A Panel Analysis of Oil Price Dynamics, Fiscal Stance and Macroeconomic Effects: The Case of Some Selected African Countries

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Abstract

In most oil-exporting countries of Africa, fiscal policy has been expansionary in the wake of high oil prices. This has added to inflationary pressure, and monetary policy has been constrained in tackling inflation as a result of the prevailing exchange rate regimes. The sharp fall in oil prices since mid-2008 has brought to the fore a different challenge – whether oil exporters in Africa can sustain spending levels reached in previous years. The study makes use of quarterly data that spans the period from 1990:q1 to 2010:q4. A panel vector autoregressive (PVAR) technique was employed to examine the impact of oil price dynamics on the economic performance of five (5) oil exporting countries in Africa. The countries are: Algeria, Angola, Egypt, Libya and Nigeria. In order to achieve this, the study used the following variables: oil price volatility, real gross domestic product (real GDP), fiscal deficit, gross investment and money supply shocks. The impulse response functions show that of all the macroeconomic variables considered, gross investment responds more to oil price volatility than fiscal deficit, real GDP and money supply. On the whole, the findings suggest that gross investment is the main channel through which oil price dynamics influenced the macroeconomic performance of these economies.

Key words: *Fiscal stance, Gross investment, Money supply, Panel VAR, Africa*

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I. Introduction

A detailed analysis of the effects of oil price dynamics on fiscal deficit (a measure of fiscal stance) and macroeconomic performance in some selected oil exporting countries in Africa is the focus of this study. The purpose of fiscal policy is basically to stimulate economic and social development by pursuing a policy stance that ensures a sense of balance between taxation, expenditure and borrowing that is consistent with sustainable growth. Nonetheless, the extents to which oil price and fiscal policy engender

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economic growth continue to attract theoretical and empirical debate, especially in developing countries. In recent times, the debate has been given impetus in African countries; the basis of that agitation is due to the argument that the seemingly steady growth that has been recorded over the past decade has not translated to a reasonable level of job creation. Furthermore, the sharp fall in oil prices since mid-2008 has brought to the fore a different challenge – whether oil exporters in Africa can sustain spending levels reached in previous years.

However, most of the empirical studies on the effect of oil price dynamics on key macroeconomic variables carried out have focused on the oil-importing economies, particularly developed economies. Few studies exist yet for oil exporting countries. Besides, some of the few available studies are country-specific; however, the problem of omitted variables which might cause biased estimates in a single individual regression cannot occur in a panel context. This study intends to fill this gap by focusing on multi-country analysis. In the light of the debate, the study seeks to examine the effects of oil price dynamics on macroeconomic variables, such as, fiscal policy, gross investment, money supply and economic growth in oil-exporting countries in Africa. Further motivation for the paper hinges on the fact that, debate on the efficacy of oil price in stimulating macroeconomic performance and growth in Africa seems to have received scanty attention. This study, seeks to contribute to the public discourse on the subject matter from a cross-country perspective

A panel vector autoregressive (PVAR) model of the African economies is constructed to test the effects of oil price volatility on economic activities of these countries and the magnitude of the impacts. The advantages of the panel VAR method are threefold. First, it provides a flexible framework which combines the traditional VAR approach with panel data and increases the efficiency and the power of analysis while capturing both temporal and contemporaneous relationships among variables (Mishkin and Schmidt-Hebbel, 2007). Second, the technique can take into account complex relationships and identifies dynamic responses of variables following exogenous shocks using both impulse response functions and variance decomposition. In that way, it provides a systematic way of capturing the rich dynamic structures and co-movements between different variables over time. This allows clear examination of the economy's response to oil price shocks. Third, it addresses the endogeneity problem by allowing for endogenous interactions and feedback effects between the variables in the system.

The rest of the article is organized into five sections. Section two presents the macroeconomic performance in the selected oil-exporting countries. Section three reviews the related literature on the subject matter. The methodology, estimation techniques and data sources are discussed in section four. The major findings and policy implications are reported in section five, while, section six concludes.

II. Overview of Macroeconomic Performance in the Selected Countries

II.1 Trends in Macroeconomic Variables and GDP

In Table 1, we present some selected macroeconomic variables as percentages of GDP in the pooled countries, namely, oil revenue, fiscal deficit, gross investment and money supply. The series are presented as four-year averages. The share of oil revenue between 1990 and 1993 was 46.3%. it fell to about 41.0% between 1994 and 1997, but it later increased to 51.9%, 65.0% and 69.3% during the period 1998-2001, 2002-2005 and 2006-2010 respectively. It is conspicuous that there was an increasing trend in the share of oil revenue as a percentage of GDP between 1990 and 2010. This may probably be due to the increase in oil price at the international market over the period. Particularly relevant to the current discussion is the size of the fiscal position as a share of GDP, which was negative (budget deficit) between 1990 and 1993, and positive (16.0%) between 1994 and 1997. This proportion oscillated between 0.5% and 12.9% during the last three periods. The justification for this was that, government expenditure was highly elastic with respect to revenue development during these periods.

When gross investment as a share of GDP is considered, it is evident that government generally increased investment over the years from a low of 6.4% in the 1990s to an average of 21.8% between the periods 2006 and 2010. This increase in gross investment may have positive welfare implications on the society. In addition, some striking features are discernible from the growth rate of real GDP. This value stood at 8.1% between the period 1990 and 1993, it fell to 7.5% and 7.0% during the periods 1994-1997 and 1998-2001 respectively. The highest growth rate of GDP was recorded during the period 2002-2005, which stood at 9.22%, however, it was observed that the lowest GDP growth rate (3.10%) was recorded in during 2006-2010.

Considering the share of money supply (MS) as a percentage of GDP, it is apparent that the ratio of MS stood at an average of 82.2% in the first four years. It fell significantly to 46.7% between the period 1994 and 1997. However, the share increased remarkably to 84.0% in the next period. It plummeted to a mean of

46.2% between the period 2002 and 2005. The proportion of MS as a percentage of GDP in the last period averaged 62.3%. The volatile nature of MS as a share of GDP might emanate from the unpredictability of oil prices at the international market because these countries depend on oil for their revenue generation and the consequence of this is that the supply of money also follows the same dynamic trend.

However, there was a significant increase in the growth rate of real GDP between the period 2002 and 2005 which stood at 9.2%. On average, it was about 3.0% between 2006 and 2010. The plausible reason for the fall in the growth rate of GDP is not unconnected with the global economic and financial crises of 2008-2009, which led to a crash in the international crude oil price in the late 2008 stemming from low demand for crude oil in the market, which subsequently influenced the output growth in these economies.

Table 1: Trends in Macroeconomic Variables and GDP, 1990-2010

Period Average	**1990-1993**	**1994-1997**	**1998-2001**	**2002-2005**	**2006-2010**
As percentage of GDP					
Oil Revenue	46.30%	40.95%	51.87%	65.04%	69.32%
Fiscal Deficit	-1.73%	16.02%	7.69%	12.85%	0.47%
Gross Investment	6.42%	13.40%	15.06%	18.26%	21.78%
Money Supply	82.15%	46.65%	84.01%	46.16%	62.26%
Real GDP Growth	8.17%	7.51%	6.99%	9.22%	3.10%

Source: Authors' computations-Data from IFS, 2011 and OPEC annual statistical bulletin 2010/2011 edition.

II.2. Fiscal Policy in Oil-Exporting Countries: Stylized Facts

In oil-exporting countries, government finance is heavily dependent on the oil sector. Hence government revenues tend to be highly volatile. In addition, oil price shocks tend to be persistent and the oil price cycles are highly unpredictable. These characteristics make fiscal management more challenging in such countries with very important implications for their growth performance. Some of these implications are highlighted as follows. The oil price volatility can be transmitted to the economy through the large fluctuations in government revenues. The uncertainty about future oil revenues and the variability of such revenues would result in changes in spending as the government reassesses its expected revenue stream, generating significant adjustment costs (Hausmann et al. 1993). Therefore, the resulting pro-cyclicality of government spending can ultimately lower growth rates. Looking carefully into some of the potential expenditure mechanisms, one can identify the following scenarios:

A positive revenue shock that is perceived as permanent typically leads to higher government spending, especially on non-tradables, creating incentives to shifting resources away from the (non-oil) tradable sector to the non-tradable sector. Such resource movements would lead to higher unemployment, output losses, and ultimately the de-industrialization of the economy-a phenomenon known as the "Dutch disease". To the extent that the manufacturing sector provides positive spillovers to other sectors, the resource (government revenue) windfall would have a negative effect on long-run growth (Sachs and Warner, 1995).

If a positive shock is perceived as temporary, accumulating the budgetary surpluses in developing economies is politically unpopular and the government will be subject to pressures to increase spending, especially on public projects. For example, during the period 1974-1978, 85%, of the windfall gains that accrued to the governments of Nigeria, were channeled to increasing public investment (Gelb et. al, 1988). Many studies found that most of the large surges in public capital spending during boom times are non-productive and typically have a very low return (Talvi and Vegh, 2000).

A negative shock, on the other hand, typically induces downward adjustments in government expenditures. This adjustment could be very costly. On the one hand, cutting current expenditures is usually unpopular because of its negative social consequences. Also, cutting capital expenditures would disrupt public projects, reducing the productivity of the initial investment and causing high social costs.

In a downturn, it is common for governments to delay adjustment to avoid immediate spending cuts. If the shock turns out to be permanent, the persistent budget deficit and the growing public debt would put into question fiscal policy and current account sustainability, as well as government solvency. Ultimately, a larger adjustment at a higher cost would be inevitable at some point in the future. For example, in 1986, Venezuela did not allow for spending adjustment in response to the negative large oil shock. In 1989, the looming balance of payments crisis led to substantial costly adjustments (Hausmann et al., 1993).

A fiscal consolidation in response to a permanent negative oil shock that aims to put fiscal policy on a sustainable path would adversely affect growth, leading to a more unsustainable path. A given level of primary deficit that may seem sustainable given a certain growth rate could be unsustainable at a lower rate of growth. This endogeneity of fiscal policy appears to be crucial in designing fiscal adjustments in shock-prone economies (Elanshasy et al, 2005).

Oil exporting countries tend to have higher borrowing capacity during boom times. Therefore, an oil boom could induce an expansion of easy borrowing, especially with the large growth in domestic absorption that lately resulted in the phenomenon of highly-indebted oil-rich economies (Isham et al 2004). The accumulation of debt during times of plenty makes the adjustment more costly and more difficult during the period of scarcity because it implies larger adjustments. Therefore, oil price downturns in oil economies may face foreign borrowing constraints, which would adversely hinder their development programs (Mehlum et al, 2006). In addition, this leaves the fiscal authorities with fewer options to finance the deficit. Sharp expenditure cuts may become inevitable, potentially harming long-run growth.

II.3 Measurement of Oil Price Volatility: GARCH Model

Prices of oil, like those for many other commodities, are inherently volatile and volatility itself varies over time. To measure the oil price volatility, the study made use of two measures: (i) the oil price volatility measured by equation (1) and; (ii) oil price instability captured by equation (2). These equations are estimated based on auto-regressive estimates to account for deviations from an expected trend by taking the standard deviation using the rolling window technique[3].

$$\mathrm{oilp}_t = \beta_1 + \beta_2 \mathrm{oilp}_{t-1} + \beta_3 \mathrm{oilp}_{t-2} + \varepsilon_{1t} \quad (1)$$

$$\mathrm{oilp}_t = \beta_4 + \beta_5 T + \beta_6 T^2 + \varepsilon_{2t} \quad (2)$$

where T is the time trend. Oil price volatility is captured in (1). The relevance of (2) is that it represents oil price instability as simple variability around a time trend (with the polynomial included to allow for a break in the trend). Hence, the GARCH model can be represented as follows:

$$Y(t) = x(t)P + e(t) \quad (3)$$

[3]see, Lensink and Morrissey, 2001

$$\mathrm{e(t)}\varphi_{t\text{-}1} \sim \mathrm{N}[0,\ \sigma^2\mathrm{(t)}] \tag{4}$$

$$\sigma^2(t) = \delta_0 + \sum_{t=1}^{p}\alpha_i e^2(t-1) + \sum_{j=1}^{q}\omega_j\sigma^2(t-j) \tag{5}$$

The empirical observation that volatility is not constant over time and that it has memory led to the more sophisticated time series models, known as the Generalised Autoregressive Conditional Heteroskedasticy (GARCH) models. These models capture the persistence of volatility, time-varying mean as well as the non-constant nature of volatility. Since the conditional variance at time t is known at time t-1 by construction, it provides a one-step ahead conditional variance forecast. Hence, the justification for making use of the GARCH technique in this study.

Where the conditional information set at time $t-1$ is denoted by φ_{t-1}. The variance of the ARCH process exists when $\Sigma\alpha<1$ and is given by $(Y(t) = \alpha_0/(1-\Sigma\alpha_t)$. In this study $Y(t)$ is equal to the change in log of oil prices. $X(t)$ is a 1x k vector of lagged endogenous variables included in the information set. P is a kx1 vector of unknown parameters. p and q are the order of the process. Equation 5 is the variance equation, which contains three components: a constant, last period volatility (the ARCH term) and last period variance (the GARCH term). The autoregressive root which governs the persistence of volatility shocks is the sum of α and β. If the sum of α and β is very close to unity then the shocks die out rather slowly. The existence of volatility used in this study is based on the above volatility modeling process.

III. Review of Related Literature

III.1 Theoretical Literature Review

There are numerous channels through which oil price volatility affects the macro-economy. First, an increase in oil price leads to an upward shift in the aggregate supply curve for oil exporting countries. Oil price volatility change firms' optimal production plans by altering the incentive to utilize energy resources. Therefore, existing capital and labour do not produce output as before resulting in a reduction in potential output. The second channel works via the effect of changes in net imports of oil on domestic aggregate demand. The direction of such effects is based on a country's net oil export stance. Countries that are net oil importers experience a decline in aggregate demand when oil prices fall and those self-sufficient in oil remain unaffected. Net oil exporters respond such that from a rise in oil prices aggregate demand increases (Rasche and Tatom, 1977).

According to Rotemberg and Woodford (1996) model, firms that have identical production functions produce output, and households consume an aggregate consumption good and undertake investment. It is assumed that money is absent from the model and there is no unemployment. The condition for output market clearing is that the sum of all households' consumption and investment, including government purchases, must equal aggregate output excluding materials. The Langrange multiplier from the first-order conditions on the production function is an endogenous mark-up variable. An oil price volatility permits increases in mark-ups, depressing output following an oil shock in a magnitude and temporal pattern similar to the empirical path of output response to an oil price shock in impulse response functions.

Furthermore, the general equilibrium effects of a booming oil sector on the rest of the economy in both developed and developing countries have also been systematically analysed within the Dutch Disease framework (Enders and Herberg, (1983). The Dutch Disease model has been used in understanding the re-allocation of productive factors among different economic activities. The sectoral changes resulting from resource boom are often influenced by movements in relative prices (Corden, 1984). A typical model of this nature assumes a small open economy producing both tradeables and non-tradeables (Corden, 1984). The tradeable goods which comprise importables and exportables have exogenously determined world prices while the non-tradeables have prices which are subject to changing domestic supply and demand conditions. One of the two tradeable sectors is sub-divided into the booming sector and the traditional export-competing sector. Hence, the rest of the economy and macroeconomic aggregates in general are influenced by changes in the booming sector through two distinct effects: the spending and resource-movement mechanisms.

The spending channel is often analysed using a model that consider the booming sector an enclave with no obvious supply side links with the rest of the economy. Within this setting, the booming sector does not use domestic factors of production but induces income received. Thus, a change in relative prices as a result of higher level of income is spent on both tradeable and non-tradeable goods. Excess demand for the non-tradeable sectors output places upward pressure on prices within that sector, whereas the increased demand in the tradeables sector is augmented through increased imports. This results in both a fall in output of the tradeable sector and expansion of activities in the non-tradeable sector

The resource-movement effect works where the booming sector has supply side interactions with the rest of the economy. A boom in this instance causes an upward shift in the demand curve for non-tradeables implying an increase in relative prices. Since labour is assumed to be the only mobile factor, capital being sector-specific, the relative price change causes an upward movement in the wage rate of the traditional tradeables sector resulting in the flow of labour services to the other sectors. The excess labour requirement in the latter sectors is assumed to be drawn from the fixed total supply of labour in the economy.

Davis et al (2003) dispersion hypothesis has been a central focus of this research applied to oil price shocks. The dispersion hypothesis posits that a considerable amount of unemployment can be accounted for by sectoral shifts in demand, which require time for reallocation of labour.

Using quarterly data over the period 1947-1982, Loungani (1986) found that when the relative price of oil is held fixed, such dispersion of unemployment has little residual explanatory power for fluctuations in the aggregate unemployment rate. He suggested that this result might imply that oil price shocks may have been the principal cause of such re-allocative shock affecting the U.S. economy during this period, and that the oil price shocks of the 1950s as well as those of the 1970s may have required an unusual amount of inter-industrial reallocation of labour. Davis et al (2003) reports that his own research "showed that oil price shocks explain much of the time-series variation in the pace of labor reallocation (as proxied by a Lilien-type dispersion measure) and do so in a way predicted by the sectoral shifts hypothesis." Reinforcing this interpretation of empirical findings on the dispersion hypothesis, Long and Plosser (1987) found that the explanatory power of common, aggregate disturbances to industrial output is significant, but not very large for most industries." The study therefore, concluded that sectoral independent and random productivity shocks can cause co-movement of activity across different sectors (Long and Plosser 1987).

Table 2: Summary of Major Empirical Findings on Oil Price Volatility, Fiscal Policy and Macroeconomic Growth

Author	Methodology, Type of Data and Scope	Variable used	Major Findings
Darby (1982)	used data spanning between 1948 and 1978 for eight OECD countries	Oil price, money supply, inflation	Oil prices volatility could be attributed to three distinct causal factors; the shock to oil prices, tight monetary policy targeted at combating inflation and the imposition and eventual removal of price controls from 1971-1975.
Hamilton (1983)	Granger Causality in testing the direction of effects of oil shocks within a business cycle framework.	Oil price, real GDP, money supply	Concluded that in the short-run, oil price shock seemed to be a potential mechanism for yielding the unanticipated but transitory supply shocks usually assumed by real business cycle.
Semboja (1994)	calibrated a Computable General Equilibrium (CGE) model on the Kenyan economy	Oil price, terms of trade, trade balance	The responses suggest that increasing oil prices lead to deterioration in both the terms of trade and trade balance.

Bernanke at al, (1997)	counterfactual analysis in VAR framework in U.S	Monetary policy, oil price, GDP	Most of the reductions in U.S GDP during the recessions that followed the 1973, 1979/80 and 1990 episodes were attributable to monetary policy and not the oil price shocks.
Ayadi et al (2000),	The study spans between the period 1975 and 1992. VAR technique was used in their estimation.	Oil production, output, inflation, domestic currency, exchange rate	The results of their impulse response functions showed that a positive oil production shock was followed by rise in output, reduction in inflation and a depreciation of the domestic currency in Nigeria.
Eltony (2001)	Linear oil price shocks were important explanations for fluctuations in macroeconomic variables in Kuwait.	Oil price, government expenditure, GDP	Their result showed that government expenditure which is the major determinant of economic activity in the country was significantly influenced by shocks to oil prices.
Raguindin and Reyes (2005)	Data covering the period between 1981 and 2003 examine the effects of oil price shocks on the Philippine economy. In the non-linear VAR.	Oil price, real GDP, money supply, inflation	Their impulse response functions for a linear specification of oil prices revealed that oil price shocks lead to prolonged declines in real GDP.

Anshasy et al (2005)	Investigated the effects of oil price shocks on Venezuela's economic performance between 1950 and 2001. They employed both VAR and VECM models	oil prices, government revenue, government spending on consumption, investment and real GDP	Their results showed two long run relationships consistent with economic growth and fiscal balance. These relationships were important for both long-run performance and short term fluctuations
Olomola and Adejumo (2006)	Used a VAR model.	output, inflation, real exchange rate and money supply in Nigeria	They demonstrated that oil price shocks do not have substantial effects on output and inflation rate in Nigeria. However, Inflation rate depend on shocks to output and the real exchange rates.
Omojolaibi, (2011)	Employed a Structural VAR technique	Fiscal impulse, real output, money supply, inflation	Fiscal impulse has a positive effect on real output and money supply, however, its effect on inflation is negative.
Wakeford (2006)	Used a VAR model	Import prices, producer prices and consumer inflation rates in South Africa.	He found a negative response of non-oil import prices to oil price shocks. For producer prices and consumer prices, the shock had significant positive and insignificant positive effects respectively.

Source: Authors' Compilation

It is clear that the previous authors applied the vector autoregressive (VAR), VECM, Granger Causality and CGE techniques to estimate their models. However, most of these studies are country specific. This present study, however, departs from previous methodological works because it intends to fill this gap by focusing on multi-country analysis. To get a better understanding in terms of the transmission channels of oil price shocks to macro-economy, a Panel Vector Autoregressive (PVAR) model of the African economies is constructed to provide new evidence on whether oil price shocks affect economic activities of these countries, and if they do, what are the channels of transmission and the magnitude of the impact.

IV. The Model and Sources of Data

IV.1 The Model

The structural model for the panel of small open emerging market economies can be grouped into the following system of equations.

$$\left.\begin{aligned}
OP_{it} &= \alpha_{i0} + \alpha_1 OP_{it-1} + \sigma *_{Xt} - \sigma *_t \varepsilon OP_{it} \\
GDP_{it} &= \lambda_{i0} + \lambda_1 GDP_{it-1} + \lambda_2 OP_{it} + \varepsilon GDP_{it} \\
FD_{it} &= \beta_{i0} + \beta_1 OP_{it} + \beta_2 FD_{it-1} + \beta_3 GDP_{it} + \varepsilon FD_{it} \\
GI_{it} &= \gamma_{i0} + \gamma_1 OP_{it} + \gamma_2 GDP_{it} + \gamma_3 GI_{it-1} + \gamma_4 FD_{it} + \varepsilon GI_{it} \\
MS_{it} &= \omega_{i0} + \omega_1 OP_{it} + \omega_2 GDP_{it} + \omega_3 MSi_{t-1} + \omega_4 FD_{it} + \omega_5 GI_{it} + \varepsilon MS_{it}
\end{aligned}\right\} \quad (6)$$

The panel VAR model combines the traditional VAR approach that treats all variables in the system as endogenous with the panel data approach that allows for unobserved individual heterogeneity. The first row of equation (6) accounts for external influence of oil price on other macroeconomic variables considered.

Rearranging the model equations by putting all the endogenous variables to the left and distinguishing between the lagged variables, the interactions of the variables in all the countries, the following matrix equation is obtained:

$$AZ_{it} = X_i + BZ_{it-1} + CX_{t*} + \varepsilon_{it} \quad (7)$$

Where,

$$A=\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ -\lambda_2 & 1 & 0 & 0 & 0 \\ -\beta_1 & -\beta_3 & 1 & 0 & 0 \\ -\gamma_1 & -\gamma_2 & -\gamma_4 & 1 & 0 \\ -\omega_1 & -\omega_2 & -\omega_3 & -\omega_4 & 1 \end{pmatrix}$$

$$B=\begin{pmatrix} \alpha_1 & 0 & 0 & 0 & 0 \\ 0 & \lambda_1 & 0 & 0 & 0 \\ 0 & 0 & \beta_2 & 0 & 0 \\ 0 & 0 & 0 & \gamma_3 & 0 \\ 0 & 0 & 0 & 0 & \omega_3 \end{pmatrix}, \qquad C=\begin{pmatrix} 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

where Z_{it} is the vector of endogenous variables (a five-variable vector of oil price volatility, real GDP, fiscal deficit, gross investment and money supply). A is the matrix of lagged interactions, C is the matrix of external time interactions, X_i is the vector of constants for each country, Xt* is the vector of exogenous variables from the rest of the world at time t and ε_{it} is the vector of structural disturbances which are normally distributed with mean zero, constant variance and serially uncorrelated. While $\alpha_i, \lambda_i, \beta_i, \gamma_i$ *and* ω_i are the structural parameters.

Identification of oil price shocks is achieved through a methodology that is commonly known as the recursive approach. This methodology assumes that oil price does not react contemporaneously to shocks to other variables in the system. To this end, a reduced form model with variables ordered as oil price volatility, real GDP, fiscal deficit, gross investment and money supply is used.

The methodology is a restricted version of the multi-country VAR modeling approach put forth by Canova and Ciccarelli (2004). As a starting point, consider a panel VAR where each equation contains lagged values of all variables in all countries.

A panel VAR model is estimated in order to identify unanticipated shocks to the endogenous variables. i is use to index countries and t to index time periods. The PVAR model includes five variables: oil price volatility, OP_{it}; gross domestic

product, GDPit, measured in real term; fiscal deficit, FDit; gross investment, GIit and money supply, MSit The inclusion of money supply is to capture the monetary policy variable which allows for a broad consideration of the range of economic policy variables that may be driving growth or otherwise.
The vector of variables, Z_{it} , is given by

$$Z_{it} = \left[OP_{it} \ GDP_{it} \ FD_{it} \ GI_{it} \ MS_{it}\right]' \tag{8}$$

The VAR model reads as follows

$$Z_{it} = \mu_i + \sum_{k=1}^{K} C_k x_{it-k} + \psi_{it} \tag{9}$$

where ψ_{it} denotes a vector of constants, capturing country fixed effects. In the estimation, we also control for time fixed effects. C_k are appropriately defined matrices. In the baseline specification, we allow for four lags, that is, we set K = 4. The choice of this lag length hinges on the Akaike information criterion (AIC). In addition, we remove country-specific linear time trends. We identify oil price shocks by assuming that oil price is predetermined relative to the other variables in the VAR model. This assumption is in the spirit of Blanchard and Perotti (2002), but more restrictive, as we consider quarterly rather than annual data.
The PVAR specification in its structural form is represented thus:

$$A_0 Z_{it} = A(L) Z_{it} + e_{it} \tag{10}$$

where Z_{it} is the (mx1) vector of endogenous variables and A_0 is an (mxm) matrix with 1's on the diagonal. It contains the structural parameters that capture the contemporaneous relations among the endogenous variables. Furthermore, e_{it} is the vector with the structural shocks, while A(L) is the lag operator. For the baseline model,

$$Z_{it} = \left[OP_{it}, GDP_{it}, FD_{it}, GI_{it}, MS_{it}\right]' \tag{11}$$

and

$$e_{it} = \left[e_{it}^{OP}, e_{it}^{GDP}, e_{it}^{FD}, e_{it}^{GI}, e_{it}^{MS}\right]' \tag{12}$$

The structural equation (10) cannot be estimated directly because of the correlation between the variables and the error terms. Therefore the structural equations is transformed into reduced form equations which can actually be estimated. This is achieved by pre-multiplying equation (10) by A_0^{-1}, to obtain a reduced-form equation:

$$Z_{it} = B(L)Z_{it-1} + \mu_{it} \tag{13}$$

where $B(L) = A_0^{-1}A(L)$ and $\mu_{it} = A_0^{-1}e_{it}$ is the reduced-form residual vector which is assumed to be white noise.

We can write out $A_0\mu_{it} = e_{it}$ as:

$$\begin{array}{ccccc} A_0 & & \mu_{it} & & e_{it} \\ \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ G_{21} & 1 & 0 & 0 & 0 \\ G_{31} & G_{32} & 1 & 0 & 0 \\ G_{41} & G_{42} & G_{43} & 1 & 0 \\ G_{51} & G_{52} & G_{53} & G_{54} & 1 \end{bmatrix} & & \begin{bmatrix} \mu_{it}^{OP} \\ \mu_{it}^{GDP} \\ \mu_{it}^{FD} \\ \mu_{it}^{GI} \\ \mu_{it}^{MS} \end{bmatrix} & = & \begin{bmatrix} \varepsilon_{it}^{OP} \\ \varepsilon_{it}^{GDP} \\ \varepsilon_{it}^{FD} \\ \varepsilon_{it}^{GI} \\ \varepsilon_{it}^{MS} \end{bmatrix} \end{array} \tag{14}$$

where $\mu_{it}^{OP}, \mu_{it}^{GDP}, \mu_{it}^{FD}, \mu_{it}^{GI}$ *and* μ_{it}^{MS} are the reduced-form residuals.

The zeros in the first row of A reflect our identification assumption, the remaining zeros are a convenient normalization (see Christiano et al, 1999). The restriction implies that oil price volatility does not respond to contemporaneous changes from other variables because it is determined exogenously. However, all other variables in the system are contemporaneously affected by changes in oil price.

IV.2 Sources of Data

The data used in the study is quarterly and spans 1990 to 2010. The macroeconomic variables considered are: fiscal deficit or surplus (FD) which is used to represent the fiscal policy. Gross investment (GI) is used to account for investment expenditure. The gross domestic product (GDP) captures the real output growth in the economy. Monetary policy variable used in the study is money supply (MS). Oil price volatility (OP) is used to capture exogenous factors that can affect output growth. GDP, GI, FD and MS data series were taken from the International Monetary Fund International Financial Statistics (IFS) CD ROM 2011, while oil price data was abstracted from OPEC annual statistical bulletin 2010/2011 edition.

V. Estimation Results and Interpretations

V.1 Data Characteristics: Unit root tests

All the data series were tested for stationarity to forestall the possibility of drawing conclusions based on statistically spurious relationship. The unit root test results are presented in Table 2. The first stage of the empirical analyses involved examination of the statistical properties of all the variables under consideration, i.e., oil price volatility, real GDP, fiscal deficit, gross investment and money supply. The results of the ADF unit root tests are summarized in Table 2 below. The results suggest that the null hypothesis of the presence of unit root in the variables in levels could not be rejected indicating that all the variables are non-stationary in levels. However, after first-differencing the variables, the null hypothesis of the unit root in each of the series were rejected at the 5% level of significance. Therefore it can be inferred that all the variables are integrated of order 1, that is, I (1).

The implication of this test is to determine whether the VAR model should be estimated in the level or first difference form. Thus, the evidence of the result suggest that first differencing is sufficient for modeling the panel series considered in this study.

Table 2: Detailed Unit-Root Test Results

Levels	**OP**	**GDP**	**FD**	**GI**	**MS**
Algeria	-2.36	-2.02	-1.35	-2.28	-2.08
Angola	-3.12	-2.97	-3.10	-1.01	-0.56
Egypt	-2.03	-3.10	-2.28	-1.20	-1.22
Libya	-1.03	-3.17	-2.76	-1.35	-1.69
Nigeria	-2.19	-3.01	-2.15	-1.24	-1.56
1st diff.					
Algeria	-3.92	-3.80	-7.30	-2.81	-2.32
Angola	-2.85	-3.63	-4.98	-7.86	-3.14
Egypt	-2.60	-5.60	-3.23	-7.25	-2.20
Libya	-2.53	-4.92	-2.32	-9.39	-2.17
Nigeria	-3.74	-3.77	-2.44	-4.37	-3.02

Note: *Except for the oil price volatility, where we include a constant only, the tests for the levels include a constant and a trend and five lags, whereas the test for the differences include a constant and four lags. The choice of the lag length is based on AIC which was found to be the most appropriate. The test statistics are distributed as N (0, 1). Bold face denotes significance at the 5 percent level.*

Source*: Authors' Computation using E-views 7.1*

V.2 Impulse Response Function (IRF) Analysis[4]

A selection of key impulse response functions of the variables (one standard deviation) shocks is discussed in this section. Since the estimated shocks are assumed to have unit root variances in the panel VAR, their sizes and speed of adjustment can be inferred by analysing the associated impulse response functions. The sizes of the shocks are measured by the standard deviations of the corresponding orthogonal errors obtained from the PVAR model. Figures 1 and 2 reveal the responses of real GDP, fiscal deficit, gross investment and money supply to a shock in oil price for the five countries and an accumulated impulse response to shocks with 95% confidence interval for the countries respectively. The Impulse response functions (IRFs) are derived and used to examine the dynamic responses of the variables to various shocks within the PVAR system.

The confidence bands are reported as dotted lines. When the horizontal line falls within the confidence interval, then, the null hypothesis that, there is no effect of oil price shock on the target macroeconomic variables cannot be rejected. Thus, including the horizontal line for the particular time period obtained in this manner is interpreted as evidence of statistical significance.

The real GDP response to the shock from oil price is depicted in Figure 1(b). Real GDP does not respond in the first three periods. It is also non-significant in these periods. However, the response becomes negative in the fourth period and this continued till the tenth period. As regards the response of fiscal deficit to shock from oil price (Figure 1(c)), there were significant responses starting from the first period to the eighth period. During these periods, the effects were all positive. The responses became insignificant at the ninth period and died off at the tenth period. Meanwhile, the effects were positive for these two periods.

Turning to the response of gross investment to oil price volatility in Figure 1(d), the response of this variable was significant from the first period to the last period. However, the effect was positive. It is evident from Figure 1(d) that, the positive effect was increasing as the periods proceed, indicating that the positive effect reaches its maximum value at the tenth period. The significant effect is further strengthened through the relationship between the horizontal line and the confidence interval. Figure 1(d) is the only chart in which the horizontal line falls in between the confidence intervals from the first period to the tenth period. The response of money supply to the volatility from fiscal impulse is depicted in Figure 1(e). The response of money supply to oil price volatility was significant in the first

[4] *The country specific Impulse response functions (IRFs) are shown in the appendices 1-5.*

five periods. However, the effect was negative. The response became insignificant from the sixth period to the last period.

Figure 1 : PVAR Impulse Response Functions: Response of endogenous variables to volatility from oil price for the five countries.

Figure 1(a)

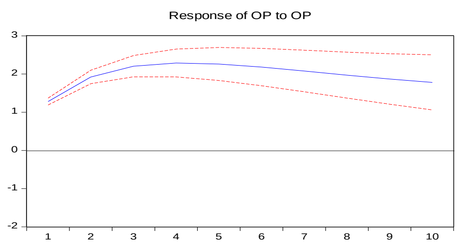


Figure 1(b)

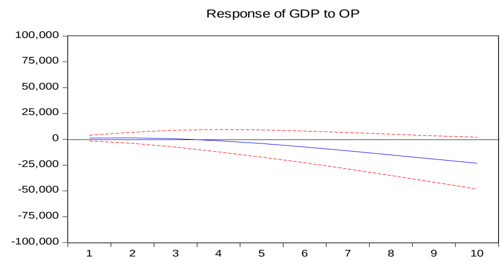


Figure 1(c)

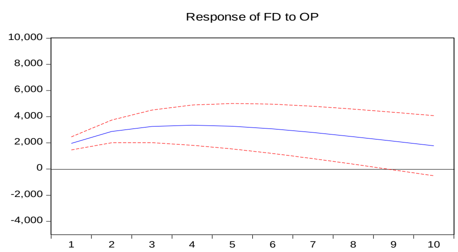


Figure 1(d)

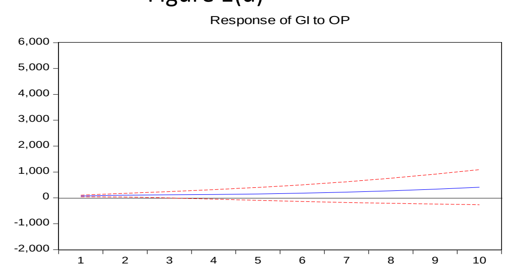
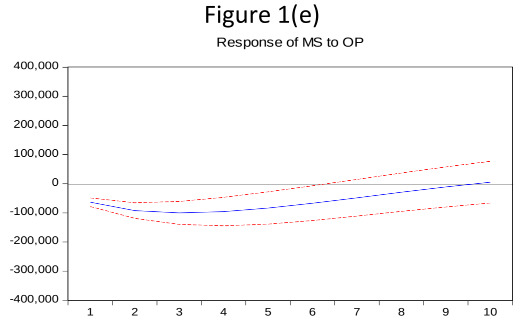
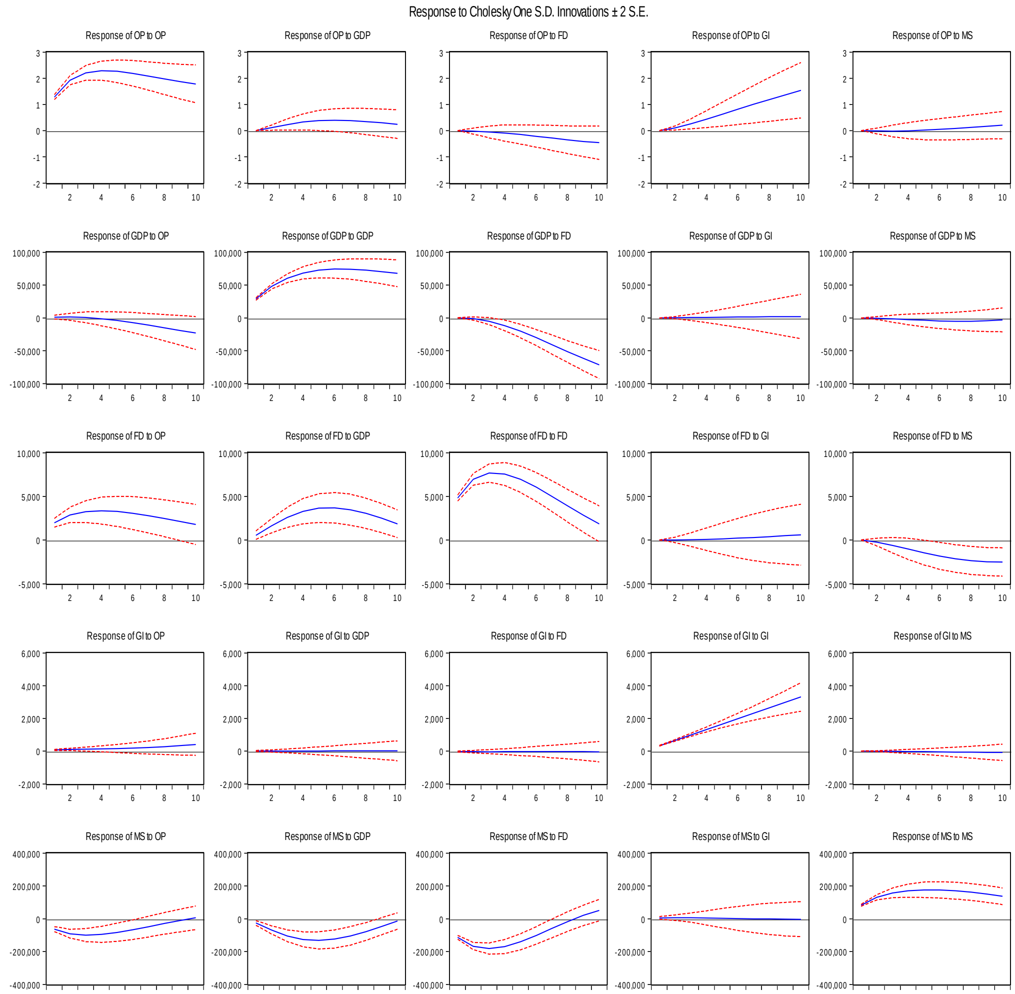


Figure 1(e)



Source: Authors' computations using E-views 7.1

Figure 2: Accumulated PVAR impulse response to shocks with 95% confidence interval for the five countries



Source: Authors' computations using E-views 7.1

The accumulated PVAR impulse response in Figure 2 measures the cumulative sum of the impulse response functions. This can be interpreted as the effects that changes in the exogenous variables have on the endogenous variable.

V.3 Variance Decomposition (VDC) Results

Table 3 presents the summary of the VDC results for the five countries. The variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. When all the countries were pooled, and there was fluctuation from oil price, it is evident that gross investment (GI) contributed the highest information (16.04%) to oil price volatility. This means that about 16% of the forecast error variance of oil price volatility can be explained by GI. This can be interpreted that the channel through which oil price shock transmits to these economies is gross investment. The summary of the transmission channels for each of these countries is reported in Table 4. A closer examination of Table 4 shows that the transmission channel of oil price volatility to Algeria, Angola, Egypt, Libya and Nigeria are fiscal deficit, gross domestic product, money supply, fiscal deficit and gross domestic product respectively.

Table 3: Summary of the Variance Decomposition (VDC) Results

Country (Period)	**% Contributions to volatility in oil price (OP) by:**			
	GDP	FD	GI	MS
All Countries (1990:q1-2010:q4)	1.81	1.33	16.04	0.19
Algeria (1990:q1-2010:q4)	2.09	28.68	3.14	8.57
Angola (1990:q1-2010:q4)	31.47	7.52	0.08	1.03
Egypt (1990:q1-2010:q4)	11.88	1.12	2.81	11.96
Libya (1990:q1-2010:q4)	10.86	41.76	19.30	1.47
Nigeria (1990:q1-2010:q4)	14.78	0.72	4.67	1.72

Note: *Red figures represent channels with highest contributions.*

Source: *Authors' computations; underlying data from IFS, 2011*

Table 4: Transmission Channels of Oil Price Volatility to each of the countries.

Country	**Channel**	**Percentage**	**Magnitude**
Algeria	Fiscal Deficit (FD)	28.68	Low
Angola	Real GDP (GDP)	31.47	moderate
Egypt	Money Supply (MS)	11.96	Too low
Libya	Fiscal Deficit (FD)	41.76	moderate
Nigeria	Real GDP (GDP)	14.78	Too low

Source: *Authors' computations; underlying data from IFS, 2011*

VI. Conclusion and Policy Implications

The paper sought to examine the relationship between oil price volatility, fiscal policy and macroeconomic performance of some selected oil-exporters in Africa. Panel vector autoregression technique (PVAR) was used to estimate the effects of oil price volatility on economic growth, fiscal deficit, gross investment and money supply. The analyses covered the period 1990:q1 to 2010:q4. The outcome supports four broad conclusions. (i) The impulse response function of the PVAR analysis shows that of all the macroeconomic variables considered, gross investment respond more rapidly to oil price volatility. However, fiscal deficit, real GDP and money supply respond slowly to oil price volatility; (ii) fiscal deficit is the channel through which oil price volatility transmits to the economies of Algeria and Libya; (iii) the channel through which oil price volatility transmits to the economies of Angola and Nigeria is real gross domestic product; and (iv) the channel through which oil price volatility affects the economy of Egypt is monetary policy (as proxied by money supply).

The results from this study stand in sharp contrast to studies on developed economies such as the work of Fu et al, 2003. Nevertheless, the result of this study has an intuitive appeal as well given by the important role of government in correcting the massive macro-economic imbalances that can emanate from external shocks.

The policy lesson that can be distilled from the findings of the individual country effect is that the continued use of fiscal deficit and gross domestic product as policy tools in oil exporting countries in Africa can speed up economic development even in the presence of oil price volatility. However, the findings from the cross country analysis suggest that gross investment is apparent as the main route through which volatility in oil price influenced the real sector of these economies. In consequence, any government desirous of using gross investment as a potent instrument of macroeconomic stabilization in oil exporting economies in Africa should focus on the dynamics of oil price because of its multiplier effects.

References

Anashasy, E.A., D.B. Bradly and F. Joutz (2005), "Evidence on the Role of Oil Prices in Venezuela's Economic Performance: 1950-2001". Working Paper, George Washington University.

Araujo, J.T. and M.A.C. Marins (1999), "Economic growth with finite lifetimes", *Economic Letters Vol.* 62, pp. 377-381.

Arellano, M. and O. Bover (1995). "Another look at instrumental variable estimation of error-components models", Journal of Econometrics, Vol. 68, pp. 29-51.

Aschauer, D. A. (1989), "Is Public Expenditure Productive?". *Journal of Monetary Economics Vol.* 23, pp. 177–200.

Ayadi, O. F., A. Chatterjee and C. P. Obi (2000), "A Vector Autoregressive (VAR) Analysis of an Oil-Dependent Emerging Economy-Nigeria", OPEC *Review*, December, pp. 329-349.

Barro, R.J. and X. Sala-I-Martin (1995), *Economic Growth*, McGraw-Hill.

Bernanke, B.S., M. Gertler and M. Watson (1997), "Systematic monetary policy and the effects of oil price shocks". Brookings Papers on Economic Activity, Vol. 1, pp. 91–142.

Blanchard, O. and R. Perotti (2002). "An Empirical Characterization of the Dynamic Effects of Fiscal Policy". *Mimeo, Department of Economics, Columbia University*

Bleaney, M., N. Gemmel and R. Kneller (2000), "Testing the endogenous growth model: Public expenditure, taxation and growth over the long-run", Discussion Paper No. 00/25, University of Nottingham.

Blinder, A.S. and R.M. Solow (2005), "Does fiscal policy matter? In A. Bagchi, ed., Readings in Public Finance. New Delhi:Oxford University Press, pp. 283-300

Canova, F. and M. Ciccarelli (2004), Forecasting and Turning Point Predictions in Bayesian Panel VAR Model, Journal of Econometrics, 120, 2004, 327-359.

Christiano, L., M. Eichenbaum, and C. Evans, (1999). "The Effects of Monetary Policy Shocks: Evidence from the flow of Funds". *Review of Economics and Statistics Vol. 78, pp.126-149.*

Corden, M. W., (1984). Booming sector and Dutch disease Economics: Survey and Consolidation, *Oxford Economic papers, vol.* 36, pp. 359-380.

Darby, M. R. (1982). The price of Oil and World Inflation and Recessions", *American Economic Review, vol.* 72, pp.738-751.

Davis, J. M., O. Rolando and F. Annalisa, (2003). *Fiscal Policy Formulation and Implementation in Oil-Producing Countries* (Washington: International Monetary Fund).

De-la-Fuerente, A., (1997), Fiscal policy and growth in the OECD. London: Centre for Policy Research.

Devarajan, S.V., V. Swaroop and H. Zhou (1996), "The composition of public expenditure and economic growth", *Journal of Monetary Economics, Vol.* 37, pp. 313-344.

Dornbusch, R.S., R. Fischer, and R. Starz (1998), Macroeconomic, USA: The McGraw-Hill Companies, Inc.

Easterly, W. and S. Rebelo, (1993), "Fiscal policy and economic development: An empirical investigation", *Journal of Monetary Economics, Vol.* 32, pp. 417-458.

Elanshasy, A., M. Bradley and F. Joutz (2005). Evidence on the Role of Oil Prices in Venezuela's Economic performance, *the 25th Annual North American Conference Proceedings of the International Association of Energy Economics*, Denver: September 18-21.

Eltony, M. N. (2001), "Oil Price fluctuations and their Impact on the Macroeconomic Variables of Kuwait: A Case Study Using VAR Model for Kuwait". Arab Planning Institute (API), Working Paper number 9908.

Enders K., and H. Herberg., (1983). The Dutch Disease: Causes. Consequences, Cure and Calmatives", *Weltwirtschaftliches Archiv*, vol. 119, pp. 473-497.

Engen, E. and J. Skinner (1996), "Taxation and economic growth", *National Tax Journal, Vol.* 49, pp. 617-41

Folster, S. and M. Henrekson (2001), 'Growth Effects of Government Expenditure and Taxation in rich Countries', *European Journal of Political Economy*, Vol. 45, pp. 1501 – 1520.

Fu, D., L.L. Taylor and M.K. Yucel (2003), "Fiscal policy and growth", Research Department Working Paper 0301, Federal Reserve Bank of Dallas.

Gelb, A. H. et al (1988), Oil Windfalls: Blessing or Curse? New York, NY: Oxford University Press. http://documents.worldbank.org/curated/en/1988/

Glomm, G. and B. Ravikumar (1997), Productive government expenditures and long-run growth", *Journal of Economic Development and Control, Vol.* 21, pp. 183-204.

Grossman, G. M. and E. Helpman (1991), "Quality Ladders in the Theory of Growth", *Review of Economic Studies, Vol.* 58, pp. 43–61.

Hamilton, J. D. (1983), "Oil and the Macroeconomy Since World War II," *Journal of Political Economy*, 91, pp. 228-248.

Hausmann, R., A. Powell and R. Rigobon (1993), An Optimal Spending Rule Facing Oil Income uncertainty (Venezuela), In *External Shocks and Stabilization Mechanisms,* eds. E. Engel and P. Meller, Washington DC: Inter-American Development Bank.

IMF, (2011), International financial statistics, CD ROM, Washington, D.C.: International Monetary Fund.

Isham, J., M. Woolcock, L. Pritchett and G. Busby (2004). The varieties of Rentier experience how natural resource export structures affect the political economy of economic growth. Discussion Paper No. 03-08, Department of Economics, Middlebury College, Vermont.

Jones, C., (1995) R&D-Based Models of Economic Growth, *Journal of Political Economy, Vol. 103*, pp. 759–784.

Kneller, R., M.F. Bleaney, and N. Gemmel, (1999), "Fiscal policy and growth: Evidence from the OECD countries", *Journal of Public Economics, Vol.* 74, pp. 171-190.

Kocherlakota, N. and K.M. Yi (1997), "Is there endogenous long-run growth? Evidence from the US and the UK", *Journal of Money, Credit and Banking,Vol.* 29, no. 2, pp. 235-262.

Lensink, R. and O. Morrissey (2001), FDI Flows, Volatility and Growth, University of Nottingham: CREDIT Research Paper 01/06.

Levine, R., and D. Renelt (1992), "A sensitivity analysis of cross-country growth regressions", *American Economic Review, Vol.* 82, no. 5, pp. 942-963.

Lin, S., (2000), "Government debt and economic growth in an overlapping generations model, *Southern Economic Journal, Vol.* 66, no. 3, pp. 754-763.

Long, J. B., Jr. and C. I. Plosser., (1987). Sectoral vs. Aggregate Shocks in the Business Cycle," American Economic Review, Papers and Proceedings 77 (1987), pp. 333-336.

Loungani, P. (1986). "Oil Price Shocks and the Dispersion Hypothesis", *Review of Economics and Statistics,* Vol. *68,* pp.536-539.

Martin, R. and M. Fardmanesh (1990), "Fiscal variables and growth: A cross-sectional analysis", *Public Choice, vol.* 64, no. 3, pp. 239-252

Mauro, P. (1995), 'Corruption and Growth', *Quarterly Journal of Economics*, Vol. 110, pp. 681 – 712.

Mehlum, H., K. Moene and R. Torvik., (2006)." Institutions and the Resource Curse". *The Economic Journal*, vol. 116, pp.1-20.

Miles-Ferretti, G. M. and N. Roubini (1998), "Growth effects of income and consumption taxes", *Journal of Money, Credit and Banking, Vol.* 30, no.4, pp.721-744.

Mishkin, F.S. and K. Schmidt-Hebbel (2007), "Does Inflation Targeting makes a Difference"? Working Paper 12876, National Bureau of Economic Research, Cambridge.

Morales, M. F. (2001), Research Policy and Endogenous Growth, Universitat Auto`noma de Barcelona and Universitat de Murcia.

Olomola, P.A. and A.V. Adejumo (2006), "Oil Price Shock and Macroeconomic Activities in Nigeria". *International Research Journal of Finance and Economics, vol. 3, no 1, pp. 28-34*.

Omojolaibi, J.A. (2011), "The Macroeconomic Effects of Fiscal Stance in Nigeria: A Dynamic Analysis". *West African Journal of Monetary and Economic Integration, Vol. 11, no. 1, pp.1-30*.

Organization of Petroleum Exporting Countries (OPEC), Annual statistical bulletin 2010/2011 edition

Raguindin, C.E. and R.G. Reyes., (2005). The effects of Oil price shocks on the Philippine economy: A VAR Approach, *Working paper*, University of the Philippines School of Economics.

Rasche, R.H. and J.A. Tatom (1977). The Effects of the New Energy Regime on Economic Capacity, Production, and Prices. *Federal Reserve Bank of St. Louis Review,* vol. 59, issue 5, pp. 2-12.

Rebelo, S. (1991). "Long-Run Policy Analysis and Long-Run Growth," *Journal of Political Economy*, Vol. 99 (June).

Rotemberg, J.J. and M. Woodford (1996), "Imperfect Competition and the Effects of Energy Price Increases on Economic Activity", *Journal of Money, Credit, and Banking*, Volume 28, Issue 4, Part 1 Nov., pp. 550-577

Sachs, J.D. and A.M. Warner (1995). Natural resource abundance and economic growth. NBER, Working Paper No. 2456.

Semboja, H.H., (1994). "The effects of energy taxes on the Kenyan economy A CGE analysis". *Energy Economics,* vol. 16, no.3, pp. 205-215

Stokey, N. and S. Rebelo, (1995), "Growth Effects of Flat-Rate Taxes," *Journal of Political Economy*, Vol. 103 (June).

Talvi, E. and C. Vegh (2000), Tax Base Variability and Procyclical Fiscal Policy", NBER Working Paper No. 7499.

Turnovsky, S. J. (1996) Optimal Tax, Dept and Expenditures Policies in a Growing Economy, *Journal of Public Economics, Vol.* 60, pp. 21–44.

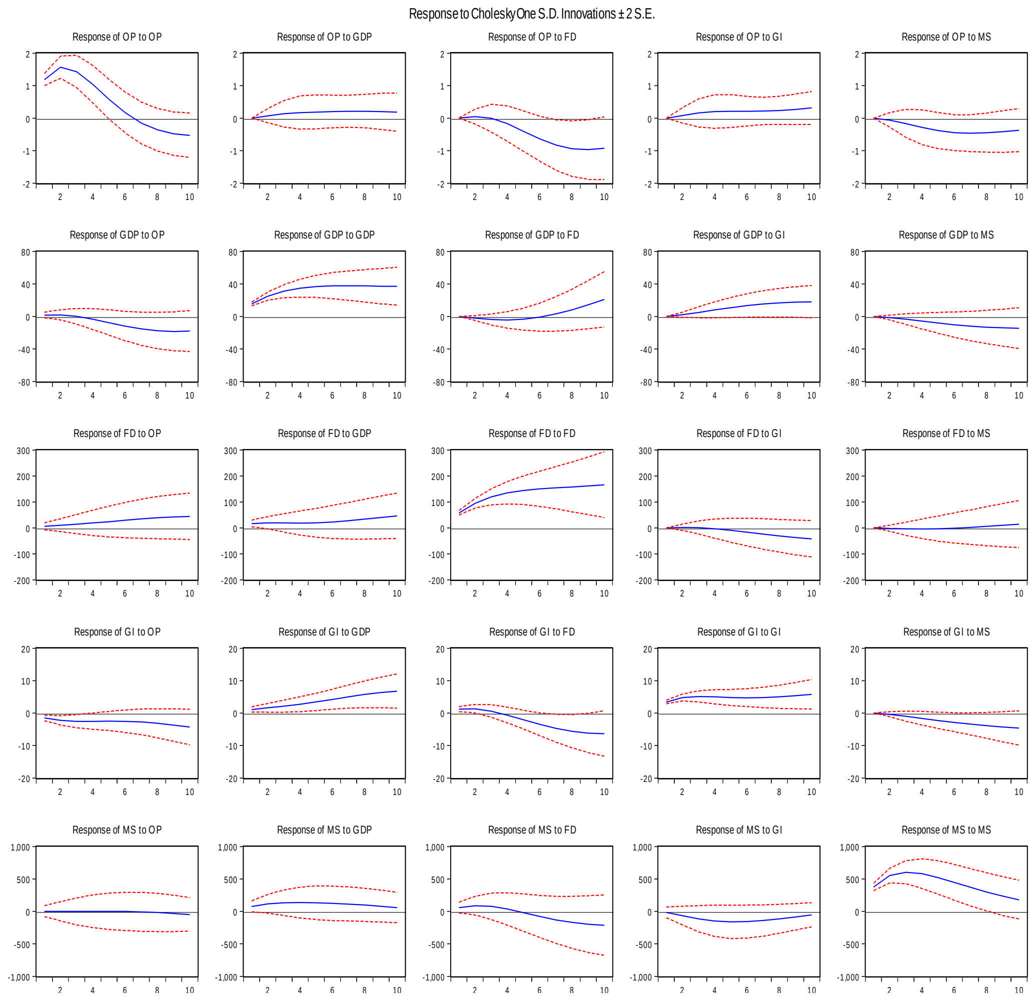
Turnovsky, S. J. (2000) Fiscal Policy, Elastic Labour Supply, and Endogenous Growth, *Journal of Monetary Economics, Vol.* 45, pp. 185–210.

Wakeford, J.J. (2006), The impact of oil price shocks on the South African Macroeconomy: History and prospects, South African Reserve Bank (SARB), Conference, 2006, pp. 95-115

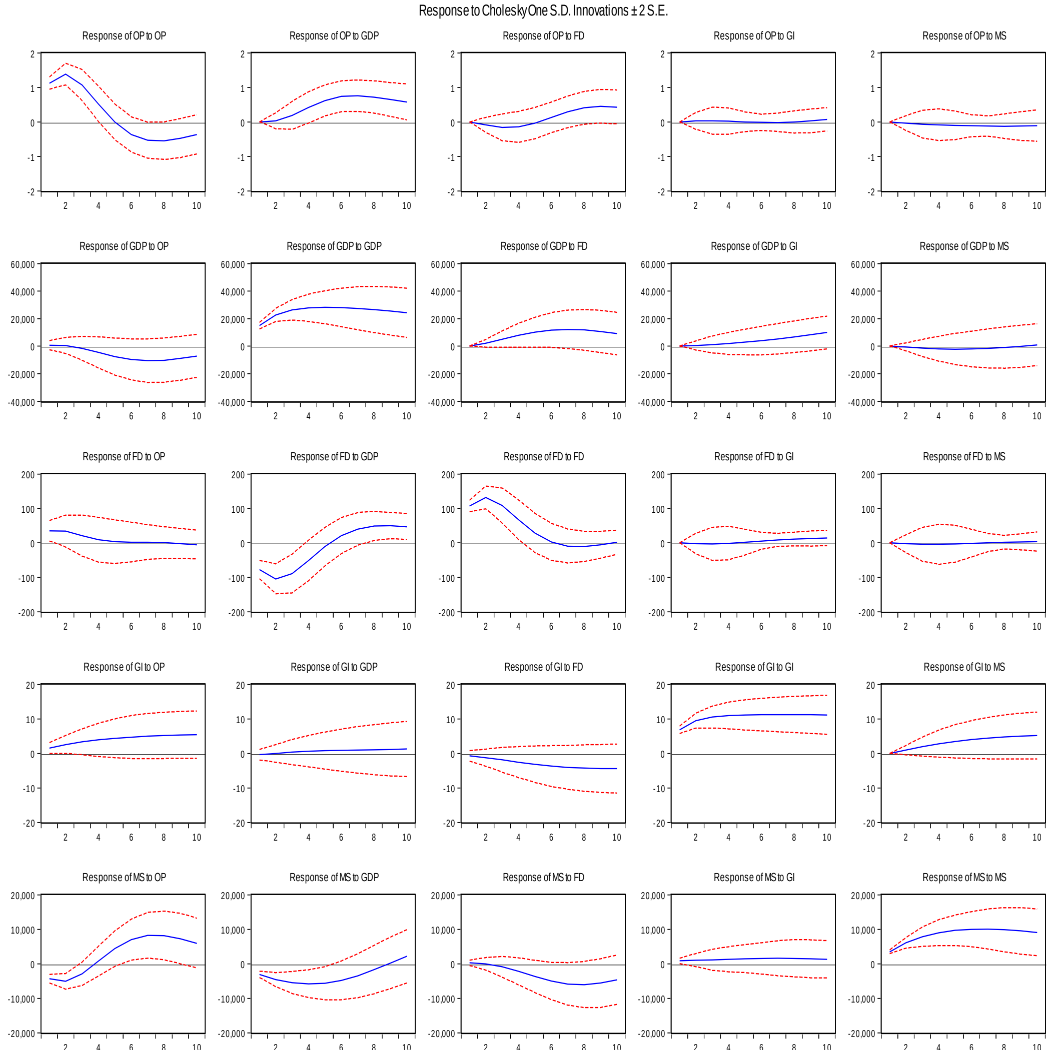
Zagler, M and G. Durnker (2003), "Fiscal policy and economic growth", *Journal of Economic Surveys, Vol.* 17, no.3, pp. 397-418

Appendices

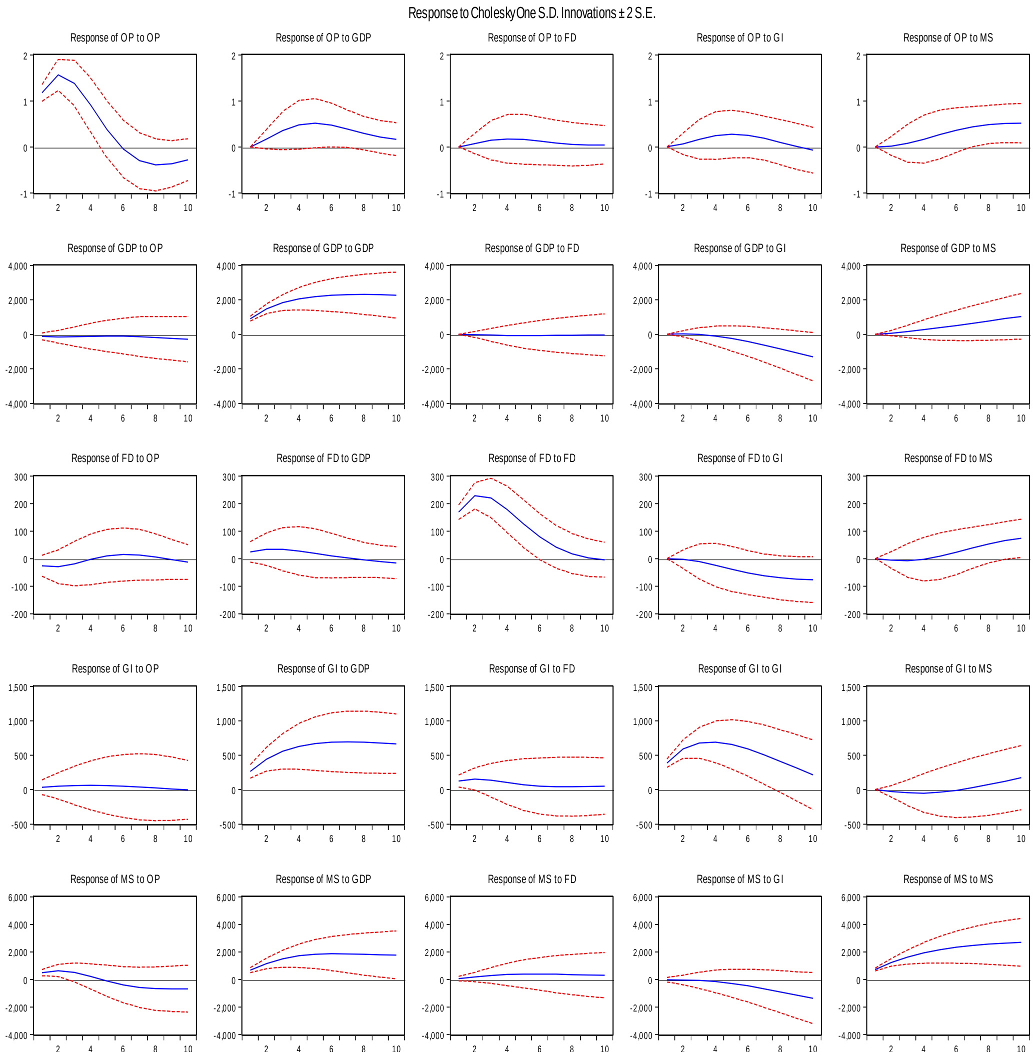
Appendix 1: Impulse Response VAR Model For Algeria



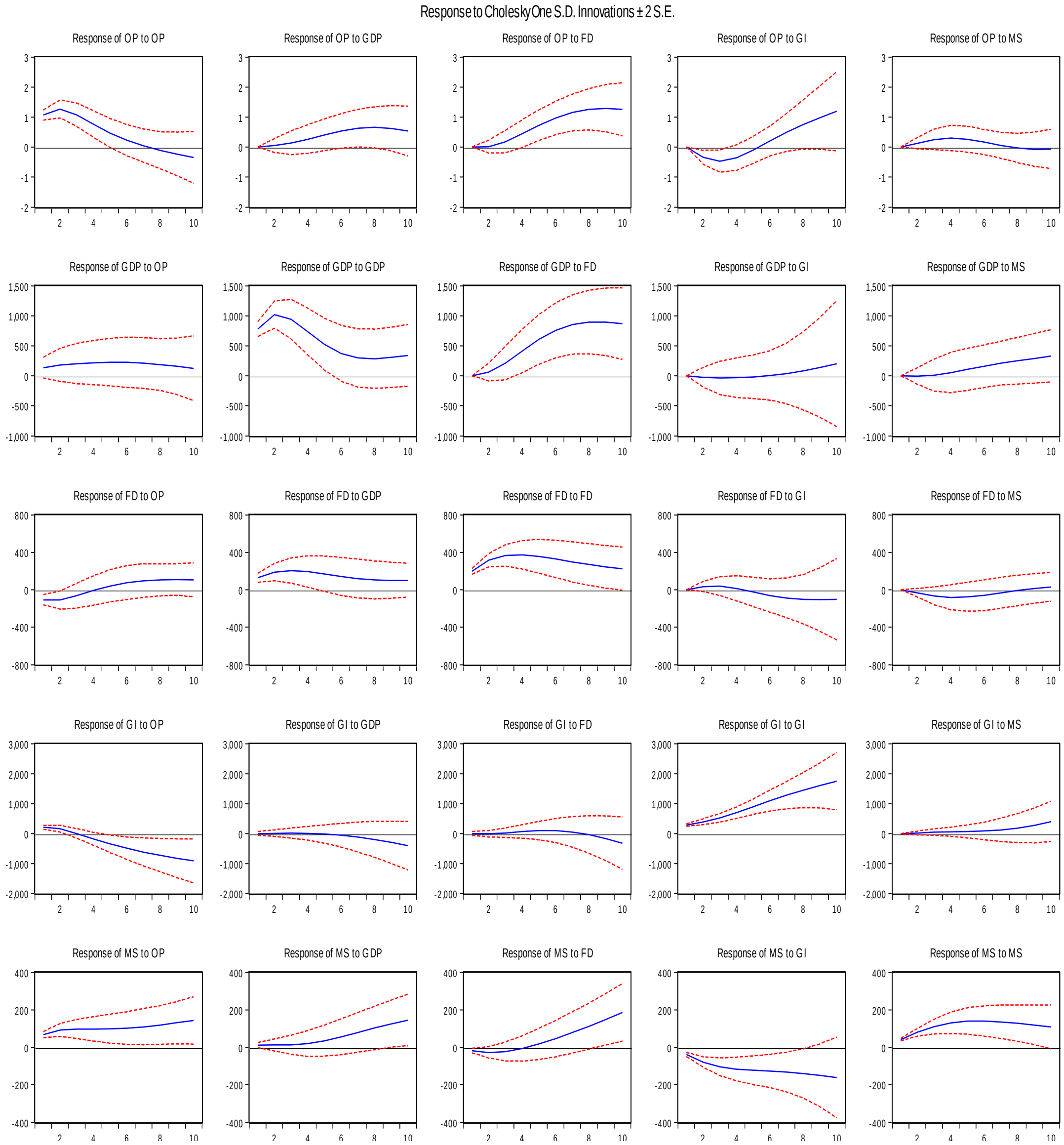
Appendix 2: Impulse Response VAR Model for Angola



Appendix 3: Impulse Response VAR Model for Egypt



Appendix 4: Impulse Response VAR Model for Libya



Appendix 5: Impulse Response VAR Model for Nigeria