Oil Price Shocks and Macroeconomic Performance in Nigeria

Simeon Oludiran Akinleye and Stephen Ekpo*

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Abstract: This paper examines the macroeconomic implications of symmetric and asymmetric oil price and oil revenue shocks in Nigeria, using the vector autoregressive (VAR) estimation technique. The paper finds that both positive and negative oil price shocks influence real government expenditure only in the long run rather than in the short run, while examining positive and negative shocks to external reserves revealed stronger implications for expenditure in the long run, with positive rather than negative oil price shocks having stronger short and long run effects on real GDP, and therefore triggering inflationary pressure and domestic currency depreciation as importation rises. This implies that the country exhibits the Dutch disease syndrome in the short and long run. However, results obtained show that oil revenue shocks are capable of impeding economic growth only in the long run while raising general price levels marginally in the short run after the initial shocks, with evidence of serious threat to interest rate and the domestic currency in the short and medium term, as the volume of imports increases significantly along with the external reserves. Findings on the asymmetric effects of oil revenue shocks revealed that positive shocks to oil revenue stimulate expansionary fiscal posture in the Nigerian economy in the short run in line with theory, thereby creating inflationary pressure and domestic currency depreciation. The combined implications of these discoveries suggest the need for proper coordination of fiscal and monetary policy for sustainable macroeconomic stability to be achieved.

Keywords: oil price shocks, oil revenue, macroeconomic performance, VAR.

Shock de precios del petróleo y el desempeño macroeconómico de Nigeria

Resumen: Este trabajo examina las implicaciones macroeconómicas de los choques simétricos y asimétricos de precios e ingresos petroleros en Nigeria mediante la técnica de estimación autorregresiva vectorial (VAR, por sus siglas en inglés). El

*Simeon Oludiran Akinleye, soakinleye@unilag.edu.ng, Senior Lecturer; Stephen Ekpo, stevannek@yahoo.com, Graduate Research Student, Department of Economics, Faculty of Social Sciences, University of Lagos. Lagos, Nigeria.

documento encuentra que los shocks de los precios del petróleo, tanto positivos como negativos, tienen influencia sobre el gasto gubernamental real sólo en el largo (más que en el corto) plazo, mientras que al examinar los shocks, positivos y negativos, de las reservas externas se encontró que existen implicaciones más fuertes para el gasto en el largo plazo, y que los shocks de los precios petroleros positivos (más que los negativos) tienen efectos de corto y largo plazo sobre el PIB, lo que consecuentemente desata presión inflacionaria y depreciación de la moneda nacional conforme aumenta la importación. Esto implica que el país exhibe el síndrome de la enfermedad holandesa en el corto y largo plazo. Sin embargo, los resultados muestran que los shocks de los ingresos petroleros tienen capacidad para impedir el crecimiento económico sólo en el largo plazo, mientras que elevan marginalmente el nivel general de precios en el corto plazo luego de los shocks iniciales; con evidencia de una amenaza seria a la tasa de interés y a la moneda nacional en el corto y mediano plazo conforme el volumen de importaciones se incrementa considerablemente junto con las reservas externas. Los resultados sobre los efectos asimétricos de los shocks del ingreso petrolero revelaron que los shocks positivos de los ingresos del petróleo estimulan la postura fiscal expansionista en la economía nigeriana en el corto plazo (de acuerdo con la teoría), creando en esa forma presión inflacionaria y depreciación monetaria. Las implicaciones combinadas de estos hallazgos sugieren la necesidad de una coordinación apropiada de las políticas monetaria y fiscal si se quiere alcanzar la estabilidad macroeconómica sostenida.

Palabras clave: shocks de los precios del petróleo, ingresos petroleros, desempeño macroeconómico, VAR.

JEL classification: C13, C22, E39, F42, 055.

Introduction

Nigeria is highly vulnerable to fluctuations in the international oil market, given the fragile nature of the economy and the heavy dependence on crude oil proceeds, despite being the sixth largest producer of oil in the world (Akpan, 2009). The provision of plausible explanations for the relationship between oil price movements and macroeconomic performance has occupied the attention of economists over the last four decades. The steep upward trend in the price of crude oil in recent years, reaching a record nominal high of US $147 in mid-2008 and a sharp drop to US $46 a barrel a year later, has led to increasing concern about its macroeconomic implications, both abroad and in Nigeria.

The Nigerian economy has consistently relied on export of crude oil for foreign exchange earnings and revenues, particularly as it accounts for over 95 per cent of export earnings and about 85 per cent of government revenues. Its contribution to GDP, however, stood at 17.85 per cent in 2008 (Aliyu, 2009). Nigeria's oil statistics show that the country has an estimated 36.2 billion barrels of oil reserves which places the country as the second largest in terms of oil reserve on the African continent. The Energy Information Administration (2009) estimates Nigeria's effective oil production capacity to be around 2.7 million barrels per day. Serious drop in oil production levels, which affected exports and the plummeting of world oil prices in late 2008 resulted in huge revenue gaps for the country. Equally, the country is exposed to oil price shocks through massive importation of refined petroleum products since the collapse of local refineries in the late 1980s. Currently, the country imports almost 85 per cent of refined products for local consumption. The near collapse of the power generation and distribution industry in the country further accentuates the acute shortage of energy. The burden on the government to provide energy resources at subsidised rate became very unwieldy, and between 1999 and 2008, the Federal Government of Nigeria reduced its subsidy approximately nine times. This adversely affected production, consumption and investment decisions and hence the rate of economic growth (Aliyu, 2009).

Theoretically, a transmission channel mechanism has been devised to explaining the media through which oil prices affect real economic activity. Notably, two channels; supply and demand, have been prominent in the literature, while other postulated channels such as economic policy reaction, valuation and asymmetric response channels have been viewed to be ambiguous with the latter channels technically oriented. The supply side effects relate to the fact that crude oil is a basic input to production and commerce, and hence an increase in oil price leads to a rise in production and distribution costs that induce firms to lower output. Changes in oil price also entail demand-side effects on consumption and investment. Oil price changes also influence foreign exchange markets and generate stock exchange panics, higher interest rate, produce inflation and eventually lead to monetary and financial instability (Jiménez-Rodríguez and Sánchez, 2005).

Furthermore, an oil-price increase leads to a transfer of income from importing to exporting countries through a shift in the terms of trade. The magnitude of the direct effect of a given price increase depends on the share of the cost of oil in the national income, the degree of dependence on imported oil and the ability of end-users to reduce their consumption and switch away from oil. In net oil-importing countries, higher oil prices lead to inflation, increased input costs, reduced non-oil demand and lower investment. Tax revenues fall and the budget deficit increases, due to rigidities in government expenditure, which drives interest rates up. Given the resistance to real declines in wages, an oil price increase typically leads to upward pressure on nominal wage levels, thereby stimulating wage pressures with far reaching implications which manifests, possibly in all the postulated channels: supply, demand, economic policy reaction, valuation and asymmetric response (Wakeford, 2006).

A large body of research has examined the impact of oil price shocks on output and summarily suggests that oil price volatility tends to exert a positive effect on the GDP growth for a net oil exporting country and a negative effect on net oil importing countries. Early empirical studies found a linear negative relationship between oil prices and real activity in oil importing countries, while results from studies done in the mid-1980s suggest reversal of initial outcomes in light of the declines in oil prices that occurred over the second half of the 1980s. Thus, Mork (1989), Lee *et al.* (1995) and Hamilton (1996) introduced non-linear transformations of oil prices to re-establish the negative relationship between increases in oil prices and economic downturns. Recently, Hamilton (2003) and Jiménez-Rodríguez and Sánchez (2005) also found evidence of a non-linear relationship between the two variables for the US economy. The issue of asymmetry in non-linear relationship between GDP and oil prices in the literature has thus proposed two other non-linear transformations, namely: scaled specification (Lee *et al.*, 1995), taking the volatility of oil prices into account; and net specification (Hamilton, 1996), which considers the amount by which oil prices have gone up over the last year. However, asymmetries in the response of real activity to oil prices have been relatively ambiguous.

More concretely, this explanation relates to adjustment costs resulting from the implied sectoral reallocation of resources. According to this argument, an increase (decrease) in oil prices would lead to a contraction (expansion) in sectors that make use of oil in the production process. The contractions and expansions that occur in energy-efficient and energy intensive sectors as a result of changes in oil prices thus stimulate adjustments and readjustments that could give rise to the asymmetric effect (Akpan, 2009).

This paper adopts a unique quarterly data on crude oil price by using the Bonny light crude oil price obtained from the Central Bank of Nigeria (CBN) online statistics database for its analysis, since the Bonny light crude accounts for more than 55 per cent of the Nigerian crude oil export over the years as against the UK Brent crude oil price and the Nigerian-Forcados crude oil price employed by other authors (Olomola and Adejumo, 2006; Akpan, 2009; Aliyu, 2009 and Chuku *et al.,* 2011). This thus ensures that the macroeconomic consequence of shocks to oil price in Nigeria is captured using more reliable crude oil price data. The study also examined the effects of shocks to oil revenue on key macroeconomic variables and was able to show the differences between symmetry and asymmetry shocks to oil price and oil revenue as well as their impact on the Nigerian economy using separate models, a novel approach. Furthermore, aside from the plausible discoveries made, the study was able to provide empirical evidence that shows that both positive and negative shocks to oil revenue relatively increase the level of external reserve in the mid to long run. This outcome could be traceable to the steady resort to external borrowings among different political regimes in the period covered, with salutary implication on importation of capital goods for infrastructural projects as contained in series of national development plans. Similarly, available data revealed less demand pressure on external reserves in periods of sharp decline in oil revenue. This thus neutralized the downside effects that expectedly would have emanated from negative shocks to revenue from oil export.

The rest of the paper is structured as follows. Section I presents the literature review, while section II explains the theoretical framework and methodology, including sources of data and analytical techniques. The empirical result is discussed in section III, with conclusion provided in the final section.

I. Literature Review

A number of empirical works on the relationship between oil prices fluctuations and economic activity has been carried out using different estimation approaches. By looking at the channel of transmission of oil price shocks to the larger economy, many researchers have argued that fluctuations in oil prices are linked to macroeconomic performance.

I.1. Developed Countries

Bernanke *et al.* (1997) studied the role of monetary policy as the central issue rather than a factor contributing to discontinuity in the oil price-GDP relationship. Evidences from their impulse response functions show that had the Federal Reserve maintained the funds rate at the pre-shock level, most of the GDP response to oil price over the 1973, 1979-1980, and 1990 episodes would have been avoided. This suggests that most, if not all, of the reduction in GDP during the recessions following those episodes was attributable to monetary policy rather than the oil price shocks themselves.

Hamilton and Herrera (2001) reexamined the Bernanke *et al.* (1997) study, and arrived at a diametrically opposite conclusion about the relative contributions of monetary policy and oil price shocks to the recessions following the 1973, 1979-1980, and 1990 oil price shocks. From their analysis of the impulse response functions, they discovered that the potential of monetary policy to avert the contractionary consequences of an oil price shock is not as great as suggested by the analysis of Bernanke *et al*. Rather, oil shocks appear to have a bigger effect on the economy than suggested by their VAR, and they were unpersuaded of the feasibility of implementing the monetary policy needed to offset even small shocks.

It is believed that monetary policy's response to oil price shocks can cause aggregate economic fluctuations. Brown and Yücel (1999) tested such hypothesis using a seven-variable VAR model in the US economy and found that a constant federal funds rate during an oil shock is an accommodative monetary policy stance; on the other hand, holding nominal GDP constant corresponds to a neutral monetary policy. Similar study by Eltony and Al-Alwadi (2001) employed the unrestricted VAR, the Vector Error Correction Model and the structured VAR, and found all three versions estimates indicating high degree of interrelation among the major macroeconomic variables.

Backus and Crucini (2000) study on the terms of trade and the volatility of oil price in the US economy indicates that heightened terms of trade volatility are significantly related to increased oil price volatility, as opposed to fluctuations in nominal or real exchange rates that are both insignificant with respect to the terms of trade volatility.

Focusing on the inflationary effects of oil price shocks, Hooker (2002) assessed the contribution of oil price changes on US inflation in a Phillips curve framework, taking into account the asymmetries, non-linearities and structural break effects. His results on structural break indicate that changes in the price of oil had significant effects on core inflation before 1980 but weakened after that period.

Contrary to previous research outcomes, the Cuñado and Pérez de Gracia (2003) study on 15 European countries revealed mixed results, as cointegrating long-run relationship between oil prices and economic activity was found only in two countries (the United Kingdom and Ireland). Therefore, they suggest that the impact of oil shocks on economic activity is limited to the short run. They conclude that the use of either world oil price index or a national real price index is part of the explanation to the difference.

Jiménez-Rodríguez and Sánchez (2005) using multivariate VAR analysis in a study involving major industrialised OECD countries found that the response of real GDP to oil price shocks differ between net oil importers and exporters with the exception of United Kingdom (net exporter) and Japan (net importer). Also, their asymmetric (non-linear) specification showed that oil price declines are significant only in few countries, while shocks to oil price, together with monetary shocks, are found to be the largest source of volatility in real output aside itself. The authors re-specified earlier models and employed standard vector autoregression methods for linear and non-linear specified models. Their results indicate that non-linear impact of oil prices on real GDP is positively significant, especially as oil price increases influence GDP growth substantially than that of oil price declines, with the latter being statistically insignificant in most cases.

Guo and Kliesen (2005) used a measure of realized volatility constructed from daily crude oil future prices traded on the Nymex, and find that, over the period 1984-2004, oil price volatility has a significant effect on various key US macroeconomic indicators, such as fixed investment, consumption, employment and the unemployment rate.

The VAR model analysis by Blanchard and Gali (2007) found that the relationship between oil price increase and GDP in 6 countries (US, England, Germany, France, Italy and Japan) changed from negative to positive from the 2000s shock in comparison to shocks in the 1970s and 1980s, in addition to minimal impacts on GDP, unemployment, wage and CPI for the period. Lardic and Mignon (2006) studied 12 European countries for the period 1970 to 2003 and found asymmetric relationship between oil price and economic activities; implying that rising oil prices retard aggregate economic activity more than falling oil prices stimulate same.

Sill (2007) in a study on the US economy found that a 10 per cent increase in the price of oil is associated with about 1.4 per cent drop in the level of US real GDP, while increases in oil prices have no significant effect on US. inflation. Nevertheless, the evidence suggests that the recent rise in oil prices has worked to restrain domestic output growth. Gounder and Bartleet (2007) used both linear and nonlinear oil price transformation models to discover a direct link between net oil price shock and economic growth in New Zealand, followed by substantial effect on inflation and exchange rate. Also, Chen and Chen (2007) found a co-integrating relationship between real oil prices and real exchange rates.

Jin (2008), in a comparative analysis, discovered that oil price increases exert a negative effect on economic growth in Japan and China and a positive effect on Russia. Specifically, a 10 per cent permanent increase in international oil prices is associated with a 5.16 per cent growth in Russian GDP and a 1.07 per cent decrease in Japanese GDP.

In a recent study, Elmi and Jahadi (2011) used VAR approach to analyze the effect of oil price shocks on economic growth fluctuations in selected OPEC and OECD countries for the period 1970-2008, and found that both OPEC and OECD countries are affected by oil price shock albeit at different degrees.

I.2. Developing Countries

Sinha and Bhide (1997) examined the relationship between oil price shocks, output and inflation in India, and show that a 10 per cent hike in the price of international oil when passed on to the domestic petroleum sector prices would lead to a 2 per cent increase in the overall domestic price level. A similar study by Bhattacharya and Kar (2005) found that a 100 per cent increase in the price of imported oil would lead to a 15 per cent increase in the domestic prices, and a 3 per cent decline in industrial production.

Also, Ayadi *et al.* (2000) studied the effects of oil production shocks for Nigeria, as a net exporter of oil for the period 1975-1992 using the VAR approach, and found that output responds positively to positive oil production shock, while inflation response was negative after a positive oil production shock to the extent that an oil price increase leads to an oil production increase. The authors' results thus suggest that output increases; inflation decreases and the national currency depreciate following a positive oil-price shock in Nigeria.

Abeysinghe (2001) studied the impact of oil price changes by focusing on only 12 economies, which include Indonesia, Malaysia, Singapore, Philippines, and Thailand using data over the 1978-1998 period. This study evaluates the direct and indirect effects of oil prices on GDP growth of these economies. Chang and Wong (2003) examined the impact of oil price fluctuation on the Singapore economy, using cointegrated VECM technique, impulse response analysis and VDC. The results obtained suggest that oil price shock only had a marginal effect on Singapore's macroeconomic performance, particularly as descriptive analysis showed that Singapore's oil intensity and expenditure on oil consumption as a percentage of GDP have fallen over time. Cuñado and Pérez de Gracia (2005) found that oil prices have a statistically significant effect on both economic growth and inflation in the short-run in six small and open Asian economies, including Malaysia, Singapore, Philippines, Thailand and some OECD countries.

Berument *et al.* (2010) in a study on Middle East and North African countries found the asymmetric effects of world oil price shocks on the GDP of Algeria, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, Tunisia, and UAE to be positive and statistically significant, while positive but insignificant results were reported for Bahrain, Egypt, Lebanon, Morocco and Yemen. Raguindin and Reyes (2005) impulse response functions results showed that oil price shock leads to a prolonged reduction in the real GDP of the Philippine economy, while asymmetric VAR model analysis suggest that oil price decreases play a greater role in each variable's fluctuations than oil price increases. In a related study, Elanshasy *et al.* (2005) examine the subject matter on Venezuela for period (1950 to 2001) using similar estimation approach, and reported positive and statistically significant short and long-run relationships, even with fiscal balance (government revenues and expenditure).

Wakeford (2006) study on the South African economy revealed that while commodity exports —especially gold— provided an initial buffer, the economy was not immune to sustained price shocks and several short-run supply risks. However, using VAR methodology for the period 1970-2003, Olomola and Adejumo (2006) found that contrary to previous empirical findings, oil price shocks do not significantly affect output and inflation in Nigeria, while oil price shocks was found to significantly influence the real exchange rate. This result is slightly different from that obtained by Ayadi (2005), which suggests that oil price changes significantly influence economic development in Nigeria via industrial production. The results further suggest that oil price changes affect industrial production indirectly through its effect on exchange rate albeit insignificantly.

Farzanegan and Markwardt (2009) found a strong positive relationship between oil price changes and industrial output growth and real effective exchange rate for the Iranian economy. However, results obtained by Jbir and Zouari-Ghorbel (2009) indicate that there is no direct impact of oil price shock on the economic activity in both linear and non-linear specifications in Tunisia, rather oil prices affect economic activity indirectly and also oil price shock was discovered to be mostly transmitted via government's spending. Using vector autoregressive (VAR) methodology, Lorde *et al.* (2009) found that unanticipated shock to oil price volatility brings about random swings in the macroeconomy of Trinidad and Tobago. However, only government revenue and the price level exhibit significant responses, while magnitude of oil price volatility responses tend to yield smaller macroeconomic impacts. Also, Granger-causality tests indicate causality from oil prices to output and oil prices to government revenue. Similarly, Bekhet and Yusop (2009) reveal evidence of a stable long-run relationship and substantial short run interactions between the oil price and employment, economic growth and growth rate of energy consumption in Malaysia.

Akpan (2009) using VAR model analysis found a positively significant asymmetric effect of oil price shocks on real government expenditure in Nigeria, while such effect on industrial output growth was found to be marginal with observed significant appreciation of the real exchange rate. These findings reinforce results obtained in earlier studies by Olomola and Adejumo (2006) and Ayadi (2005) on Nigeria. Similarly, Aliyu (2009) used a non-linear approach and found evidence of both linear and non-linear effects of oil price shocks on real GDP in Nigeria; precisely, the study found that asymmetric oil price increases in the non-linear models have larger positive impacts on real GDP growth than in other specifications. The study, which focused on the effects of oil price shock and real exchange rate volatility on real economic growth in Nigeria, found a unidirectional causality running from oil prices to real GDP and bidirectional causality from real exchange rate to real GDP and vice versa, while further results indicate that oil price shock and appreciation in the level of exchange rate exert positive impact on real economic growth in Nigeria.

Omisakin *et al.* (2009) examined the short run implications of oil price shocks on the Nigerian economy using Vector Error Correction (VECM) model on data for the period 1970-2006 and found that a 10 per cent increase in oil price brought about 79 per cent increase in oil revenue, 45 per cent increase in government expenditure, 17 per cent increase in money supply, 11 per cent decrease in CPI and 31 per cent increase in GDP in the short run, which thus implies that the Nigerian economy is vulnerable to international oil price volatility.

Chuku *et al.* (2011) studied the linear and asymmetric impacts of oil price shocks on the Nigerian economy for the period 1970Q1-2008Q4 using VAR model and Granger causality test approach; and found that oil price shocks are not a major determinant of macroeconomic activity in Nigeria in the linear model; while Granger causality results indicate that world oil prices do not influence macroeconomic activity and that non-linear specification results show that the impact of world oil price shocks on the Nigerian economy are asymmetric. Similarly, the Tang *et al.* (2010) study on the Chinese economy emphasized the price transmission mechanism and employed a structural VAR model to show that an oil-price increase negatively affects output and investment, but positively affects inflation rate and interest rate. However, with price control policies in China, the impact on real economy, represented by real output and real investment, lasts much longer than that on price/monetary variables. Also, Du *et al.* (2010) used the multivariate VAR method on a monthly time series data for period 1995:1 to 2008:12, and found that world oil price affects economic growth and inflation significantly in China.

I.3. Developed vs Developing Countries

The IMF (2000) found, in a study on the impact of oil price increase on the global economy, that the differential impact of an oil price increase of US$5 per barrel is greater for developed countries than for developing countries as a group, with differences in terms of the relative size of oil importing to exporting countries accounting for much of the disparity; while oil price shocks was precisely shown to lower aggregate demand by redistributing income between net oil importers and exporters. The study further indicated that differences in oil intensity levels in domestic production, exports and imports, and degree of openness also accounted for some of the observed discrepancy. Additional results indicate that oil price change is positively correlated with economic growth in oil producing countries, while estimates of the first round impact of higher oil prices on GDP growth for some ASEAN countries, viz Indonesia (+0.5%), Malaysia (+0.2%), Philippines (–0.5%), and Thailand (–0.4%), were found to be mixed.

Lescaroux and Mignon (2008) considered the effect of oil price changes on GDP, CPI, unemployment rate and bond price in OPEC member countries and some oil importing countries. In two cases, Iran and Saudi Arabia, causality is birectional. For Brazil and Oman causality runs from GDP to oil price. For other cases, oil price change causes GDP change. Cologni and Manera (2008) investigated the impact of oil prices on inflation and interest rates in a cointegrated vector autoregressive (VAR) framework for G7 countries, and found that, except for Japan and the UK, oil prices significantly affect inflation, which is transmitted to the real economy by increasing interest rates.

Table 1. Summary of Oil Price-macroeconomy Relationship

Study	*Subject of investigation*	*Approach*	*Major findings*
Developed countries			
Bernanke *et al.* (1997)	Monetary policy as the central issue in the oil price-GDP relationship in the US.	VAR model.	Reduction in GDP during the recessions was attributable to monetary policy rather than the oil price shocks.
Hamilton and Herrera (2001)	Reexamined Bernanke *et al.* (1997) study on the relative contributions of monetary policy to the recessions following the 1973, 1979-80, and 1990 oil price shocks.	VAR model.	Oil shocks appear to have a bigger effect on the economy than suggested by Bernanke *et al.* and thus inferred that monetary policy is not feasible in order to offset even their small shocks.
Brown and Yucel (1999)	Monetary policy in the oil price-GDP relationship in the US.	Employed seven-variable VAR model.	Found that a constant federal funds rate during an oil shock is an accommodative monetary policy stance; while holding nominal GDP constant corresponds to a neutral monetary policy.
Eltony and Al-Alwadi (2001)	Monetary policy in the oil price-GDP relationship in the US.	Unrestricted VAR, the Vector Error Correction Model and the structured VAR.	All three versions estimates indicate high degree of interrelation among the major macroeconomic variables.
Backus and Crucini (2000)	Terms of trade and the volatility of oil price in the US economy.	VAR model.	Heightened terms of trade volatility are significantly related to increased oil price volatility, as opposed to fluctuations in nominal or real exchange rates that are both insignificant with respect to the terms of trade volatility.

Study	*Subject of investigation*	*Approach*	*Major findings*
Hooker (2002)	The contribution of oil price changes on US inflation.	Employed Phillips curve framework with the asymmetries, non-linearities and structural break effects taken into account.	Results on structural break indicate that changes in the price of oil had significant effects on core inflation before 1980 but weakened since that period.
Cuñado and Pérez de Gracia (2003)	Oil price and economic activity in 15 European countries.	VAR model.	Cointegrating long-run relationship between oil prices and economic activity was found only in two countries (the United Kingdom and Ireland). The impact of oil shocks on economic activity is limited to the short run. The use of either world oil price index or a national real price index accounts for the difference in outcome.
Jiménez-Rodríguez and Sánchez (2005)	Oil price-GDP relationships in selected OECD countries.	Employed standard vector autoregression methods for linear and non linear specified models.	The response of real GDP to oil price shocks differ between net oil importers and exporters (with the exception of United Kingdom (net exporter) and Japan (net importer)). Asymmetric (non-linear) specification showed that oil price declines are significant only in few countries, while shocks to oil price, together with monetary shocks, are found to be the largest source of volatility in real output aside itself.
Guo and Kliesen (2005)	Oil price volatility and the US macroeconomy.	Used a measure of realized volatility constructed from daily crude oil future prices traded on the Nymex for the period 1984-2004.	Oil price volatility has a significant effect on various key US macroeconomic indicators, such as fixed investment, consumption, employment and the unemployment rate.

Table 1. Summary of Oil Price-macroeconomy Relationship (Cont.)

Study	*Subject of investigation*	*Approach*	*Major findings*
Blanchard and Gali (2007)	Oil price increase and GDP in 6 countries (US, England, Germany, France, Italy and Japan).	VAR model.	The relationship has changed from negative to positive in 2000s shock in comparison to 1970s and 1980s shocks, in addition to minimal impacts on GDP, unemployment, wage and CPI for the period.
Lardic and Mignon (2006)	Oil price shock-GDP relationships in 12 European countries for the period 1970-2003.	VAR model with assymetric specifications.	Asymmetric relationship between oil price and economic activities; which implies that rising oil prices retard aggregate economic activity more than falling oil prices stimulate such.
Sill (2007)	Oil price-GDP relationship in the US.	VAR model with assymetric specifications.	Ten per cent increase in the price of oil is associated with about a 1.4 per cent drop in the level of US real GDP, while increases in oil prices have no significant effect on U.S. inflation. Recent rise in oil prices have worked to restrain domestic output growth.
Gounder and Barleet (2007)	Oil price shock and economic growth in New Zealand.	Used both linear and nonlinear oil price transformation models.	Found a direct link between net oil price shock and economic growth followed by substantial effect on inflation and exchange rate.
Jin (2008)	Oil price shock-GDP relationship in Japan, China and Russia.	VAR model.	Oil price increases exerts a negative impact on economic growth in Japan and China and a positive impact in Russia. Specifically, a 10 per cent permanent increase in international oil prices is associated with a 5.16 per cent growth in Russian GDP and a 1.07 per cent decrease in Japanese GDP.

Study	*Subject of investigation*	*Approach*	*Major findings*
Elmi and Jahadi (2011)	Effects of oil price shocks on economic growth fluctuations in selected OPEC and OECD countries for the period 1970-2008.	VAR model.	Both OPEC and OECD countries are affected by oil price shock albeit at different degrees.
Developing countries			
Sinha and Bhide (1997)	Relationship between oil price shocks, output and inflation in India.	VAR model.	A 10 per cent hike in the price of international oil when passed on to the domestic petroleum sector prices would lead to a 2 per cent increase in the overall domestic price level.
Bhattacharya and Kar (2005)	Oil price and Indian macroeconmy.	VAR model.	A 100 per cent increase in the price of imported oil would lead to a 15 per cent increase in domestic prices, and a 3 per cent decline in industrial production.
Ayadi *et al.* (2000)	Effects of oil production shocks in Nigeria for the period 1975-1992.	VAR model.	Output responds positively to positive oil production shock, while inflation response was negative after a positive oil production shock to the extent that an oil price increase leads to an oil production increase.
Abeysinghe (2001)	Oil price and economic activity in 12 selected developing countries for the 1978-1998 periods.	VAR model.	The direct and indirect effects of oil prices on GDP growth differ across developing countries.
Chang and Wong (2003)	Oil price fluctuation in the Singapore economy.	Cointegrated and VAR model.	Oil price shock only had a marginal effect on Singapore's macroeconomic performance, particularly as oil intensity and expenditure on oil consumption as a per centage of GDP have fallen over time.

Table 1. Summary of Oil Price-macroeconomy Relationship (Cont.)

Study	*Subject of investigation*	*Approach*	*Major findings*
Cuñado and Pérez de Gracia (2005)	Macroeconomic effects of oil price fluctuation in six small and open Asian economies.	VAR model.	Oil prices have a statistically significant effect on both economic growth and inflation in the short-run.
Berument *et al.* (2010)	Macroeconomic effects of oil price fluctuation in Middle East and North African countries.	VAR model.	Asymmetric effects of world oil price shocks on GDP of Algeria, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, Tunisia, and UAE was positive and statistically significant, while positive though insignificant results were reported for Bahrain, Egypt, Lebanon, Morocco and Yemen.
Raguindin and Reyes (2005)	Oil price-GDP relationship in the Philippine economy.	VAR model.	Oil price shock leads to a prolonged reduction in real GDP while asymmetric VAR shows oil price decreases play a greater role in each variable's fluctuations than oil price increases.
Elanshasy *et al.* (2005)	Oil price-GDP relationship in Venezuela for period (1950 to 2001).	VAR model.	Positive and statistically significant short and long-run relationships, even with fiscal balance (government revenues and expenditure).
Wakeford (2006)	Oil price-GDP relationship in South Africa.	VAR model.	Commodity exports —especially gold— provided an initial buffer, but the economy was not immune to sustained price shocks and several short-run supply risks.
Olomola and Adejumo (2006)	Oil price-GDP relationship in Nigeria for the period 1970-2003.	VAR model.	Contrary to previous empirical findings, oil price shocks do not significantly affect output and inflation in Nigeria, while oil price shocks significantly influenced the real exchange rate.

Study	*Subject of investigation*	*Approach*	*Major findings*
Aliyu (2009)	Oil price-GDP relationship in Nigeria.	VAR model	Evidence of both linear and non-linear effects of oil price shocks on real GDP; with asymmetric oil price increases in the non-linear models having larger positive impacts on real GDP growth than in other specifications.
Farzanegan and Markwardt (2009)	Oil price shocks and the Iranian Economy.	VAR model.	The study found a strong positive relationship between oil price changes and industrial output growth and real effective exchange rate for the Iranian economy.
Jbir and Zouari-Ghorbel (2009)	Oil price-GDP relationship in Tunisia.	VAR model.	No direct impact of oil price shock on economic activity in both linear and non-linear specifications, rather oil prices affect economic activity indirectly.
Lorde *et al.* (2009)	Oil price-GDP relationship in Trinidad and Tobago.	VAR model.	Unanticipated shock to oil price volatility brings about random swings in the macroeconomy; while only government revenue and the price level exhibit significant responses, with magnitude of oil price volatility responses yielding smaller macroeconomic impacts.
Bekhet and Yusop (2009)	Oil price-GDP relationship in Malaysia.	VAR model.	Stable long-run relationship and substantial short run interactions between the oil price and employment, economic growth and growth rate of energy consumption.
Akpan (2009)	Oil price-GDP relationship in Nigeria.	VAR model.	A positively significant asymmetric effect of oil price shocks on real government expenditure in Nigeria, while such effect on industrial output growth was found to be marginal with observed significant appreciation of the real exchange rate.

Table 1. Summary of Oil Price-macroeconomy Relationship (Cont.)

Study	*Subject of investigation*	*Approach*	*Major findings*
Omisakin *et al*. (2009)	Short run implications of oil price shocks on the Nigerian economy for period 1970-2006.	Vector Error Correction (VECM) model.	A 10 per cent increase in oil price brought about 79 per cent increase in oil revenue, 45 per cent increase in government expenditure, 17 per cent increase in money supply, 11 per cent decrease in CPI and 31 per cent increase in GDP in the short run, which thus implies that the Nigerian economy is vulnerable to international oil price volatility.
Chuku *et al*. (2011)	Oil price-GDP relationship in Nigeria for the period 1970Q1-2008Q4.	VAR model and Granger causality test.	Oil price shocks are not a major determinant of macroeconomic activity in Nigeria in the linear model.
Tang *et al*. (2010)	Oil price-GDP relationship in China.	Structural VAR model.	Oil-price increase affects output and investment negatively, but affects inflation rate and interest rate positively.
Du *et al*. (2010)	Oil price-GDP relationship in China for period 1995:1 to 2008:12.	Multivariate VAR	World oil price affects economic growth and inflation significantly in China.

Source: Author's own elaboration with synthetized information from the literature review.

II. Theoretical Framework and Methodology

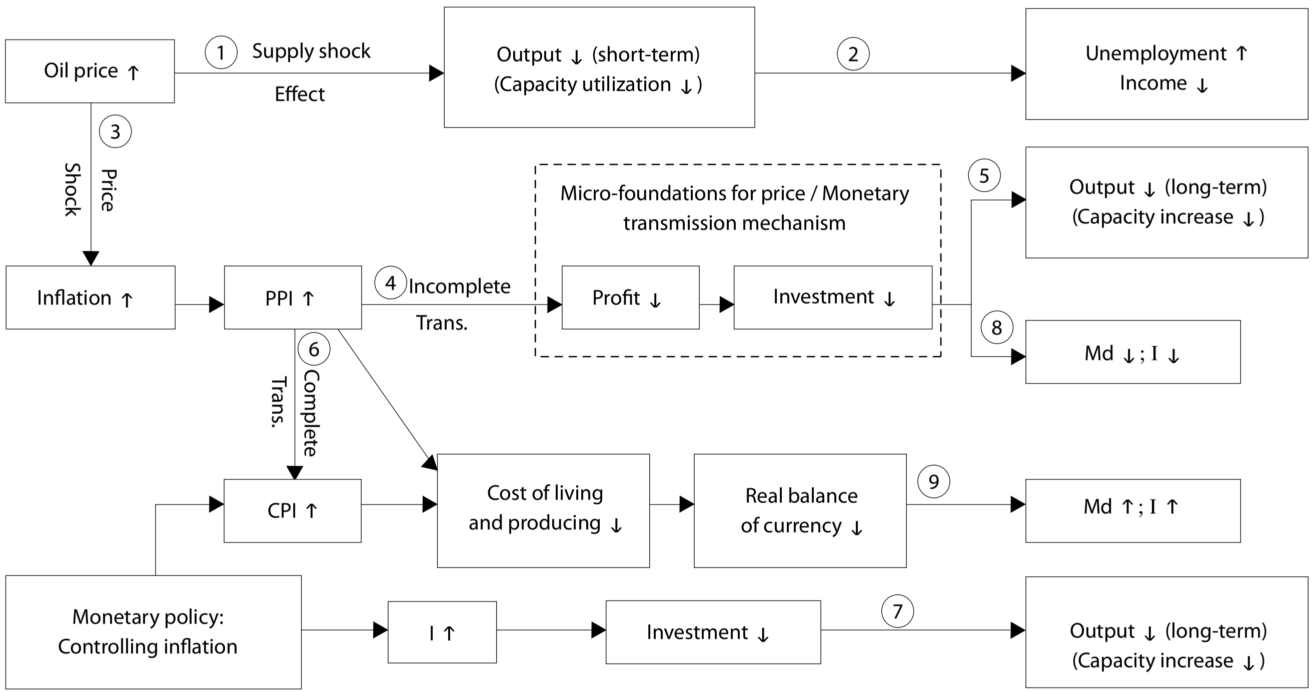
II.1. Theoretical Overview

There has been extensive theoretical work on the macroeconomic consequences of oil price shocks. Most of these studies argued that since the mid-1970s, oil price movements have been a major source of business cycle fluctuations, but rather failed to reach consensus on the validity of a peculiar transmission channel that helps to explain the processes by which fluctuations in oil prices influence the macro economy.

According to Hunt *et al.* (2002), an increase in oil prices can influence the economy through many channels. The first mechanism reflects the transfer of income from oil-importing to oil-exporting countries, which leads to a decrease in global demand in the oil-importing nations. The decrease in demand in the oil-importing countries outweighs the increase in the oil-exporting countries because of an assumed low propensity to consume in the latter. Secondly, given the level of capital stock and assuming that wages are relatively inflexible in the short run, an increase in input costs of production will result in non-oil output being affected. Also, since crude oil is a basic input in production, an increase in oil prices leads to an increase in production costs. The third channel is when workers and producers resist a decrease in their real wages and profit margins. This results in upward pressure on labour costs and prices. The fourth channel is through the definition of core inflation. An increase in energy prices raises the consumer price index, leading to calls for action from the central bank. A tight monetary policy has dire consequences on economic output. Finally, the extent to which monetary authorities' reactions are inconsistent with announced policy objectives could erode their credibility.

Tang *et al.* (2010) in a study of the short and long-term effects of oil shocks on the Chinese economy identified six transmission channels. Namely: Supply-side shock effect, focusing on the direct impact on output due to the change in marginal producing costs caused by oil-price shock; wealth transfer effect, emphasizing on the different marginal consumption rate of petrodollar and that of ordinary trade surplus; inflation effect, analyzing the relationship between domestic inflation and oil prices; real balance effect, investigating the change in money demand and monetary policy; sector adjustment effect, estimating the adjustment cost of industrial structure, which is mainly used to explain the asymmetry in oil-price shock impact; and unexpected effect, focusing on the uncertainty over oil

Figure 1. Oil Price Shocks-macroeconomy Transmission Channel



Source: Adapted by the authors from Tang *et al.* (2010).

price and its impact. These channels have been proven to be valid in industrialised countries.

According to the authors, crude oil is one of the most fundamental and crucial raw materials for industrial production and the change in its price can affect the output directly. As Arrow (1) in figure 1 indicates, oil-price shocks can increase the marginal cost of production in many industries, and thus reduce the production. This is referred to as the supply-side shock effect. The reduction of output due to the cut in capacity utilization can recover quickly within the range of capacity. However, oil-price shocks also have long-term effect on output which is carried out through price/monetary transmission mechanism (Arrow (3)).

Cost shocks in the upstream industry can be transmitted from producers and sectors to end-users. A well developed industrial chain can transmit inflationary shock from upstream to down-stream, leaving the producers' profit rate slightly affected. That can raise the overall cost for consumers and producers, thus reducing the consumers' real balance. This transmission ends up with the reduction of consumption and the real output as well. This is the story witnessed in most developed countries. But in China, hackneyed price controls, surplus production due to limited domestic demand and tough price competition in exporting sectors make the output prices very sticky (Arrow (3)) (Tang *et al.*, 2010).

Due to limited space for mark-up, down-stream producers could only reduce their profit to assimilate the cost increase, which would doubtlessly cause the decrease in their investment. Since investment determines the increase of production capacity, i.e. the potential output ability, which cannot recover in a short period of time even when the cost shock disappears, a decrease in investment would abate output in the long run. In the authors' view, this channel is more important and dominant in China. Real balance decrease can enlarge money demand in the market while investment decrease can lessen it, so the net impact of an oil price shock on interest rate is unclear and neither the corresponding monetary policy needed (Tang *et al.*, 2010). Similar theoretical analysis was asserted to be valid by Jin (2008), West African Monetary Agency, WAMA (2008) and Lescaroux and Mignon (2008), who also added that the macroeconomic effects of oil shocks are transmitted via supply and demand side channels and are substantially minimized by economic policy reactions.

Altogether, two major channels (demand and supply) have been put forward, in addition to three other recent ones (economic policy reactions, valuation and asymmetric response). Precisely, the supply side channel focuses on oil as an input in the industrial and production processes, with its attendant effects on firm's productivity and supply, non-oil potential supplies, workers' and producers' real wages and profit margins (Jiménez-Rodríguez and Sánchez 2005; Hunt *et al.*, 2002). Other identified manifestations of supply side channel consequences include, the tendency of shrinking current investment in the oil and gas sector as well as aggravating future potentials (Hamilton, 1996), just as possible structural shift occasioned by changes in resource (capital and labour) requirements in both energy-intensive and non-energy-intensive industries due to oil price volatility.

The demand side channel consequences of increase in oil prices reflects through lower demands due to high production cost induced higher selling price; transfer of income and resources from oil-importing to oil-exporting economies which affects aggregate demand and consumption globally as demand in the former is likely to decline more than it will rise in the latter (Hunt *et al.*, 2002) and heightened economic uncertainty (WAMA, 2008).

Other identified channels such as economic policy reactions, valuation, and asymmetric response are considered as follows: Economic policy reactions occur through monetary authorities' actions toward curtailing adverse effects of increase in oil price such as inflation and lower aggregate demand, through interest rate and money supply. Money supply plays a role in the negative correlation between oil prices and economic activity, as the real money balances channel presupposes that increases in oil prices cause inflation which, in turn, reduces the quantity of real balances in the economy (Ferderer, 1996). Besides, counter-inflationary monetary policy responses to oil price shocks are considered responsible for the real output losses associated with these shocks.

Asymmetric response channel relates to identifying the responses between oil prices and macroeconomic variables, such as GDP responses and employment. One of these include sectoral shifts hypothesis, similar in nature to the demand side effects, as oil price shocks lead to many costs in the form of job losses in one sector or region and net changes in aggregate employment. Second is the demand decomposition mechanism which operates eventually through employment but begins as a disturbance to sector-specific demand. Last is the investment pause effect in which reductions in orders and purchases remain uncertain. To deal with cases where oil price decreases, unlike increases, have positive real income (terms-of-trade) effects that offset identified negative impacts, many time-series modellers include nonlinear, asymmetric oil-price specifications

(Mork, 1989). Mork hypothesized that oil price decreases had little effects on economic activity compared to oil price increases. His results confirmed this hypothesis by incorporating both an oil price increase variable and an oil price decrease variable in the model.

The valuation channel of adjustment relies on changes in asset prices in response to oil demand and oil supply shocks. The magnitude and the nature of these capital gains and losses depend on the size of the initial gross foreign asset holdings and liabilities of oil importers and exporters, as well as their precise composition by financial instrument and currency. Standard diversification arguments suggest that oil-exporters should hold some of their wealth in the form of assets in oil importing economies (and *vice versa*). This diversification of asset holdings plays an important role. Under the additional assumption that an increase in the price of oil, *ceteris paribus,* will cause profits and asset prices to increase in the oil-exporting economy (and to fall in the oil-importing economy), some of the increased wealth associated with higher oil prices will be transferred from oil exporters to oil importers. Thus, positive oil-specific demand shocks and negative oil supply shocks should be associated with a temporary capital loss in oil exporting countries (and a corresponding capital gain in the rest of the world). In the long-run, asset prices return to their steady state level and the valuation channel vanishes. However, it is suggested that the valuation effect should be larger for oil exporters than for oil importers, *ceteris paribus*. Although this prediction ignores the important role of relative exchange rate adjustments triggered by oil demand and oil supply shock, in general, one would not expect the stylized bilateral and symmetric model to generate accurate predictions for specific oil-importing economies.

II.2. Methodology

II.2.1 Dataset and Description

This paper employs quarterly data for the period 1970:I-2010:IV to examine the effects of oil price shocks and oil revenue shocks on different sectors of the Nigerian economy, *i.e.:* the supply-side of the economy, real balances, inflation and the sector adjustment effects. However, certain events that shaped the global economy and crude oil price in particular within the period covered were identified and categorized as periods that exerted exogenous shocks to both oil price and the domestic economy and the world at large. In this regard, the Iranian revolution (1979), the Iraq-Iran war (1980-1988), the Iraq-Kuwait war (1990), the financial crisis of South

East Asia (1998), the terrorist attacks on the USA (2001) and the Iraq war (2003) as well as the global economic and financial crisis (2007-2010) were considered pertinent, hence we incorporated six dummy variables to capture these shocks. Seasonal dummies are used in all specifications of VARs to control for probable seasonalities in selected variables with more emphasis on capturing the cost of oil price changes and not seasonal patterns mostly in the positive and negative values of oil price and oil revenue. Seven endogenous variables are selected along with the crude oil price which is categorized as an exogenous variable based on the fact that it is largely influenced by external factors. The endogenous variables include: real government expenditure, (Rgovexp), real gross domestic product (RGDP), inflation rate (INF) proxy by the Consumer Price Index, interest rate (INT), real effective exchange rate (REXR), real volume of import (RIMP) and external reserves (Extrevs).

II.2.2. Data Sources

For real oil price (Roilprice), the Nigerian-Bonny light spot crude oil price was used as it accounts for a larger proportion of the country's crude oil export over the years, with data obtained from the Central Bank of Nigeria. The dollar prices were transformed to its equivalent Naira value using the corresponding real effective exchange rate published by the Central Bank of Nigeria (2011).

Real oil revenue (Roilrev) data was obtained from both the Central Bank of Nigeria (CBN) Statistical Bulletin (2011) and the Nigerian National Petroleum Corporation (NNPC) Annual Statistical Bulletin. Data for real government expenditure (Rgovexp) were obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin in annual forms but transformed to quarterly form using the cubic spline approach, while quarterly data for real gross domestic product (RGDP), inflation rate (INF) proxied by the Consumer Price Index and interest rate (INT) (CBN's benchmark rate) were sourced from the CBN Statistical Bulletin (2011). Similarly, data for real volume of import (RIMP) and external reserves (Extrevs) were obtained from the bulletin in annual form but transformed into quarterly form using the cubic spline approach, while data for real effective exchange rate (REXR) were sourced from the International Financial Statistics, IFS (2011).

II.2.3. Model Specification

Following Sims' (1980) seminal paper, the vector autoregression (VAR) model has become one of the leading approaches employed in the analysis of dynamic economic interactions (Adrangi and Allender, 1998, and Palm, 1983), especially in investigations of the oil price shocks-macroeconomy relationship. This study follows suit by employing the VAR model to examine the short and long-run impacts of oil price distortions on leading macroeconomic indicators in Nigeria. The VAR approach is founded on Granger's (1969) specification of causality. Causality in Granger's sense is inferred when values of a variable, say X_t has explanatory power in a regression of Y_t on lagged values of Y_t and X_t.

Following, we consider a VAR model of order k, thus:

$$Y_t = C_0 + \sum_{i=1}^{k} \Phi_i Y_{t-1} + \varepsilon_t \tag{1}$$

Where: Y_t = (*Roilprice, Rgovexp, RGDP, INF, INT, REXR, RIMP, Extrevs*) is an $n \times 1$ vector of seven endogenous variables, and, *Roilprice* is real oil price, Rgovexp is real government expenditure, *RGDP* is Real GDP, INF is inflation rate; INT is interest rate; *REXR* is Real Exchange Rate, *RIMP* is real volume of import , while Y_{t-1} is the corresponding lag term for order i. Φ_i, is the $n \times n$ matrix of auto regressive coefficient vector Y_{t-1}, for $i = 1, 2, \ldots k$. $C_0 = (C_1, C_2, \ldots, C_n)$ is the C intercept vector of the VAR model. $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots, \varepsilon_{nt})$ is the $n \times 1$ vector of white noise process. K is the number of lagged terms. VAR estimations are very sensitive to lag structure of variables.

A similar model is built for oil revenue shock and thus specified as equation two as follows:

$$Y_t = (Roilrev, Rgovexp, RGDP, INF, INT, REXR, RIMP, Extrevs) \tag{2}$$

With other variables defined as above while Roilrev is real oil revenue.

The VAR system can be transformed into its moving average representation in order to analyze the system's response to real oil price shock on one hand and its response to oil revenue shock on the other hand, as follows:

$$Y_t = \mu + \sum_{i=0}^{\infty} \gamma_i \varepsilon_{t-1}$$

Where γ_0 is the identity matrix, μ is the mean of the process. The MA representation is used to obtain forecast error variance decomposition and the impulse-response function.

The vector of exogenous variables mentioned above is specified as equation 3 as follows:

$$X = \{\text{Constant}, Q_1, Q_2, Q_3, D_1, D_2, D_3, D_4, D_5, D_6\} \tag{3}$$

Where $Q_1 - Q_3$ refers to seasonal dummies and $D_1 - D_6$ refers to all other important exogenous events mentioned above for the period 1970-2010.

Using a sufficient lag length may help to reflect the long-term impact of variables on others. However, including longer lag lengths will lead to multicollinerarity problems and will increase the degrees of freedom (DOF) (Tang *et al.*, 2010). Empirical simulations show that for any $K \geq 11$, the model will become divergent with at least one auto regressive root that is greater than one. According to sequential modified Likelihood Ratio test statistic (LR), lag orders between 1 and 3 are recommended for models of this nature (Chuku *et al.*, 2011). Accordingly, to determine the optimal lag length to use for our model, we employ five different lag order selection criteria (*LR, FPE, AIC, SIC, HQ*) to guide our decision. The essence of the battery of tests is for confirmatory analysis.

II.2.3.1. Asymmetric Specification

Based on the postulation that the effects of oil price shocks on macroeconomic variables are usually asymmetric in nature (see Hamilton, 2009 and Du *et al.*, 2010), the authors examine the asymmetric impacts of oil price and oil revenue shocks by adopting the kind of oil price transformation put forward by Mork (1989) and Hamilton (1996). According to Mork's definition, oil price change is segmented into increase and decrease, with a specific rate of change in the world oil prices divided into positive and negative version; while the Hamilton specification considers net oil increase and decrease as follows:

$$\text{roilp}_t+ = \max\,(0,(\text{roilp}_t - \text{roilp}_{t-1})) \tag{1}$$
$$\text{roilp}_t- = \min\,(0,(\text{roilp}_t - \text{roilp}_{t-1})) \tag{2}$$

If the value for the current quarter exceeds the previous year's maximum, the percentage change over the year's maximum is calculated. If the price of oil at time t is lower than it had been at some point during the previous four quarters, the series is defined to be zero for date t. Although, the two specifications were taken into cognizance for models developed, we however choose only the Mork's asymmetric specification for the VAR analysis in order to report findings based on a specific approach and thus avoid ambiguous findings.

II.2.4. Estimation Procedures

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) techniques are used to test for unit roots in the variables included in the model so as to avoid spurious regression; while Johansen cointegration test is employed to determine the existence of long run relationships in the specified model. Vector Autogressive (VAR) technique is employed for estimation purpose through the Impulse Response Function and Variance Decomposition analysis.

The VAR technique was adopted because it captures the effect of variation in one variable on the others. In adopting the VAR methodology, we ignore the argument put forward by Hamilton (1994) which suggests that one could ignore the non-stationarity of included variables altogether and simply estimate the VAR in levels, relying on standard t- and F- distribution for testing any hypotheses as the true process is a VAR in differences while preliminary estimation of VAR in levels rendered the VAR model invalid. Besides, we relied on a body of literature which argued that, in the short term, unrestricted VAR performs better than even a cointegrated VAR or VECM if VAR in differences is adopted, particularly as demonstrated by Hoffman and Rasche (1996) and Naka and Tufte (1997). Also, this study follows the example of the citations in the literature reviewed where most adopt the VAR estimation method. We conduct the VAR lag length selection test, AR root stability test and residual tests to examine the validity and appropriateness of the specified model. Also, we consider different alternative orderings for the estimated VAR models as a robustness check as well as examine the possibility of inconsistency in the results obtained.

Using the VAR technique, the symmetric and asymmetric effects of oil price and oil revenue shocks on the Nigerian economy were analyzed. In estimating the asymmetric effects of oil price shocks, Mork (1989) and Hamilton (1996) oil price change specifications were adopted while oil revenue shocks were analyzed using the oil price change methodology put forward by Mork (1989).

III. Empirical Results

III.1. Unit Root Test Results

The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root test conducted to determine the stationarity properties of selected variables and the appropriate specification for VAR estimation are

Table 2. Unit Root Test

	ADF				*PP*			
	Without t1		*With t1*		*Without t1*		*With t1*	
Variables	*Level*	*First diff.*	*Level*	*First diff.*	*Level*	*First diff.*	*level*	*First diff.*
RGDP	-2.07	-10.95***	-2.22	-11.11***	-2.13	-12.77***	-2.13	-12.86***
REXR	0.02	-11.52***	-2.02	-11.50***	-0.06	-11.53***	-2.11	-11.52***
INF	-3.68**	-11.05***	-3.66**	-11.02***	-3.35*	-11.03***	-3.33*	-10.96***
INT	-1.43	-11.72***	-0.53	-11.83***	-1.34	-11.72***	-0.09	-11.98***
Rgovexp	-0.82	-6.82***	-1.76	-6.80***	-0.61	-6.68***	-1.45	-6.66***
Extresv	-2.26	-7.13***	-3.39*	-7.12***	-2.09	-15.06***	-3.21	-15.05***
Rimp	-0.41	-4.70***	-2.03	-4.68***	-0.29	-3.53**	-1.92	-3.45**
Roilprice	-0.28	-10.02***	-3.94**	-9.99***	-0.06	-9.73***	-3.44**	-9.71***
Roilprice+	-10.43***	-9.80***	-10.41***	-9.77***	-10.27***	-107.89***	-10.25***	-108.87***
Roilprice–	-10.39***	-9.75***	-10.37***	-9.73***	-10.23***	-107.83***	-10.21***	-111.65***
Roilrev	-0.99	-6.14***	-2.09	-6.10***	-0.83	-3.42**	-2.29	-5.59***
Roilrev+	-5.17***	-8.39***	-5.15***	-8.35***	-3.19	-5.99***	-3.18	-5.91***
Roilrev–	-6.12***	-8.36***	-6.14***	-8.33***	-3.18	-5.65***	-3.17	-5.57***

Source: Authors' own computation. *Note:* *, ** and *** imply significance at 10, 5 and 1 per cent level, respectively.

presented in table 2. Taking into cognizance, the intercept as well as the trend properties, the results obtained shows that, with the exception of inflation, real oil price and revenue changes, all other variables are characterized by unit root at level, while all the variables revealed evidence of stationarity at first difference mostly at 1 per cent significance level and as such are integrated of order one. Hence, the model is built on I (1) process with the efficacy of the VAR model in establishing the relationship among variables considered appropriate.

III.2. Cointegration Test

The Johansen cointegration test conducted to determine whether long run relationship exists among the variables takes into consideration the effects of including intercept and trend in models as the entire five deterministic trends recommended in the Johansen Cointegration techniques were tested for. Table 3 provides the summary of results obtained across the different levels for both the symmetry and asymmetry models built for oil price shocks and oil revenue shocks respectively. Specifically, the results indicate that a linear, non-linear as well as quadratic combination of two or more time series is non-stochastic, as a minimum of two (2) cointegrating equations were reported across trace and maximum eigenvalues statistics using critical values from Osterwald-Lenum (1992) at 5 per cent

Table 3. (i) Cointegration test summary for symmetry oil price shocks model

Data trend	*None*	*None*	*Linear*	*Linear*	*Quadratic*
Test type	*No intercept*	*Intercept*	*Intercept*	*Intercept*	*Intercept*
Trace	4	4	3	4	3
Max. Eigenvalue	4	3	3	3	2

(ii) Cointegration test summary for asymmetric oil price shocks model: *roilprice+*

Method	*Data trend*	*None*	*None*	*Linear*	*Linear*	*Quadratic*
	Test type	*No intercept*	*Intercept*	*Intercept*	*Intercept*	*Intercept*
Mork	Trace	4	3	3	4	4
	Max. Eigenvalue	4	2	3	3	3

(iii) Cointegration test summary for asymmetric oil price shocks model: *roilprice-*

Method	*Data trend*	*None*	*None*	*Linear*	*Linear*	*Quadratic*
	Test type	*No intercept*	*Intercept*	*Intercept*	*Intercept*	*Intercept*
Mork	Trace	8	5	5	5	5
	Max. Eigenvalue	5	3	4	4	4

(iv) Cointegration test summary for symmetry oil revenue shocks model

Data trend	*None*	*None*	*Linear*	*Linear*	*Quadratic*
Test type	*No intercept*	*Intercept*	*Intercept*	*Intercept*	*Intercept*
Trace	6	6	5	5	4
Max. Eigenvalue	5	4	2	4	3

(v) Cointegration test summary for asymmetric oil revenue shocks model: *roilrev+/-*

Shocks	*Data trend*	*None*	*None*	*Linear*	*Linear*	*Quadratic*
	Test type	*No intercept*	*Intercept*	*Intercept*	*Intercept*	*Intercept*
Positive	Trace	5	5	5	5	5
	Max. Eigenvalue	3	2	3	3	2
Negative	Trace	6	5	5	6	5
	Max. Eigenvalue	4	4	4	5	4

Source: Authors' own computations.

level, hence, we reject the null hypothesis of no cointegration and conclude that the variables for the models are cointegrated at either 5 per cent and/ or 1 per cent level of significance as provided by MacKinnon *et al.* (1999). This therefore confirms the existence of long-run equilibrium relationships among the variables and further points to the suitability of adopting the unrestricted VAR approach at levels. The optimal lag length is 4, 4, and 8 for symmetry and positive and negative oil price model, while symmetry and positive and negative oil revenue model reported optimal lag length of 3, 8 and 5 respectively. In addition, since the variables are cointegrated, the equations of the VAR also include the lagged values of the variables in levels to capture their long-run relationships.

III.3. Optimal Lag Length Selection and Stability Test

The optimal lag length is conducted for appropriate representation of the model. We select different lag lengths for the different models based on the results obtained from the VAR lag length selection criteria: Likelihood Ratio (LR); Final Prediction Error (FPE); Akaike Information Criterion (AIC); Schwarz Information Criterion (SIC) and Hannan-Quinn Information Criterion (HQ). Table 4 (a and b) shows the VAR lag length selection criteria results.

Table 4. (a) VAR lag length selection criteria results for oil price shocks model

	Model	*LR*	*FPE*	*AIC*	*SC*	*HQ*	*Chosen lag*
Type	Roilprice	4	4	4	1	3	4
Mork	Roilprice+	4	4	4	1	3	4
	Roilprice–	8	4	8	2	3	8

(b) VAR lag length selection criteria results for oil revenue shocks model

Model	*LR*	*FPE*	*AIC*	*sc*	*HQ*	*Chosen lag*
Roilrev	7	4	8	3	3	3
Roilrev+	8	4	8	2	3	8
Roilrev–	5	5	8	2	3	5

Source: Authors' own computations.

Also, the AR root test conducted to determine the stability of the VAR models show that all the specification satisfies stability condition as depicted in table 5 below:

Table 5. AR root stability test results

Type	*Model*	*Lag length*	*VAR satisfies the stability condition*
	Roilprice	4	Satisfies stability conditions
Mork	Roilprice+	4	Satisfies stability conditions
	Roilprice–	8	Satisfies stability conditions
Mork	Roilrev	3	Satisfies stability conditions
	Roilrev+	8	Satisfies stability conditions
	Roilrev–	5	Satisfies stability conditions

Source: Authors' own computations.

III.4. VAR Analysis for Oil Price Shocks

Based on the Johansen cointegration results and the results from the lag selection criterion, a VAR Model with cointegrating vector(s) is estimated. Tests conducted to prevent spurious regression indicate that the residuals of the estimated VAR are appropriately uncorrelated, indicating that the estimated VAR is correctly specified and the parameter estimates are consistent. The coefficients from the estimated VAR are not of primary interest in this empirical work. Rather, we focus on the impulse response functions (IRFs) and variance decomposition (VDC) generated from the VAR.

III.4.1. Impulse Response Function

The variance-covariance matrix of the VAR was factorized using Cholesky decomposition method suggested by Doan (1992) in order to identify orthogonalised innovations in each of the variables and the dynamic responses to such innovations. The generalized impulse response functions capture the responsiveness of the dependent variable in the VAR estimates to shocks to each of the variables. For each equation, a unit shock is applied to the error, and the effects upon the VAR system over twelve quarters are noted. As the VAR system contains eight variables, a total of 64 impulses are expected to be generated. The impulse response functions are estimated at 68 per cent confidence interval, obtained from 1 000 Monte Carlo simulations to reflect the level of significance. Furthermore, we include dummy variables to capture series of exogenous shocks that emanated in the period covered by the study.

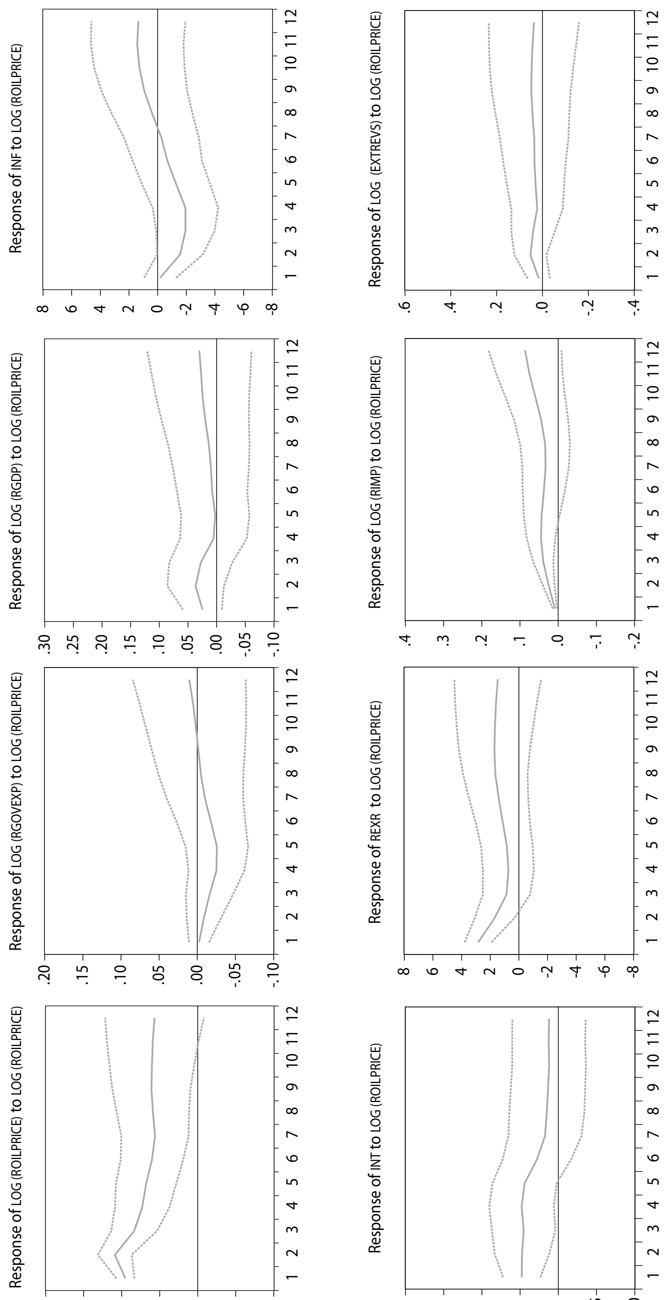
However, since our main objective is to examine the effect of oil price shocks on the seven macroeconomic variables, the response of the dependent macroeconomic variables are solely identified. Also, since it has been observed that IRFs are sometimes subject to the ordering of the variables in the system, we try 56 different permutations of the variables. We observe no significant differences in the shapes of the IRFs for the different permutations and altering orderings conducted. Since it is known in the literature that oil price shocks usually have an immediate and direct impact on government expenditure, GDP, inflation, exchange rate, volume of import and external reserves, we choose the ordering Rgovexp, RGDP, INF, INT, REXR, RIMP, and Extrevs.

(a) Symmetric Effects

Figure 2 shows the IRFs for generalized one standard innovation for the period of 1974:I-2010:IV. The shocks in real oil price slightly reduced real government expenditure for the first eight quarters but became marginally positive in the last three quarters. The slight but steady falls in real government expenditure therefore reduced the general price level significantly for the first four quarters. However, shocks in real oil price significantly increased real GDP, interest rate and real effective exchange rate for the first three quarters after initial shock; although these variables fell slightly before rising mildly for real GDP from the fifth to the twelfth quarter, positive but insignificant for interest rate from sixth to twelfth quarter, and positively insignificant for real effective exchange rate from fourth to twelfth quarter. Real import responds in positively insignificant manner after initial shocks in oil price, thereafter volume of import rises moderately in the medium and long term. External reserves responded in a positively insignificant fashion to shocks in oil price in the first four quarters but became flat in same insignificant manner from the fifth to twelfth quarter. The reverse reaction to shocks in oil price by real government expenditure and real GDP suggests that growth motivating forces lies outside government expenditure, such forces seems likely to have neutral effect on general price levels.

Taking into cognizance the frequent adjustments in Nigerian fiscal framework in response to prevailing economic situation in the period covered, budgetary operations thus, became a function of different factors, and are designed to achieve specific objectives across different political regimes. Reduction in real government expenditures and the corresponding ease in inflation, therefore reflect the effect of reflationary budget usually implemented by the Executive arm of government through the Federal Ministry of Finance and the Budget Office, in periods of oil price growth as witnessed during the Gulf war. Conversely, short run rise in real GDP, interest rate and real effective exchange rate, would be traced to the corresponding effects of contractionary monetary policy designed by the Central Bank of Nigeria (CBN) to achieve macroeconomic stabilization objectives, through upward review of benchmark interest rate, liquidity ratio and devaluation of local currency, so as to reduce the adverse effect of oil price growth. Medium-and long-run reactions also reflect appropriate adjustments in policy mix (fiscal and monetary) in accordance to prevailing political and economic conditions. This became more apparent during and after the introduction of the Structural Adjustment Programme (SAP). The insignificant rise in the volume of imports is due to fall in demand for capital goods as a result of reduction in government expenditure. Results for external reserves would naturally be traced to the debilitating effects of external debt servicing on huge external debt profile prior to the debt relief and restructuring exercise of 2005.

Figure 2. Symmetry oil price shocks IRF figures



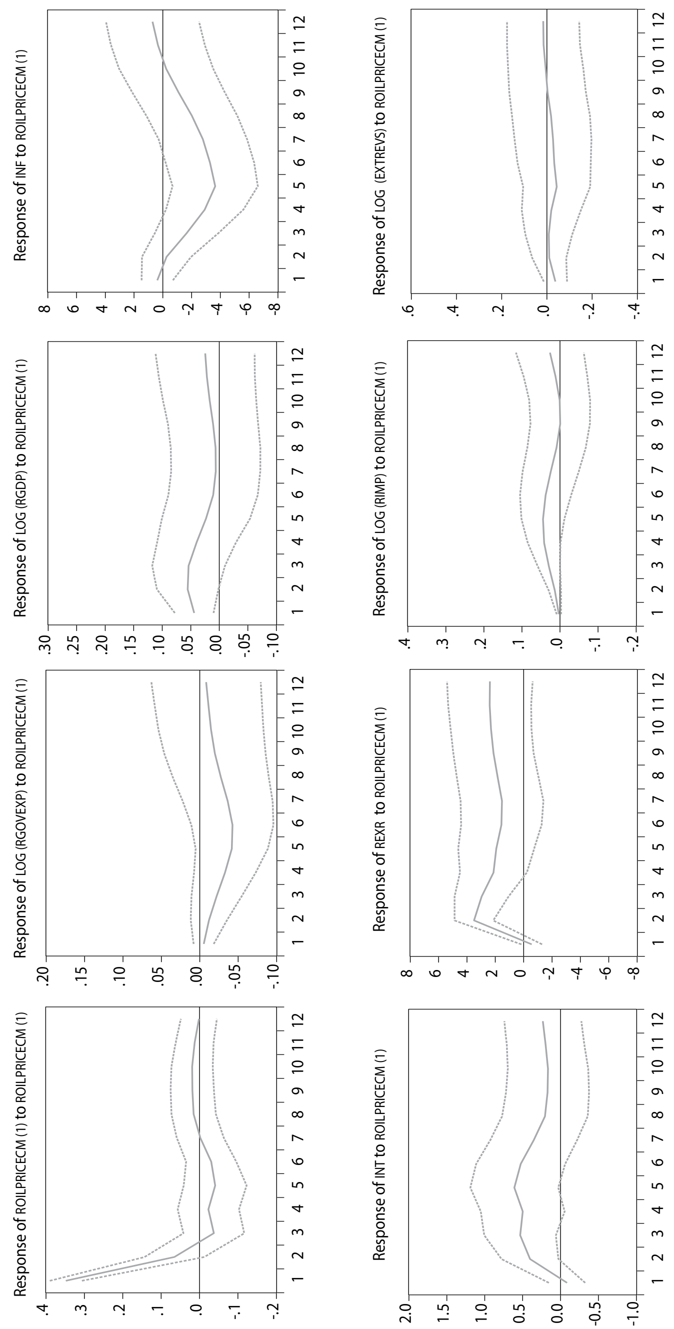
Source: Authors' own computations.

(b) Asymmetric Effects

Figure 3 displays the IRFs for generalized one standard deviation shock to positive changes in oil price for the period of 1974:I-2010:IV. Real government expenditure responded negatively but insignificantly to positive changes in oil price more in the first four quarters than in the medium and long term. Real GDP responds to such positive changes in a statistically insignificant way especially in the last six quarters. The results obtained with respect to real government expenditure and GDP thus reflect the dominant influence of public sector spending in overall economic activities, as efforts to ensure macroeconomic stability through effective coordination of fiscal and monetary policy prevent immediate monetization of oil proceeds through increase public spending, which therefore kept growth at modest levels. The general price level falls significantly from the third to seventh quarters to show that the Nigerian economy does not suffer from the usual inflationary pressures associated with positive changes in oil prices in the short run. This was made possible by policy response in the form of monetary tightening stance which effectively tamed growth in broad money supply in the medium-and long-run.

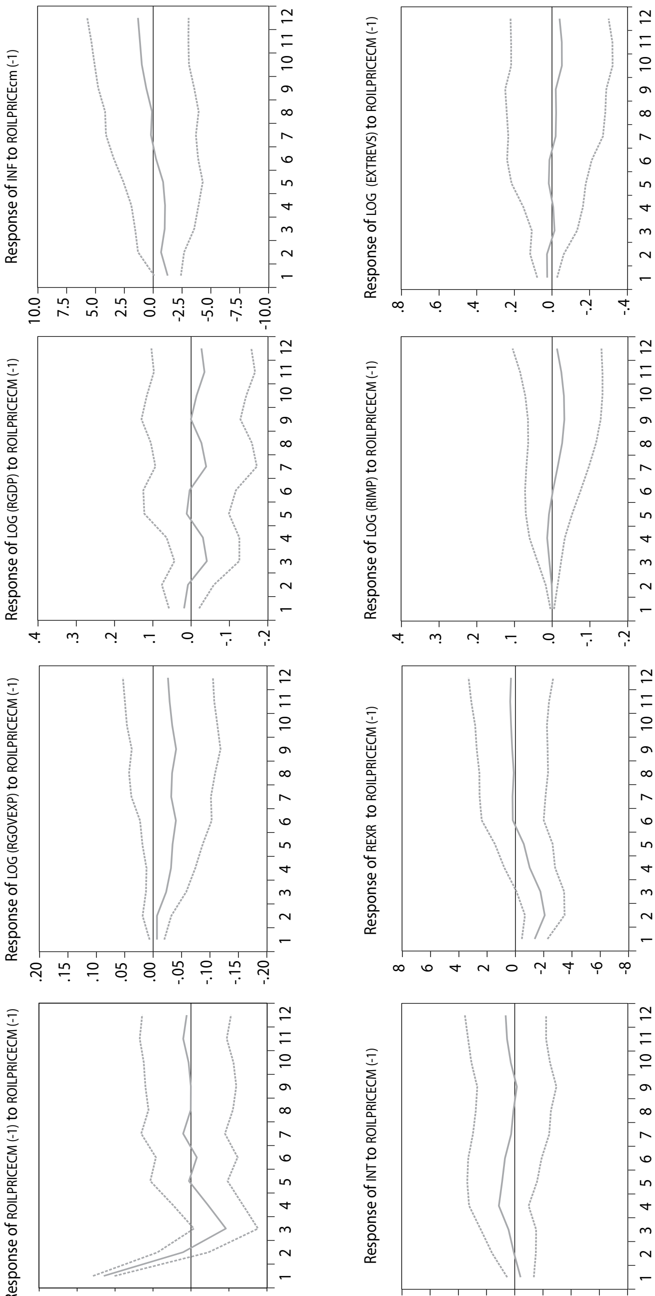
Interest rate grows steadily for the first six quarters to peak in the fifth quarter after initial positive changes in oil price but slows down gradually in the medium to long term all in a less significant manner. This conveys the reaction of interest rate to effective liquidity tightening measures by the monetary authority mostly through increase in benchmark interest rate. Real effective exchange rate jumped sharply in the first three quarters in response to positive changes in oil price, slows down in the medium to long term but was consistently significant throughout the periods to suggest the downside risk to the country's currency on increase oil price, particularly following the liberalization of the Nigerian foreign exchange market as part of the broad financial sector reforms programme of SAP. However, volume of real import rose slightly from the second to the seventh quarters from such changes shocks and act as a built-in stabilizer, which helped to mitigate the downside risk of possible inflationary pressures from increased money supply after positive oil price shocks. The statistically significant drop in long-run trend of CPI, could further be attributed to slight increase in import volumes coupled with the monetary tightening policy effects. External reserves fell slightly and consistently for the first nine quarters in response to positive oil price changes possibly due to modest monetization of oil proceeds.

Figure 3. Asymmetry oil price shocks IRF figures (Positive oil price shocks)



Source: Authors' own computations.

Figure 4. Asymmetry oil price shocks IRF figures (Negative oil price shock)



Source: Authors' own computations.

Figure 4 demonstrates the responses of variables to generalized one standard deviation shock to negative changes in oil price for the period of 1979:I-2010:IV. The response of real government expenditure to decreasing real oil price is slightly but consistently negative throughout the periods though in a less significant manner. The slight but steady decrease in government expenditure slowed down aggregate demand and thus reduced real GDP in same manner from the third to twelfth quarters. Inflation fell marginally in the short to medium term and rose mildly in the long term as captured by the last four quarters. However, interest rate rises gradually but insignificantly in the short to medium term but slowed in the long run in response to decreasing oil price, which apparently reflects the expansionary monetary policy stance of the Central bank, which prevailed in such period in order to achieve moderate GDP growth in a less inflationary environment. Significant depreciation in the real effective exchange rate was short-lived in the short term, specifically in the first two quarters and moved out of the region in the medium to flatten out in a positively insignificantly manner in the last six quarters in its response to decrease in oil price. Volume of real import responded gradually to negative shocks in oil price, reducing slightly but steadily toward the medium to long term, which possibly captured the reaction to shortfall in liquidity and financing sources for import and reduced demand for both capital and consumer goods. Similarly, external reserves seems relatively resilient to decreasing oil price in the short to long term as it gradually declined insignificantly from the medium to long term as reflected in the last six quarters. This could be attributed to the effect of deficit financing with much reliance on foreign creditors in conjunction with domestic sources. Periodic foreign currency denominated debt interest payment therefore accounted for the slight but consistent reduction in short-medium-and long term external reserves level.

III.4.2. Variance Decomposition Analysis

We further examine the forecasting error variance decomposition to determine the proportion of the movements in the time series that are due to shocks in their own series as opposed to shocks in other variables, including oil prices, as the impulse response functions basically analyze the qualitative response of the variables in the system to shocks in real oil prices.

(a) Symmetric Effects

Table 6 demonstrates the variance decompositions of the VAR model in symmetry definition of oil price shock. Oil price growth stimulates the

Table 6. Variance decomposition for symmetry effects

Quarter	*Roilprice*	*Rgovexp*	*RGDP*	*INF*	*INT*	*REXR*	*RIMP*	*Extrevs*
Variance decomposition of Roilprice								
1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	81.10	1.09	13.57	0.28	0.71	0.49	1.95	0.80
8	72.00	0.68	17.11	1.81	0.68	0.31	6.69	0.72
12	61.64	0.61	16.47	4.06	0.79	0.26	15.06	1.12
Variance decomposition of Rgovexp								
1	0.09	99.91	0.00	0.00	0.00	0.00	0.00	0.00
4	2.48	87.42	0.23	0.46	0.07	0.02	0.20	9.13
8	2.51	59.76	5.05	0.28	0.20	0.23	0.22	31.75
12	1.81	45.11	7.12	0.75	0.60	1.44	0.26	42.94
Variance decomposition of RGDP								
1	1.56	0.27	98.17	0.00	0.00	0.00	0.00	0.00
4	2.83	1.99	91.06	1.97	0.17	0.34	0.64	0.99
8	2.02	6.38	78.64	1.81	1.70	0.83	2.49	6.14
12	2.82	7.25	69.40	1.39	3.64	1.45	3.36	10.69
Variance decomposition of INF								
1	0.06	0.73	0.00	99.21	0.00	0.00	0.00	0.00
4	6.59	1.53	0.12	85.72	1.20	2.83	1.31	0.70
8	5.39	4.67	0.16	64.16	7.99	6.85	8.77	2.03
12	6.11	4.92	0.30	50.33	18.21	10.20	7.80	2.15
Variance decomposition of INT								
1	10.73	0.65	0.07	1.37	87.18	0.00	0.00	0.00
4	15.70	0.53	0.12	2.35	78.06	1.47	0.22	1.54
8	16.68	0.44	6.17	2.40	60.77	6.34	2.68	4.52
12	15.84	0.41	7.52	2.36	55.00	7.39	5.11	6.37
Variance decomposition of REXR								
1	24.15	3.74	1.22	0.46	2.93	67.50	0.00	0.00
4	13.20	7.45	0.61	1.70	4.34	71.16	0.46	1.07
8	11.72	10.51	0.53	15.65	2.90	52.46	2.05	4.20
12	11.88	10.48	0.41	20.22	3.82	38.86	9.93	4.40

Table 6. Variance decomposition for symmetry effects (Cont.)

Quarter	*Roilprice*	*Rgovexp*	*RGDP*	*INF*	*INT*	*REXR*	*RIMP*	*Extrevs*
Variance decomposition of RIMP								
1	6.50	0.01	0.01	2.93	0.00	0.96	89.58	0.00
4	9.78	0.27	0.43	4.39	4.00	1.48	78.79	0.86
8	7.89	1.96	1.11	2.15	13.91	1.37	59.23	12.39
12	12.78	4.46	0.66	1.27	10.70	3.16	43.96	23.02
Variance decomposition of Extrevs								
1	0.30	4.24	0.42	0.00	0.41	0.42	2.57	91.64
4	1.43	11.48	1.53	4.14	6.28	3.03	3.74	68.36
8	1.52	15.00	1.13	3.88	10.93	2.50	3.03	62.01
12	2.39	15.71	1.19	4.16	10.52	2.36	3.60	60.08

Source: Authors' own computations.

volatility of the other variables in the model to varying degrees. In symmetric form, oil price shocks strongly accounts for its own fluctuation in the first eight quarters, while real GDP and real effective exchange rate jointly explains 51.9 per cent in the twelfth quarter. Fluctuations in real government expenditure emanates from its own shocks between the 1st and 8th quarter except for the 12th quarter where external reserves proves strong and when combined with real GDP account for about 51.25 per cent of fluctuations in the 12th quarter; however oil price accounts for between 1.81 to 2.51 per cent throughout the periods. Real GDP and interest rate solely and strongly accounts for their fluctuation through the period with oil price shocks having 1.56-2.83 per cent and 0.06-6.6 per cent influence on both variables from the 1st-12th quarters. However, oil price shocks relatively accounts for variations in real effective exchange rate in the short run with about 37.3 per cent but proved minimal with 23.6 per cent in the long run. Other variables exhibit similar trend with oil price shock having less than 13 per cent influence in their variations over the 12 quarters.

(b) Asymmetric Effects

Table 7 shows the variance decompositions of the VAR models that captured the asymmetric effects of oil price shocks on the selected macroeconomic variables. For variations in real government expenditure, both positive and negative oil price shocks had insignificant influence on real government

Table 7. Variance decomposition for asymmetry effects using mork specification

Quarter	*Roilprice+*	*Roilpric–*	*Rgovexp+*	*Rgovexp–*	*RGDP+*	*RGDP–*	*INF+*	*INF–*	*INT+*	*INT–*	*REXR+*	*REXR–*	*RIMP+*	*RIMP–*	*Extreus+*	*Extreus–*
Variance decomposition of Rgovexp																
1	0.42	1.82	99.58	98.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	4.43	4.06	85.48	76.53	0.63	0.01	0.46	4.98	0.02	0.20	0.03	0.17	0.15	0.48	8.80	11.97
8	8.27	4.67	52.39	45.05	7.98	2.00	0.31	2.96	0.07	1.33	0.09	5.63	1.03	1.80	29.85	36.56
12	6.26	4.15	39.60	28.32	10.19	2.36	0.74	1.97	0.25	4.70	1.92	9.56	1.74	4.57	39.28	44.38
Variance decomposition of RGDP																
1	4.94	0.64	0.08	0.52	94.98	98.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	9.84	2.24	2.39	1.30	83.90	90.41	1.65	4.24	0.32	0.20	0.46	0.22	0.31	0.95	1.11	0.44
8	6.64	1.50	6.75	2.83	72.27	80.55	1.71	4.12	2.90	1.58	0.54	0.54	2.35	5.06	6.84	3.81
12	5.71	1.34	7.63	2.69	63.73	76.40	1.29	3.75	6.06	2.58	0.71	0.62	3.64	6.83	11.23	5.79
Variance decomposition of INF																
1	0.35	5.38	0.68	0.18	0.03	0.09	98.94	94.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	7.71	4.21	0.79	0.88	0.77	0.22	85.29	85.70	1.24	2.51	2.51	2.38	0.63	2.42	1.05	1.28
8	19.44	3.10	2.34	6.15	1.31	1.70	57.43	68.45	5.86	6.02	8.21	1.71	3.35	9.78	2.07	3.09
12	16.25	3.00	2.62	5.51	1.50	1.51	47.65	53.79	14.46	20.21	11.96	1.98	3.26	10.99	2.31	3.00
Variance decomposition of INT																
1	0.37	0.04	0.56	0.51	0.00	0.26	2.39	1.79	96.67	97.40	0.00	0.00	1.98	0.00	0.00	0.00
4	11.37	1.93	1.01	1.05	0.67	0.54	2.49	0.97	82.63	83.09	0.43	5.66	0.16	4.92	1.23	1.85
8	19.30	2.07	0.91	1.85	2.84	4.59	3.01	1.48	66.61	59.60	1.71	6.66	0.59	11.60	5.03	10.99

Table 7. Variance decomposition for asymmetry effects using mork specification (Cont.)

Quarter	*Roilprice+*	*Roilpric–*	*Rgovexp+*	*Rgovexp–*	*RGDP+*	*RGDP–*	*INF+*	*INF–*	*INT+*	*INT–*	*REXR+*	*REXR–*	*RIMP+*	*RIMP–*	*Extrevs+*	*Extrevs–*
12	19.51	3.44	0.89	2.52	3.94	7.70	2.86	6.32	62.83	46.51	2.78	6.40	1.22	13.99	5.96	13.11
Variance decomposition of REXR																
1	1.84	3.81	5.99	5.75	1.32	0.13	0.04	1.89	1.17	4.53	89.64	83.89	0.00	0.00	0.00	0.00
4	23.29	12.20	3.73	17.00	2.35	1.05	0.56	8.22	3.58	2.28	59.99	56.84	0.95	2.14	2.11	0.28
8	19.95	8.00	5.75	19.33	1.72	3.12	6.37	17.60	3.16	2.65	59.99	39.15	0.95	3.68	2.11	6.47
12	21.51	5.49	6.00	16.66	1.66	3.93	11.16	25.40	2.31	5.49	50.46	27.51	4.00	11.31	2.90	4.21
Variance decomposition of RIMP																
1	0.72	0.10	0.72	2.02	0.03	1.05	3.63	1.09	0.06	4.02	1.68	0.01	93.84	91.72	0.00	0.00
4	6.11	1.54	0.77	2.06	0.02	2.11	5.16	2.64	1.62	1.82	1.34	0.67	84.13	86.07	0.84	0.43
8	5.82	1.05	3.15	1.14	0.44	3.01	4.09	2.07	5.86	3.25	1.03	4.88	17.72	70.56	4.43	14.04
12	3.81	0.82	5.41	0.76	0.28	1.91	2.33	1.19	14.69	17.21	0.66	3.22	55.15	51.07	17.67	23.83
Variance decomposition of Extrevs																
1	1.60	1.99	4.32	2.57	0.93	0.31	0.02	0.04	0.36	7.70	0.37	0.83	3.45	2.86	88.95	83.69
4	0.54	0.61	11.25	5.30	2.03	1.31	3.74	0.85	7.31	15.91	2.47	2.00	4.76	7.67	67.89	66.35
8	0.88	0.69	14.43	4.63	1.30	1.87	3.24	1.58	13.43	19.10	1.46	3.62	4.12	10.79	61.15	57.72
12	0.87	0.60	15.30	4.09	1.40	2.52	3.27	2.90	13.47	17.40	1.79	3.82	4.74	15.14	59.17	53.53

Source: Authors' own computations. Cholesky ordering: ROILREVCM(+/-) LOG(RGOVEXP) LOG(RGDP) INF INT REXR LOG(RIMP) LOG(EXTREVS) standard errors: Monte Carlo (1000 repetitions).

expenditure in the short and long run; however, both positive and negative shocks to external reserves had stronger implications for expenditure in the long run among other variables (excluding real government expenditure itself). For fluctuations in real GDP, positive oil price shocks had a comparatively moderate short and long run role compared to negative oil price shocks. While positive oil price shocks account for 15.5 per cent and 13.3 per cent of variances in real GDP in the short and long run respectively, negative oil price shocks explain just 2.8 and 24.4 per cent of fluctuations for the same period. However, the past innovations in real GDP explain more than 80 per cent of the variance in real GDP in the short-run (one to four quarters after shock) and more than 60 per cent in the long run (eight to twelve quarters after shock) in both positive and negative oil price shocks while only real government expenditure and external reserves seems relatively influential on real GDP in the long run (twelfth quarter after shock) in both positive and negative oil price shocks. For variations in inflation, both positive and negative oil price shocks had inconsequential effect on inflation one quarter after shock; however only positive oil price shock accounts for more than 16 per cent of variances in inflation in the long run (eighth to twelfth quarter after shock). Positive rather than negative shocks to oil price explain more about variations in interest rate in the long run.

For variations in real effective exchange rate, both positive and negative oil price shocks explain more about changes in real effective exchange rate four quarters after shock, while the influence of positive shocks proves stronger than that of negative oil price shock in the long run (eighth to twelfth quarter after shock); in the same vein, inflation also accounts for more than 17 per cent of variations in real effective exchange rate in the long run (eighth to twelfth quarter after shock). Both positive and negative shocks to oil price do not stimulate fluctuation in the volume of imports immediately after initial shock; however, positive oil price shock explains little in the fourth to eighth quarter after shock in this regard. In addition, negative shock to inflation stimulates inflation throughout the period after shock, while both positive and negative shocks to external reserves accounted more for variations in the volume of imports in the long run (more than 14% in the twelfth quarter after shock). For fluctuations in external reserves, neither positive nor negative oil price shocks changed external reserves, rather both positive and negative shocks to real government expenditure proved influential in this regard throughout the period (after its own innovations) while both positive and negative shocks to interest rate and volume of imports also account for more of the variations in external reserves (after the fourth to twelfth quarter from initial shocks). This demonstrates the close connection between government expenditure, volume of imports and foreign exchange.

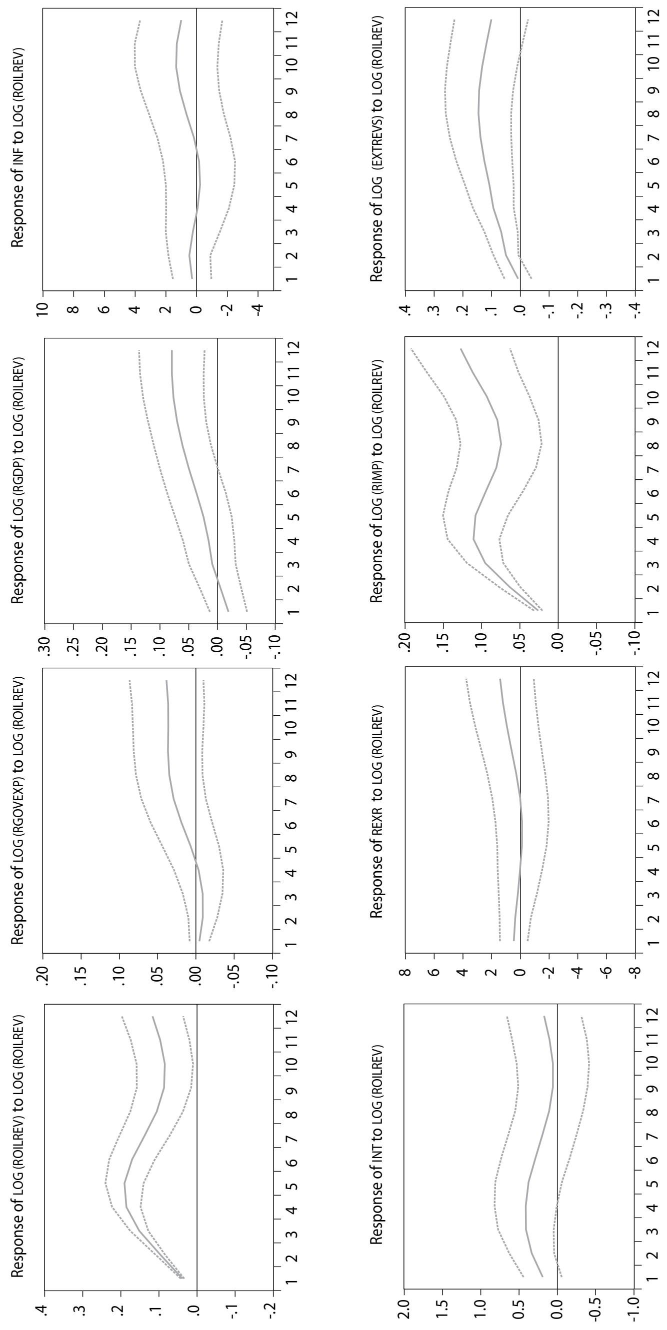
III.5. VAR Analysis on Oil Revenue Shocks

III.5.1. Impulse Response Function

(a) Symmetric Effects

Figure 5 shows the IRFs for generalized one standard innovation for the period of 1973:I-2010:IV. The shocks in real oil revenue reduced real government expenditure marginally for the first four quarters but increased slightly and consistently in the medium term (fifth to seventh quarter) to long term (the last three quarters) as it reached its peak at the eighth quarter. However, real GDP rose steadily but insignificantly consequent upon oil real revenue shock from the third quarter to the last quarter to show the salutary but weak growth-inducing effect of shocks in real oil revenue to economic growth in line with similar reaction by real government expenditure which thus reflects the widely held empirical view of the positive association between government expenditure and economic growth, prominent in less developed countries such as Nigeria. Inflation response to oil revenue shock was weak throughout the period, as it oscillated slightly within the short and medium only to stabilize following gradual up-tick in the last five quarters. In contrast, interest rate increase significantly in response to oil revenue shock only in the third to fifth quarters but declined and became flattened in the long term to suggest that monetary policy induced-increase in interest rate in response to perceived improvement in the volume of money-in-circulation occasioned by oil revenue inflows seems potent shortly after initial shocks in oil revenue with moderation in the use of the instrument by the monetary authority in the long term as macroeconomic variables reaction to such shock becomes apparent empirically. The response of real effective exchange rate to shocks in oil revenue exhibit resilient posture as it consistently flattens out positively throughout the period insignificantly. Shocks to oil revenue growth increase the volume of imports in an oscillated fashion from the second to the last quarter, recording its peak at the fourth quarter. A similar trend was reported for external reverse which rose steadily throughout the period, albeit insignificantly. Altogether, this shows that while oil revenue shocks in symmetric definition increases real government expenditure, real GDP, volume of import and external reserves mostly in the long run at different

Figure 5. Symmetry oil revenue shocks IRF figures



Source: Authors' own computations.

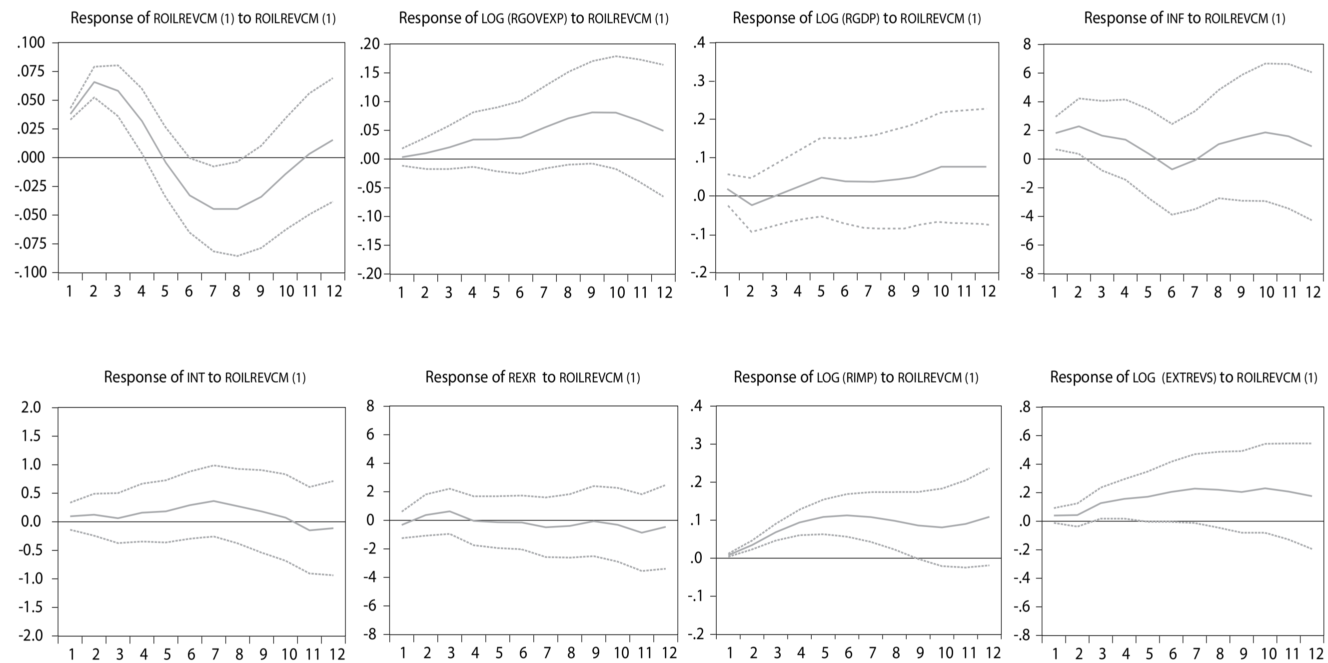
degree, its effects on inflation, interest rate and real effective exchange rate exhibits minimal increase in both the short and long run.

(b) Asymmetric Effects

Figure 6 displays the IRFs for generalized one standard deviation shock to positive changes in oil revenue for the period of 1977:I-2010:IV. Real government expenditure responded in an insignificantly positive manner to positive changes in oil revenue in the first seven quarters, after which it grew slightly and significantly in the last four quarters to peak at the ninth quarter after shock. Positive change in oil revenue reduced Real GDP shake-off slightly in the first two quarter and later moderated slightly to increase steadily in the medium term to the long term in weak form. Inflation only increased significantly in the first two quarters after positive oil revenue shocks with its long term effects being less severe. However, interest rate only increased marginally in the first ten quarters in response to positive shocks in oil revenue and later fell in the last two quarters to suggest mixed reaction in the long run. The response of real effective exchange rate to positive shocks in oil revenue was mixed, appreciating marginally in the first four quarters before depreciating steadily for the rest of the period in an insignificant manner. Meanwhile, the volume of imports and external reserves reported similar reactions to positive oil revenue shocks with steady but insignificant increase recorded throughout the period. Consequently, the results revealed that positive oil revenue shocks reduced growth rate slightly in the short run but strongly improved it along with real government expenditure in the long run, while similar effect increase inflation rate only in the short run. Also, the impact of such shocks on interest rate and real effective exchange rate results in minimal increase only in the short term; while it stimulated insignificant increases in the volume of imports and external reserves almost year round.

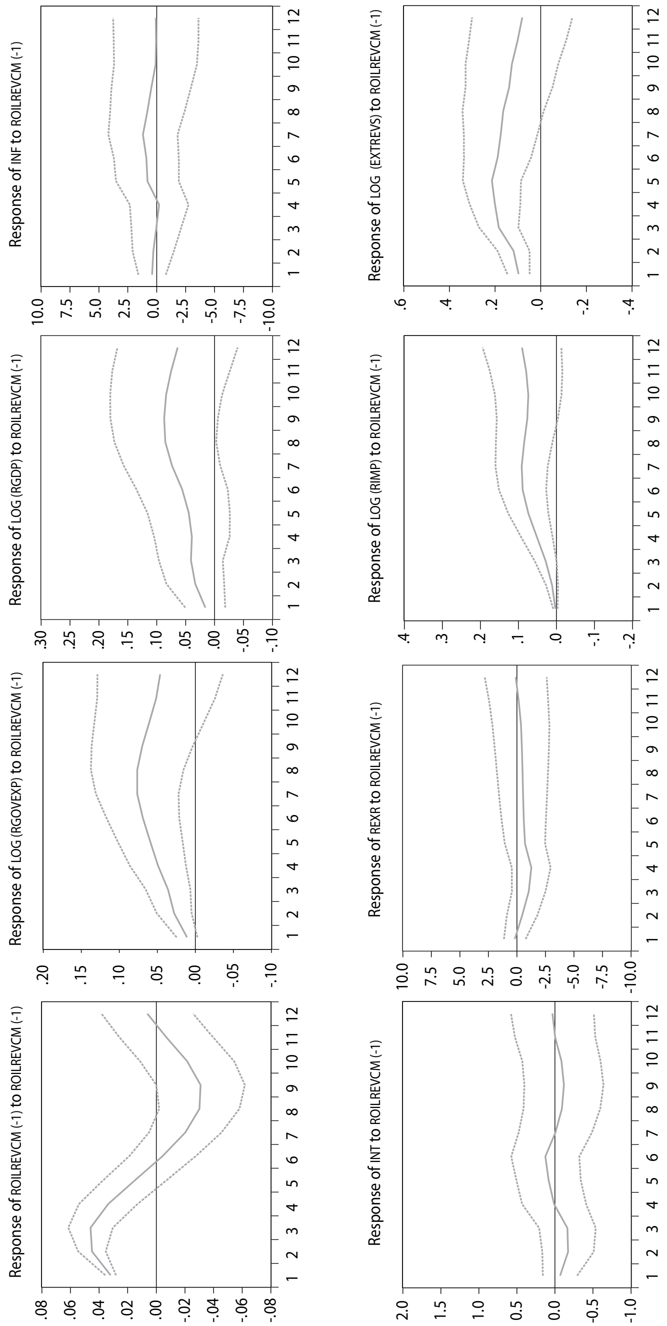
Figure 7 demonstrates the responses of variables to generalized one standard deviation shock to negative changes in oil revenue for the period of 1974:I-2010:IV. Surprisingly, negative change to oil revenue shocks increase real government expenditure and real GDP steadily, albeit insignificantly, throughout the period to reach its peak in the medium term in the eighth quarter. This could clearly be attributed to the implementation of deficit budget in periods of dwindling oil fortunes, which helped to stimulate increased public spending and real GDP growth, apparently to ward-off slowdown in real GDP and other downside risks associated with negative shocks to oil price which would otherwise lead to economic instability.

Figure 6. Asymmetry oil revenue shocks IRF figures (positive oil price shock)



Source: Authors' own computations.

Figure 7. Asymmetry oil revenue shocks IRF figures (negative oil price shock)



Source: Authors' own computations.

Inflation exhibited neutral posture both in the short and long term with marginal rise associated with the medium term; however, interest rate response oscillated to depict insignificant decrease in both the first and last quarter with unsustainable mild increase in the medium term. The mild response of inflation to negative oil price shocks in the short- and long-run as well as the marginal rise experienced in the medium term expectedly coincided with interest rate movements to underscore their respective reactions to prevailing monetary policy stance within those periods. Real effective exchange rate depreciates slightly throughout the quarters in response to negative oil revenue shock; while both the volume of imports and external reserves increased insignificantly between the first to seventh quarters, before decelerating gradually for the rest of the period. The insignificant rise in the volume of imports is in response to increased public sector spending through deficit finance; while external reserve rise in similar fashion arises from reduced dependence on accrued reserves for budget financing in favour of foreign credit, even with debt servicing becoming a recurring decimal.

III.5.2. Variance Decomposition Analysis

(a) Symmetric Effects

Table 8 shows the variance decompositions of the VAR model in symmetry definition of oil revenue shock. Oil revenue growth stimulates the volatility of the other variables in the model to varying degrees. In symmetric form, fluctuations in real government expenditure emanates from its own shocks throughout the quarters with shocks to oil revenue contributing 8.25 per cent in the 12th quarter while other variables such as the volume of imports, real effective exchange rate and external reserves accounts for 17.4 per cent, 10.77 per cent and 6.2 per cent respectively; however oil revenue shock only influenced real GDP significantly in the 12th quarter as it accounted for 20.11 per cent of variations in real GDP during the period, with about 11.4 per cent support from the volume of import. Oil revenue shocks contribute little to variations in inflation and real effective exchange rate throughout the quarter; while it exhibits marginal influence (4.5% on the average) on the variations in interest rate in the eighth and twelfth quarter after shocks, with support from real GDP and real effective exchange rate. However, shocks to oil revenue prove strongly significant for variations in the volume of import throughout the periods, accounting for more than 47 per cent in each quarter. However, oil revenue shocks contribute more than 15 per cent of the variations in external reserves in the eighth and twelfth quarter after shock, with the contribution of real effective exchange rate being the other close contributor from the fourth to the twelfth quarter.

Table 8. Variance decomposition for symmetry effects

Quarter	*Roilrev*	*Rgovexp*	*RGDP*	*INF*	*INT*	*REXR*	*RIMP*	*Extrevs*
Variance decomposition of Roilrev								
1	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	97.75	0.12	0.01	1.22	0.45	0.10	0.27	0.07
8	91.00	0.11	0.32	3.69	2.94	0.12	1.60	0.22
12	86.40	0.63	0.72	6.54	2.42	0.30	1.48	1.52
Variance decomposition of Rgovexp								
1	0.36	99.64	0.00	0.00	0.00	0.00	0.00	0.00
4	0.52	91.28	0.11	0.83	0.57	0.53	4.65	1.51
8	3.74	71.07	0.56	0.95	1.11	4.88	12.27	5.43
12	8.25	55.43	0.45	0.77	0.90	10.77	17.41	6.02
Variance decomposition of RGDP								
1	1.01	0.86	98.13	0.00	0.00	0.00	0.00	0.00
4	0.89	0.79	92.32	3.63	0.23	0.07	1.29	0.79
8	7.69	0.97	79.26	4.61	1.08	0.29	5.25	0.85
12	20.11	0.77	59.57	4.05	2.32	0.42	11.14	1.63
Variance decomposition of INF								
1	0.15	1.08	0.01	98.75	0.00	0.00	0.00	0.00
4	0.21	1.49	0.08	90.71	2.02	3.72	1.06	0.70
8	0.42	3.27	0.50	80.25	7.87	5.10	1.96	0.64
12	2.53	3.13	0.51	68.24	16.11	5.65	3.16	0.67
Variance decomposition of INT								
1	1.62	0.01	0.02	0.70	97.65	0.00	0.00	0.00
4	7.53	0.63	1.17	0.48	85.48	0.99	0.05	3.68
8	9.41	3.20	7.27	0.39	71.38	3.84	0.05	4.45
12	8.91	4.26	9.61	0.63	64.42	7.06	0.07	5.04
Variance decomposition of REXR								
1	0.65	1.20	0.03	0.02	8.40	89.69	0.00	0.00
4	0.40	1.42	0.87	1.11	7.50	87.09	0.14	1.48

Table 8. Variance decomposition for symmetry effects (Cont.)

Quarter	*Roilrev*	*Rgovexp*	*RGDP*	*INF*	*INT*	*REXR*	*RIMP*	*Extrevs*
8	0.30	6.06	1.65	11.47	4.96	68.93	3.30	3.33
12	2.35	9.34	1.59	17.72	3.73	56.51	4.10	4.66
Variance decomposition of RIMP								
1	47.53	0.68	0.47	1.66	0.00	1.30	48.35	0.00
4	51.45	0.98	1.49	5.81	1.53	2.18	36.53	0.03
8	56.18	0.80	1.78	5.70	6.78	2.17	24.47	2.13
12	65.47	0.56	1.73	5.60	5.77	2.23	16.71	1.93
Variance decomposition of Extrevs								
1	0.08	1.97	0.00	0.47	0.09	0.26	1.49	95.63
4	7.30	5.29	1.60	5.31	8.19	0.38	10.75	61.18
8	16.29	4.76	5.50	3.72	12.24	0.84	26.56	30.09
12	22.61	3.95	7.33	3.15	10.48	1.17	26.98	24.32

Source: Authors' own computations.

(b) Asymmetric Effects

Table 9 shows the variance decompositions of the VAR models that captured the asymmetric effects of oil price shocks on the selected macroeconomic variables. Negative shocks to oil revenue contributes more of variation in real government expenditure than positive shock in the eighth to twelfth quarters with both positive and negative shocks to external reserves being very significant for variations in real government expenditure over similar quarters. For fluctuations in real GDP, negative oil revenue shocks have a stronger long run role compared to positive oil revenue shocks. Only positive shocks to oil revenue have a relatively significant contribution to inflation rate in the first quarter after shock, with both positive and negative shocks to real effective exchange rate and the volume of imports contributing more to variation in inflation rate in the eighth and twelfth quarter. Both positive and negative shocks to oil revenue contribute little to variations in interest rate and real effective exchange rate throughout the quarters.

However, positive shocks to oil revenue accounted for more of the contribution to variation in the volume of import than negative oil revenue shock, although both exhibit some degree of influence in the fourth to twelfth quarters. In contrast, negative shocks in oil revenue contributes more to varia-

Table 9. Variance decomposition for asymmetry effects using mork specification

Quarter	*Roilrev+*	*Roilrev–*	*Rgovexp+*	*Rgovexp–*	*RGDP+*	*RGDP–*	*INF+*	*INF–*	*INT+*	*INT–*	*REXR+*	*REXR–*	*RIMP+*	*RIMP–*	*Extrevs+*	*Extrevs–*
Variance decomposition of Rgovexp																
1	0.16	1.96	99.84	98.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	4.22	11.52	77.12	77.76	1.11	0.01	1.35	3.00	0.13	0.04	0.67	0.17	10.29	1.45	5.12	6.05
8	13.85	27.29	44.77	45.22	3.33	1.63	1.07	2.74	0.41	0.28	0.87	2.06	16.37	1.18	19.33	19.60
12	22.25	27.79	29.54	34.65	3.14	2.63	3.30	2.63	1.85	0.58	2.34	6.02	18.02	0.98	19.55	24.99
Variance decomposition of RGDP																
1	0.61	0.63	0.00	0.32	99.39	99.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	1.22	4.34	1.21	1.78	90.34	86.91	5.50	5.69	0.50	0.32	0.17	0.23	0.81	0.59	0.25	0.15
8	4.27	12.00	3.49	5.11	82.75	70.68	4.01	6.04	1.41	1.74	0.39	0.15	2.77	2.59	0.91	1.69
12	11.63	18.51	3.74	5.45	70.28	57.22	4.29	5.62	2.26	3.21	0.62	0.15	6.19	6.06	3.79	3.48
Variance decomposition of INF																
1	8.14	0.36	0.71	0.70	0.59	0.07	90.56	98.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	9.85	0.18	1.88	0.86	1.35	0.17	78.41	88.14	2.33	1.44	1.83	5.96	3.47	2.42	0.89	0.81
8	7.23	1.52	7.68	4.84	0.99	0.46	62.97	64.93	7.96	7.48	1.43	6.38	6.93	12.73	4.82	1.66
12	8.36	1.34	5.95	4.92	1.46	0.63	46.70	54.68	22.97	17.00	4.45	7.23	5.95	12.10	4.16	2.10
Variance decomposition of INT																
1	0.55	0.24	0.73	0.58	0.46	0.16	0.50	1.69	97.76	97.32	0.00	0.00	0.00	0.00	0.00	0.00
4	1.39	1.31	0.48	0.90	0.30	0.30	2.10	0.77	79.75	89.31	11.83	2.93	1.16	**2.80**	2.99	1.67
8	6.74	1.62	3.53	0.99	1.38	2.03	4.19	1.48	55.32	73.27	11.66	4.45	5.15	9.59	12.03	6.58
12	5.98	1.64	5.02	0.93	1.98	5.07	15.03	4.05	42.60	60.90	60.90	4.37	8.14	14.13	11.78	8.92

Quarter	*Roilrev+*	*Roilrev–*	*Rgovexp+*	*Rgovexp–*	*RGDP+*	*RGDP–*	*INF+*	*INF–*	*INT+*	*INT–*	*REXR+*	*REXR–*	*RIMP+*	*RIMP–*	*Extrevs+*	*Extrevs–*
Variance decomposition of REXR																
1	0.40	0.11	1.51	3.08	0.00	0.08	1.19	0.56	2.86	7.77	94.04	88.48	0.00	0.00	0.00	0.00
4	1.45	3.85	4.47	3.84	2.44	2.73	1.81	2.98	1.85	5.17	82.77	77.06	3.83	0.03	1.39	4.34
8	1.55	3.51	7.25	6.62	4.10	4.69	17.17	17.87	2.11	3.74	55.31	55.56	3.08	1.57	9.42	6.45
12	2.48	2.36	9.67	9.04	2.92	4.38	22.30	23.05	12.35	4.04	40.04	42.62	4.51	9.83	6.25	4.56
Variance decomposition of RIMP																
1	11.87	0.69	0.93	0.19	1.09	0.03	0.94	4.11	0.96	1.05	0.98	0.01	83.23	93.92	0.00	0.00
4	55.34	7.54	3.10	0.19	1.06	0.29	0.76	4.73	2.53	1.10	1.55	0.06	34.43	86.07	1.23	0.02
8	64.61	23.20	1.83	0.52	0.44	0.18	4.09	4.97	5.86	3.40	1.03	0.36	17.72	62.88	4.43	4.48
12	47.62	24.39	1.61	1.54	2.05	0.18	9.70	4.79	11.37	9.99	0.88	0.25	13.08	48.30	13.68	10.58
Variance decomposition of Extrevs																
1	1.99	10.49	2.27	2.01	1.07	0.22	0.02	0.13	3.93	1.83	0.14	0.07	4.22	0.50	86.37	84.75
4	13.42	28.57	4.32	5.29	1.31	0.35	5.28	1.22	11.96	9.47	0.70	0.11	16.07	1.67	46.95	53.33
8	22.73	31.18	2.90	7.37	5.03	3.22	11.00	0.62	11.00	12.84	0.29	0.40	19.24	2.67	27.66	41.68
12	28.69	30.78	2.21	6.70	6.56	4.22	16.00	0.87	8.20	11.07	0.26	1.26	15.99	8.18	22.09	36.91

Source: Authors' own computations. Cholesky ordering: ROILREVCM(+/–) LOG(RGOVEXP) LOG(RGDP) INF INT REXR LOG(RIMP) LOG(EXTREVS) Standard errors: Monte Carlo (1 000 repetitions).

tions in external reserves than positive shock to oil revenue, as it accounts for about 10.5 per cent of such variations in the first quarter and more than 28 per cent in the fourth down to the twelfth quarter after shocks.

IV. Conclusion and Policy Implications

Based on the empirical findings, it can be concluded that symmetry shocks to oil price do not pose significant inflationary threat to the Nigerian economy in the short run; rather, it improves the level of real GDP during this period, while concerns for macroeconomic stability can only be traced to the relatively significant increase in interest rate, real effective exchange rate and real volume of import it would have engendered after the initial shock, along with significant fall in external reserves. As regards the asymmetric effects of oil price shocks, both positive and negative oil price shocks only influence real government expenditure in the long run, rather than in the short run, while both positive and negative shocks to external reserves revealed stronger implications for expenditure in the long run, among other variables (excluding real government expenditure itself). However, for fluctuations in real GDP positive oil price shocks have a stronger short and long run role compared to negative oil price shocks, and thus suggest that positive oil price shocks could guarantee growth in the short run when aligned with the qualitative outcome of the IRF. Furthermore, as only positive oil price shock accounts for more than 16 per cent of variances in inflation in the medium to long run (eighth to twelfth quarter after shock), it is concluded that positive shocks to oil price could trigger inflationary pressure during such period. Also, positive rather than negative shocks to oil price explain more about variations in interest rate in the long run, while both positive and negative oil price shocks explain more about changes in real effective exchange rate four quarters after shock. Furthermore, only positive oil price shock explains stimulated fluctuation in the volume of imports in the fourth to eighth quarter after shock, while neither positive nor negative oil price shocks move external reserves; rather, both positive and negative shocks to real government expenditure proved influential in this regard in the short and long run. These findings are therefore relatively in line with the demand side transmission channel postulated by Tang *et al.* (2010), as positive shocks to oil price motivates variations in government spending, stimulate growth, inflationary pressures, increase interest and real effective exchange rate and real volume of import. Hence, this implies that proper coordination of fiscal and monetary policy is needed to ensure that while growth potential is embedded in positive shocks to oil price, the downside risks from inflation rate, interest rate, exchange rate and drastic fall in external reserves deserve immense attention. More importantly, the country exhibits the Dutch disease syndrome, since positive oil price shocks increase the real effective exchange rate and appreciate domestic currency in the short and long run, thereby reducing the price of imports while increasing the price of exports in the process. Similarly, the vulnerability of the economy is further underscored by a significant fall in the real effective exchange rate in the short run, which consequently depreciates the local currency.

The empirical findings on oil revenue shocks show that real GDP growth is impeded only in the long run, with inflation rate rising marginally in the short run after initial shocks, and pose serious threat to interest rate in the medium term, depreciating real effective exchange rate slightly in the short and long run, while increasing the volume of imports and the level of external reserves significantly in the medium to long term. However, asymmetric effects of oil revenue shocks revealed that positive oil revenue shocks increased real government expenditure slightly in the short and medium term after shocks, and reduced real GDP slightly in the short run, but increase it in the long run, while negative oil revenue shocks significantly increase real government expenditure and real GDP in the long run. Hence, positive oil revenue shocks increase inflation rate, interest rate and real effective exchange rate slightly only in the short run, with negative shocks having mild effects on the variables; meanwhile, both positive and negative shocks significantly increase the volume of imports and external reserves in the medium and long term respectively. This implies that positive shocks to oil revenue stimulate expansionary fiscal stance in the Nigerian economy in the short run, in line with the envisaged effects of positive oil price shocks by Tang *et al.* (2010), and thereby create inflationary pressure and domestic currency depreciation. In this regard, monetary tightening policy is envisaged for sustainable macroeconomic stability to be achieved.

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