The Asymmetric Effects of Oil Price Shocks on Output and Prices in Nigeria using a Structural VAR Model

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This paper develops a structural VAR model in which the asymmetric impact of oil shocks on output and price is analyzed in a unifying model. The model is applied to Nigeria using monthly data spanning 1999:01 to 2008:12 and the empirical results show that the impact of oil price shocks on output and prices is asymmetric in nature; with the impact of oil price decrease significantly greater than oil price increase. Also, from the variance decompositions, oil price changes play a significant role in determining the variance decompositions of output and prices. The implication is that any policy that is aimed at moving the economy forward must focus on price stability in which changes in oil price play a significant role.

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I. Introduction

Questions regarding the relationship between the price of oil and economic activity are fundamental empirical issues in macroeconomics. Hamilton (1983) shows that oil prices have significant impact on real economic activity in the United States prior to 1972 while Hooker (1996) is of the view that the estimated linear relations between oil prices and economic activity appear much weaker after 1973. In the debate that followed, several authors have suggested that the apparent weakening of the relationship between oil prices and economic activity is illusory, arguing instead that the true relationship between oil prices and real economic activity is asymmetric, with the correlation between oil price decreases and output significantly different from the correlation between oil price increases and output (Mork 1989; and Hamilton, 2003). However, Edelstein and Kilian (2007, 2008) evaluate alternative hypotheses and argue that the evidence of asymmetry cited in the literature is driven by a combination of ignoring the effects of the 1986 Tax Reform Act on fixed investment and the aggregation of energy and non-energy related investment.

Theoretically, the immediate effect of positive oil price shocks is to increase the cost of production for oil-importing countries. This is likely to decrease output, and its magnitude depends on the shape of the aggregate demand curve. Higher oil prices lower disposable income and this decreases consumption. Once the oil

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price increases are perceived as permanent, private investments also decrease. Moreover, if the shocks are perceived as persistent, oil is used less in production, capital and labor productivity both decrease and potential output falls (Berument, et al, 2009). Other studies provide empirical evidence that rising oil prices reduce output and increase inflation (Rasche and Tatom, 1977, 1981; Darby, 1982; Burbidge and Harrison, 1984; Hamilton, 1983, 1996; Mork, 1989; Santini, 1985; Gisser and Goodwin, 1986; and Lee, et al., 1995). As a result, tax revenues fall and budget deficits increase. Oil price changes also affect trade and exchange rates. Oil consumption is difficult to decrease in the short-run for oil-importing countries. When oil prices increase, the inelastic demand curve for oil means total spending on oil imports increases. This puts pressure on the exchange rate and depreciates the local currency. This depreciation, in turn, may further affect economic performance. Even if depreciation increases the aggregate demand for oil-importing countries, prices may increase due to the exchange rate pass-through and lower output may occur due to higher input costs (Berument, et al 2009). However, the reverse will be the case for oil-exporting countries.

With regard to oil price shocks, one interesting issue is the asymmetric effect of oil price changes; that the impact of oil price increases and oil price decreases are not the same. Park and Ratti (2007) show that oil price increases have a greater (or significant) influence on the economy than a decrease in oil price. It is of empirical importance, therefore, to investigate the asymmetric effect of oil price changes on output and prices in Nigeria in view of the role of oil in an oil-dependent economy, like Nigeria. The rest of the paper is structured as follows. Section 2 provides the literature review and the theoretical background, while Section 3 presents the structural vector autoregressive (VAR) model. The empirical analysis is conducted in Section 4, while the summary and conclusions are contained in the last Section.

II. Literature Review

Although there is vast literature that investigates the effects of oil prices on the real economy, there are relatively few studies that investigate the asymmetric effect of oil price changes on economy activities, in developing economies, like Nigeria. Lee, et al. (1995) are the first to employ recent advances in financial econometrics and model oil price asymmetry using a univariate generalized autoregressive conditional heteroscedasticity (GARCH, 1, 1) model. They calculate an oil price shock variable, reflecting the unanticipated component as well as the time-varying conditional variance of oil price changes, introduce it in various vector autoregression (VAR) systems, and find that oil price volatility is highly significant in explaining economic growth. They also establish evidence of asymmetry, in the sense that positive shocks have a strong effect on growth while negative shocks do not. A disadvantage of the Lee, et al. (1995) approach, however, is that oil price volatility is a generated regressor.

Elder and Serletis (2008) examine the direct effects of oil price uncertainty on real economic activity in the United States, over the modern Organization of Petroleum Exporting Countries (OPEC) period, in the context of a structural VAR that is modified to accommodate GARCH-in-Mean errors. As a measure of uncertainty about the impending oil price, they use the conditional standard deviation of the forecast error for the change in the price of oil. Their main result is that uncertainty about the price of oil has had a negative and significant effect on real economic activity over the post-1975 period, even after controlling for lagged oil prices and lagged real output. Their estimated effect is robust to a number a different specifications, including alternative measures of the price of oil and of economic activity, as well as alternative sample periods. They also find that accounting for oil price uncertainty tends to reinforce the decline in real GDP in response to higher oil prices, while moderating the short-run response of real GDP to lower oil prices.

Rahman and Serletis (2008) investigate the asymmetric effects of uncertainty on output growth and oil price changes as well as the response of uncertainty about output growth and oil price changes to shocks using general bivariate framework in a modified vector autoregression. They employ simulation methods to calculate Generalized Impulse Response Functions (GIRFs) and Volatility Impulse Response Functions (VIRFs) to trace the effects of independent shocks on the conditional means and the conditional variances, respectively, of the variables. They find that bivariate, GARCH-in-mean, asymmetric VAR-BEKK model embodies a reasonable description of the monthly U.S. data, over the period from 1981:1 to 2007:1. They show that the conditional variance-covariance process underlying output growth and the change in the real price of oil exhibits significant non-diagonality and asymmetry, and presents evidence that increased uncertainty about the change in the real price of oil is associated with a lower average growth rate of real economic activity.

Mork (1989) investigates whether a strong relationship between oil price changes and the GNP growth rate in the US continues to hold when the sample period is extended to the oil price collapse in 1986 and the oil price is corrected for the effect of oil price control. He finds that the negative correlation between oil price increases and the GDP growth rate still exists. But the real effects of oil price decreases are different from those of oil price increases, with oil price decreases not having a statistically significant impact on the US economy.

Davis and Haltiwanger (2001) use VAR to examine the response of job creation and destruction to separately defined, positive and negative oil price shocks with plant-level census data from 1972Q2 to 1988Q4 on employment, capital per employee, energy use, age and size of plant, and product durability, at the four-digit SIC level. Examining the job creation and destruction between aggregate and allocative transmission mechanisms, they find that aggregate channels would increase job destruction and reduce job creation in response to an oil price increase, while an oil price decrease reduces job destruction and increases job creation symmetrically. However, allocative channels would increase both job creation and destruction asymmetrically in response to both price increases and decreases.

Hooker (1996) studies the asymmetric effects of oil price shocks on GNP by analyzing the response of interest rates to oil price shocks. He believes that monetary policy responds to oil price increases and not to oil price decreases. In the impulse response function analysis, response of short-term interest rates to the oil price increases and decreases is asymmetric, which means that oil price shocks influence the GDP through interest rates asymmetrically.

Sadorsky (1999) investigates the dynamic interaction between oil price and other economic variables using an unrestricted VAR with US data on industrial production, interest rate of a 3-month T-bill, oil price (measured using the producer price index for fuels), real stock returns (calculated using the difference between the continuously compounded returns on the S&P 500, and inflation measured using the consumer price index). The data are monthly from 1947.1 to 1996.4. After unit root and cointegration tests, he runs an unrestricted VAR with ordering of interest rates, real oil price, industrial production and real stock returns. For oil price changes he uses the growth rate of real oil price and oil price volatility (*SOP*) which is calculated by a GARCH(1 1). He finds that oil price changes and oil price volatility have a significantly negative impact on real stock returns. He also finds that industrial production and interest rates respond positively to real stock returns shocks. According to him, the response of the stock market to oil price shocks is asymmetric. When he uses asymmetric oil price shocks (positive oil price changes and negative oil price changes), positive shocks explain more forecast error of variance in real stock returns, industrial production and interest rates than negative shocks during the full sample period. For the post-1986 period, positive and negative oil price shocks explain almost the same fraction of forecast error variance of real stock returns, while in the pre-1986 period positive oil price shocks contribute more to the forecast error variance in real stock returns than negative oil price shocks.

In a research work conducted by Park and Ratti (2007) using multivariate vector autoregressive approach for a sample period of 1986:1-2005:12 in Norway (an oil-exporting economy like Nigeria), their findings reveal that oil price fluctuations account for a six percent volatility in real stock returns. However, for most European economies understudied, it has been shown that increased volatility of oil prices significantly depresses real stock returns. For the United States, the study reveals that oil price shocks, rather than interest rates, explain more of the fluctuations in real stock market returns. This also conforms to the study of Sadorsky (1999) that oil prices explain a larger fraction of the forecast error variance in real stock returns than interest rates after 1986.

In a work conducted by Bjørnland (2008) for Norway, in which stock returns are incorporated in a structural VAR model, it is observed that a 10 percent rise in oil prices, increase stock returns by 2.5 percent with robust results for linear and non-linear measures of oil prices. The author concludes that the Norwegian economy responds to higher oil prices by increasing aggregate wealth and demand, while emphasizing the role of monetary policy shocks, in particular, as driving forces behind stock price variability in the short run.

Eryiğit (2009) analyze the impacts of oil price changes on the sectoral indices of the Turkish stock exchange using daily data. Adopting the ordinary least square technique, he estimates an extended market model which include market return, oil prices (in Turkish Lira), oil price in dollars and exchange rate (USD/TL) to determine the effects of the oil price (USD) changes on market indexes in Istanbul Stock Exchange (ISE) for the period of 2000 - 2008. His findings show that changes in oil price (TL) has statistically significant effects on electricity, wholesale and retail trade, insurance, holding, investment, wood, paper, printing, basic metal, metal and non-metal products, machinery and mineral products indices at the 5 percent significance level. In addition, changes in oil price (USD) have a significant positive effect on wood, paper printing, insurance and electricity sub-sector indices.

Using a similar methodology as well as the Granger causality approach for the United States for the period 1990:1 to 2007:2, Afshar, *et al* (2008) examine three specifications of oil prices on stock returns. They find out that oil price declines have a significant impact on stock returns, but not oil price increases. Further analysis by these authors suggests that oil price shocks and the USD currency are important sources of stock return variability. According to Basher and Sadorsky (2006), oil price increases act as inflation tax, which will lead consumers to source for alternative energies, increase risk and uncertainty which adversely affect stock prices and reduce wealth. They adopt an international multi-factor model that allow for both conditional and unconditional risk factors to explore the link between oil price risk and emerging stock market returns. They find strong evidence that oil price risk impacts stock price returns in emerging markets.

Miller and Ratti (2009) examine the long-run relationship between the world crude oil price and international stock markets for the sample period 1971:1–2008:3 using a co-integrated VECM. They conclude that international stock market indices respond negatively to increases in the oil price in the long run. They also establish the existence of a long-run co-movement between crude oil price and stock market during 1971:1–1980.5 and 1988:2–1999.9 with evidence of a breakdown in the relationship after this period. They find that it was suggestive of the possibility that the relationship between real oil price and real stock prices has changed in recent time period compared to the earlier period.

Papapetrou (2001) attempts to investigate the linkages among oil prices, real stock prices, interest rates, real economic activity and employment for Greece using a multivariate vector-autoregression (VAR) approach. The empirical results from the paper suggest that while oil prices were important in explaining stock price movements, stock market returns do not lead to changes in real activity and employment. They however, observe that changes in the oil price affect real economic activity and employment. Driesprong, *et al* (2003) findings suggest that oil price changes significantly predict negative excess returns and that financial investors seem to under-react to information in the oil price. They observe a strong linkage between monthly stock returns and lagged monthly changes in oil price.

Cunado and de Gracia (2003) analyze the effect of oil price changes by looking at the asymmetric effect of oil price changes on output for a set of European countries. Following the existing literature, they measure oil prices in four different ways. These four methods are: oil price growth from four quarters earlier; only the positive of these growths; maximum growth level of oil prices compared to one, two, three, and four years prior; and the positive standardized oil price shocks with the conditional standard deviation that comes from the GARCH (1,1) specification. They provide the evidence that (i) oil price increases lower the output but the evidence for oil price decreases on output is not statistically significant and (ii) oil price shocks' effect on output is higher when oil prices are more stable than when they are more volatile. Their results suggest that a non-linear relationship(s) may exist between oil prices and output.

In a later study, Jimenez-Rodriguez and Sanchez (2005) extend the previous study by including Norway (a net oil-exporting European country) and a set of non-European countries including Canada, Japan, and the US. They also consider positive as well as negative standardized oil shocks to the analyses. They find that the effect of oil-price rise on output decline is higher than the effect of oil-price fall on output increase. With the oil-exporting countries in their sample (Norway and the UK), oil price increase favorably affects Norway but adversely affect the UK.

It is important to recognize that the effects of oil price increases on output growth of individual countries are mostly positive. They do not find negative and statistically significant effects of oil price shocks on the output growth even for oil-importing countries. They note that not finding these effects of oil price increases on oil-importing countries does not contradict the existing literature.

Mountford (2005) find that positive oil shocks (even non-significant ones) increase output for two periods in the UK. Similarly, Hooker (1996) argues that after 1973, oil prices no longer Granger causes output and Jimenez-Rodriguez and Sanchez (2005) observe that Japanese output increases with oil shocks. Jimenez-Rodriguez (2008) also argues that even if "[a]n oil price increase lowers the level of aggregate manufacturing output in all countries under study ... [t]his similarity of response is, however, unclear when we consider the eight industry groups within manufacturing." She observes that textile, wearing apparel, and leather industry output increases for France, Germany, and Spain with positive oil price shocks. However, this does not mean that the adverse effects of oil price shocks for growth are not present.

Lippi and Nobili (2008) maintain that the source of oil shocks may affect economic performance differently: oil price increases due to higher oil demand shocks affect output differently than oil price increases due to lower world oil supply shocks. They argued that positive oil supply shocks decrease domestic production. In order to assess the effects of oil supply shocks, they employ the sign-restrictions approach pioneered by Canova and Nicolo (2002) and Uhlig (2005). They set up a three-variable VAR model that includes world crude oil production, twelve real price changes, and domestic growth rates. Following Lippi and Nobili (2008), they define positive oil supply price shocks such that oil production decreases but oil prices increase at the contemporaneous period where no additional restrictions are put on for additional periods as well as for their effect on output.

In Nigeria, attempts have been made to examine the asymmetric effect of oil price on output and prices. For example, Aliyu (2009b) assesses empirically, the effects of oil price shocks on real macroeconomic activity in Nigeria. In line with the approaches employed in the literature- that is classifying oil price as asymmetric and net specifications oil price specifications- Granger causality tests and multivariate VAR analysis were carried out using both linear and non-linear specifications. Inter alia, the latter category includes two approaches employed in the literature, namely, the asymmetric and net specifications oil price specifications. The paper finds evidence of both linear and non-linear impact of oil price shocks on real GDP. In particular, asymmetric oil price increases in the non-linear models are found to have positive impact on real GDP growth of a larger magnitude than asymmetric oil price decreases adversely affects real GDP. The non-linear estimation records significant improvement over the linear estimation and the one reported earlier by Aliyu (2009a). Further, utilizing the Wald and the Granger multivariate and bivariate causality tests, results from the latter indicate that linear price change and all the other oil price transformations are significant for the system as a whole. The Wald test indicates that our oil price coefficients in linear and asymmetric specifications are statistically significant.

Olomola (2006) investigated the impact of oil price shocks on aggregate economic activity (output, inflation, the real exchange rate and money supply) in Nigeria using quarterly data from 1970 to 2003. The findings revealed that contrary to previous empirical findings, oil price shocks do not affect output and inflation in Nigeria significantly. However, oil price shocks were found to significantly influence the real exchange rate. The author argues that oil price shocks may give rise to wealth effect that appreciates the real exchange rate and may squeeze the tradable sector, giving rise to the "Dutch-Disease".

Akpan (2009) analyses the dynamic relationship between oil price shocks and economic acivities. His findings show that major oil price shocks significantly increase inflation and also directly increases real national income through higher export earnings, though part of this gain is seen to be offset by losses from lower demand for exports generally due to the economic recession suffered by trading partners. The findings also reveal a strong positive relationship between positive oil price changes and real government expenditures.

III. Econometric Specification

The Nigerian economy can be described in a structural form model as follow:

$$V_0 y_t = V(L) y_{t-1} + \varepsilon_t \tag{1}$$

where V_0 is the contemporaneous coefficient matrix; V(*L)* is a matrix of polynomial in the lag operator *L* , y_t is an n x 1 data vector that includes [rGDP, CPI, M_2, Dr, RER, Po, ASI]. rGDP stands for real gross domestic product; CPI is the consumer price index; M_2 represents monetary aggregate broadly defined, Dr is the deposit rate (which is the policy variable) and RER stands for rer exchange rate defined as nominal exchange rate (naira/dollar) multiplied by relative prices of the US CPI and the Nigerian CPI; Po is the oil prices asymmetry using the Nigeria's bonny light and ASI stands for all-share index, proxied for the activity in the capital market. ε_t is a vector of *n* x 1 serially uncorrelated structural disturbances and var(ε_t) = Θ , where Θ is a diagonal matrix, so the structural disturbances are assumed to be mutually uncorrelated.

The reduced form VAR model is:

$$y_t = M(L) y_{t-1} + \mu_t \tag{2}$$

where $M(L) = V_o^{-1} V(L)$ is a matrix of polynomial in the lag operator *L* and var(υ_t) = Ψ .

To achieve the identification of the model in equation 1 from the estimated parameters in the reduced form in equation 2, one could have used as the baseline identification scheme, the popular and convenient method based on the Choleski decomposition (as in Sims, 1980, among others). However, this approach implies a recursive structure which imposes restrictions (which cannot be tested) on the basis of an arbitrary ordering of the variables and the estimated result may be sensitive to the ordering imposed. As such, we identify the model by using a non-recursive structure based on economic theory that allows contemporaneous simultaneity among the variables by following Kim and Roubini (2000). The non-recursive identification used as the baseline identification imposes exclusion on the contemporaneous incidence of the structural shocks based on prior theoretical and empirical information about the economic structure.

As shown in equation 3 below, the following restrictions are applied to the contemporaneous structural parameters in (1). All the zero restrictions are on the contemporaneous structural parameters and no restrictions are imposed on the lagged structural parameters (An and Sun, 2008).

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & f_{16} & 0 \\ f_{21} & 1 & 0 & 0 & 0 & f_{26} & 0 \\ f_{31} & f_{32} & 1 & f_{34} & 0 & 0 & 0 \\ 0 & 0 & f_{43} & 1 & f_{45} & f_{46} & 0 \\ f_{51} & f_{52} & f_{53} & f_{54} & 1 & f_{56} & f_{57} \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ f_{71} & f_{72} & f_{73} & f_{74} & f_{75} & f_{76} & 1 \end{pmatrix} \begin{pmatrix} rGDP \\ CPI \\ M_2 \\ Dr \\ RER \\ PO \\ ASI \end{pmatrix} = K(L) \begin{pmatrix} rGDP \\ CPI \\ M_2 \\ Dr \\ RER \\ PO \\ ASI \end{pmatrix} + \begin{pmatrix} \varepsilon_{rGDP} \\ \varepsilon_{CPI} \\ \varepsilon_{M2} \\ \varepsilon_{Dr} \\ \varepsilon_{RER} \\ \varepsilon_{Po} \\ \varepsilon_{ASI} \end{pmatrix} \quad (3)$$

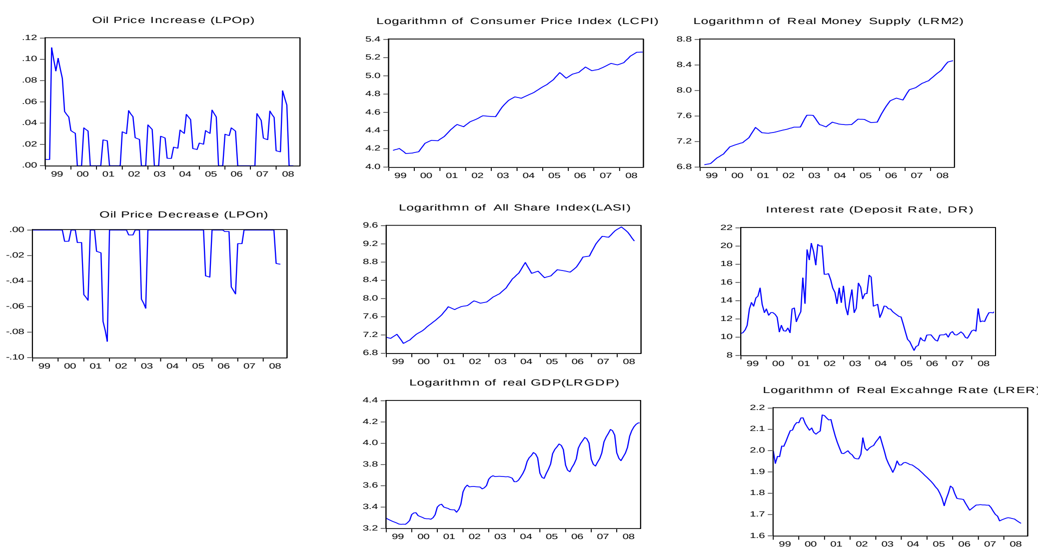
ε_{rGDP}, ε_{CPI}, ε_{M2}, ε_{Dr}, ε_{RER}, ε_{Po} and ε_{ASI}, are structural disturbances on real GDP, consumer price index, aggregate money supply, deposit rate, real exchange rate oil price asymmetry and all-share index, respectively.

Before we explain the details of our identifying restrictions, it is worth noting that the following relations are contemporaneous restrictions on the structural parameters of y_0 without further restrictions on the lagged structural parameters. In constructing the identifying restrictions in the model, the paper follows Jimenez-Rodriguez, (2007), Gordon and Leeper (1994), Kim and Roubini (2000), Davis and Haltiwanger (2001) and Lee and Ni (2002). It is assumed that aggregate output, (rGDP) is only contemporaneous influenced by oil price changes (Po), and the prices (CPI) only react immediately to innovations in aggregate output and oil prices. The first two equations of the system (3) support the idea that the reaction of the real sector (aggregate output and prices) to shocks in the monetary sector (money, interest rate and exchange rate) is sluggish (Jimenez-Rodriguez, 2007). The third equation of the system (3) can be interpreted as a short-run money demand equation. Money demand is allowed to respond contemporaneously to innovations in output, prices and interest rate.

The fourth equation represents the monetary policy reaction function. The monetary authority sets the interest rate after observing the current money stock, oil prices and the exchange rate, but does not respond contemporaneously to disturbances in aggregate output and prices. The argument is that information about the latter variables is only available with a lag, since they are not observable within a month (Jimenez-Rodriguez, 2007). The exchange rate, being an asset price, reacts immediately to all other macroeconomic variables. We also assume that oil prices are contemporaneously exogenous, that is, oil prices do not respond contemporaneously to disturbances in other macroeconomic variables (Lee and Ni, 2002; Jimenez-Rodriguez, 2007). Furthermore, all share index (ASI) responds contemporaneously to all macroeconomic variables. It is worth noting that the non-recursive structure (contrary to the recursive one) allows contemporaneous interactions between the interest rate and the exchange rate, and the non-reaction of the interest rate contemporaneously to changes in output and inflation (Sims and Zha, 1998), as well as the contemporaneous interactions between the interest rate and money stock (Kim and Roubini, 2000).

The VAR models are estimated in levels using monthly data[1] between 1999 and 2008. All the variables are in logarithms and real form except interest rate (Dr). Given the short sample, this paper does not consider an explicit analysis of the long-run behavior of the economy. By estimating the VAR in levels, implicit cointegrating relationships are allowed in the data. Standard information criteria are used to select the lag lengths of the VAR, which turn out to be 12. There is no evidence of structural breaks at the 5 percent confidence level using Chow test.

Figure 1 displays the data used for the estimation of the Structural VAR



[1] These data are collected from various publications of the Central Bank of Nigeria.

IV. Empirical Analysis

Contemporaneous Coefficients

The baseline model is estimated with 12 lags and a constant is assumed. The model is just identified, with 21 zero restrictions[2]. The likelihood ratio test suggests that over-identified restrictions cannot be rejected at conventional significance level with the Chi-square (7) = 2965 and a p-value of 0.000. Table 1 reports the estimated contemporaneous coefficients in the structural model.

Table 1: Estimated Contemporaneous Structural Parameters

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0.62* & 0 \\ 0.24* & 1 & 0 & 0 & 0 & -0.02 & 0 \\ -3.46* & -2.25* & 1 & -1.23* & 0 & 0 & 0 \\ 0 & 0 & 37.91* & 1 & -53.94* & 14.88* & 0 \\ -27.78* & -23.70* & -35.52* & -0.63* & 1 & 7.41* & -39.31* \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 84.19* & 62.83* & 76.16* & -0.21 & 23.91* & 3.82* & 1 \end{pmatrix}$$

Note: * denotes significance at 1% levels of significance.

Table 1 estimates contemporaneous structural parameters for oil price increase. Parameters of oil price decrease are not reported here but are available on request. Aggregate output (rGDP) is contemporaneously influenced by oil price changes (Po) and the impact is negative and significant (f16>0). Prices (CPI) only react immediately to innovations in aggregate output and oil prices. An increase in oil prices increases CPI but not significantly ($f_{26}<0$) and increase in output reduces prices significantly ($f_{21}>0$). The third equation of the system (3), which is a short-run money demand equation, is allowed to respond contemporaneously to innovations in output, prices and interest rate. An increase in output, prices, and exchange rate significantly increase demand for money ($f_{31}<0$; $f_{32}<0$ and $f_{34}<0$), which conform to *a priori* expectations.

The fourth equation, which represents the monetary policy reaction function, shows that monetary authority sets the interest rate after observing the current money stock, oil prices and the exchange rate, but does not respond contemporaneously to disturbances in aggregate output and prices. An increase in money demand and oil price leads to an appreciation of the currency ($f_{43}>0$;

[2] Number of restrictions are derived using the formula $(n^2-n)/2$, where n is the number of variables in the SVAR model.

and $f_{46}>0$), while a depreciation in the exchange rate increases interest rate ($f_{45}<0$). The exchange rate, being an asset price, reacts immediately to all other macroeconomic variables. An increase in output, price, money demand interest rate and all-share index results in exchange rate deprecation ($f_{51}<0$; $f_{52}<0$; $f_{53}<0$; $f_{54}<0$ and $f_{57}<0$). Also, an oil price increase results in the appreciation of the naira ($f_{56}>0$).

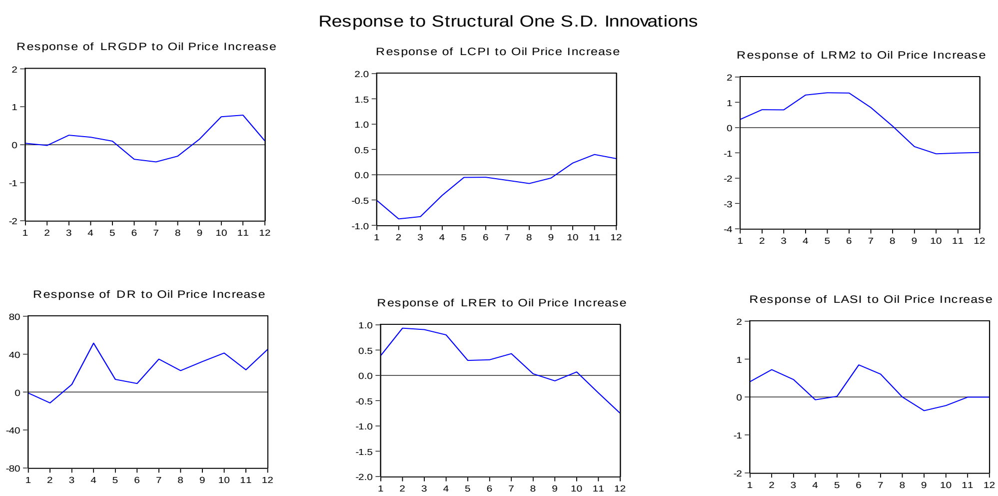
Since oil prices are contemporaneously exogenous, they do not respond contemporaneously to disturbances in other macroeconomic variables. All-share index (ASI) responds contemporaneously to all macroeconomic variables. An increase in prices and demand for money reduce all share index ($f_{72}>0$ and $f_{73}>0$). However, an increase in interest rate raises the all share index ($f_{74}<0$).

Impulse Response Functions

Asymmetry Impact of Oil Price

Impulse response functions are dynamic simulations showing the response of an endogenous variable over time to a given shock. Figures 2 and 3 reveal the impulse response of an asymmetric impact of oil prices on output, price, money demand, exchange rate and all-share index.

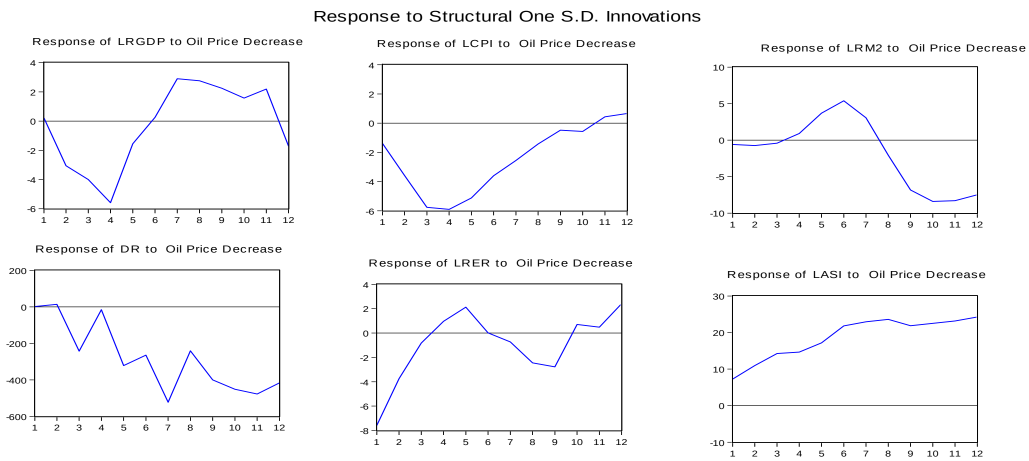
Figure 2: Impact of Oil Price Increase on output, price, money demand exchange rate and all-share index



These figures show that positive oil price shocks are associated with an increase in real GDP after two months, whereas oil price decrease significantly reduces real output immediately. It is evident that the effect of an oil-price rise on the increase in output is less than the effect of an oil-price fall on the decrease in output.

Jimenez-Rodriguez and Sanchez (2005) findings for Norway confirm this. For an oil-importing country, they found that the effect of an oil-price rise on output decline is higher than the effect of an oil-price fall on output increase.

Figure 3: Impact of Oil Price Decrease on output, price, money demand, exchange rate and all-share index



In Nigeria, oil price increase leads to depreciation of the naira, which is contrary to *a priori* expectation. This confirms the findings by Jimenez-Rodriguez and Sanchez (2005), and Chen and Chen (2007) that a rise in real oil prices led to a depreciation of the real exchange rate for G7 countries. However, Berument, et al (2009) find that the currency appreciates significantly for Oman and the UAE (which are net oil exporting countries) when oil price is increased. They also find that the currency appreciates for Iran, Kuwait, Syria, and Tunisia but these effects are not statistically significant. However, one needs to be cautious in interpreting the exchange rate effects of oil price shocks because the effect may depend on the exchange rate regime, and the willingness of central banks to use their exchange reserves for a share of oil during international trade transactions. Even though oil price increase results in exchange rate depreciation, the depreciation in exchange rate arising from oil price increase is less than that of oil price decrease.

It is expected that the impact of oil price increase on stock returns in oil-exporting countries, like Nigeria, should be positive as shown in the literature (Park and Ratti (2007). This paper establishes that oil price increase raises the all-share index immediately. However, oil price decrease also increase all-share index, which is puzzling. One may interpret this as evidence of the possible non-linearity of the relationship between oil prices and all-share index. It is also glaring that even though, oil price increase raises all-share index, the positive impact of oil price increase on all-share index is less than that of oil price decrease.

Shocks to oil price raises money supply immediately and this also impacts interest instantaneously. However, declining in price due to oil price increase for an oil-exporting country like Nigeria that is characterized by fiscal dominance is puzzling. It is expected that oil price increase will raise inflation immediately. However, oil price decrease reduces money supply immediately and this transmits into reduction in price significantly. It is glaring that the impact of an oil price decrease on price is higher than that of an oil price increase.

Variance Decomposition

What is the contribution of the different structural shocks on real GDP, consumer price index, monetary policy rate, aggregate money supply, nominal exchange rate and all-share index, arising from oil price asymmetry? The paper assesses this issue by computing the percentage of the variance of the *k*-step ahead forecast error that is accounted for by the identified structural shocks. Table 2 reports the variance decomposition at horizons up to 24 months for real GDP, consumer price index, monetary policy rate, aggregate money supply, oil price, nominal exchange rate and all-share index.

Table 2(a): Structural Variance Decomposition- Oil Price Increase

Variance Decomposition of LRGDP:

Horizon	S.E.	rGDP(Shock1)	CPI(Shock2)	M2(Shock3)	Dr(Shock4)	RER(Shock5)	P0(Shock6)	ASI (Shock7)
6months	2.05	83.50	10.35	0.011	0.006	0.002	6.122	0.000
12	2.91	52.67	26.81	0.030	0.008	0.003	20.47	0.001
24	8.41	19.57	60.23	0.030	0.012	0.002	20.142	0.003

Variance Decomposition of LCPI:

Horizon	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6months	3.76	21.008	65.653	0.005	0.002	0.000	13.331	0.001
12	4.06	20.519	65.901	0.009	0.005	0.001	13.564	0.001
24	4.54	22.647	63.394	0.008	0.005	0.002	13.942	0.002

Variance Decomposition of LRM2:

Horizon	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6months	5.41	11.188	66.613	0.0022	0.008	0.004	22.185	0.001
12	6.59	12.633	62.616	0.0034	0.005	0.003	24.736	0.001
24	7.84	13.705	54.0888	0.007	0.005	0.004	32.186	0.002

Variance Decomposition of DR:

Horizon	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6months	110	24.741	49.564	0.010	0.005	0.002	25.674	0.003
12	158	27.343	32.485	0.015	0.015	0.003	40.135	0.005
24	197	24.768	34.428	0.014	0.014	0.002	40.768	0.004

Variance Decomposition of LRER:

Horizon	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6months	3.21	29.891	44.270	0.011	0.010	0.001	25.814	0.002
12	3.72	31.964	42.435	0.014	0.013	0.002	25.566	0.003
24	4.84	34.132	32.118	0.011	0.012	0.002	33.722	0.002

Variance Decomposition of DLPOP

Horizon	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6months	1.92	10.124	16.624	0.008	0.006	0.001	73.237	0.001
12	2.04	14.454	19.030	0.009	0.006	0.001	66.497	0.001
24	2.69	13.165	38.141	0.009	0.006	0.002	48.674	0.001

Variance Decomposition of LASI

Horizon	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6months	2.77	44.682	34.051	0.025	0.055	0.119	21.063	0.003
12	3.76	48.290	36.302	0.018	0.032	0.067	15.286	0.002
24	6.81	16.433	57.434	0.013	0.023	0.040	26.051	0.002

Factorization: Structural

Shocks to oil price (increase in oil price) contribute between 22.2- 32.2% to money supply variance decomposition as shown in Table 2(a) and Appendix 1, whereas oil price decrease explains 18.1-86.5 percent of the variance decomposition of money supply in the same period (Table 2(b). It is evident that oil price decrease has a greater impact on money supply than oil price increase. Also, the impact of oil price increase on real exchange rate shock averages 28 per cent between 6 and 24 months horizon, whereas oil price decrease contributes, on the average, 88 per cent of the variation in real exchange rate, which implies that the impact of oil price decrease on real exchange rate is significantly higher than that oil price increase.

Table 2(b): Structural Variance Decomposition- Oil Price Decrease

Variance Decomposition of LRGDP

Period	S.E.	Shock1 (LrGDP)	Shock2 (LCPI)	Shock3 (LrM2)	Shock4 (Dr)	Shock5 (LRER)	Shock6 (LrPO)	Shock7 (LASI)
6	7.93	5.328	0.461	0.006	0.017	0.002	94.185	0.000
12	9.93	6.254	1.860	0.006	0.017	0.001	91.861	0.000
24	41.56	4.134	1.403	0.004	0.013	0.000	94.45	0.000

Variance Decomposition of LCPI

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6	12.11	10.652	6.060	0.002	0.008	0.000	83.278	0.000
12	12.59	10.773	6.040	0.002	0.008	0.000	83.176	0.000
24	17.70	10.167	4.710	0.004	0.011	0.001	85.108	0.000

Variance Decomposition of LRM2

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6	15.67	63.096	18.832	0.001	0.001	0.001	18.067	0.001
2	23.50	34.978	10.643	0.003	0.007	0.001	54.364	0.001
24	51.29	10.703	2.7834	0.005	0.014	0.0001	86.493	0.000

Variance Decomposition of DR

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6	513.01	7.938	3.445	0.007	0.0193	0.001	88.588	0.000
12	1173.58	2.445	0.867	0.008	0.021	0.001	96.658	0.000
24	1568.82	2.975	0.7891	0.007	0.019	0.001	96.209	0.000

Variance Decomposition of LRER

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6	9.51	8.5189	5.7837	0.007	0.022	0.001	85.667	0.000
12	10.64	7.775	5.394	0.006	0.020	0.001	86.803	0.000
24	19.73	6.147	3.612	0.005	0.014	0.001	90.219	0.000

Variance Decomposition of DLPON

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6	5.53	3.881	0.867	0.003	0.011	0.001	95.236	0.000
12	10.67	2.136	1.089	0.005	0.015	0.000	96.753	0.000
24	17.91	2.084	1.106	0.006	0.016	0.000	96.787	0.000

Variance Decomposition of LASI

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
6	39.45	10.659	1.922	0.006	0.016	0.003	87.391	0.000
12	69.00	3.526	0.802	0.006	0.016	0.001	95.645	0.000
24	112.83	2.322	0.538	0.006	0.016	0.001	97.115	0.000

Factorization: Structural

Oil price increase accounts for an average of 15.5 percent variation in real output between 6 and 24 months horizon, whereas oil price decrease contributes, on the average 93.2 percent to the variation in real output in the same period. Next to its own shocks, the contribution of oil price increase to prices is about 14 percent after 24 month horizon, while oil price decrease accounts for 85 per cent of the variation in prices after 24-month horizon. The variance decomposition suggests that shocks to oil price (increase in oil price) on the average explains 35.3 percent and 21 percent of the variation in deposit rate and all-share index, respectively, between 6 and 24 months horizon. However, oil price decrease contributes on the average 94 percent and 93 percent of the variance decomposition of deposit rate and all-share index, respectively, for the same period. It is evident from these findings that an oil price decrease impacted more significantly on the Nigerian economy than an oil price increase.

It is evident that the impact of oil price increase or decrease on output and price differs significantly, with the dominance of the impact of an oil price decrease on output and price. This is not surprising in that Nigeria depends solely on oil and any negative shocks to the price of oil will affect revenue and invariably hinder the execution of projects and plans. Moreover, in all the variance decomposition, oil price shocks, CPI and real GDP play significant role in determining the variance decompositions arising from all the shocks. The implication is that any policy to move the economy forward must center on price stability and rapid economic growth, and oil price plays a significant role in this regard.

V. Summary and Conclusions

This paper develops a structural VAR model in which the asymmetric effect of oil price shocks on output and price, among others, are analyzed within a unifying model. The model is applied to Nigeria from 1999:01 to 2008:12. Our analyses start from a set of sensible identifying assumptions which are consistent with Nigeria's economic structure. The resulting predictions support the identifying assumptions in that the estimated dynamic responses are close to the expected movements of macroeconomic variables. Then we study the relationship among oil price shocks, output, price, money, deposit rate, exchange rate and all-share index, and the following empirical results are found.

First, that positive oil price shocks are associated with an increase in real GDP after two months, whereas oil price decrease significantly reduces real output immediately. Second, that oil price decrease leads to a depreciation of naira, which is also established by Jimenez-Rodriguez and Sanchez (2005) and Chen and Chen (2007). Third that the impact of oil price shock on money supply and all-share index is asymmetric; it raises the all-share index and money supply immediately. Fourth, that shocks to oil price (increase in oil price) contribute between 22.2- 32.2% to money supply variance decomposition whereas oil price decrease contributes 18.1-86.5 percent of the variance decomposition of money supply in the same period; and fifth, that oil price increase accounts for an average of 15.5 percent variation in real output between 6 and 24 months horizon, whereas oil price decrease contributes, on average 93.2 percent to the variation in real output in the same period.

In conclusion, the asymmetric effect of oil price shocks on output and price indicates that economic policy should respond cautiously to it. This justifies the establishment of Sovereign Wealth Funds (SWF), known as the Nigerian Sovereign Investment Authority Act 2011[3]. Lucas, (quoted in Berument, et al 2009) also pointed out in his speech (Tokyo, November 11, 2004) that "[...] in reacting to oil price shocks, it is, therefore, important that policy-makers do not repeat the mistakes of the past [. . .] Monetary policy should aim to ensure that inflation expectations are not adversely affected by the unavoidable 'first-round' direct and indirect effects of an oil price shock on the price level and that they remain anchored to price stability. By preventing oil price shocks from having 'second-round' effects on inflation expectations and on wage and price-setting behaviour, monetary policy can contain the unfavourable consequences of these shocks on both inflation and growth [...]."

This study limits itself to an analysis of the effects of oil price shocks on the growth of economic activities in Nigeria. The results constitute a small portion of the domain of associations and further studies in relation to existing economic structures and the transmission channels of oil price movements are required. For example, the effects of oil price shocks on fiscal balance, current account, interest rates and real exchange rates could also be explored.

[3] A Sovereign Wealth Fund (SWF) is an investment fund owned by a sovereign state/nation with the mandate to invest in financial assets such as stocks, bonds, precious metals, property and other financial instruments. Sovereign Wealth Funds are usually established to save and invest the excess liquidity that arises from natural resource exploitation. When for instance revenue from crude oil sales exceed the budget projections, the extra revenue represents excess liquidity. Pumping the excess liquidity through spending back into the national economy has the capacity to disrupt planned economic fundamentals, particularly in a situation when the inflation rate is high. The net effect of that is that the value of money is affected, economic plans are disrupted and the economic targets become unrealized. There is thus the need to warehouse and save the excess liquidity and then invest it for the long-term in order to ensure that a nation maximizes its benefits.

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Appendix 1: Structural Variance Decomposition- Oil Price Increase

	Variance Decomposition of LRGD							
Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	1.000724	99.85536	0.000000	0.000000	0.000000	0.000000	0.144637	0.000000
2	1.311121	99.65083	0.237091	0.001111	0.000182	0.000312	0.110414	5.75E-05
3	1.399445	93.04086	3.645264	0.003298	0.000366	0.000913	3.309202	9.66E-05
4	1.739927	93.52406	3.049095	0.004695	0.001113	0.001555	3.419184	0.000300
5	1.921871	94.44085	2.517231	0.008770	0.003705	0.001738	3.027435	0.000275
6	2.055238	83.50630	10.35207	0.011129	0.006377	0.002072	6.121808	0.000249
7	2.183855	78.27181	11.99271	0.010429	0.006114	0.002063	9.715986	0.000882
8	2.209431	76.86380	11.74083	0.013909	0.007198	0.002104	11.37061	0.001543
9	2.347814	73.04432	16.46450	0.022899	0.009954	0.002151	10.45452	0.001653
10	2.672486	61.57190	22.74533	0.025579	0.009049	0.002306	15.64456	0.001280
11	2.908175	52.73440	26.83532	0.029422	0.008932	0.002661	20.38818	0.001087
12	2.910181	52.67209	26.81149	0.030017	0.008920	0.002706	20.47336	0.001411
13	3.486505	54.87414	26.42126	0.021827	0.006737	0.001920	18.67229	0.001827
14	4.484537	44.76002	37.58546	0.022849	0.008213	0.001560	17.61969	0.002219
15	5.077001	39.49647	45.51701	0.027908	0.010956	0.001855	14.94328	0.002519
16	5.525319	35.44744	51.41660	0.031306	0.013012	0.002477	13.08618	0.002981
17	5.780174	37.20347	50.41322	0.034629	0.015335	0.002949	12.32717	0.003224
18	5.866433	37.02789	49.49106	0.036290	0.016956	0.003189	13.42135	0.003268
19	6.087726	34.63072	48.13932	0.033990	0.016320	0.003022	17.17350	0.003125
20	6.480132	30.74794	49.85999	0.031647	0.014660	0.002671	19.34003	0.003065
21	7.128605	26.66131	53.66608	0.030253	0.013391	0.002367	19.62374	0.002863
22	7.826544	22.54776	56.95892	0.029200	0.012172	0.002173	20.44713	0.002645
23	8.328680	19.93164	59.48884	0.029608	0.011844	0.002176	20.53332	0.002572
24	8.410387	19.57853	60.23245	0.030173	0.011882	0.002160	20.14222	0.002580

Variance Decomposition of LCPI:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	1.376299	33.44756	52.79277	6.26E-34	4.89E-33	1.81E-32	13.75967	2.79E-34
2	2.563569	26.63812	57.75112	0.000279	3.61E-06	2.35E-05	15.61043	2.97E-05
3	3.430329	24.21577	61.22767	0.000890	5.04E-05	3.38E-05	14.55544	0.000142
4	3.647166	22.34248	63.51586	0.001786	0.000274	6.23E-05	14.13922	0.000316
5	3.717664	21.50621	64.85924	0.003262	0.000955	7.34E-05	13.62963	0.000628
6	3.761555	21.00778	65.65282	0.004891	0.002007	0.000132	13.33148	0.000895
7	3.827293	20.76324	66.25905	0.006842	0.003364	0.000338	12.96615	0.001019
8	3.872231	21.01247	66.10218	0.008214	0.004453	0.000659	12.87099	0.001033
9	3.873923	21.02800	66.06670	0.008915	0.004982	0.000916	12.88945	0.001035
10	3.916839	21.35534	65.67937	0.008787	0.004900	0.000998	12.94959	0.001016
11	4.003974	21.13530	65.46625	0.008506	0.004773	0.000957	13.38322	0.000989
12	4.069992	20.51995	65.90082	0.008533	0.004887	0.000942	13.56385	0.001021
13	4.087106	20.97259	65.46603	0.008574	0.005006	0.001032	13.54566	0.001104
14	4.110390	21.42562	65.12445	0.008491	0.005100	0.001139	13.43407	0.001125
15	4.217343	21.70991	65.10392	0.008083	0.004897	0.001219	13.17090	0.001069
16	4.318838	21.94276	64.78337	0.007740	0.004707	0.001329	13.25907	0.001022
17	4.418462	22.46773	64.17248	0.007522	0.004509	0.001474	13.34529	0.000993
18	4.477916	22.56959	63.81362	0.007490	0.004394	0.001605	13.60231	0.000992
19	4.503912	22.46470	63.72145	0.007636	0.004362	0.001684	13.79916	0.000998
20	4.510880	22.40988	63.68674	0.007870	0.004438	0.001723	13.88834	0.001011
21	4.511656	22.41215	63.66973	0.008043	0.004547	0.001742	13.90278	0.001017
22	4.515012	22.43122	63.61037	0.008039	0.004541	0.001751	13.94307	0.001016
23	4.525749	22.55197	63.38343	0.008033	0.004591	0.001761	14.04919	0.001024
24	4.546398	22.64724	63.39424	0.008281	0.004851	0.001834	13.94246	0.001093

Variance Decomposition of LRM2:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.45896	39.14602	11.12995	0.037426	0.110756	7.65E-06	49.56526	0.010581
2	1.10497	11.53108	39.27221	0.011301	0.057501	0.000927	49.12480	0.002175
3	1.77618	21.18370	44.23166	0.005141	0.044336	0.003394	34.53093	0.000850
4	3.16135	22.70953	49.81956	0.001696	0.018869	0.004481	27.44555	0.000309
5	4.35621	15.36944	60.14128	0.001738	0.011364	0.004448	24.47144	0.000284
6	5.41613	11.18804	66.61299	0.002229	0.007612	0.003862	22.18476	0.000508
7	5.78558	9.826010	68.83885	0.003219	0.006671	0.003621	21.32088	0.000749
8	5.83501	9.732507	69.28268	0.004009	0.006616	0.003802	20.96934	0.001046
9	5.94379	10.80769	67.37720	0.004194	0.006414	0.003927	21.79935	0.001219
10	6.15362	12.09378	64.69029	0.003960	0.005987	0.003782	23.20084	0.001353
11	6.35563	12.47667	63.25757	0.003727	0.005625	0.003600	24.25143	0.001380
12	6.59839	12.63357	62.61695	0.003580	0.005281	0.003361	24.73589	0.001368
13	6.81723	13.21855	62.26577	0.003626	0.004979	0.003224	24.50241	0.001441
14	6.91755	14.11882	61.52815	0.004119	0.004924	0.003212	24.33917	0.001606
15	6.95469	14.66215	61.06215	0.004658	0.004928	0.003329	24.26102	0.001763
16	6.98343	14.54217	60.71440	0.005597	0.005066	0.003564	24.72731	0.001889
17	7.05806	14.29711	59.45731	0.005998	0.004987	0.003884	26.22872	0.001997
18	7.15967	14.12942	57.79739	0.006124	0.004846	0.004185	28.05585	0.002180
19	7.31430	14.33314	55.93457	0.005972	0.004644	0.004361	29.71501	0.002305
20	7.48997	13.93082	54.51155	0.005974	0.004479	0.004534	31.54026	0.002390
21	7.62876	13.51049	53.85773	0.006236	0.004493	0.004626	32.61395	0.002466
22	7.70977	13.35786	53.83380	0.006685	0.004681	0.004617	32.78981	0.002540
23	7.78056	13.50445	53.95909	0.007101	0.005012	0.004535	32.51721	0.002609
24	7.84268	13.70490	54.08878	0.007409	0.005482	0.004473	32.18630	0.002656

Variance Decomposition of DR:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	2.68258	19.92558	58.00939	9.194802	0.002184	1.51E-07	12.86784	0.000209
2	14.3579	33.11660	2.449054	0.365194	0.000733	0.024871	64.04297	0.000569
3	16.8518	27.68096	2.901303	0.309323	0.056337	0.066194	68.94130	0.044580
4	101.662	17.41244	54.98303	0.009409	0.001805	0.001872	27.59012	0.001324
5	108.497	24.58542	49.63721	0.010156	0.003227	0.002026	25.75903	0.002927
6	110.108	24.74122	49.56448	0.010158	0.004707	0.002150	25.67428	0.003006
7	117.865	22.51709	46.33067	0.014350	0.008732	0.002656	31.12281	0.003688
8	120.647	21.91216	44.82833	0.014261	0.010724	0.002587	33.22837	0.003566
9	137.191	29.66079	39.15081	0.013396	0.010419	0.002481	31.15846	0.003641
10	145.194	28.38380	35.74796	0.012111	0.011181	0.002333	35.83903	0.003594
11	150.089	30.46123	33.51968	0.012703	0.012447	0.002576	35.98747	0.003892
12	158.847	27.34305	32.48541	0.015151	0.014826	0.002504	40.13541	0.003647
13	177.342	21.94742	37.15369	0.012182	0.012670	0.002068	40.86895	0.003019
14	179.527	22.63418	36.25610	0.012633	0.012873	0.002019	41.07904	0.003142
15	182.036	23.04095	36.65992	0.012331	0.012785	0.002134	40.26882	0.003065
16	182.991	22.81796	37.11284	0.012238	0.012755	0.002278	40.03879	0.003132
17	185.188	24.35391	36.32199	0.011950	0.012633	0.002264	39.29404	0.003209
18	187.081	24.01099	36.09302	0.011799	0.012553	0.002274	39.86620	0.003154
19	187.510	24.04216	36.09976	0.012075	0.012665	0.002294	39.82765	0.003391
20	190.474	24.97860	36.11082	0.011927	0.012349	0.002224	38.88061	0.003469
21	192.138	25.43300	35.68316	0.012004	0.012462	0.002221	38.85345	0.003704
22	193.023	25.52747	35.36855	0.012603	0.012818	0.002203	39.07250	0.003859
23	195.578	24.96043	34.90698	0.014241	0.013864	0.002220	40.09813	0.004147
24	197.293	24.76893	34.42804	0.014640	0.013925	0.002216	40.76806	0.004188

Variance Decomposition of LRER:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.786254	64.14839	10.76340	0.089708	0.050618	1.59E-05	24.92588	0.021988
2	1.957416	39.74958	33.40622	0.022385	0.016366	1.56E-05	26.79998	0.005448
3	2.891767	32.94016	44.97839	0.011488	0.009827	0.000230	22.05717	0.002734
4	3.087273	29.77029	44.12284	0.011482	0.010506	0.000401	26.08192	0.002557
5	3.174894	29.50398	44.95722	0.010862	0.009951	0.000541	25.51500	0.002444
6	3.214500	29.89078	44.27049	0.010910	0.010148	0.000683	25.81442	0.002571
7	3.299757	29.45493	44.33402	0.012249	0.011129	0.001170	26.18354	0.002961
8	3.374507	28.39024	46.53198	0.013988	0.013869	0.001682	25.04520	0.003039
9	3.386231	28.35770	46.62721	0.015394	0.015546	0.002105	24.97890	0.003137
10	3.422006	29.71772	45.74751	0.015818	0.015653	0.002598	24.49721	0.003489
11	3.531071	31.54213	44.45486	0.015194	0.014790	0.002444	23.96715	0.003438
12	3.727564	31.96470	42.43544	0.014268	0.013345	0.002195	25.56692	0.003136
13	3.789361	31.31709	41.18846	0.014174	0.013067	0.002181	27.46198	0.003051
14	3.823017	31.10199	40.61322	0.014151	0.012875	0.002275	28.25246	0.003026
15	3.917028	31.54953	41.39726	0.013653	0.012265	0.002242	27.02217	0.002885
16	4.039443	33.38428	40.77363	0.012949	0.011655	0.002360	25.81235	0.002780
17	4.231491	35.47181	39.67896	0.012025	0.010878	0.002313	24.82141	0.002596
18	4.353739	37.63495	37.91135	0.011718	0.011037	0.002576	24.42582	0.002550
19	4.365132	37.64549	37.74433	0.011827	0.011509	0.002720	24.58153	0.002597
20	4.404246	37.33493	37.20349	0.012396	0.011988	0.002726	25.43167	0.002796
21	4.483820	36.91165	36.14875	0.011971	0.011641	0.002658	26.91048	0.002849
22	4.620457	37.20825	34.82658	0.011274	0.011072	0.002549	27.93749	0.002786
23	4.736365	35.54620	33.58703	0.010792	0.011039	0.002427	30.83977	0.002733
24	4.846075	34.13226	32.11798	0.010964	0.011611	0.002361	33.72198	0.002839

Variance Decomposition of DLPOP:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	100.0000	0.000000
2	1.273294	0.068765	11.26119	0.009409	0.006137	0.000303	88.65326	0.000941
3	1.332315	7.660726	11.10351	0.011520	0.008539	0.000638	81.21420	0.000867
4	1.447821	6.736056	13.24216	0.012400	0.009688	0.000778	79.99776	0.001161
5	1.754552	11.78722	16.05046	0.009473	0.006611	0.000535	72.14491	0.000800
6	1.905086	10.12397	16.62419	0.008440	0.005656	0.000475	73.23656	0.000713
7	1.929525	11.96270	16.22469	0.009490	0.005665	0.000466	71.79628	0.000709
8	1.976875	13.94569	17.38608	0.009233	0.005621	0.000445	68.65226	0.000677
9	1.982776	14.38788	17.28658	0.009672	0.005775	0.000444	68.30897	0.000680
10	2.007197	14.52774	18.46147	0.009832	0.006197	0.000749	66.99335	0.000664
11	2.012146	14.45636	18.79674	0.009793	0.006204	0.000919	66.72925	0.000730
12	2.037578	14.45446	19.03023	0.009797	0.006282	0.001121	66.49739	0.000719
13	2.038356	14.45870	19.01735	0.010293	0.006387	0.001122	66.50542	0.000725
14	2.043764	14.84063	18.93383	0.010257	0.006358	0.001288	66.20690	0.000727
15	2.082250	14.41357	19.00726	0.011143	0.006689	0.001366	66.55924	0.000735
16	2.092854	14.50373	18.84498	0.012115	0.007362	0.001555	66.62952	0.000745
17	2.111810	15.13382	19.27256	0.012753	0.008155	0.001735	65.57011	0.000875
18	2.119141	15.36214	19.29639	0.012676	0.008674	0.002229	65.31700	0.000899
19	2.222859	13.97346	23.77028	0.011523	0.008320	0.002350	62.23324	0.000826
20	2.384986	12.20293	30.28784	0.010666	0.007245	0.002077	57.48850	0.000748
21	2.538593	11.76617	35.69598	0.010367	0.006970	0.001841	52.51791	0.000755
22	2.545751	12.06427	35.68816	0.010390	0.007242	0.001837	52.22735	0.000757
23	2.603019	12.47651	36.44155	0.010050	0.006930	0.001817	51.06240	0.000746
24	2.696327	13.16543	38.14065	0.009963	0.006586	0.001744	48.67493	0.000695

Variance Decomposition of LASI:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.476192	27.96145	0.020105	0.008926	0.035511	0.320221	71.65143	0.002360
2	1.045267	36.98355	0.213769	0.001918	0.047326	0.204369	62.54858	0.000491
3	1.563697	50.95685	12.06458	0.009550	0.082432	0.191633	36.69448	0.000478
4	2.047635	66.47436	11.73961	0.023540	0.080350	0.156227	21.52293	0.002985
5	2.201233	70.91979	10.15991	0.032652	0.084433	0.170577	18.62902	0.003624
6	2.774338	44.68199	34.05028	0.025543	0.055814	0.119751	21.06377	0.002846
7	3.071132	36.56933	42.18674	0.022647	0.046440	0.100364	21.07212	0.002362
8	3.230401	34.98623	45.81231	0.020778	0.042065	0.090860	19.04553	0.002238
9	3.442662	41.39600	40.59894	0.018588	0.037367	0.080024	17.86702	0.002061
10	3.666521	47.91379	35.83291	0.016728	0.033688	0.070872	16.13003	0.001981
11	3.714245	49.19490	34.96602	0.016414	0.032954	0.069416	15.71825	0.002051
12	3.766318	48.29022	36.30222	0.018444	0.032444	0.067739	15.28669	0.002245
13	3.925032	44.47010	40.65692	0.019989	0.030584	0.062393	14.75763	0.002389
14	4.196972	39.07154	45.16874	0.019996	0.027102	0.054571	15.65539	0.002657
15	4.534026	33.78510	48.64457	0.017882	0.023222	0.046963	17.47964	0.002616
16	5.140303	27.26519	51.94012	0.014038	0.018477	0.037205	20.72273	0.002247
17	5.718288	22.72732	53.77568	0.011343	0.015933	0.031289	23.43651	0.001927
18	5.844021	21.82766	54.33071	0.010876	0.017080	0.032183	23.77960	0.001887
19	5.868500	21.87077	53.88010	0.010905	0.019381	0.035562	24.18142	0.001872
20	5.993473	20.99429	52.16682	0.010890	0.021777	0.038773	26.76563	0.001815
21	6.139365	20.02151	50.47268	0.011383	0.024222	0.041215	29.42721	0.001775
22	6.272251	19.21836	50.63751	0.012734	0.026140	0.042898	30.06055	0.001802
23	6.460821	18.15612	52.96297	0.013368	0.026398	0.042937	28.79646	0.001754
24	6.815466	16.43297	57.43568	0.013127	0.024937	0.040514	26.05112	0.001651

Factorization:
Structural