Oil Price Shocks and Monetary Policy Aggregates in Nigeria: A Structural VAR Approach

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Oil Price Shocks and Monetary Policy Aggregates in Nigeria: A Structural VAR Approach[1]

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Contents

Abstract

Studies[3] have shown that the impact of oil price volatility varies significantly across countries and within the different sectors of a particular economy. The impact vary according to the prevailing state of an economy: whether the economy is a net importer or exporter of oil; the exchange rate regime; monetary policy framework; the vulnerability of the key sectors of the economy and the degree of openness of the economy.

In this study, we have used both restricted and unrestricted structural VAR models to decompose the impact of oil price shocks. Using a seven-variable VAR matrix which include monetary policy aggregates, we forecast the impact of a one standard deviation innovation to oil price on inflation rate, money supply, interest rate, government expenditure, GDP per capita growth rate, exchange rate and manufacturing output over a ten-year period. We imposed identification restrictions on the VAR model to identify the structural parameters of the seven equations and show the variance decomposition analysis. The results shows that the second-round effects of oil price shocks may be transmitted to the other sectors of the economy through the government expenditure - inflation rate channels with significant direct impact on the real sector and other monetary aggregates.

[3] For example Hamilton (1998) and (2003), Zha et al., (2007) and, Yucel and Brown (2007)

1 Introduction

Over the past years oil prices have increased sharply, and more importantly, with high volatility. The unpredictable nature of the rapid and volatile changes generally brings about global shocks that have stagflationary macroeconomic implications for most oil -importing countries. These implications slow down the rate of growth, increase the price level (inflation, interest and exchange rates), reduce trade, and invariably may lead to economic recession. The impact of higher oil price shocks on any particular economy depend on several factors among which are: the magnitude of the shock; the duration of the shock (persistence); the dependency of the economy on oil (energy fuel mix and intensity); the immediate policy response to the shock; and the state of the economy before the shock (absorptive capacity or vulnerability).

In order for any economy to be able to ameliorate the adverse consequence of higher oil price shock through appropriate policy responses, there is a fundamental need to understand the complexities of its impacts and the channel through which it is transmitted to other key sectors of the economy. There are several arguments as to the relationship between oil prices and economic performance. Some studies have argued that the relationship between oil price and output growth is mere statistical coincidence (e.g. Hamilton (1983, 2003), while others have associated the negative correlation to model endogeneity problem, attenuation errors and model specification errors, Barsky and Kilian (2004) and Balke Brown and Yucel (1999).

Others studies have emphasized the non-linearity of the relationship and that oil price increases have more adverse negative macroeconomic consequences than the benefit of a decrease in oil price. These arguments put to doubt the policy implications of any empirical result from an estimation of oil price impact on economic growth. This paper does not claim to have totally overcome these technical deficiencies in its estimations either, but reasonable effort is made to theoretically identify the system of equations in the vector autoregressive model -which should significantly reduce the bias in the results and enhance the reliability of the predictions and forecasts.

The paper is structured into six sections; following the introduction in section one, section 2 provides a literature survey and review of the methodology of the research, while section three analyzes the trends in oil prices and other macroeconomic aggregates in Nigeria. Section four is on model specification, identification and estimation, while section five discusses the results of the estimated models and section six concludes.

2 Literature Review

2.0.1 Structural Approach to Vector Autoregressive Modeling

The literature has defined a Vector Autoregressive (VAR) model to consist of system of reduced-form equations relating each endogenous variable to lag endogenous (predetermined) components and other exogenous variables. It is a linear approximation of a non-linear structural model which could be estimated by ordinary least squares or maximum likelihood estimator. Econometricians initially believe that the dynamic characteristics of the economic could be revealed by these functional forms without necessarily imposing structural restrictions from a prior economic theory. Several criticism follow this believes which suggests that the model is atheoretical and hence the outcome of the model have no theoretical foundation. These criticisms led to the emergence of a structural vector autoregressive approach - Bernanke (1986), Sims (1986) and Blanchard and Watson (1986) which allow econometricians to use economic theory to transform the reduced-form VAR model into a system of structural equations where the parameters are estimated by imposing contemporaneous structural restrictions. This method produces impulse response functions and forecast-error variance decomposition that can be given structural interpretations that are supported by standard economic theories.

There are several ways of specifying the restrictions to achieve identification of the structural parameters. One procedure for determining appropriate restrictions to identify a structural VAR is to use the restrictions that are implied from a fully specified macroeconomic model. For example, structural VAR models estimated by Blanchard and Watson (1986), used theory to incorporate short run restriction, Shapiro and Watson (1988) and Blanchard and Quah (1989), used theory to justify the inclusion of long - run restrictions, and Gali (1992), used theory to justify the inclusion of both short-run amd long-run restrictions.[4].

The alternative and more common approach is to choose the set of variables and identification restrictions that are broadly consistent with the preferred theory and prior empirical research. The metric used to evaluate the appropriateness of the variables and restrictions is whether the behavior of the dynamic responses of the model is consistent with the preferred theoretical view of the expected response. Recent attempts to identify monetary policy effects in small open economies by Kim and Roubini (2000) and Brischetto and Voss (1999) are some of the many applications of this second approach. This alternative approach has been described by Leeper, Sims and Zha (1996) as an informal approach to applying more formal prior beliefs to econometric modeling. They argued that the approach is in principle not different from other specification methods used in modeling, so long as the user does not fail to disclose the methods used to select the model.

[4] Garratt, Lee, Pesaran and Shin (1998), Huh (1999), and Buckle, Kim and Tam (2001) also followed this approach.

Brischetto and Voss argued however that there are still several concerns with the identification restrictions that have been applied to structural VAR models in this manner. These include the robustness of the conclusions to alternative reasonable identification restrictions[5], and the difficulty of clearly interpreting what aspects of the model arise from restrictions imposed on the model and what arise from the data. In any case, these concerns can arise in most multi-equation models and are not restricted to structural VAR models.

A popular and straightforward method is to orthogonalize reduce form error by Choleski decomposition as originally applied by Sims (1980). However, this approach to identification requires the assumption that the system of equations follow a recursive structure, that is, a Wold-causal chain. In some cases, Choleski decomposition may coincide with the prior theoretical view of the appropriate model structure and such procedure can be viewed as a special case of a more general approach. There are many circumstances where restrictions resulting from Choleski decomposition will be unreasonable. For example, it would be inappropriate if there are contemporaneous interaction between variables. In such circumstances, if monetary policy for example is implemented according to an explicit policy rule, such as a Taylor Rule, the Choleski decomposition would not enable private sector responses, such as the responses of GDP, to shocks to foreign variables and to monetary policy in a small open economy to be differentiated.

Another more general method for imposing restrictions was suggested by Blanchard and Watson (1986), Bernanke (1986) and Sims (1986), while still giving restriction. This approach permits non-recursive structures and the specification of restrictions based on prior theoretical and empirical information about private sector behavior and policy reaction functions. This more general method has subsequently been extended to small open economy by Cushman and Zha (1997), and Dungey and Pagan (2000) in their structural VAR models of Canada and Australia respectively. Their approach impose two block of structural equations- one block represents the international economy and the other block of structural equations represents the domestic economy. Dependent variables in the domestic economy block are completely absent from the equations in the international block - following naturally from the small open economy assumption.

[5] For example Faust (1998), Joiner, (2002)

3 Trends in Oil Prices and Macroeconomic Aggregates in Nigeria

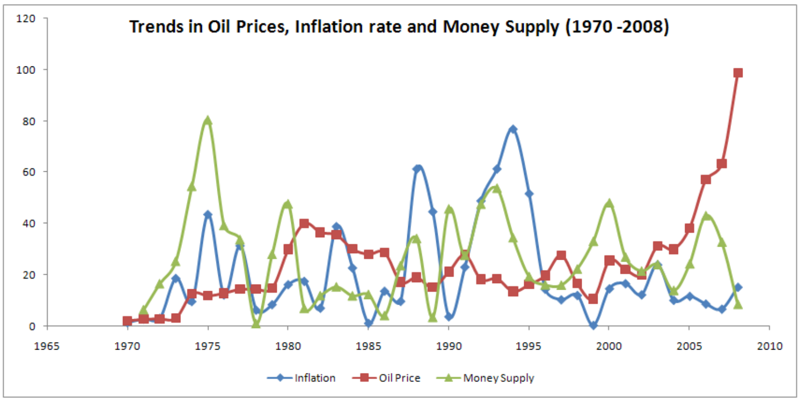

Fig. 1: Nigeria: Oil Prices, Inflation rates and Money Supply

Figure 1 shows the relationships amongst oil price, inflation rate and money supply in Nigeria over the past four decades. There has been some significant variations in the correlations amongst the variables over the period. While there have been some positive correlation between inflation rate and money supply, there are no strong positive correlation between both variables and oil prices.However, it is observed that rising oil prices in the 1970s up to the mid-1980s led to higher volatility in money supply and inflation rate compared to the trend since the late 1990s and early 2000. Since the early 2000, we observed that increases in money supply has not necessary led to corresponding increase in inflation rate, suggesting that monetary policy instruments targeted at the money base may be curtailing the tendencies for higher inflation during the periods. Rising oil prices, since the mid-2000 has also not led to rising inflation, neither is the higher oil prices associated with high inflation rate volatility compared to the periods before.

Figure 2 shows the relationship amongst oil prices, market interest rate and the Central Bank policy rate.Trends in the variables shows high volatility in all the series, particularly between 1990 and 2002. During the period also, we witnessed a persistent widening gap between the policy rate and the interest rate, suggesting a non positive responsiveness of the interest rate to cuts in the policy rate. There are no evidence of a unique relationship between the two variables and the oil price, except for the fact that since the mid-2000, the policy and interest rates have not risen dramatically as increases in oil prices. Both interest rate and the policy rate have followed a downward trend since 2005 but still maintaining a widening gap compared to the previous periods.

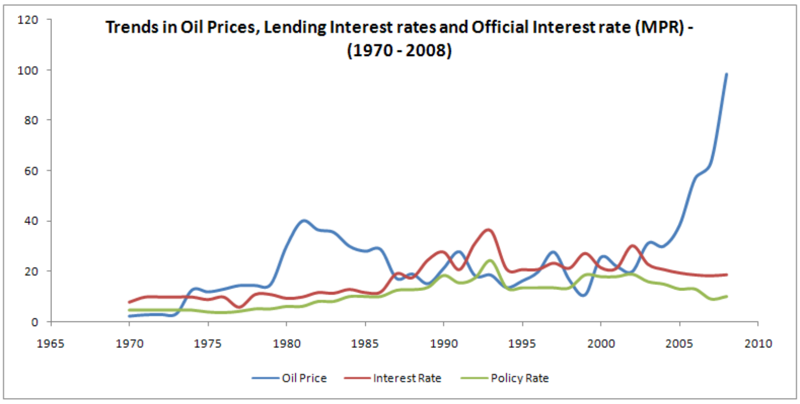

Fig. 2: Nigeria: Oil Prices, Lending Interest rates and Policy rate (MPR)

Figure 3 shows the interrelationships amongst oil price, government expen-

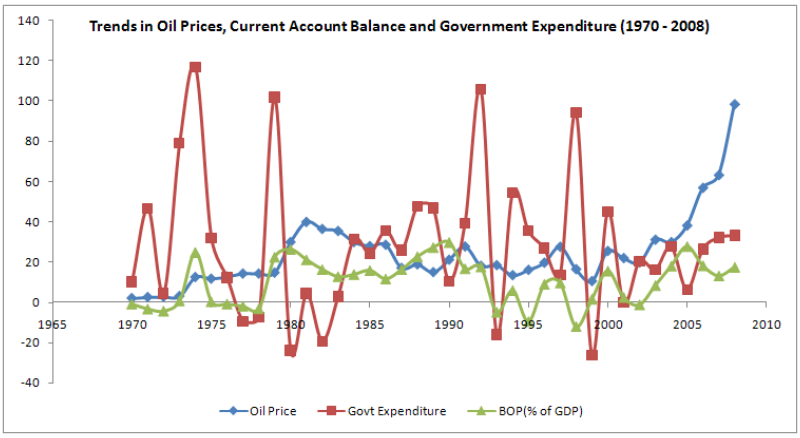

Fig. 3: Nigeria: Oil Prices, Government Expenditure and Current Account Balance (BOP)

diture and the balance of payment position. There are numerous sharp spikes in government expenditure during the review period, except for the slight moderation between 1985 and 1990. There are evidences of positive correlations between oil price and government expenditure (though with some lags), however increases in oil prices have witness more than proportionate increases in government expenditure, particularly, prior to 2000. There are significant moderation in the volatility of government spending in response to changes in oil prices since 2002. The balance of payment current account ratio to GDP remained positive between 1980 to 1993 (even during the periods to falling oil prices) but commenced a negative and volatile trends there after in response to oil price changes. There is a strong positive correlations between oil prices and the ratio of balance of payment to GDP, such that periods of higher oil prices witnessed rising positive BOP balances while falling oil prices corresponds to declining and negative balance positions. The relationship between ratio of current account balance to GDP and government expenditure is mixed with no particular clear pattern, except that in some cases declining government expenditures corresponds to positive balance ratio to GDP. This may suggest that higher government spending during periods of rising oil prices accounts more for the distortionary impacts on balance of payment position than the oil price. Some periods of declining and moderate government spending corresponds to positive and rising ratio of current account balance to GDP.

Figure 4 shows the trends amongst oil price government expenditure and infla-

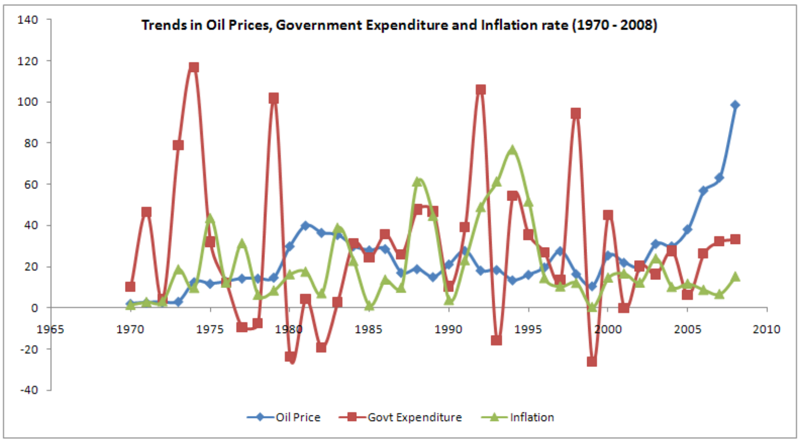

Fig. 4: Nigeria: Oil Prices, Government Expenditure and Inflation rate

tion rate. There is a clear positive correlation between government expenditure and inflation rate, such that periods of increased government expenditure corresponds to periods of rising inflation rate. The relationship between inflation rate and oil prices close and positive form the late 1990s up to 2003, however, since 2005, the periods of rising oil prices correspond to periods of declining inflation rate. Higher government spending still corresponds to rising inflation rate in this relationship too, suggesting the negative impact of government spending on the inflation rate.

Figure 5 shows the relationships amongst oil price, interest rate (lending) and manufacturing output growth. There is a wide gap between the percentage increase in oil prices and the corresponding rise in GDP growth or manufacturing output growth over the entire review period. This may suggest that higher revenue accrued from higher oil prices does not necessarily translate to increase in manufacturing output or GDP growth rate. Since 2005, there are indications of strong positive correlation between manufacturing output growth and the GDP growth rate. There are also indications that increase and volatile interest rate is associated with decline manufacturing output. Interestingly, oil price and manufacturing output maintained a positive correlation contrary to the propositions of the 'Dutch Disease' hypothesis of negative correlation. Although of lesser magnitude, the average rising oil prices since 2002 witness a corresponding marginal increase in manufacturing output growth.

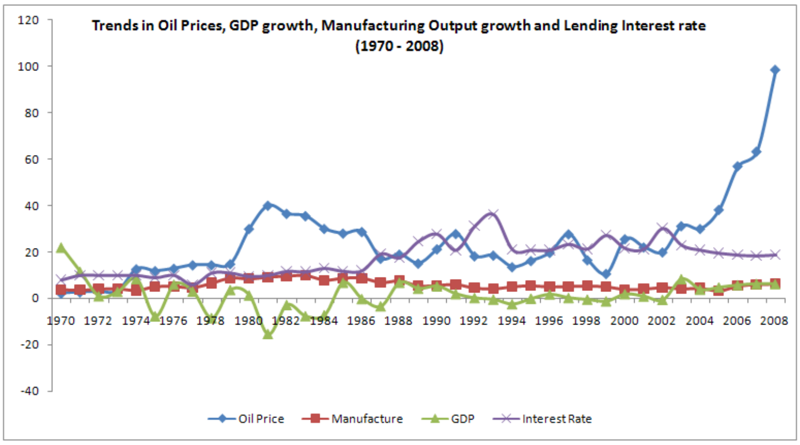

Fig. 5: Nigeria: Oil Prices, GDP growth rate, Manufacturing Output and Lending Interest rate

4 Model Specification

4.0.2 The Model

We construct an unrestricted VAR model, ignoring at the initial stage, deterministic elements such as trend and intercept terms - written as:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} +, ..., + A_p y_{t-p} + \mu_t \quad (1)$$

where:

y_t is an (n x 1) vector containing n endogenous variables,

$A_i (i = 1, 2, ..., p)$ are (n x n) matrices of coefficients,

and μ_t is an (n x 1) vector containing error terms.

$\mu_t \sim iid\ N(0, \Omega)$ - Is the assumption that the errors are normally distributed, with zero mean and serially uncorrelated with variance-covariance matrix Ω. However, the errors do possess the potential to be contemporaneously correlated across equations.

There are pn^2 parameters in the A matrices. Using the lag operator L, defined by $L^k x_t = x_{t-k}$ the equation can be rewritten as:

$$A(L) y_t = \mu_t \quad (2)$$

where
$A(L) = A_0 L^0 - A_1 L^1 - A_2 L^2 - ...... - A_p L^p$
$A_0 = I$ (identity matrix), and to ensure stationarity, the root of $|A(L)|$ lie 'outside the unit circle.'

Choosing the variables for the VAR model, we follow the standard procedure[6] to include activity variables, price variables, financial variables, policy variables and an oil variable. On account that oil price shocks have been argued to account for declining real sector oil exporting countries, we have included manufacturing output as an additional variable in the model. The variables that we have considered in the model include; GDP per growth, inflation rate, interest rate, exchange rate, money supply, government expenditure, BOP (Current), manufacturing output and oil price.

4.0.3 Data, Definitions and Robustness Tests

Monetary policy aggregates play important roles in growth sustainability and macroeconomic stability. It is found in the literature[7] that economic growth

[6] Such as suggested in Sims (1980).
[7] See Bosworth (2003)and Easterly 2001

is negatively correlated with inflation, fiscal deficits and distorted foreign exchange market. Monetary policy aggregates and other crises-related variables, such as, price inflation, parallel market premium on foreign exchange, real exchange rate over valuation, systemic banking and balance of payment crises, affects both cyclical output variability and long-term growth. These theoretical backgrounds informed our choice of variables in the VAR specification. To this end, in addition to inflation rate, money supply and interest rates, we also controlled for exchange rate, government expenditure, balance of payment (current) and manufacturing output in the model.

Inflation rate is a key component to stabilization policy for the sustenance of macroeconomic stability. Studies have established that inflation is a major channel through which fiscal and monetary policy distortions and external shocks are transmitted to other sectors of the economy. As a measure of inflation, we used the log of annual percentage change in consumer price index as against GDP deflator because this measure allows for easy of identification restrictions of other variable, such as GDP and money supply that may be correlated with inflation rate in the model. We have included government expenditure as a variable in the model, because government spending can cause a significant drain on the private sector activities and could be detrimental to macroeconomic stability. Particularly, if government inappropriately impose high tax levies to sustain ineffective fiscal spending and sustain inefficient public service or engage in over-bearing state intervention in economic activities thereby distorting efficient market mechanism and prices.

However, government expenditure can have positive effect on macroeconomic stability and economic growth. In this model, we measured government expenditure as a ratio GDP. We assumed that government expenditure contain only expenditures that do not directly affect productivity but that entails distortions of private sector decisions. These distortions can reflect the governmental activities themselves and also involve the adverse effects from the associated public finance. In measuring government expenditure, we use a data dis-integration to net out expenditure on education, infrastructure and defence. This filtering of government expenditure allows for the identification of the equation given the strong correlation with GDP.

The variables estimated in the model include: Oil Prices, Inflation rate, Money Supply, Interest rate, Exchange rate, Government Expenditure, Policy rate, Current Account Balance (BOP)and Manufacturing Output. However, each VAR estimation contains only seven variable to allow for easy of identification. The variables are generated in time series over the period 1970 - 2008. Because of the asymptotic bias arising from the use of non-uniform filters of different time series, we use seasonally-unadjusted time series. In order to adjust for the exchange rate regime switch from a system of fixed to ‘guided floating’ exchange rates, we used net end-period variation in exchange rate (growth rate). As a preliminary step towards estimating the VAR models, we perform unit root tests for each of the endogenous variables entering the model. We compared the statistics using Augmented Dickey Fuller(ADF) test[8] and Phillips-Peron test[9]. To select the truncation lag length required for the unit root test, we compared our selections using Akaike Information Criterion (AIC), Modified AIC (MAIC), Hannan-Quinn and Schwarz information criteria.

In the choice of the order of variables in the VAR model, we follow Peseran et al., (2007) by using the value of the p which yields the minimum value of the information criterion and in the cases where the different criteria do not yield the same outcome, we consider the dynamic relationships between the error terms in the VAR models. In such cases, system-wide Lagrange Multiplier (LM) statistics are computed, which enable a chi-square test of the specific order of autocorrelation. We select the ordering with the least evidence of serially correlated errors.To test whether the VAR models are correctly specified, we perform single-equation tests for each of the models using Breusch-Godfrey test for autocorrelated disturbance terms and autoregressive conditional heteroscedasticity and the Jarque-Bera test for normally distributed error terms. We also compute the Wald chi-square statistics in order to conduct exclusion tests for endogenous variables that have common lag lengths. All non stationary variables - integrated to order (1) [I(1)], entered the model in first-difference transformation - integrated to order zero [I(0)].

4.0.4 Variance Decomposition and Impulse Response Functions

Using the empirical validity that VAR estimations explains the relationships among macroeconomic variables, we describe below how the variance decomposition and impulse response functions are computed and applied in this study. Considering a re-specification of our autoregressive(AR) representation in section (3) as:

$$y_t = A(L)y_t + \mu_t \tag{3}$$

where y_t is assumed to enter the system as a stationary stochastic process and L the lag operator, while μ_t is white noise. Assuming that this representation holds, the theory requires that the roots of $det(I - A(z))$= 0 must have a module greater than 1, such that $det(I - A(z))$ is invertible. Although our VAR estimation is based on this AR representation, our interpretation of the VAR's is based on a vector moving average (MA) representation of the form:

$$y_t = \phi_t + a(L)\mu_t E(\mu_t) = 0 \tag{4}$$

$$E(\mu_t \mu_{t-k}^{'}) = Q, |k| = 0$$

$$E(\mu_t \mu_{t-k}^{'}) = 0, |k| \neq 0$$

where Q is the sample covariance matrix, ϕ_t is perfectly predictable and the matrix of coefficients of $a(L)$ at lag 0 is the identity matrix.

[8] See Dickey and Fuller (1979) and (1981).
[9] See Phillips and Peron (1988).

Assuming that the Wold decomposition of the vector (μ_t) is the forecast error of the autoregression - given information available at $t-1$, we normalize equation 4 to generate the impulse response functions and the forecast-error variance decomposition. In order to quantify the cumulative response of each variable using its generated unexplained residual component,we orthogonalize (μ_t in the variance-covariance matrix Q. However, given that the sample covariance matrix Q is diagonal. We used some type of arbitrary division of the covariance of the residuals such that the errors themselves are orthogonal. We adopt an ordering that allocates any correlation between the residuals to the variable that comes first in the ordering. Therefore, the variance decomposition we adopt is simply a function of the MA representation.

The variance decomposition of the kth-step-ahead forecast is defined as the proportion of the total forecast variance of one component of y_{t+k}, for example, inflation rate, caused by shocks to the MA representation of another endogenous variable, for example oil price. Because the variance decompositions and impulse responses are simply nonlinear functions of the underlying parameters of the AR representation and their covariance matrix, we compute asymptotic standard errors for the estimates of the variance decompositions and response functions. We used bootstrapping method to generate confidence intervals based on the empirical distribution of the residuals of the VAR, we use a normal approximation of the distribution of the parameters of the variance decomposition to generate the standard errors for the decompositions and confidence interval for the impulse response functions. These procedures are reported in the results.

4.0.5 Model Identification

The objective in the VAR estimation in this study, is partly to obtain a non-recursive orthogonalisation of the error terms for impulse response and variance decomposition analysis. This orthogonalisation which is in variant to the standard recursive Cholesky orthogonalisation requires that we impose enough restrictions to identify the orthogonal structural components of the error terms which represent the shocks.

If we assume y_t to be a k-element vector of the endogenous variables in our model and $\Sigma = E[\nu_t \nu_t^{'}]$ to be the residual covariance matrix, then our identification procedure follow the form:

$$A\nu_t = B\mu_t$$

where ν_t and μ_t are vectors of length k, ν_t is the observed residuals and μ_t is the unobserved structural innovations. A and B are kxk matrices to be estimated. The innovations in μ_t are assumed to be orthogonal- i.e. its covariance matrix is an identity matrix $E[\mu_t \mu_t^t] = I$.This orthogonal assumption of μ_t allows us to impose identifying restrictions on A and B:

$$A\Sigma A^{'} = BB^{'}$$

Suggesting that the expressions on either side of the above identity are symmetric. The identification of oil price shock is straight forward because it is an exogenous variable and it is not contemporaneously affected by shocks to other endogenous variables in the model. Since the orthogonalisation involves the assignment of contemporaneous correlation only to specific series, we choose an ordering for the variables in the system, such that, the first variable in the ordering is not contemporaneously affected by shocks to the remaining variables, but shocks to the first variable do affect the other variables in the system; the second variable affects contemporaneously the other variables (with the exception of the first one), but it is not contemporaneously affected by them.

In the below matrices, the identifying restrictions on the A and B matrices are simple zero exclusion restrictions. We specify these restrictions by creating a named matrix A and B and include it as a variable in the VAR estimation. Any elements in the matrix that we want to shock is assigned a missing value 'α_{mn}' and all non missing values in the matrix will be held fixed at the specified values. Using our 7-variables VAR model ($k = 7$), we restrict A to be a lower triangular matrix with ones on the main diagonal and B to be a diagonal matrix. In this form the model is exactly identified.

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & 0 & 0 & 0 & 0 \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & 1 & 0 & 0 & 0 \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & 1 & 0 & 0 \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} & 1 & 0 \\ \alpha_{71} & \alpha_{72} & \alpha_{73} & \alpha_{74} & \alpha_{75} & \alpha_{76} & 1 \end{pmatrix}$$

$$B = \begin{pmatrix} \alpha_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \alpha_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \alpha_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \alpha_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \alpha_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \alpha_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \alpha_{77} \end{pmatrix}$$

Using the above identification restrictions we ordered the variables as follow: oil price, government expenditure, money supply, inflation,interest rate manufacturing output, BOP and GDP. In this form, oil price affects government expenditure (but not vice versa) and government spending leads to increase money supply which feeds into inflation and then interest rate and so on to the final GDP. The first equation identifies the oil price shock while the second equation identifies government expenditure shocks. This identification holds that while oil shock affects government expenditure, government expenditure does not affect oil price - such that all other shocks affect GDP per capita growth rate. This is strictly a short-run identification restriction.

5 Results

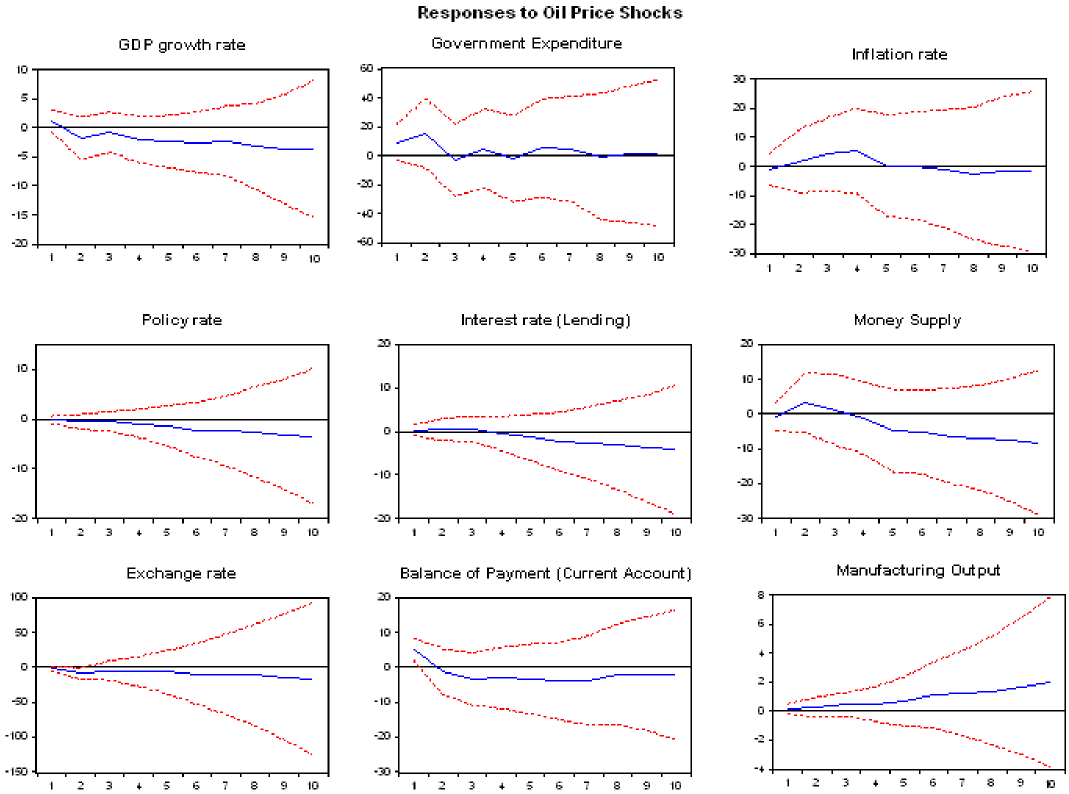

Fig. 6: Impulse Responses of Macroeconomic Aggregates to one Standard Deviation Oil Price Shock

The responses of the selected monetary and other macroeconomic aggregates to a positive shock to oil prices are reported in figure 6. The response forecast period is ten years to enable us capture both the long term and short term responses. The response function shows that shocks to oil price will lead to a sharp increase in government expenditure, money supply and inflation rate over the first two year, while GDP growth, balance of payment ratio and exchange rate decline. Interest rate rose marginally in response, while policy rate declined and the manufacturing output increased. Over the longer period, GDP, money supply,interest rate and balance for payment ratio declined while manufacturing output maintained the upward trend. Exchange rate also declined (depreciate against the US dollar) in the long run in response to oil price shock. This result strongly supports the trends witnessed amongst variables and oil prices as discussed in section 3 using the actual data series. The results indicates that oil price shock could indeed have distortionary effects on macroeconomic aggregates but the channel of transmission of the shocks is not clear, as the result reports a simultaneous response by all the variables to the same oil price shock.

In order to isolate the channel of transmission of the shock to the other sectors of the economy, we imposed a corresponding positive shock to government expenditure and inflation rate and observe the response of the other variables. These two variables are the most debated channel, in the literature, to account for the negative impact of oil price shocks.

Figure 7 shows the responses of all the variables to shock to government

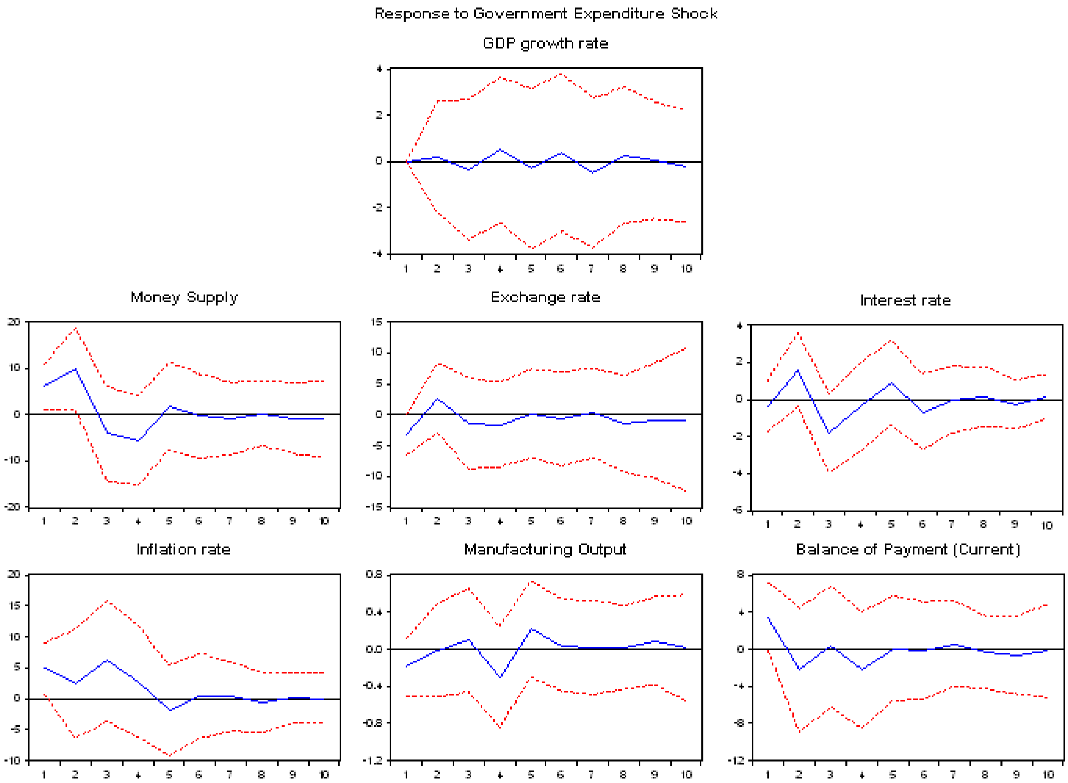

Fig. 7: Impulse Responses of Macroeconomic Aggregates to one Standard Deviation Government Expenditure Shock

expenditure. Clearly, shock to government expenditure leads to sharp increase in money supply and interest rate while exchange rate depreciate and balance of payment position worsens. Inflation rate recorded high volatility in response to government expenditure shock, however manufacturing output rose in the short run but with some volatility over the longer period. Generally, in the long-run, the effects of government expenditure shocks on all other variables revert back to the meal level, particularly from the fifth year, except for GDP and exchange rate. This may further suggest that government expenditure shocks have a long term negative effects on real output growth and exchange rate.

The responses on all the variables to shocks to inflation rate are reported

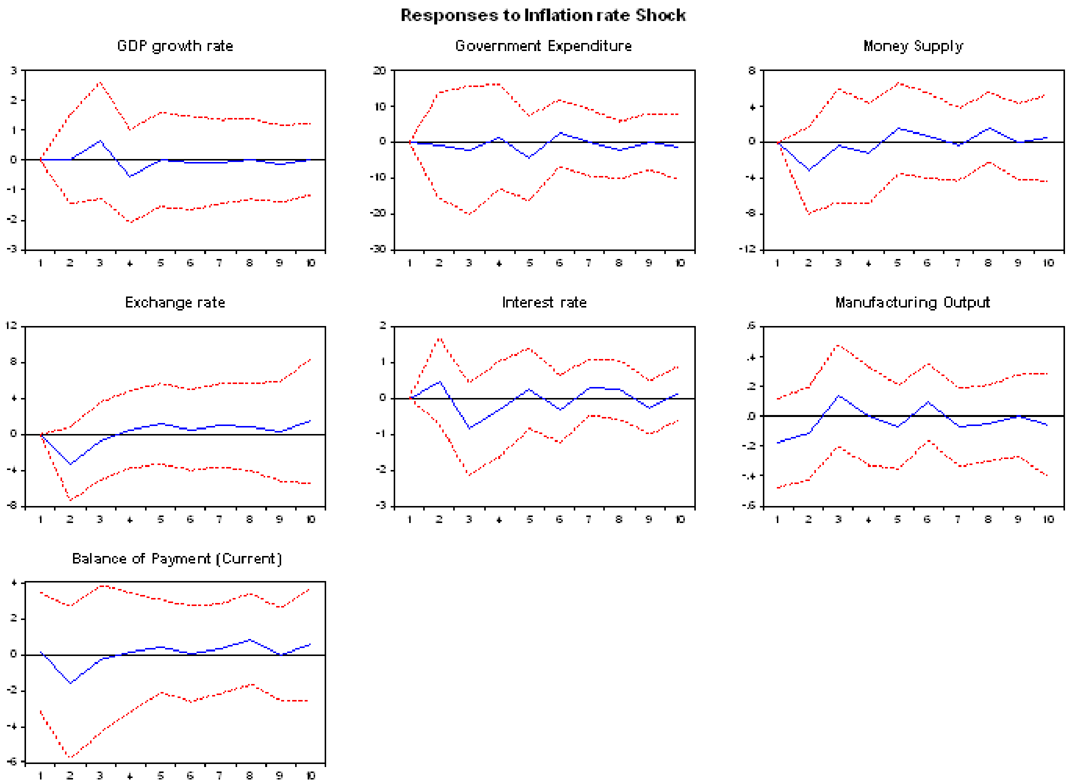

Fig. 8: Impulse Responses of Macroeconomic Aggregates to one Standard Deviation Inflation rate Shock

in figure 8. The results also show persistent volatility in all the variables in response to inflation rate shocks. Interestingly, shocks to inflation rate leads to decline in money supply and government expenditure while GDP rose in the short run (first two to three years). Exchange rate appreciated, in the first two years, in response to inflation rate shock but persistently depreciated in the long-run. Manufacturing output dropped but rose relatively in the first three years before declining sharply. The lagged expected response of manufacturing output to inflation rate shock in the short run, may be due to the structural and supply-side rigidity of the real sector of the economy. Generally, inflation rate shock also exhibit severe negative consequences for all the other sectors of the economy.

The results in figures 9 and 10 show the error forecast variance decompo-

Variance Decomposition

Period	Std. Error	Oil Price	GDP growth rate	Government Exp	Money Supply	Exchange rate	Interest rate	Inflation rate	Manufacturing Output	BOP (Current)
Oil Prices										
1	9.36	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	22.87	89.53	0.77	0.62	1.05	0.96	0.94	0.54	3.20	2.39
5	42.75	91.41	1.03	0.29	0.30	0.28	1.05	0.49	3.47	1.68
7	69.29	90.21	1.72	0.19	0.17	0.15	1.55	0.37	4.39	1.24
10	134.95	90.06	2.09	0.20	0.13	0.08	1.57	0.32	4.59	0.96
GDP growth rate										
1	5.15	3.07	96.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	7.66	18.92	68.68	0.28	0.26	4.68	2.32	0.74	2.66	1.46
5	9.43	13.95	68.73	0.58	2.57	5.28	4.30	0.81	2.67	1.12
7	10.13	15.11	62.04	0.89	2.43	6.85	6.65	0.71	4.13	1.20
10	10.71	18.27	57.44	0.90	2.26	6.82	7.76	0.65	4.71	1.20
Government Expenditure										
1	51.29	0.14	10.63	89.23	0.00	0.00	0.00	0.00	0.00	0.00
3	72.40	9.69	9.31	67.91	9.56	2.06	0.71	0.12	0.19	0.46
5	77.47	11.15	8.55	59.32	9.14	7.15	1.84	0.48	1.78	0.59
7	80.84	15.25	8.40	54.50	8.50	6.84	3.34	0.53	2.06	0.58
10	88.06	25.77	8.26	46.00	7.25	5.81	3.07	0.54	2.71	0.59
Money Supply										
1	15.64	2.57	0.35	15.09	81.99	0.00	0.00	0.00	0.00	0.00
3	24.52	2.42	5.14	25.11	45.65	9.81	4.35	1.71	3.72	2.09
5	28.25	10.14	10.71	23.34	34.80	8.82	3.84	1.76	3.67	2.91
7	29.92	15.61	9.95	20.92	31.14	8.38	5.79	1.63	3.77	2.80
10	37.18	39.81	7.94	13.67	20.34	5.90	4.89	1.26	3.90	2.29
Exchange rate										
1	10.49	0.00	13.11	9.62	0.74	76.52	0.00	0.00	0.00	0.00
3	17.59	22.60	5.63	6.41	1.23	35.81	2.87	3.79	2.52	19.15
5	22.88	44.05	6.41	4.29	0.74	22.09	2.68	2.54	5.53	11.66
7	27.87	57.56	4.74	2.97	0.66	14.93	2.86	1.87	6.34	8.07
10	43.17	76.23	3.36	1.45	0.37	6.33	2.03	0.93	5.37	3.93

Fig. 9: Variance Decomposition of Variations in Macroeconomic Aggregates

sition of all the variables included in the model. It shows the percentage of variation in a particular variable that is accounted for by the other variables in the model. Generally, oil price is an exogenous variable in the model, as variations in oil prices are not significantly accounted for by any other variable in the model. However, variations in all the other variables, except interest rate, are significantly accounted for by changes in the oil price. Government expenditure and GDP growth rate accounts for over 20 percent of the variations in interest rate, while oil price accounts for less than 7 percent over the 10 years forecast period.

Exchange rate and government expenditure accounts for over 20 percent of

Variance Decomposition (Cont.)										
Interest rate										
Period	Std. Error	Oil Price	GDP growth rate	Government Exp	Money Supply	Exchange rate	Interest rate	Inflation rate	Manufacturing Output	BOP (Current)
1	4.11	1.68	2.57	0.77	3.24	0.45	91.28	0.00	0.00	0.00
3	5.84	6.79	13.78	17.39	4.12	1.92	50.66	2.84	1.53	0.98
5	6.36	6.52	14.39	17.13	4.14	5.75	46.71	2.79	1.55	1.02
7	6.66	7.28	17.11	16.66	3.89	5.90	43.56	2.95	1.54	1.11
10	6.92	9.55	17.98	15.74	3.83	5.86	41.12	3.05	1.67	1.21
Inflation rate										
Period	Std. Error	Oil Price	GDP growth rate	Government Exp	Money Supply	Exchange rate	Interest rate	Inflation rate	Manufacturing Output	BOP (Current)
1	17.41	14.09	32.05	7.75	1.81	3.94	0.67	39.69	0.00	0.00
3	25.35	11.52	25.55	10.30	5.08	16.43	2.33	25.18	0.39	3.22
5	26.86	10.84	26.12	10.76	5.84	15.37	2.40	23.72	0.88	4.08
7	27.61	11.25	25.65	10.22	5.72	16.89	2.42	22.55	0.83	4.48
10	28.20	12.61	25.31	9.84	5.70	16.69	2.65	21.70	0.97	4.53
Manufacturing Output										
Period	Std. Error	Oil Price	GDP growth rate	Government Exp	Money Supply	Exchange rate	Interest rate	Inflation rate	Manufacturing Output	BOP (Current)
1	1.01	10.29	3.93	3.53	0.46	0.31	2.86	3.21	75.41	0.00
3	1.39	28.86	2.57	2.33	1.80	8.94	5.78	3.37	44.61	1.74
5	1.62	24.12	7.67	6.87	2.22	7.97	8.67	2.65	38.32	1.49
7	1.80	32.95	7.78	5.62	2.67	7.02	7.50	2.59	32.64	1.22
10	2.26	51.37	7.65	3.74	1.77	4.65	5.06	1.76	22.84	1.16
Balance of Payment (Current)										
Period	Std. Error	Oil Price	GDP growth rate	Government Exp	Money Supply	Exchange rate	Interest rate	Inflation rate	Manufacturing Output	BOP (Current)
1	13.81	10.30	24.57	6.29	0.94	6.88	0.39	0.01	10.65	39.98
3	16.33	9.56	20.32	6.47	9.16	7.13	0.39	0.99	13.82	32.17
5	17.88	17.58	18.09	7.04	8.02	6.10	0.48	0.89	14.08	27.73
7	18.94	23.87	16.16	6.37	7.16	5.46	1.39	0.82	13.98	24.79
10	23.34	45.82	11.42	4.30	4.83	3.76	1.60	0.73	10.85	16.68

Fig. 10: Variance Decomposition of Variations in Macroeconomic Aggregates

the variations in inflation rate, while balance of payment and money supply account for less than 5 percent. GDP growth accounts for over 22 percent of the variations in inflation rate. Oil price accounts for over 60 percent of the variations in exchange rate, while balance of payment accounts for about 10 percent. GDP growth rate and manufacturing output accounts for about 25 percent of the variations in balance of payment, while government expenditure and exchange rate accounts for about 6 percent each. Oil price accounts for over 40 percent of variation in manufacturing output, while interest rate and inflation rate play less significant role.

6 Conclusion

The study investigates the impact of oil prices on macroeconomic aggregates, with particular focus on the monetary sector. The main objective of the research is to identify the trajectory of oil price shocks, to enable the monetary authority use the appropriate instruments to curtail the contagious effects on the monetary and financial sectors. A trend analysis of selected key policy variables was used to identify the relationships across the various sectors of the economy, including monetary, fiscal and real sectors. The relationships amongst the variables exhibits some unique characteristic which, in some cases, negate prior theoretical expectations , but depicts the structural fundamentals of the Nigerian economy.

In the study, we adopted a dynamic structural autoregressive approach to identify the structural parameters of a model of selected monetary aggregates. Careful attempt was made to orthogonalize the parameters of the estimated model for error forecast analysis and response functions. The results show that oil price shocks negatively impact on many macroeconomic indicator, however through a second-round channel of higher government expenditure and increased inflation rate. Indeed oil price shocks impact positively on real sector growth, as manufacturing output growth increased in response to a positive oil price shock.

The study, therefore suggests that in order to curtail the macroeconomic distortions associated with oil price increases, monetary authorities need to have a closed cap on inflationary pressure, since the control of fiscal excesses is exogenous to the sector. It also follows that for the effective management of the economy, particularly in response to external shocks, both the monetary and fiscal authorities need to synergize on a common policy framework and implementation strategies. The financial sector is indeed sensitive to changes in oil prices, however if excess oil proceeds inflows (through higher oil prices) could be sterilized, through appropriate fiscal measures, the trickle-down effects to the other sectors of the economy could be significantly reduced. Finally, it could be presumed from the study, that for a developing small-open economy like Nigeria, inflation targeting approach to monetary policy management, could prove as an effective tool for sound financial system and macroeconomic stability.

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