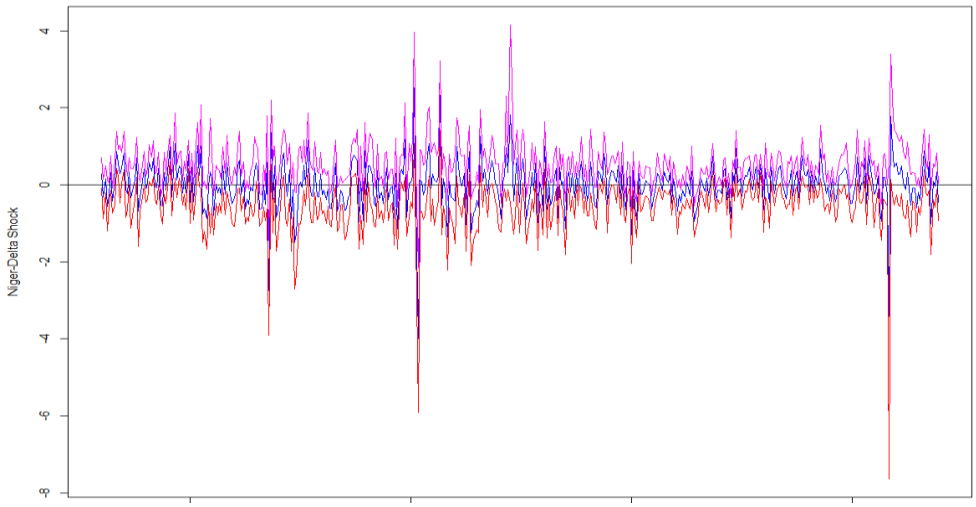
The figure 4 gives the estimates of the forecast error variance decomposition with oil supply shock. We can see that as the time horizons increases into the future, the contribution of the GDP, exchange rate, consumer price index, oil production gap, GDP deflator and interest rate becomes significant in the economy.

Table 3: Selected macroeconomic indicators

Period	GDP	Food Infl.	Core Infl.	Exc. Rate	Oil
1	8.26	6.93	6.83	5.68	7.78
10	9.31	8.27	7.49	8.59	8.36
20	12.16	9.49	8.02	9.92	9.38
30	13.15	9.73	8.43	10.36	9.83
40	12.81	9.67	9.06	10.45	10.12
50	12.48	9.85	9.62	10.55	10.26
60	12.34	9.97	9.86	10.6	10.3

***Source*:** Authors' Computation 2022

From the table 3, it can be seen that at the initial forecast horizon, the role of interest rate can be strongly felt by the economy (12.15), although marginal, but exert greater influence in the economy. The contribution of the real IR and real GDP remain strong in the economy till the last end of the forecast error. Thus, the table 3 reveals that much of the fluctuation of the Nigeria's economy following oil supply shock is traced to the vulnerability of the real measure of economic activity, real GDP and real interest rate. Other significant determinant of the macroeconomic fluctuations in Nigeria's, as revealed from the table, is traced to the role of exchange rate in the country. Thus, the study further illustrates the Importance of external economy in (dis)stabilizing the economy.



***Source*:** Authors computation 2022

Fig 5: Exogenous Shock of Oil Price

4.4 Oil Shock

In this sub-section, the study aims at achieving the role of oil fluctuation in explaining inflation changes in Nigeria. The study uses this variable as exogenous in the model and extract orthogonal shock from error-covariance matrix and produce figure 5.

Inference from the plot in figure 5 suggests that the oil production gap is significant in determining the performance of the economy. The series causes significant changes in the oil production and this creates instability in the performance of the economy, loosely put, the shock coming from disruption of oil price shock. From the figure 5, volatility in oil production which is induced from oil disruption is erratic and unpredictable, with high tendencies of producing fluctuations in the real GDP of the country. For this, one can say that, based on the evidence in figure 5, the activities of the global oil shock has far reaching negative consequences on the performance of oil sector, it's production level, the revenue generated and subsequently, economic activities in the country.

5. Summary and Conclusion

5.1. Summary of Findings and Contribution to Literature

The main objective of this empirical investigation, is to determine the impact of monetary policy shock on the disaggregated behaviour of prices in Nigeria using three component of inflation; food, core and headline to represent disaggregated price behavior. The study, has also among other things, analysied the impact of oil price volatility on the macroeconomy of Nigeria and has been able to unveil interesting facts in several layers and obtain data-driven conclusions. Thus, we were able to establish contribution to knowledge in empirical application as well as methodological gap.

The contributions of this study can be summarized constructively in two folds. In the area of empirical application, the study can report, with high degree of confidence, to the best of our knowledge, that there has not been any study in Nigeria that incorporate core, food and headline inflation. The study accomplishes this task intuitively and scientifically by generating a series of disaggregated price data and analysing the impact of the contractionary monetary policy shock on the dynamics of price movement in Nigeria.

On the issue of methodology, the study can argue, with reasonable justification, that most of the existing studies in Nigeria that analyze monetary policy and oil price shocks employ weak and less-encompassing method of

identification. It must be mentioned that recursive identification, short-run identification and long-run identification are the main dominant of monetary policy and oil price shock identification in structural vector autoregression. It is already established in the literature that recursive identification cannot properly identify oil price shock in structural vector autoregression, and equally, the short-run and long-run identification scheme cannot yield orthogonal shock. So, it is based on these weakness that this study adopts more robust and superior method of shock identification; sign restriction of Arias et'al (2014).

5.2. Conclusion

The purpose of this paper has been to examine the impact of monetary policy shocks on disaggregated inflation in Nigeria over the period January 2002 – June 2020. In so doing, the paper employs the linear S-VAR method and the analysis conducted clearly indicated that contractionary monetary policy shock lead to contraction in all inflation components; food and core while significantly expanding output growth. Three other key findings were highlighted in the paper as follows:

First, a contractionary monetary policy leads to a rise in core and food inflation and the impact persists beyond the 60th horizon. This seems to imply that a decline of the monetary policy rate does not reduce inflation. Secondly, exchange rate seems to have a significant impact on core inflation. That is, a shock to exchange rate decreases core inflation in the long-run, although there is no impact in the short-run. However, in the case of food inflation, an exchange rate shock increases food inflation in the long-run, likely due to the impact on food import.

Third, it is established that oil price is characterized with switches in its dynamic behavior. This means that there are discrete changes in the prices of oil which allows us to assume that the oil prices have differing regimes. The low oil price volatility and high oil price volatility are established in the study based on the characteristics of the volatility, skewness, fat-tails, persistence, varying correlations in the oil price. Second, the study further establishes that the volatilty of the oil price is time varying. Put loosely, there is strong support from the estimates of the model that volatility in the daily oil price is not fixed, but rather revolving and time-specific. This new finding is not so surprising because there are evidences of oil boom (high prices) and oil slump (low prices). In these two different episodes, the mean, variance and covariances of the oil series are not only expected to be different, but it is also expected to be time varying.

Lastly, the study found evidence that oil price shock is key in explaining fluctuations in macroeconomic variables in Nigeria. The volatility in oil revenue leads to volatility in fiscal spending by government and subsequently creating deficit in governmet's ability to provide its fiscal responsibility. Oil shocks from demand side, supply side and other specific shocks that's demand-driven are establsihed to have impacted on the economy of the country. Thus, the study reaffirms the role of oil in influencing the Nigerian economy.

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