An Investigation into the Crude Oil Price Pass-Through to Economic Growth in Nigeria

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Abstract: This study evaluated oil price pass-through to economic growth in Nigeria. The motivation for this study originated from the need to understand the transmission channels and mechanisms through which sudden oil price changes affect economic output and to make recommendations on how to bring about output sustainability. This study employed the new Hamilton Index within the Structural Vector Autoregressive (SVAR) environment to investigate the responses of macroeconomic variables to sudden changes in oil prices. It was observed that the structure of the variables in the transmission process of these macroeconomic variables to endogenous and exogenous shocks play key roles in the determination of the effectiveness of their influence on output growth. The study found that negative oil price movements have a stronger effect on economic growth than any other forms of oil price fluctuation. Interest rate and money supply were found to be effective macroeconomic policy in Nigeria that has the capacity of efficiently driving economic output. The study concludes that oil price is transmitted to economic output through the exchange rate, money supply and interest rate. The study recommends that Nigeria should adopt aggressive monetary control measures whenever there are positive or negative oil price shocks. Secondly, the interest rate should be efficiently used in times of oil price movements in order to ensure that economic growth in Nigeria is not compromised.

Keywords: Hamilton's Index; transmission mechanism; Nigeria; economic growth

JEL Classification: F42; O55; O47; P22

1. Introduction

Numerous factors have been identified as key elements in explaining the sources of fluctuations in output growth. However, in a developing oil-producing economy, studies have attributed the changes in output growth to continuous oil price movements (Park, 2009; Fowowe, 2014; Chen, 2016). In this context, linear and

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symmetric estimations of oil price movements' pass-through to economic growth were unable to fully capture the real influence of oil price fluctuations on economic output. In this respect, numerous studies resorted to non-linear models and recorded that oil price movements have asymmetric effects on economic outputs (Hamilton, 2008; Olomola and Adejumo, 2006; Oyinola, 2001; and Omolade, Ngalawa and Kutu 2019). This study was motivated by the fact that prices are downward sticky and oil prices have non-linear characteristics and are expected to indirectly affect economic growth through other macroeconomic variables (Katircioglu, 2015 and Killian and Murphy, 2015).

Several of the above mentioned studies were influenced by Hamilton (1983) who observed that oil price increases were the cause of 95 percent of the world recessions. However, over the years, the decline in the oil price did not translate to increase in output growth, and the relationship between oil price movement and output performance can be seen to be non-linear (Kilian and Vigfusson, 2013). This suggested that output performance can react differently to negative and positive movements in oil prices. Prior studies, among them were Aleem, (2010), Kilian and Vigfusson (2013), Barunik et al (2015) and Kutu and Ngalawa (2016) however lost sight of the combined influences of the negative and the positive oil prices on the output performance and the channels of transmission of oil price movements to output growth, something which motivated this study. Specifically, the studies by Aleem (2010); Kilian and Vigfusson (2013), Barunik et al (2015) among others concentrated on the positive effects of oil price shocks on economic growth and using either Vector Autoregressive (VAR) techniques, Ordinary Least Square, Autoregressive Distributed Lag (ARDL) or other estimating techniques that lack the capacity of examining both the negative and positive impacts of oil prices on the macroeconomic indicators. This study however used both positive and negative Hamilton indexes in the Structural Vector Autoregressive (SVAR) environment to investigate the channels of transmission of oil price movements to economic growth in Nigeria. Consequently, the output performance to positive and negative oil price changes was investigated. Another issue to note is that prior studies focused on data from OECD economies and on oil-importing economies that are gradually shifting from non-renewable energy sources. However, the focus of this study is on Nigeria, a crude oil-dependent economy. Finally, oil price movement transmission - economic growth gap needs to be empirically investigated and bridged if economic growth has to be sustained in Nigeria.

2. Literature Review

Several researchers contend on the channels by which macroeconomic variables influence one another and ultimately impact on economic growth. In other words, these researchers question the severity and the nature (either directly or indirectly)

how these variables affect economic growth. For example, Barth and Ramey (2001) studied oil price transmission channels in the Pakistani economy using non- linear transformation and noted that oil prices can influence the economy through numerous channels, including transfer of income from oil-importing to oil-exporting countries, via increases in input costs of production and through the decrease in real wages and profit margins. Olumide (2009) studied the oil price pass-through in Russian economy with annual data from the year 1940 to 1980 using SVAR and found that an increase in energy prices raises the consumer price index. Lamazoshvili (2014) investigated the oil price pass-through to output growth in Iran and postulate that the effects of oil price shocks can be viewed from three factors, which are the source of shocks, the transmission mechanism of oil shocks and the structure of energy flows. Kilian (2014) provided a broad discussion on the need to understand the origins or the sources of oil shock and how the oil price effects transmit to the whole economy. The study maintained that the effects of oil prices can transmit through various channels, including the inflationary or supply channel. Benigno and Benigno (2015) conducted an analysis of the transmission effect of oil prices on CPI (inflation) in a group of emerging Asian countries. The study found evidence of long-run transmission effects of oil on CPI (inflation) in the majority of the countries but the results were not significant in the short run. Ibrahim (2015) investigated the transmission and the relationship between food price and oil prices for Malaysia using a nonlinear ARDL model. The study concluded that oil price transmits to food price. Other authors that studied the transmission of oil price to economic growth include: Jiménez-Rodríguez and Sánchez (2005), Blanchard and Gali (2007), Alvarex and Cook (2009), Aleem, (2010), Kilian and Vigfusson (2013), Barunik et al (2015), Jiranyakul (2015), Katircioglu (2015) and Ijirshar (2015). However, all these oil price movement transmission mechanisms studies were conducted in the advanced countries and also failed to capture the effect of negative oil prices, which was observed to be more significant in oil exporting economies. Most of these studies pointed out that since the mid-1970s, oil price movements have been a major source of business cycle fluctuations, but failed to reach consensus on the validity of a particular transmission channel that explains the processes by which movement of oil prices influence economic growth. Finally, all the studies focused on the positives rather than the negatives of oil price changes. Such results might not fully represent the situation in Nigeria and may provide a misleading interpretation of the situation in Nigeria. Adding that these economies are more developed and advanced than the economy of Nigeria, there is therefore need to conduct similar studies in Nigeria to observe how the changes in oil price can transmit to the economy for appropriate and applicable policy formulation.

3. Data and Methodology

This study utilizes Quarterly data from 1980Qs1 to 2018Q4, which was sourced from the International Monetary Fund (IMF), World Economic Outlook, Energy Information Administration (US. EIA) and the World Bank. Following Chaudourne, Feve and Guay (2014) 35 years was considered long enough to capture the latest oil price movements in the international market.

Based on the series' mixed stationarity properties, that is I(0) and I(1) and the nature of the long run relationship among the variables, the study adopted a Structural Vector Autoregressive (SVAR) estimating technique. In investigating the oil price pass-through, the study examined both the positive and the negative effects of oil price movements on the economy. Therefore, the study employed both the positive Hamilton Index (H1) which captures the net oil price increase (NOPI) and the negative Hamilton index (inverse H1) which captures the negative oil price decrease (NOPD) into the model (Demachi, 2012; Omolade, Ngalawa and Kutu, 2019).

Equations (1) and (2) capture both the net oil price increase (NOPI) and the net oil price decrease (NOPD).

$$H1_t = \{(oilprice_t - maxoilprice)\} > 0.0\ for(oilprice_t - maxoilprice) \leq 0\} \ldots\ldots (1)$$

$$InvH1_t = \{(oilprice_t - minoilprice)\} < 0.0\ for\ (oilprice_t - minoilprice) \geq 0\} \ldots (2)$$

Where, the *maxoilprice* in Equation 1, represents the highest oil prices in the preceding year (within the 4 quarters) and the *minoilprice* in Equation 2, represents the lowest oil price in the preceding year (within the 4 quarters). This study employed the two Hamilton price indexes, the (*H1*) and (*InvH1*) in the SVAR model to evaluate the impacts of the macroeconomic fundamentals and policy reactions within a comparatively short period of time. Equation (3) is the reduced form SVAR derived from the primitive SVAR and can be used to produce the Impulse Response Functions (IRFs) and the Variance Error Decomposition (VED).

$$\begin{bmatrix} V_t^{oilp} \\ V_t^{oilpv} \\ V_t^{K} \\ V_t^{gdpgr} \\ V_t^{infr} \\ V_t^{ms} \\ V_t^{exchr} \\ V_t^{intr} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ B_{21}^0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ B_{31}^0 & 0 & 1 & 0 & 0 & 0 & 0 & B_{38}^0 \\ B_{41}^0 & 0 & B_{43}^0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & B_{53}^0 & B_{54}^0 & 1 & B_{56}^0 & 0 & 0 \\ B_{61}^0 & B_{62}^0 & 0 & 0 & B_{65}^0 & 1 & B_{67}^0 & 0 \\ B_{71}^0 & B_{72}^0 & B_{73}^0 & B_{74}^0 & B_{75}^0 & B_{76}^0 & 1 & 0 \\ 0 & 0 & 0 & 0 & B_{85}^0 & B_{86}^0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{oilp} \\ \mu_t^{oilpv} \\ \mu_t^{k} \\ \mu_t^{gdpgr} \\ \mu_t^{infr} \\ \mu_t^{msgr} \\ \mu_t^{exchr} \\ \mu_t^{intr} \end{bmatrix} \ldots\ldots\ldots (3)$$

Because of the misspecification problems inherent with long run restrictions, the study employed contemporaneous restriction on the B_0 matrix to identify the dynamics in oil price movements as shown in Equation (3). This is because the study investigated the short-term and medium-term reactions of the variables as used by Elbourne, (2007). The non-linear SVAR model was used as in Demachi (2012) and Omolade, Ngalawa and Kutu (2019). The SVAR model in Equation (3) has eight variables. Row 1 contains the oil price (*oilp*) whereas row 2 contains the two types of oil price movements (*viz*), the positive Hamilton Index (*H1*) and the negative Hamilton index (*invH1*). The oil price (*oilp*) and its derivatives (*H1* and *invH1*) are treated as exogenous variables. These exert external burdens on the economies that depend heavily on oil and those that produce mainly primary goods, (Demachi, 2012). Becklemans, (2005) observed that international fluctuations always transmit quickly into the economy.

Positive oil price (*H1*) can only influence itself whereas the negative oil price (invH1) reacts to the previous price increases. So, the reaction of *invH1* is a function of *H1* (Demachi, 2012 and Omolade et al., 2019). Rows 3 and 4 contain the residuals of non-policy variables, namely; capital formation and the GDP growth rate. The Policy variables which are controlled by the monetary authorities namely; interest rate, money supply, exchange rate and inflation rate are contained in rows 5, 6, 7 and 8.

The stochastic term μ represents a vector of reduced form uncertainties to the domestic and external variables in the model. The variables in the model are placed in the order in which they influence themselves in the scheme of identification. For example, the non- zero component B_{ji}^0 indicates that variable j affects variable i contemporaneously. Oil price in the row 1 depicts that oil prices react to its own lagged values whereas row 2, which represents oil price movements, depicts that it only reacts contemporaneously to oil price fluctuations as indicated by B_{21}^0. In addition, row 2 also shows how oil price and oil price movements react to monetary policy shocks which occur as a result of information delays by policymakers (Bernanke, 2008; Becklemans, 2005; and Omolade et al., 2019).

Rows 3 and 4 show the equations in the goods market. The zeros define nominal rigidities, (Elbourne, 2007). B_{31}^0 and B_{38}^0 show that GDP growth rate reacts contemporaneously to interest rate and oil price changes whereas B_{41}^0 and B_{43}^0 show that GDP growth rate reacts contemporaneously, (Kutu and Ngalawa, 2016). Rows 5 and 6 show the inflation rate and the real money supply. The coefficients B_{53}^0, B_{54}^0 and B_{56}^0 show the possibility of GDP growth rate and money supply growth rate contemporaneously affecting one another on the one hand and affecting inflation on the other hand, corroborating Vonnak (2005) and Bernanke (2008) who claimed that inflation affects productivity.

Money supply growth rate is presented in row 6 and it reacts only to oil price, oil price movement, inflation and exchange rate. The assumption inherent in SVAR method for money supply is that not all the variations in monetary policy influence the economy, (Sousa *et al*, 2013). This may be the reason for the slow reactions to GDP growth rate and interest rate. Row 7 depicts that the exchange rate faces competition in the market and therefore exerts a contemporaneous reaction to all the variables in the model. Finally, row 8 shows the interest rate variable which reacts to inflation and money supply as can be seen in B_{85}^{0} and B_{86}^{0}. Since the independent variable is integrated of order zero (0), this study estimated the SVAR.

In order to ascertain the appropriate model to adopt in this study, the study tested for the stationarity properties of the variables in the data set. This is achieved by testing the unit root with three different alternative methods, namely, Augmented Dickey Fuller, Dickey Fuller and Phillips-Perron. The study identified that some variables were integrated at levels I(0) while some integrated at the first differences I(1) (See Table 1).

Table 1. Results for Unit Root Test

Dickey Fuller (DF)			**Augmented Dickey-Fuller (ADF)**		**Philips-Perron (PP)**		
Variables	Order of Integration	P-Value	Order of Integration	Prob. Value	Order of Integration	Integration P-Value	Most Consistent results
LNOILP	I(1)	0.0000***	I(1)	0.0000***	I(1)	0.0000***	I(1)
H1	I(0)	0.0123***	I(0)	0.0143	I(0)	0.0005***	I(0)
InvH1	I(1)	0.0000***	I(1)	0.0000***	I(1)	0.0000***	I(1)
LNK	I(0)	0.0049***	I(0)	0.0510*	I(0)	0.0000***	I(0)
LNGDPGR	I(0)	0.0123***	I(0)	0.0143	I(0)	0.0005***	I(0)
LNINFR	I(1)	0.0000***	I(1)	0.0000***	I(1)	0.0000***	I(1)
LNINTR	I(1)	0.0000***	I(1)	0.0000***	I(1)	0.0000***	I(1)
LNMSGR	I(0)	0.0580	I(0)	0.08270	I(1)	0.0000***	I(0)
LNEXCHR	I(1)	0.0000***	I(1)	0.0000***	I(1)	0.0000***	I(1)

Source: Author's Computation, 2019 ***, ** and * represent statistical significance at 1%, 5%, and 10%, respectively.

Based on these results, levels of VAR were adopted. The levels of VAR usage will prevent the modeler from losing key information from the data sets as a result of differencing. In addition, lagged lengths inclusion in the VAR model takes care of the non-stationarity properties of the residuals in the model. Several recent studies followed the same procedure (Elboure, 2007; Mordi and Adebiyi, 2010 and Ngalawa and Viegi, 2011) among others.

Table 2 shows that all lag order selection criteria suggested 2 lags as the most suitable lag order to be used in this analysis. This is a more general model which has been used in SVAR estimation by numerous researchers

Table 2. VAR Lag Order Selection Criteria

	LogL	LR	FPE	AIC	SC	HQ
0	-705.8496	NA	1.16e+09	40.73426	41.04533	40.84164
1	-489.8458	333.2630	87868.04	31.19119	33.67975	32.05024
2	-400.5490	102.0535*	12549.17*	28.88851*	33.55456*	30.49923*

Source: Author's Computation, 2019

4. Results, Discussion and Inferences to other studies

The reactions of the Nigerian gross domestic growth rate and other macroeconomic variables are presented and analyzed using the impulse response functions and variance decomposition. Figure 1 shows the different shades of oil price shocks while figures 2 and 3 show the impulse responses to one-standard deviation of oil price movement shocks to the other seven variables shocks in the model.

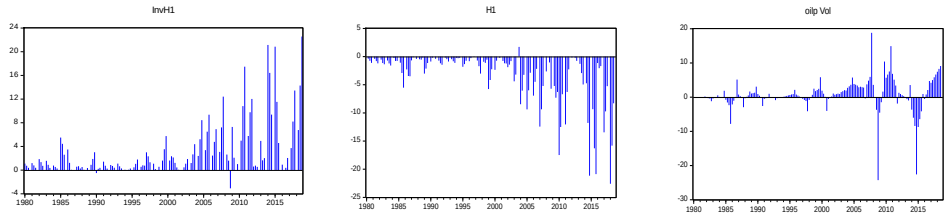

Figure 1. Different Shades of Crude oil price shocks/movements

Source: Author's Computation 2019

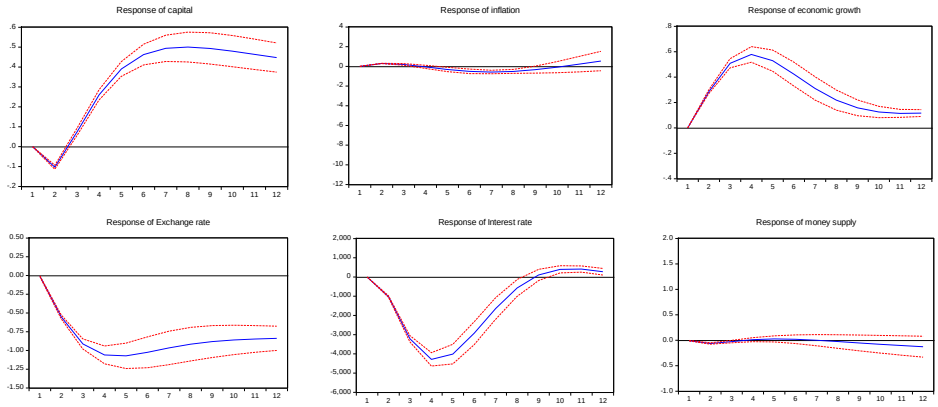

Figure 2. Responses to Hamilton index H1

Source: Author's Computation 2019

From the figures 1 and 2, it was observed that the reactions of the variables to the positive Hamilton index (H1) were similar to the findings of earlier studies, for example, Kutu and Ngalawa, 2016, Omolade et al, 2019 among others. This may not be unrelated to the fact that oil price movement measures one positive standard deviation of oil prices. Nevertheless, few variations in their responses to the shocks on H1 were observed. It is noteworthy that the spike in the oil price as represented with H1 did not increase the inflation rate significantly, in accordance with what the study found in the normal oil price shock. A similar scenario occurred in the response of money supply to H1. Nevertheless, it was noticed that economic growth rose significantly to a peak before declining. The exchange rates and interest rates declined markedly in response to H1, as opposed to what was observed in oil price shock. In all, some resemblance and some differences in the reactions of macroeconomic variables to both H1 and ordinary oil price shocks was noticed. The semblance may have arisen due to a positive oil change. However, the difference in their reactions is that capital and output (economic growth) are highly significant; they increased sharply and are sustained throughout the period in Nigeria.

The results in figure 3 depicts that the reactions of the variables to a negative Hamilton Index (invH1) are not the opposite reactions that the macroeconomic variables show in response to the shock to H1 as against the conclusions of researchers who used SVAR (see Kutu and Ngalawa 2016, Omolade et al. 2019) among others. A number of variables show the opposite reaction to what we observed in H1. For example, capital formation and output growth react significantly negative to a decrease in oil prices.

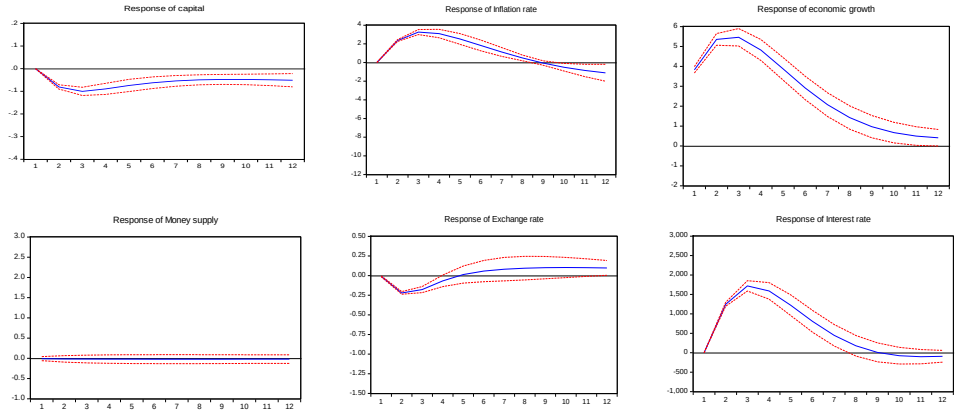

Figure 3. Responses to Inverse Hamilton index InvH1

Source: Author's Computation 2019

The study observed an initial positive reaction of inflation rate to a diminishing oil price shocks, but later declined. However, while money supply shock rises significantly to a shock in oil price, its reaction to a negative oil price shock was non-significant. In addition, a negative oil price shock (*invH1*) has a negative influence on exchange rate shock and a positive influence on interest rate from the onset and stayed for longer periods before declining. But interest and exchange rates are not significant in response to oil price shocks.

In as far as the analysis of the variance decomposition of the shocks is concerned, Tables 3 and 4 show the responses of different levels of oil price movements to the performance output in Nigeria. The result showed that a negative Hamilton index (invH1) exerted a total influence of 88% on output growth in Nigeria, while the positive Hamilton index exerted a total influence of 46 % on output growth in Nigeria. The implication is that comparing the influences of the oil derivatives, namely; oil price volatility, H1 and invH1, the negative oil price movement (invH1) has the highest influence on output behavior in Nigeria. The results from the impulse response function and variance decomposition have shown that monetary policy variables, namely, interest rate and money supply have been effective macroeconomic policy in Nigeria that has the capacity of efficiently driving the economic output. These corroborate Ngalawa and Viegi (2011) who noted that monetary policy is one of the most effective tools developing economies can use to improve and stabilize the behavior of the economy.

Table 2. Variance Decomposition of H1

PERIOD	OILP	InvH1	K	GDPGR	INF	MSGR	EXR	INTR
3	55.70834	0.126719	17.62968	0.047833	0.796518	1.997548	1.257525	22.43583
6	44.44126	0.039687	10.65190	0.025394	0.226410	0.587879	0.826770	43.20071
9	42.85406	0.034681	9.410210	0.025793	0.343312	0.578030	0.749531	46.00439
12	44.55904	0.033907	9.226909	0.025896	0.418395	1.100459	0.825226	43.81017

Source: Author's Computation 2019

Table 3. Variance Decomposition of INVH1

PERIOD	OILP	InvH1	K	GDPGR	INF	MSGR	EXR	INTR
3	20.96859	0.732108	3.151280	0.031183	4.121318	46.68296	3.155323	21.15723
6	8.883372	0.284964	40.55205	0.028875	1.892318	20.81763	1.261945	26.27884
9	8.506611	0.163953	39.75781	0.043137	1.140765	13.66192	1.203389	35.52242
12	8.503898	0.134755	34.09408	0.061308	1.046330	11.51774	1.250186	43.39171

Source: Author's Computation 2019

The Interest rate has a significant negative relationship with output growth in Nigeria, indicating that interest rate can be used as a tool for a contractionary and expansionary framework to moderate the behavior of output. The classical and Keynesian theories emphasized that the nexus between money supply and interest rate is indispensable for sustainable economic growth. This nexus is hinged on the impact interest rate has on investment which affects output growth. The theories apply equally where expansionary monetary policy causes a reduction in interest rate, which eventually increases output growth.

The second monetary policy variable (money supply) exerts a significant influence on output growth in Nigeria. This result corroborates Ushie, *et al* (2012), but contrary to Sousa *et al* (2013). However, it has been noted that the difference in the result of the influence of money supply on output growth may largely depend on the proxies the researchers used for money supply, (Berument et al., 2010 and Omolade et al, 2019).

Thirdly, the key policy variable used in the model is the exchange rate. It shows a significant negative relationship with the output performance. The implication is that currency devaluation in Nigeria might not have a sustainable positive impact on the

output performance. The relationship between exchange rate and output growth is mixed. For example, exchange rate shows a negative reaction to economic output but with time, it started to respond positively as output grows. An increase in exchange rate means depreciation of local currency. The implication is that the result has both negative influence in the short run and positive influence in the long run. Dada and Oyeranti (2012); Eze and Okpala (2014) among others noted that in as much as Nigeria is a developing country, the nexus between output growth and exchange rate should be positive, thus a devaluation will enhance output performance.

The responses of money supply and interest rate to exchange rate in Nigeria is significantly positive. The results show that over and above the oil price shock which is exogenously determined, the interest rate and money supply are mostly impacted by exchange rate shocks. This result supports the Mundel and Flemming model that stipulated that monetary policy is a key factor in determining exchange rate for the economies that operate a floating exchange rates system, (Romer, 1996). The implication is that the transmission channel through which exchange rates emit into the economy is through the instrumentality of monetary policy.

Figure 3 shows the necessary and sufficient conditions for the diagnostic test. The moduli of the eigenvalues of the dynamic matrix fall within the unit circle, implying that the estimated VAR model appears stable.

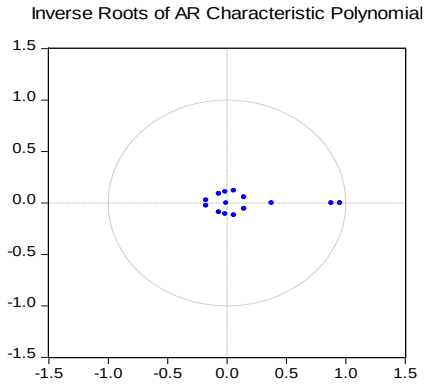

Figure 3. Inverse Roots of AR Polynomial Result

Source: Author's Computation, 2019

5. Conclusion and Recommendations

This study sought to examine the oil price movement pass-through to economic growth in Nigeria. The main findings were that a negative oil price movement (invH1) shock has a stronger effect on the economic growth more than any other forms of oil price fluctuations. The behavior of monetary policy variables (MPVs) were found to be significantly impacted by oil price shocks. Monetary policy variables have been effective as a macroeconomic policy in Nigeria and have the capacity of efficiently driving the economic outputs. It was concluded that the transmission channel through which oil price movement transmit to economic growth in Nigeria is through the exogenously determined variable shocks (oil price). This impacts on exchange rate; the shock from the exchange rate on its own impacts on monetary policy variables (money supply and inflation rate) and, finally, the impact is further transmitted to the output growth.

As far as the impacts of oil price volatility on the output performance in Nigeria is concerned, the study has made a number of findings and inferences that can bring about significant conclusions to the debate in an oil exporting economy, such as Nigeria. There is still no agreeable pattern of influence of oil price volatility on output performance of Nigeria. The debate is largely linked to the fact that oil price volatility cannot totally estimate the impacts of oil price movements on the performance of economic growth in Nigeria. Nevertheless, the study has contributed to the existing literature by arriving at the following findings and conclusions.

The study therefore recommends that Nigeria should adopt aggressive monetary control measures whenever there are positive or negative oil price shocks. Secondly, the monetary authorities should use the interest rate efficiently during times of oil price movements, as to ensure that economic growth in Nigeria is not compromised. The study also recommends that the monetary authority should adopt a monetary policy that will encourage currency depreciation. This policy may significantly and positively affect Nigerian economic growth, in the short run, encouraging domestic production, reducing the unemployment rate and encouraging exports.

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