# Determining Sources of Systemic Risk: A Case Study of Nigeria and Its Dependence on Oil

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*I develop a toolkit that examines potential sources of systemic risk in countries. Using the Nigeria as a case study, I examine the effect of volatility in oil price on its economy given its perceived degree of dependence on oil. I find that there seems to have been a diversification away from oil revenue, implying a much lower dependence on oil. This toolkit can be adapted to any country and any variable can be investigated giving governments, regulators, businesses, and potential investors insights into economy wide performance so that decisions made can be as accurate as possible.*

## INTRODUCTION

The benefits from investing in developing or emerging markets are unquestionable, but the uncertainties associated with these investments most times dissuade potential investors. More often than not, these countries focus on a very specific aspect that drives their growth and as such are exposed to systemic risk as a result. Systemic risk in this context is defined as the overdependence on one aspect of growth that should this aspect fail, would negatively impact the whole country. A typical example of this is predominant in the natural resource curse literature where countries tend to be overly dependent on natural resources and are therefore at the mercy of commodity price fluctuations. For example, the recent depreciation of the Nigerian currency (the Nigerian Naira) which coincided with the decline of World crude oil prices has raised several questions regarding the country's reliance on oil production and the possible consequences of said reliance. An overdependence on oil production could lead to a devastating recession in the country should world price of crude oil plummet. As a result, establishing the level of dependence and aspects of the economy driven by oil price fluctuations can provide policy makers with vital information in order to properly institute policies, and provide potential investors with relevant information, resulting in a more efficient allocation of financial capital.

In this paper, I develop a tool kit outlined in three steps, designed to determine the extent of the impact of oil production on the economic welfare of the Nigerian economy. As the tenth largest oil producer in the world, the abundance of this resource in the country has led to the fact that oil production constitutes about 35% of the country's GDP, makes up 96% of Nigeria's Government revenue and is 78% of total exports. These statistics seem to indicate an over reliance on oil production.

The literature suggests two possible ways through which this reliance on oil production could negatively impact the economy: the Dutch Disease phenomenon and the natural resource curse. The literature on resource curse is extensive and cannot all be covered in this paper. What follows are examples that highlight some points relevant for what I do in this paper. For more on the resource curse, see Frankel (2010), Ross (1999, 2015), Stevens and Dietsche (2008), and Wick and Bulte (2009). Sala-i-Martin and Subramanian (2003) show that countries with an abundance of natural resources tend to exhibit lower levels of institutional development, which broadly encompass corruption, rent seeking, weak governance and plunder. They, also using Nigeria as an example, show that the poor economic performance of the country is due to the mismanagement of the country's income from oil production rather than the Dutch disease phenomenon, suggesting that Nigeria is affected more by the natural resource curse owing to its under developed institutions. In addition to this, Sachs and Warner (2001) show that the resource curse findings are robust to geographical and climate variables, further strengthening the presence of the natural resource curse in economies with an abundance of natural resources. They also found that due to the fact that resource rich countries tended to be high-priced economies, they did not experience the export led growth other countries that were low priced experienced.

Benjamin (1989) examines the Dutch disease phenomenon in developing countries, particularly countries with imperfect substitutability between domestic and imported goods. It is found that not all other sectors will be harmed by the presence of natural resources. Using Cameroon as a case study, it is found that the presence of natural resources was most likely to harm the agricultural sector but will boost the manufacturing sector. These findings were corroborated by Fardmanesh (1991), where the author showed that the manufacturing sectors of Algeria, Ecuador, Indonesia, Venezuela and Nigeria were improved but found a contraction in their respective agricultural sectors.

More recently however, the literature seems to support the idea that abundance alone is not enough, but that it is the volatility in the price of these resources that contributes negatively to the country's wellbeing. For example, Van der Ploeg and Poelhekke (2009) suggest that there exists a positive impact of natural resources, but this positivity is over shadowed by the negative effects via volatility. In essence, they find that the volatility associated with the natural resources increases the volatility of the unanticipated output growth which in turn, impacts growth negatively. The volatility and uncertainty generated by the country's over dependence on natural resources will lead to a decline in investment, which further feeds back into the declining growth rate, and in the advent of a sharp decline in the demand for the natural resource, could in an extreme case, lead to a financial crisis.

Finally, a note on findings of a curse and the empirical methodology employed. Collier and Goderis (2008) highlight the discrepancy in findings that depend on what econometric procedure is used to investigate the dependence on natural resources, they point out that cross sectional analysis finds support for the theory of the natural resource curse, while the vector auto regression (VAR) time series approach shows a positive relationship between natural resources and economic growth dispelling the theory of the natural resource curse. They address this problem by using a panel co-integration approach and find that increases in the prices of these natural resources have a positive short run impact on the economy but a negative long run impact specifically in reference to high-rent non-agricultural goods, reconciling the different findings in the literature.

While it has already been established that the presence of oil in the country has contributed to increasing levels of corruption and decline in the quality of the country's institutions, and that its reliance on oil production has harmed some of its sectors (most notably its agricultural sector), it remains to be seen whether the extent of Nigeria's dependence on oil production is cause for worry. In essence, I intend to investigate whether or not the abundance of crude oil in Nigeria is a source of systemic risk that threatens the economic stability of the country, i.e. are most aspects of the Nigerian economy mostly governed by changes in demand for oil or has the country sufficiently diversified its production interests and as such, is not as dependent on oil as the statistics above seem to imply. I look at several key aspects of the Nigerian economy including the growth rate, bank lending rates, inflation rates, stock market returns and stock market volatility (Stock market returns is switched out for stock market volatility to study the effect of changes in oil price on both) and identify what role if any, the changes in the price of oil plays in the determination of these variables. The rest of the paper is outlined as follows; section 2 deals with the data and methodology and the reasoning behind the approach taken, section 3 categorizes the results obtained and the interpretations of said results while section 4 concludes.

## DATA AND METHODOLOGY

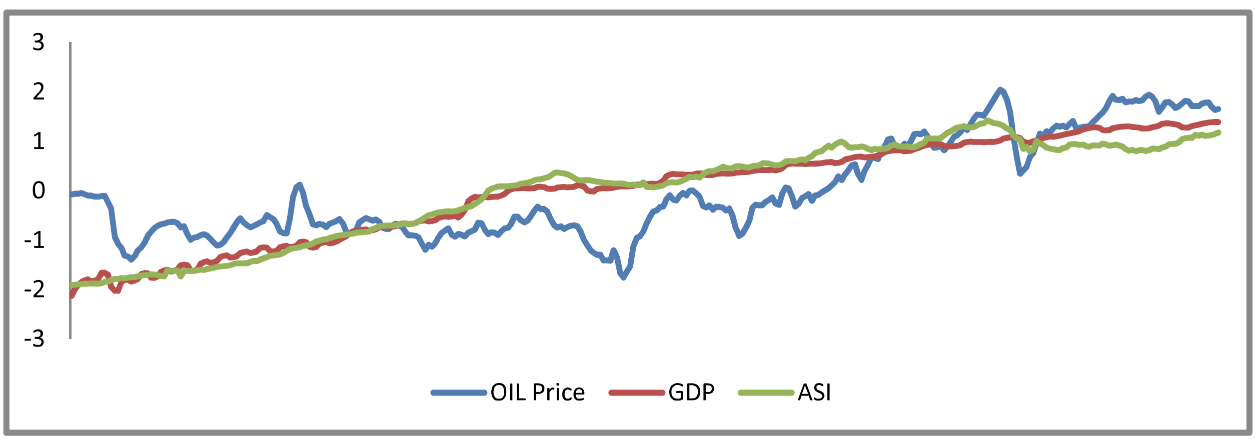
### Data

The data used in this analysis covers a period between 1985 and 2013. Monthly data in this period was obtained for Nigerian real GDP (measured in Nigerian Naira), GDP deflator, the all share index (ASI) of the Nigerian stock exchange market, oil prices, and bank lending rates. A detailed description as well as sources of the data is provided in the appendix of this paper. The natural logs and first difference were taken of all these variables except the bank lending rates (since banking rates were already non-stationary) to obtain the growth rate, inflation rates, stock market returns, and oil price growth respectively rendering all variables non-stationary. Table 1 below presents a summary of the data used in the analysis, while figure 1 shows the evolution of the stock market, the output and price of oil between 1985 and 2013.

**TABLE 1**
**SUMMARY OF VARIABLES**

| Variable | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|
| **Oil price** | 7.52 | 126.3 | 37.418 | 31.429 |
| **GDP** | 1.91E+10 | 1.16E+13 | 2.80E+12 | 3.31E+12 |
| **ASI** | 111.3 | 65652.38 | 13277.6 | 14707.17 |
| **Inflation rate** | -0.462 | 0.334 | 0.01412 | 0.0678 |
| **Bank lending rates** | 8.5 | 37.8 | 19.269 | 4.721 |

**FIGURE 1**
**EVOLUTION OF OIL PRICE, GDP, AND ASI**




All variables are standardized to accommodate the difference in the magnitude of observations.

### Methodology

There are essentially three stages in this toolkit used to determine the role of oil price fluctuation in the Nigerian economy. In the first stage, using a dynamic factor model, I establish that there are common factors between all the variables mentioned above. In the second stage, I propose oil price variation as a component of the basket of common factors using a vector auto regression (VAR) frame work to examine how oil price variation impacts each variable. In the third and final stage, I use the time varying parameter approach to re-derive the relationship between the variables using the VAR estimates as a guideline so as to categorize the relationship between oil price fluctuations and these variables over time.

*Stage 1*

To estimate the common component across all four variables, I use the dynamic factor model approach to approximate the contribution of a common component to the levels of each variable and I estimate the weights assigned by each variable to the basket of common variables. In essence, I assume the following relationship

$$y_{it} = \delta_i c_t + \eta_{it} \tag{1}$$

where:

$y_{it}$ is variable i at time t (where i can represent either stock market growth, output growth, inflation rate, or bank lending rates)

$c_t$ is the common component across all variables at time t

$\eta_{it}$ is the idiosyncratic component of each variable i at time t. (with econometric specifications for each given below)

and $\delta_i$ is the weight each variable i assigns to the common component.

To obtain appropriate (best guesses of) econometric specifications for variables $C_t and\ \eta_{it}$, I determine the auto regressive specification that best predicts each variable. Table 2 below summarizes the AR classification of the variables under consideration, as well as the smallest Schwarz Information criteria (SIC) value which signifies the best fit.

**TABLE 2**
**ARMA SPECIFICATION**

| Variable | Specification | SIC value |
|---|---|---|
| **Growth rate of oil price** | AR(1) without drift | -2.438 |
| **Growth rate of GDP** | AR(3) with drift | -3.385 |
| **Growth rate of stock market** | AR(2) with drift | -2.793 |
| **Inflation Rate** | AR(3) with drift | -3.174 |
| **Bank Lending rates** | AR(1) with drift | 3.4778 |

In light of table 2, I assume that the common and idiosyncratic components follow the following processes with the following assumptions in mind:

1. I assume that oil price is part of the common component and as such, have modelled the common component to follow the process that the growth in oil follows, i.e. AR (1) process. I have also modeled the idiosyncratic components to follow the processes defined by their respective variables.
2. All data entries are standardized and a variance of 1 is imposed to obtain standard normal values of the common component so as to easily identify the variances of the idiosyncratic component.

As a result,

$$c_t = \beta c_{t-1} + v_t,\ v_t \sim WN(0,1) \tag{2}$$

$$\eta_{1t} = \mu_1 + \phi_{11}\eta_{1t-1} + \phi_{12}\eta_{1t-2} + e_{1t} \tag{3}$$

$$\eta_{2t} = \mu_2 + \phi_{21}\eta_{2t-1} + \phi_{22}\eta_{2t-2} + \phi_{23}\eta_{2t-3} + e_{2t} \quad (4)$$

$$\eta_{3t} = \mu_3 + \phi_{31}\eta_{3t-1} + \phi_{32}\eta_{3t-2} + \phi_{23}\eta_{3t-3} + e_{3t} \quad (5)$$

$$\eta_{4t} = \mu_4 + \phi_{41}\eta_{4t-1} + e_{4t} \quad (6)$$

with $e_{it} \sim WN\left(0, \sigma_i^2\right)$

Where index 1 represents returns to the stock market/stock volatility, index 2 is the growth rate, index 3 is the rate of inflation and index 4 is the bank lending rate and WN represents a white noise distribution. From this process, we can estimate the percentage of variation in variable i that is a result of the common component and what percentage in variation is variable specific (see section 3 for the results). This will provide a preliminary extent to which oil price movement is contributing to each variable, with the assumption that oil production, and hence the price of oil, is a part of the common component. To verify this supposition, we proceed to stage 2.

*Stage 2*

In this stage, a VAR model is estimated to determine the relationship if any, between changes in oil price and the variables under investigation. Since these variables are all endogenous, the recursive ordering method of evaluating the VAR system of equations is utilized to deal with not just this problem, but the identification problem as well, when the structural VAR is converted to the reduced form VAR as shown below. The recursive ordering method involves stacking the variables in the VAR system from most exogenous to least exogenous. Table 3 below shows the results from the lag specification criteria of the VAR system being considered.

**TABLE 3**
**LAG SELECTION CRITERIA**

VAR Lag Order Selection Criteria
Endogenous variables: GASI GOIL GRO INF INT
Sample: 1985M01 2013M12
Included observations: 339

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 922.2828 | NA | 3.07e-09 | -5.411698 | -5.355267 | -5.389210 |
| 1 | 1483.279 | 1102.135 | 1.30e-10 | -8.573919 | -8.235335 | -8.438993 |
| 2 | 1507.447 | 46.76657 | 1.31e-10 | -8.569007 | -7.948270 | -8.321643 |
| 3 | 1652.698 | 276.7920 | 6.43e-11 | -9.278456 | -8.375565 | -8.918654 |
| 4 | 1730.376 | 145.7318 | 4.71e-11 | -9.589239 | -8.404195* | -9.116999 |
| 5 | 1771.691 | 76.29183 | 4.28e-11 | -9.685491 | -8.218293 | -9.100812 |
| 6 | 1853.190 | 148.0940 | 3.07e-11* | -10.01882* | -8.269472 | -9.321706* |
| 7 | 1868.422 | 27.22744 | 3.26e-11 | -9.961190 | -7.929685 | -9.151635 |
| 8 | 1899.113 | 53.95865* | 3.16e-11 | -9.994766 | -7.681108 | -9.072773 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

From the SC column in table 3, the identified optimal lag is 4. In this VAR model, the structural VAR is written in the following state space form:

$$BY_t = \Gamma_0 + \sum_{p=1}^{4} \Gamma_p Y_{t-p} + \varepsilon_t \tag{7}$$

where

$$B = \begin{pmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{pmatrix}; \qquad Y_t = \begin{pmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \\ y_{4t} \\ y_{5t} \end{pmatrix}; \qquad \Gamma_0 = \begin{pmatrix} \gamma_{10} \\ \gamma_{20} \\ \gamma_{30} \\ \gamma_{40} \\ \gamma_{50} \end{pmatrix};$$

$$\Gamma_P = \begin{pmatrix} \gamma_{11}^P & \gamma_{12}^P & \gamma_{13}^P & \gamma_{14}^P & \gamma_{15}^P \\ \gamma_{21}^P & \gamma_{22}^P & \gamma_{23}^P & \gamma_{24}^P & \gamma_{25}^P \\ \gamma_{31}^P & \gamma_{32}^P & \gamma_{33}^P & \gamma_{34}^P & \gamma_{35}^P \\ \gamma_{41}^P & \gamma_{42}^P & \gamma_{43}^P & \gamma_{44}^P & \gamma_{45}^P \\ \gamma_{51}^P & \gamma_{52}^P & \gamma_{53}^P & \gamma_{54}^P & \gamma_{55}^P \end{pmatrix}; \qquad \varepsilon_t = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{pmatrix} \text{ with } \varepsilon_{it} \sim WN\left(0, \sigma_i^2\right)$$

where:

$b_{ij}$ represents the contemporaneous relationship between variables $y_i$ and $y_j$

and $\gamma_{ij}^P$ represents relationship between variable $y_i$ and the pth lag of variable $y_j$, i,j = 1,2,3,4,5.

This implies that the reduced form VAR can be written as;

$$Y_t = A_0 + \sum_{p=1}^{4} A_p Y_{t-p} + v_t \tag{8}$$

where $A_0 = B^{-1}\Gamma_0$; $A_P = B^{-1}\Gamma_P$ and $v_t = B^{-1}\varepsilon_t$

Equation 7 has 55 parameters while equation 8 has only 45 parameters and this implies that the reduced form VAR does not fully identify the parameters in the structural form VAR. The recursive ordering approach essentially decreases the number of contemporaneous relationships between the variables in the VAR system. If $y_{1t}$ is the most exogenous, it implies that $y_{2t}$, $y_{3t}$, $y_{4t}$, $y_{5t}$ have no effect on the value of $y_{1t}$ which in turn implies that all $b_{ij}$ in the first row become zeros. Similarly, if $y_{2t}$ is the second most exogenous variable, then all $b_{ij}$ except $b_{21}$ in the second row become zeros and so on. This will result in a lower triangular matrix for B, and as such only 45 parameters in the structural VAR remain to be estimated, which is identical to the number of parameters in the reduced form VAR, hence the system is fully identified.

Estimates of the coefficients from the reduced form VAR show exactly how the price of oil is related to each good and how long it takes for a change in oil price to influence each variable. This gives us an average measure across time for the relationship between oil and each variable, the main idea behind this paper is to examine this relationship across time and to observe how the relationship changes with fluctuations in oil price. To ascertain this, we proceed to stage 3.

*Stage 3*

Finally, an approximate relationship from the VAR model is examined and a time varying parameter approach is applied to it. Essentially, we estimate

$$y_{it} = \tau_{it} + \beta_t X_t + u_{it} \quad (9)$$

where:

$\tau_t$ is the constant (intercept) also allowed to vary with time

$X_t$ are the covariates that prove to be statistically significant from the VAR estimation.

$\beta_{it}$ which are elements of $\beta_t$ are the coefficients of each covariate, allowed to vary over time as well.

It is assumed that each $\beta_i$ follows a random walk to allow for the unpredictability of the eventuality of the relationship between oil and each variable in each time period. The estimates of the relationship between the variables and oil price will enable us to determine the level of dependence of the country on oil. If the estimates are fairly constant and independent of fluctuations in oil price, we can conclude that that variable is not over dependent on oil, but if the relationship fluctuates with fluctuations in oil price, then we can conclude that the variable is over dependent on oil. If enough of these variables are over dependent on oil, then it is safe to say that the country as a whole is over dependent on oil.

## ESTIMATION RESULTS

### Stage 1 Results

Applying the Kalman filter procedure, the dynamic factor model yields the following common and idiosyncratic components plotted over time

**FIGURE 2**
**COMMON COMPONENT (USING STOCK MARKET RETURN)**

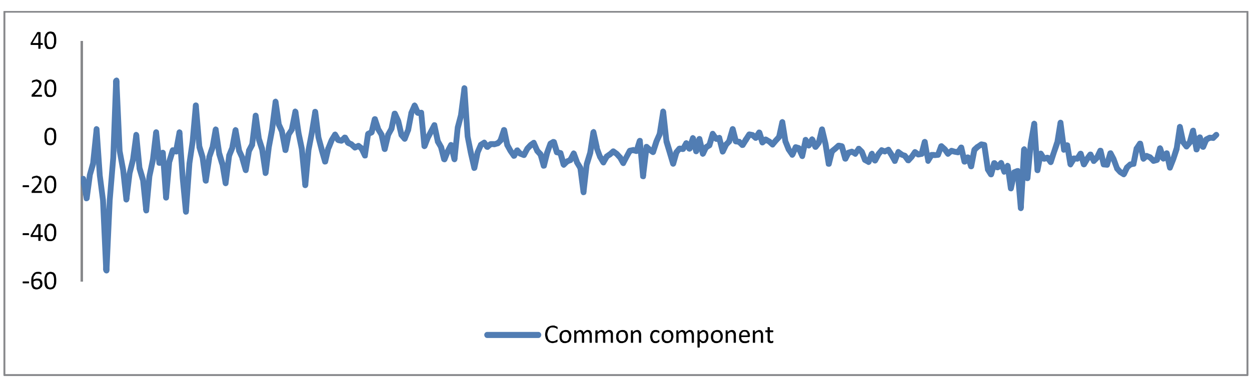


**FIGURE 3**
**IDOSYNCRATIC COMPONENT OF STOCK MARKET RETURN**

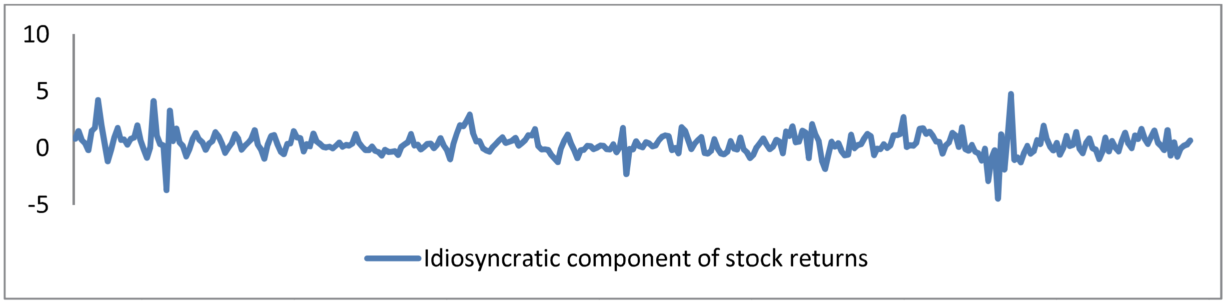



**FIGURE 4**
**IDOSYNCRATIC COMPONENT OF GROWTH RATE**
**(USING STOCK MARKET RETURN)**

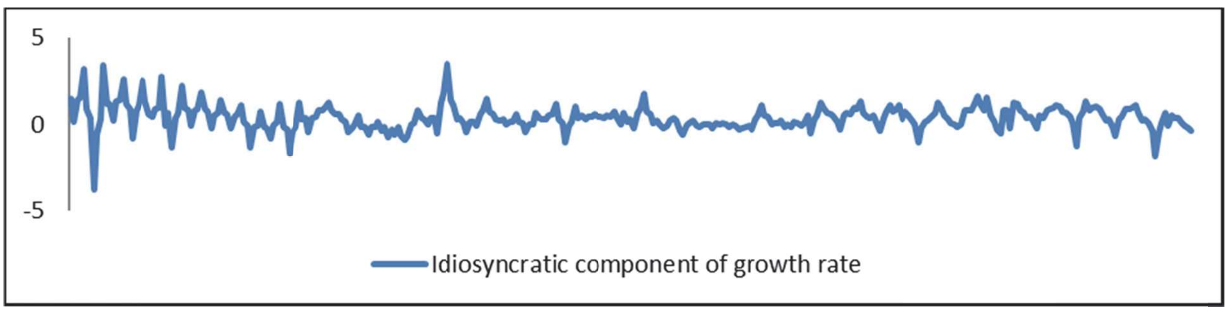



**FIGURE 5**
**IDOSYNCRATIC COMPONENT OF INFLATION RATE**
**(USING STOCK MARKET RETURN)**

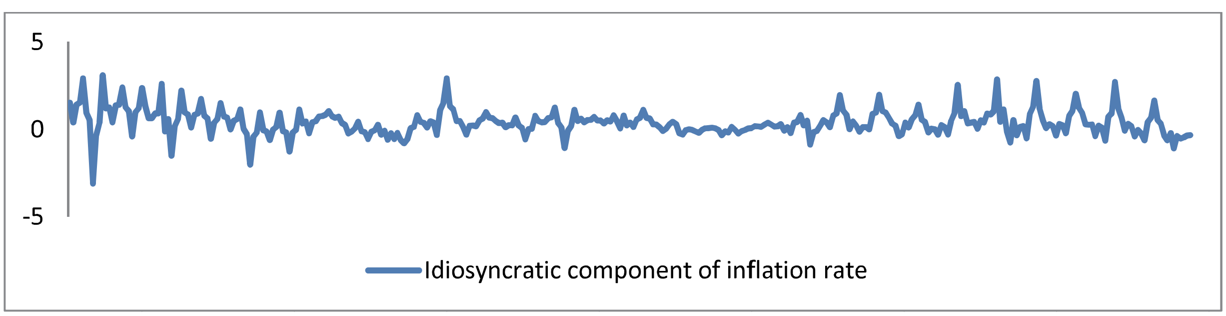
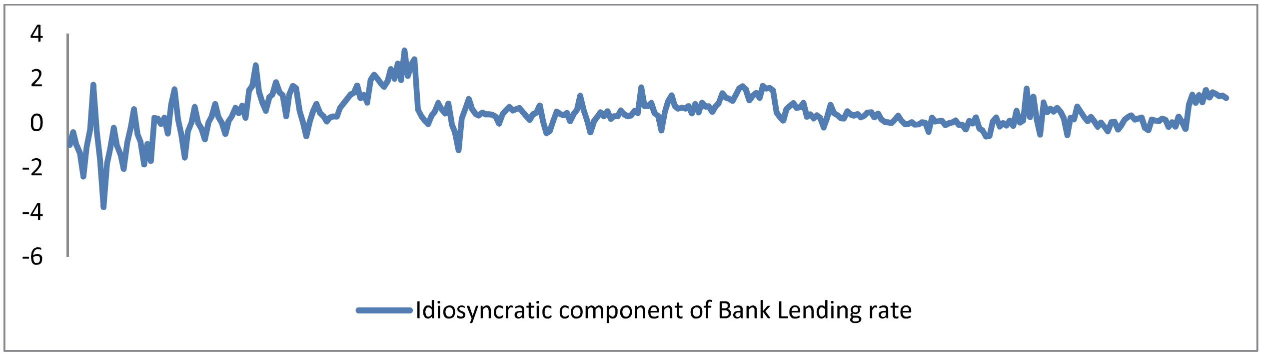


**FIGURE 6**
**IDOSYNCRATIC COMPONENT OF BANK LENDING RATE**
**(USING STOCK MARKET RETURN)**




The following estimates are the weights assigned to the common factor by each variable and the AR (1) parameter for the common component obtained by the dynamic factor model;

$\delta_1 = 0.009921$; $\delta_2 = 0.841580$; $\delta_3 = 0.737393$; $\delta_4 = 0.017872$; $\beta = 0.543611$

The full specification containing the estimates of all parameters can be found in table 11 in the appendix. To estimate the percentage contribution of the common component to each variable, consider the following formula for determining the variance of each variable:

Recall equation 1: $y_{it} = \delta_i c_t + \eta_{it}$

This implies that

$$Var(y_{it}) = \delta_i^2 Var(c_t) + Var(\eta_{it}) + 2\delta_i \operatorname{cov}(c_t, \eta_{it}) \quad (10)$$

Since $\operatorname{cov}(c_t, \eta_{it}) = 0$ by design

$$\Rightarrow Var(y_{it}) = \delta_i^2 Var(c_t) + Var(\eta_{it}) \quad (11)$$

Recall equation 2: $c_t = \beta c_{t-1} + v_t$, $v_t \sim WN(0,1), |\beta| < 1$

$$Var(c_t) = \beta^2 Var(c_{t-1}) + Var(v_t)$$
$$Var(c_t)\left[1-\beta^2\right] = 1 \quad (12)$$
$$\Rightarrow Var(c_t) = \frac{1}{1-\beta^2}$$

Since $y_t$ was normalized, we can assume that $y_t \sim N(0,1)$. This implies that $\frac{\delta_i^2}{1-\beta^2}$ is the contribution of the common component to the variation of each variable $i$.

For stock market returns, $\frac{\delta_1^2}{1-\beta^2}$ = 0.014% of the variation in stock market returns is accounted for by the common component

For Growth rate, $\frac{\delta_2^2}{1-\beta^2}$=100% of the variation in the growth rate is accounted for by the common component

For inflation rate, $\frac{\delta_3^2}{1-\beta^2}$ = 77.18% of the variation in the rate of inflation is accounted for by the common component

For interest rate, $\frac{\delta_4^2}{1-\beta^2}$ = 0.045% of the variation in the interest rate is accounted for by the common component.

Next, stock returns is switched out for stock market volatility, to determine if changes in oil price might have more of an impact on the volatility of the stock market. To get the volatility of the stock market the following GARCH (1, 2) model is approximated (chosen using the Schwarz information criteria, yielding a minimum value of -3.23);

$$s_t = c + \lambda s_{t-1} + e_t \text{ with } e_t \sim N\left(\mu, \sigma_t^2\right) \tag{13}$$

$$\sigma_t^2 = \theta_0 + \theta_1 e_{t-1}^2 + \theta_2 \sigma_{t-1}^2 + \theta_3 \sigma_{t-2}^2 \tag{14}$$

Where $s_t$ is stock market returns in time period t. Table 4 below summarizes the results of the regressions of equations 13 and 14.

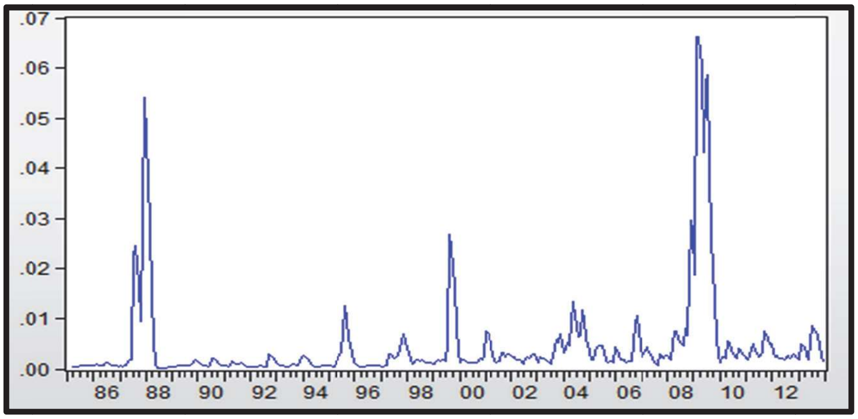
**TABLE 4**
**SUMMARY OF ESTIMATES FROM THE GARCH (1, 2) PROCESS**

| Variable | Estimated parameter | Standard Error |
|---|---|---|
| $\mu$ | 0.024552*** | 0.001664 |
| $\lambda$ | 0.257429*** | 0.043635 |
| $\theta_0$ | 0.000116*** | 0.0000259 |
| $\theta_1$ | 0.408062*** | 0.054204 |
| $\theta_2$ | 0.948475*** | 0.042126 |
| $\theta_3$ | -0.282882*** | 0.019274 |

* , **, and *** indicates statistical significance at the 10%, 5%, and 1% levels respectively

The conditional variance of the GARCH (1, 2) process over time is then forecasted for the in-sample period to yield the approximate volatility of the stock market. Figure 7 below shows the estimated volatility of the stock market;

**FIGURE 7**
**VOLATILITY OF THE NIGERIAN STOCK MARKET FROM 1985 TO 2013**




The above figure depicting the estimates of the volatility in the stock market is to be trusted as its three highest peaks signifying periods of extreme volatility, coincide with the three major financial crisis to have hit the global financial system in three decades; the financial crisis following Black Monday in 1987, the Asian financial crisis in the late 90's and the 2008 global financial crisis.

Using the estimated volatility measure, the dynamic factor model is once again used to estimate the common factor between stock market volatility, growth rates, inflation and bank lending rates. The following figures show the common and idiosyncratic components over time:

**FIGURE 8**
**COMMON COMPONENT (USING STOCK MARKET VOLATILITY)**

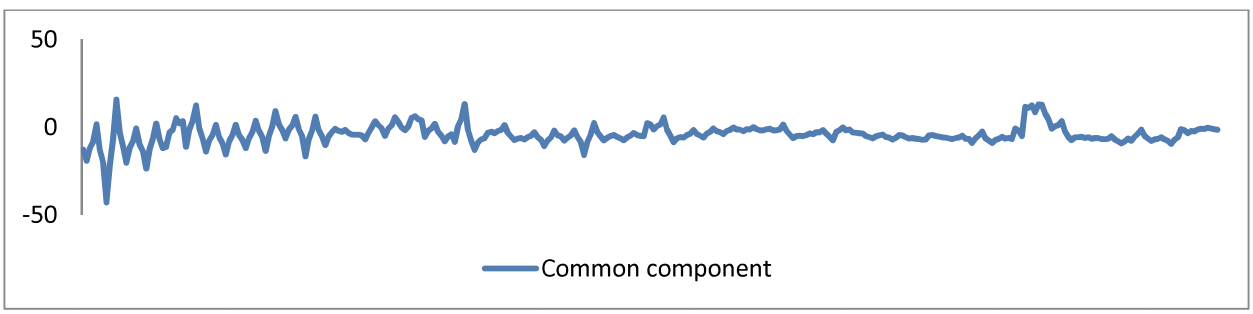



**FIGURE 9**
**IDOSYNCRATIC COMPONENT OF STOCK MARKET VOLATILITY**

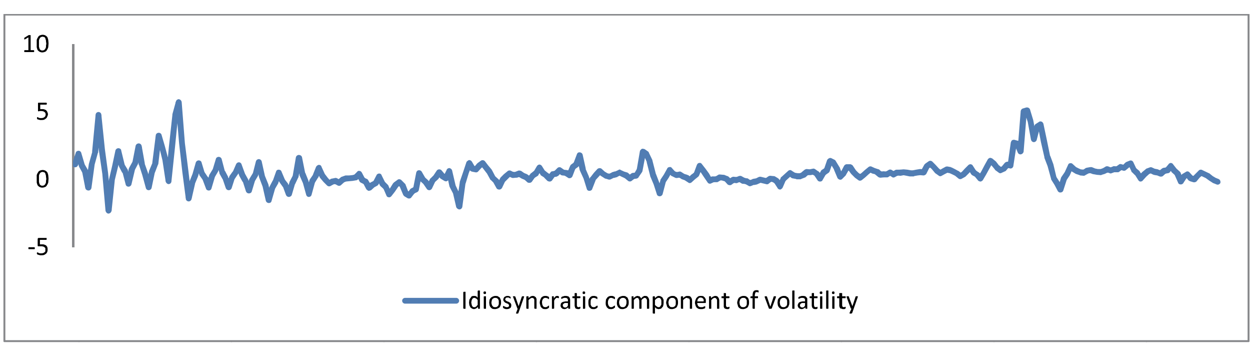


**FIGURE 10**
**IDOSYNCRATIC COMPONENT OF GROWTH RATE**
**(USING STOCK MARKET VOLATILITY)**

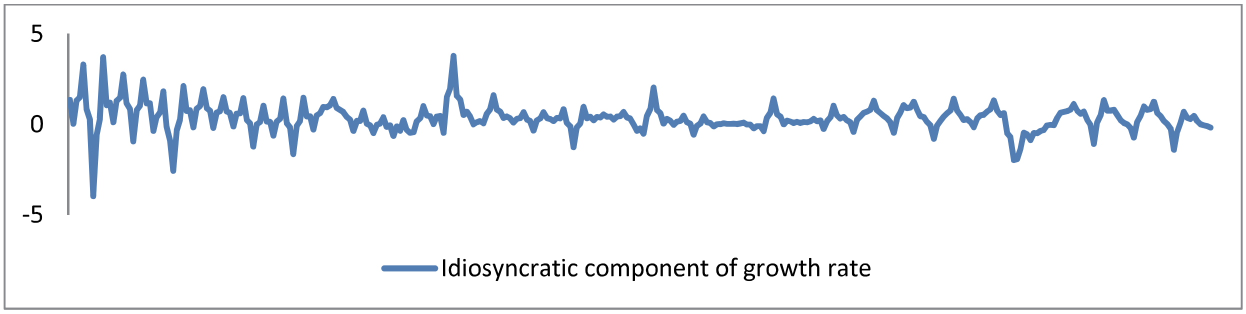



**FIGURE 11**
**IDOSYNCRATIC COMPONENT OF INFLATION RATE**
**(USING STOCK MARKET VOLATILITY)**

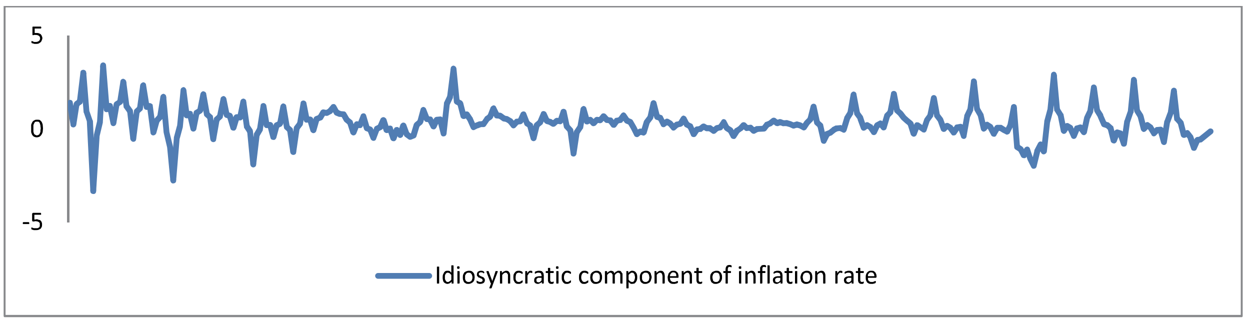
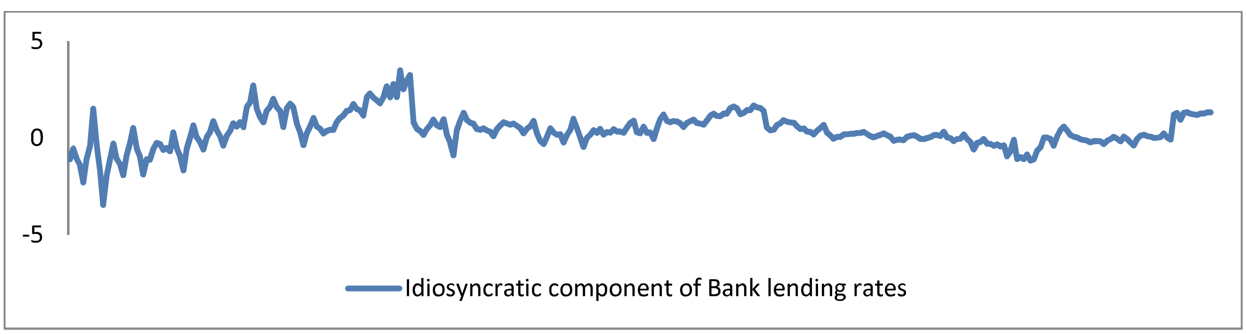



**FIGURE 12**
**IDOSYNCRATIC COMPONENT OF BANK LENDING RATE**
**(USING STOCK MARKET VOLATILITY)**




The following estimates are the weights assigned to the common factor by each variable and the AR (1) parameter for the common component obtained by the dynamic factor model;

$\delta'_1 = 0.0000$; $\delta'_2 = 0.393577$; $\delta'_3 = 0.618914$; $\delta'_4 = 0.017712$; $\beta' = 0.529709$

The full specification containing the estimates of all parameters can be found in table 12 in the appendix.

For stock market volatility, $\frac{\delta'^2_1}{1-\beta'^2}$ = 0.00% of the variation in stock volatility returns is accounted for by this common component

For Growth rate, $\frac{\delta'^2_2}{1-\beta'^2}$ =21.5% of the variation in the growth rate is accounted for by this common component

For inflation rate, $\frac{\delta'^2_3}{1-\beta'^2} = 53.25\%$ of the variation in the rate of inflation is accounted for by this common component

For interest rate, $\frac{\delta'^2_4}{1-\beta'^2} = 0.044\%$ of the variation in the interest rate is accounted for by this common component.

The estimates above seem to suggest that the commonality between stock volatility and other variables is less than that of stock returns which seems contradictory. This contradiction should be cleared up in the next stage when the VAR system is estimated, and we can establish exactly which variable depends on the price of oil.

**Stage 2 Results**

Now that we have found some evidence of commonality between most of the variables considered, it is time to check if the price of crude oil is part of that basket of common factors that contributes to the variables of interest. In order to estimate the VAR system of equations using the recursive ordering strategy, the variables must first be arranged from most exogenous to least exogenous. To do this, pairwise granger causality tests are carried out for each combination of the five variables of study; oil price growth (GOIL), growth rate of the economy (GRO), stock market return (GASI), inflation rate (INF) and Bank lending rates (INT). Table 5 below shows the results of the granger causality tests for the variables mentioned above. The granger causality tests are carried out using the lag length specification obtained in table 2 above

**TABLE 5**
**PAIRWISE GRANGER CASUALTY TESTS**

Pairwise Granger Causality Tests
Sample: 1985M01 2013M12
Lags: 4

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| GOIL does not Granger Cause GASI | 343 | 1.49827 | 0.2023 |
| GASI does not Granger Cause GOIL | | 0.46934 | 0.7582 |
| GRO does not Granger Cause GASI | 343 | 0.36091 | 0.8364 |
| GASI does not Granger Cause GRO | | 1.77165 | 0.1341 |
| INF does not Granger Cause GASI | 343 | 1.76474 | 0.1356 |
| GASI does not Granger Cause INF | | 0.66792 | 0.6146 |
| INT does not Granger Cause GASI | 343 | 1.89393 | 0.1111 |
| GASI does not Granger Cause INT | | 0.09733 | 0.9833 |
| GRO does not Granger Cause GOIL | 343 | 1.51246 | 0.1981 |
| GOIL does not Granger Cause GRO | | 1.20526 | 0.3083 |
| INF does not Granger Cause GOIL | 343 | 2.27064 | 0.0614 |
| GOIL does not Granger Cause INF | | 1.20895 | 0.3068 |
| INT does not Granger Cause GOIL | 343 | 1.31031 | 0.2658 |
| GOIL does not Granger Cause INT | | 1.25739 | 0.2866 |
| INF does not Granger Cause GRO | 343 | 2.86640 | 0.0233 |
| GRO does not Granger Cause INF | | 11.3384 | 1.E-08 |
| INT does not Granger Cause GRO | 343 | 0.45195 | 0.7710 |
| GRO does not Granger Cause INT | | 0.95660 | 0.4315 |
| INT does not Granger Cause INF | 343 | 0.13018 | 0.9713 |
| INF does not Granger Cause INT | | 1.41229 | 0.2295 |

At the 5% level, the granger causality tests above seem to indicate that there is no predictive power of any of the variables on the other with the exception of the reverse granger causality between growth rate and inflation rates. Seeing as growth's influence on inflation is accepted under the 1% level, but inflations influence on growth is only significant at the 5% level, growth is stacked before inflation rate in the VAR system of equations. This implies that the first variable in the stack is GOIL, followed by GASI, then INT, then GRO and finally INF. There seems to be a granger causality running from the inflation rate to the oil growth rate at the 10% level. The measure of oil used in this study is the OPEC market basket of the oil prices set by all its member countries contained within a set interval that no country is allowed to violate. The presence of this relationship might be due to the fact that all member countries are responding to some global inflation rate that is reflected in the price of oil, and not just the Nigerian inflation rate. This is supported by the fact that there is causality between inflation and oil price, and inflation and growth, but no causality between oil price and growth.

With the order determined by the granger causality tests, all that remains is to run the VAR regression of equation 8 and obtain the estimates. Table 6 below summarizes the results and the Impulse response functions resulting from this estimation are plotted in figure 19 in the appendix

**TABLE 6**
**RESULTS FROM THE VAR SYSTEM ESTIMATION**
**(WITH STOCK MARKET RETURNS)**

| Variable | GOIL | GASI | INT | GRO | INF |
|---|---|---|---|---|---|
| **GOIL(-1)** | 0.532*** | 0.0024 | 1.624 | 0.048* | 0.006 |
| **GOIL(-2)** | -0.103 | 0.012 | -0.023 | 0.004 | 0.0197 |
| **GOIL(-3)** | 0.005 | 0.082 | -1.223 | 0.007 | -0.013 |
| **GOIL(-4)** | -0.114** | -0.059 | -0.074 | -0.018 | -0.036 |
| **GASI(-1)** | 0.015 | 0.106* | 0.595 | -0.0023 | 0.043 |
| **GASI(-2)** | -0.0116 | 0.141*** | 0.194 | 0.015 | -0.046 |
| **GASI(-3)** | 0.06 | 0.134** | -0.497 | 0.076** | 0.062* |
| **GASI(-4)** | -0.037 | -0.138** | 0.164 | -0.032 | -0.011 |
| **INT(-1)** | 0.003 | -0.0004 | 0.843*** | -0.0004 | -0.0009 |
| **INT(-2)** | -0.007* | -0.0026 | 0.123* | -0.0008 | -0.0003 |
| **INT(-3)** | 0.003 | 0.006* | 0.103 | 0.0018 | 0.0013 |
| **INT(-4)** | 0.002 | -0.001 | -0.117** | -0.0003 | 0.000008 |
| **GRO(-1)** | 0.087 | -0.207* | -1.03 | 0.591*** | 0.04 |
| **GRO(-2)** | -0.259* | 0.187 | 1.39 | 0.107 | -0.028 |
| **GRO(-3)** | 0.026 | -0.06 | -0.94 | -0.693*** | -0.412*** |
| **GRO(-4)** | 0.105 | -0.180 | 1.605 | 0.315*** | 0.417*** |
| **INF(-1)** | 0.144 | 0.254** | 3.26 | 0.048 | 0.629*** |
| **INF(-2)** | 0.135 | -0.141 | -1.87 | -0.056 | 0.074 |
| **INF(-3)** | 0.0167 | 0.05 | -1.48 | -0.121* | -0.462*** |
| **INF(-4)** | 0.0517 | 0.22** | 0.402 | 0.184*** | 0.148** |

* , **, and *** indicates statistical significance at the 10%, 5%, and 1% levels respectively

The table above shows only a dependence of the growth rate of the economy on the changes in the price of oil at the 10% level of significance, suggesting that an increase in the growth of oil price leads to an increase in the rate of growth of the Nigerian economy in the next period. While there are no other direct impacts of changes in oil price on the other variables, there are indirect causes that could still lead to over dependence. For example, the growth of oil price affects the growth rate of the Nigerian economy, which according to the VAR estimates affects the inflation rates, which in turn affects stock market returns. The extent to which oil price permeates the entire economy will depend on the extent of the influence it has on the growth rate of the economy, and the extent to which growth influences the other variables.

Next, as was done before to test a different aspect of the stock market, stock market returns is switched out for stock market volatility. The same procedure is applied and tables 7, 8 and 9 show the lag length specification results, the pairwise granger causality tests and the VAR estimates respectively.

**TABLE 7**
**LAG LENGTH SPECIFICATION (USING STOCK MARKET VOLATILITY)**

VAR Lag Order Selection Criteria
Endogenous variables: GASIGARCH GRO GOIL INF INT
Exogenous variables: C
Sample: 1985M01 2013M12
Included observations: 338

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 1549.329 | NA | 7.40e-11 | -9.138043 | -9.081489 | -9.115504 |
| 1 | 2358.829 | 1590.259 | 7.13e-13 | -13.78005 | -13.44073 | -13.64482 |
| 2 | 2389.428 | 59.20633 | 6.90e-13 | -13.81318 | -13.19109 | -13.56525 |
| 3 | 2534.123 | 275.6916 | 3.40e-13 | -14.52144 | -13.61658* | -14.16081 |
| 4 | 2606.266 | 135.3209 | 2.57e-13 | -14.80039 | -13.61276 | -14.32707 |
| 5 | 2643.209 | 68.20202 | 2.40e-13 | -14.87106 | -13.40065 | -14.28504 |
| 6 | 2723.060 | 145.0549 | 1.74e-13* | -15.19562* | -13.44245 | -14.49690* |
| 7 | 2737.742 | 26.23718 | 1.85e-13 | -15.13457 | -13.09863 | -14.32316 |
| 8 | 2769.873 | 56.46699* | 1.77e-13 | -15.17676 | -12.85805 | -14.25266 |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

GASIGARCH is the estimated volatility in the stock market

The Schwarz information criterion suggests a VAR (3) process, which is used as the lag specification of the granger causality tests and to also estimate the VAR system of equations.

**TABLE 8**
**PAIRWISE GRANGER CAUSALITY TEST**
**(USING STOCK MARKET VOLATILITY)**

Pairwise Granger Causality Tests
Sample: 1985M01 2013M12
Lags: 3

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| GRO does not Granger Cause GOIL | 344 | 1.27751 | 0.2820 |
| GOIL does not Granger Cause GRO | | 2.71824 | 0.0446 |
| INF does not Granger Cause GOIL | 344 | 1.78610 | 0.1496 |
| GOIL does not Granger Cause INF | | 1.21029 | 0.3059 |
| INT does not Granger Cause GOIL | 344 | 1.53759 | 0.2046 |
| GOIL does not Granger Cause INT | | 1.56539 | 0.1976 |
| GASIGARCH does not Granger Cause GOIL | 343 | 0.84110 | 0.4721 |
| GOIL does not Granger Cause GASIGARCH | | 3.09490 | 0.0271 |
| INF does not Granger Cause GRO | 344 | 2.17635 | 0.0906 |
| GRO does not Granger Cause INF | | 7.65075 | 6.E-05 |
| INT does not Granger Cause GRO | 344 | 0.63682 | 0.5917 |
| GRO does not Granger Cause INT | | 0.70668 | 0.5486 |
| GASIGARCH does not Granger Cause GRO | 343 | 2.70165 | 0.0456 |
| GRO does not Granger Cause GASIGARCH | | 1.08946 | 0.3536 |
| INT does not Granger Cause INF | 344 | 0.32732 | 0.8056 |
| INF does not Granger Cause INT | | 1.13761 | 0.3339 |
| GASIGARCH does not Granger Cause INF | 343 | 1.81707 | 0.1438 |
| INF does not Granger Cause GASIGARCH | | 1.14317 | 0.3317 |
| GASIGARCH does not Granger Cause INT | 343 | 0.04820 | 0.9860 |
| INT does not Granger Cause GASIGARCH | | 0.79144 | 0.4993 |

The pairwise granger causality in table 8 above, show a one-way granger causality between the growth rate of oil price and the growth rate of the economy and between growth of oil price and the volatility in the stock market. It also reinforces the reverse granger causality between inflation and growth rate, with growth rate once again influencing inflation more than inflation influences growth. In addition to this, it is also determined that volatility granger causes growth as well but not inflation as was the case for stock market returns. These results suggest the following order GOIL, then GASIGARCH, then INT, then GRO, and finally INF (Since there is no granger causality between the volatility and the bank lending rates, either can be stacked before the other).

**TABLE 9**
**RESULTS FROM THE VAR SYSTEM ESTIMATION**
**(USING STOCK MARKET VOLATILITY)**

| Variable | GOIL | GASIGARCH | INT | **GRO** | **INF** |
|---|---|---|---|---|---|
| **GOIL(-1)** | 0.542*** | 0.0037 | 1.65 | 0.078** | 0.045 |
| **GOIL(-2)** | -0.097 | -0.008* | 0.14 | -0.003 | 0.013 |
| **GOIL(-3)** | -0.052 | -0.003 | -1.13 | 0.029 | -0.002 |
| **GASIGARCH(-1)** | -0.902 | 1.10*** | 9.301 | -0.552 | -1.28** |
| **GASIGARCH(-2)** | 1.717 | -0.39*** | -1.602 | -0.67 | 0.563 |
| **GASIGARCH(-3)** | -0.154 | 0.18*** | -7.798 | 0.992* | 0.241 |
| **INT(-1)** | 0.003 | 0.000057 | 0.8373*** | 0.000027 | -0.00048 |
| **INT(-2)** | -0.008** | 0.000046 | 0.11 | -0.00176 | -0.00113 |
| **INT(-3)** | 0.005* | -0.000015 | 0.008 | 0.001761 | 0.001421 |
| **GRO(-1)** | 0.0355 | -0.025*** | -2.277 | 0.432*** | -0.149* |
| **GRO(-2)** | -0.31** | 0.024*** | 1.853 | 0.107 | -0.05 |
| **GRO(-3)** | 0.082 | -0.013 | -0.47 | -0.61*** | -0.254*** |
| **INF(-1)** | 0.093 | 0.022*** | 3.149 | -0.145** | 0.425*** |
| **INF(-2)** | 0.215 | -0.018** | -1.994 | -0.001 | 0.147* |
| **INF(-3)** | 0.012 | 0.016** | -1.146 | -0.0345 | -0.432*** |

* , **, and *** indicates statistical significance at the 10%, 5%, and 1% levels respectively and Impulse response functions corresponding to this output are plotted in figure 20 in the appendix

The VAR system of equations with stock volatility above shows a relationship between the change in the price of oil and two other variables: growth and stock volatility. This implies that the growth rate of oil price has no impact on the returns to the Nigerian stock market but impacts the volatility. An increase in the growth rate of oil price decreases volatility in the stock market and increases the growth rate of the economy. Once again, it is to be noted that all variables are interconnected and as such, over dependence on oil also depends on the impact of changes in oil price on the growth rate of the economy and the volatility of the stock market. To estimate the impact of oil on both the growth of the economy and the volatility of the stock market, it is prudent to observe the reaction of these variables when there is a fluctuation in the change in price of crude oil.

*Stage 3 Results*

Based on the results from tables 6, when considering stock returns, the growth rate of the economy is influenced by the first lag of oil price growth, the third lag of the stock market returns, the fourth lag of the inflation rate and previous lags of the growth rate. From table 9, when stock market volatility is considered, the growth rate of the economy depends on the first lag of oil price growth, the third lag of stock market volatility, the first lag of inflation rate and other lags of growth, while the volatility of the stock market depends on the second lag of oil price growth, the first and second lags of the economy's growth rate, the first, second and third lags of the inflation rates and other lags of volatility. To ascertain the impact across time of oil price growth on these dependent variables looking at stock returns and stock volatility, we apply the time varying parameter approach and estimate the following regression equations:

$$Gro_t^{sr} = c_1 + \beta_{1t} Goil_{t-1} + \beta_{2t} Gasi_{t-3} + \beta_{3t} Inf_{t-4} + \varepsilon_{1t} \tag{15}$$

$$Gro_t^{sv} = c_2 + \lambda_{1t} Goil_{t-1} + \lambda_{2t} Gasigarch_{t-3} + \lambda_{3t} Inf_{t-1} + \varepsilon_{2t} \tag{16}$$

$$Gasigarch_t^{sv} = c_3 + \gamma_{1t} Goil_{t-2} + \gamma_{2t} Gro_{t-1} + \gamma_{3t} Gro_{t-2} + \gamma_{4t} Inf_{t-1} + \gamma_{5t} Inf_{t-2} + \gamma_{6t} Inf_{t-3} + \varepsilon_{3t} \tag{17}$$

"Sr" represents VAR system with stock returns and "sv" is the VAR system with stock volatility. Figures 13, 14 and 15 below show the response of each variable to changes in the growth rate of oil price contrasted with the growth rate of oil price over time to capture the level of dependence.

**FIGURE 13**
**RESPONSE OF GROWTH RATE TO OIL PRICE GROWTH RATES**
**(USING STOCK MARKET RETURNS)**

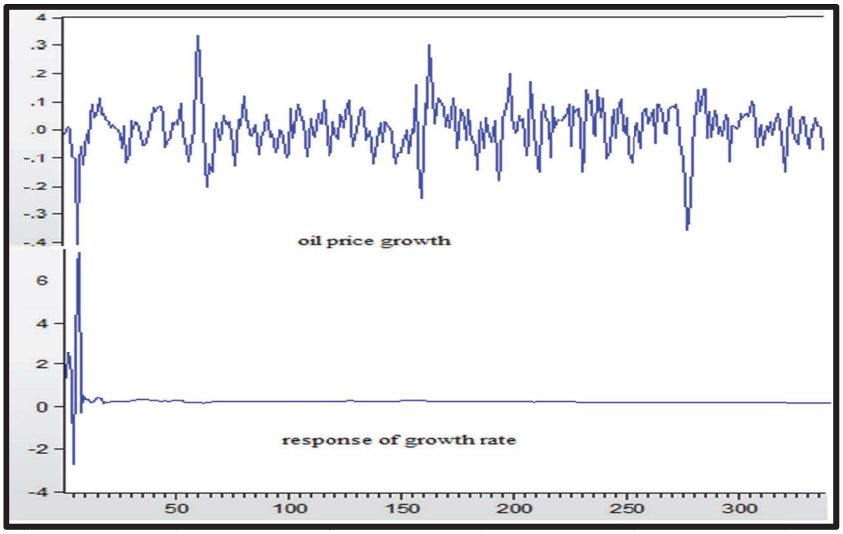



**FIGURE 14**
**RESPONSE OF GROWTH RATE TO OIL PRICE GROWTH RATES**
**(USING STOCK MARKET VOLATILITY)**

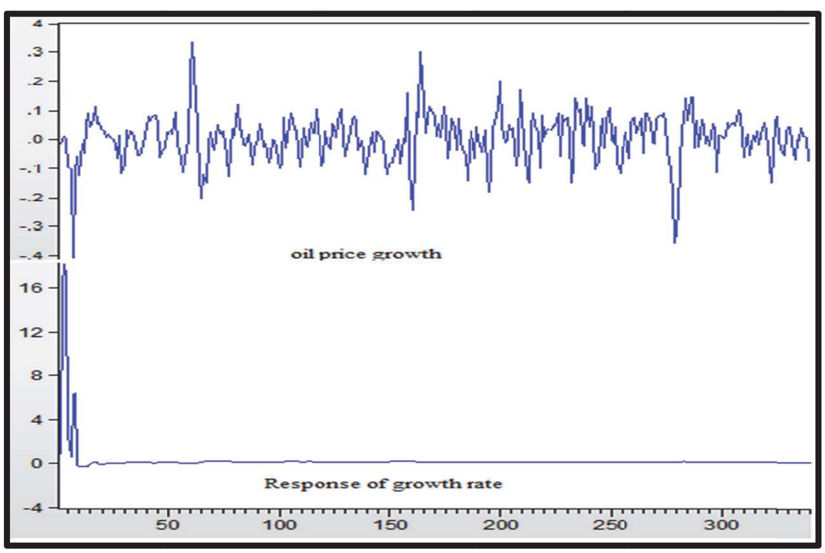
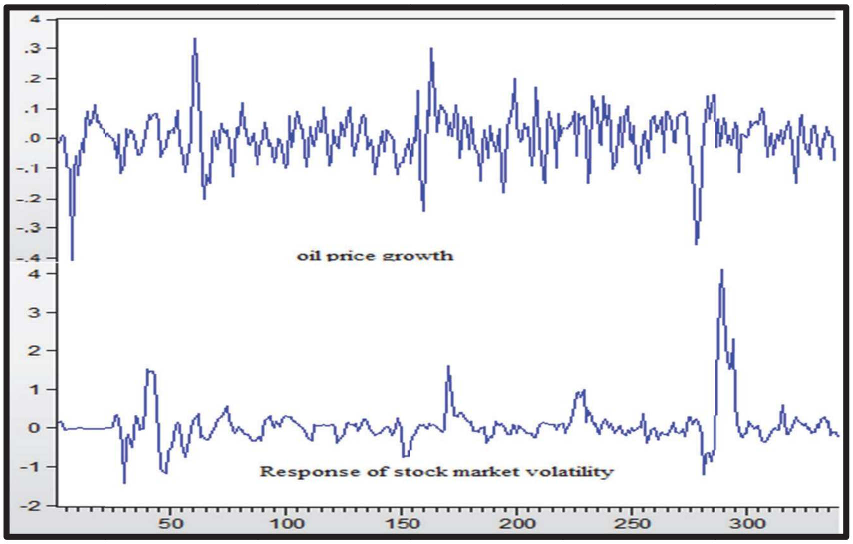


**FIGURE 15**
**RESPONSE OF STOCK MARKET VOLATILITY TO OIL PRICE GROWTH RATES**




The figures above seem to present an open and shut case with regards to the level of dependence on oil on the Nigerian economy. Figures 13 and 14 depicting the response of the growth rate to oil price change whether considering stock returns or stock market volatility show the same results; there is evidence of over dependence in the beginning of the sample, as fluctuations in oil price growth lead to sharp responses in the growth rate of the economy, but as time progressed that overdependence dies out - it would seem completely - with fluctuations in oil price growth having no effect on the growth rate of the Nigerian economy. Figure 15 however captures a level of overdependence of the volatility in the stock market on changes in oil price, as drops in oil price growth soon lead to increases in stock market volatility. An increase in volatility generally leads to a decline in investment as uncertainty increases, this in turn would imply a decline in the gross domestic product, and inevitably reduce the growth rate of the economy. This effect however, is not significantly transferred to the growth rate of the economy, implying that there are other measures in place that curtail this effect. The literature here suggests that better legal and financial institutions may be responsible for this finding (see Leong and Mohaddes (2009) and Jarrett, Mohaddes and Mohtadi (2018).

Due to the extreme response of the growth rate of the economy to oil price growth in beginning of the sample, the variation after the first few observations is not noticeable in the figures presented. To account for this, the same regressions are run but the first ten observations are omitted and the results are once again plotted in figures 16, 17 and 18.

**FIGURE 16**
**RESPONSE OF GROWTH RATE TO OIL PRICE GROWTH RATES (USING STOCK MARKET RETURNS)**

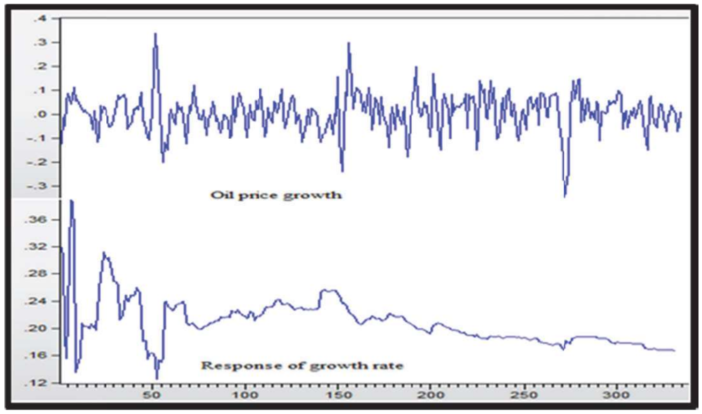



**FIGURE 17**
**RESPONSE OF GROWTH RATE TO OIL PRICE GROWTH RATES (USING STOCK MARKET VOLATILITY)**

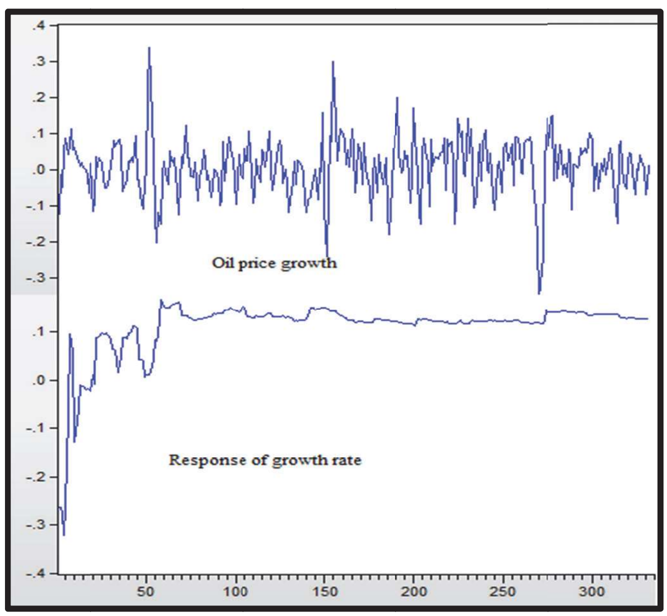
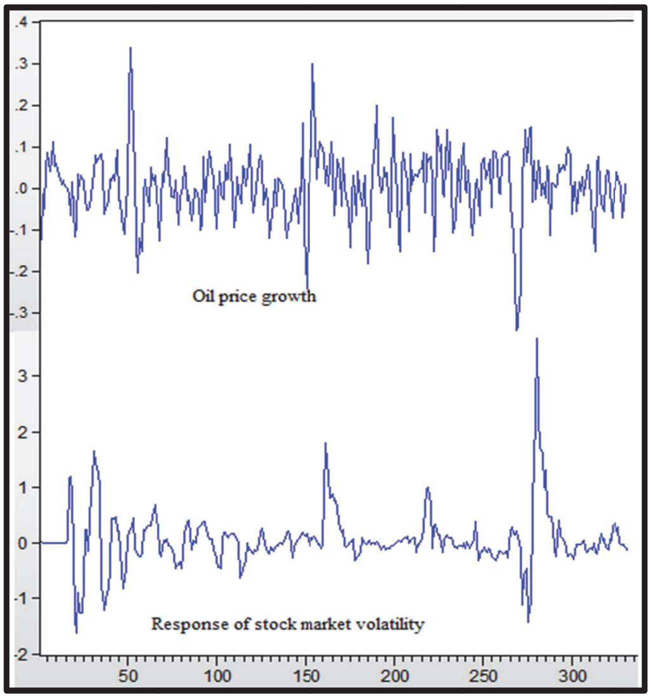


**FIGURE 18**
**RESPONSE OF STOCK MARKET VOLATILITY TO OIL PRICE GROWTH RATES**




The same observations are made in these series of figures as with figures 13, 14 and 15. The only difference is that the variation in response in growth rates to oil price does not completely die out but is significantly reduced with time. It suffices to say that the Nigerian economy might have been over dependent on oil production in the years preceding 1986, but has taken steps to decrease that dependence, as the response of growth rates to the fluctuation in the growth rate of oil prices seem to have been diminishing or at least remained relatively constant over time.

## CONCLUSION

In this paper, a tool kit is developed to investigate and detect the underlying cause of systemic risk in a particular country. In particular, the impact of an abundance of natural resources (crude oil) on the Nigerian economy is estimated using monthly data on the Nigerian stock market's all-share index (ASI), GDP, inflation rate, bank lending rates and the OPEC oil price between 1985 and 2013. The impact of crude oil on the Nigerian economy was estimated in three stages. In the first stage, it was established by using the dynamic factor model that there is in fact a basket of common variables that determined several facets of the Nigerian economy, namely; stock market returns, growth rate of the economy, inflation rates, and bank lending rates, with different weights assigned to the common factor by each facet. In the second stage, the growth rate of oil is suggested as a possible component of that basket of common variables and a VAR system of equations was estimated to determine which facets were influenced by oil price and how much time it took for the changes in oil price growth to impact different facets. It was found that oil price growth is positively correlated with the growth rate of the economy and was negatively correlated with the volatility in the stock market. In the third and final stage, estimates of this relationship were obtained over time using the time varying parameter model based on the results from the VAR estimation in stage 2. It was found that while there was evidence of overdependence on oil in the pre-1986 period of the country's development, the dependence on oil has greatly reduced as fluctuations in the price of oil does not yield severe fluctuations in the response of the growth rate of the economy even in periods of severe downturn in the growth rate of oil prices.

In light of these results, it is fair to say that the Nigerian economy has put measures in place, either in avoiding the "Dutch disease" phenomenon by developing other aspects of the economy, or hedging the stock market against drops in the price of oil or a reduction in rent seeking activities that impact the growth rate of the economy significantly. While all three are theoretically possible, evidence points to the performance of the Nigerian financial system as the best possible explanation for this phenomenon. The development in regulation and organization of the banking system in the country has done a lot to improve financial standards in the country. This coupled with the fact that the rate of corruption is still high and the relative simplicity of its agricultural sector, points to the ability of the financial system to restrict over dependence on oil. Such an analysis has definite implications for potential investors, using oil as the only indicator for successful Nigerian investments will yield a less than optimal outcome. Businesses and investors both domestic and international will do well to heed this warning.

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## APPENDIX

**TABLE 10**
**DATA DESCRIPTION**

| Variable | Description | Source |
|---|---|---|
| **Stock returns** | The first difference of the natural logs of the Nigerian stock exchange's all share index. The all share index is a weighted average the prices of all shares listed on the Nigerian stock exchange. | *FDHL Analytics (fdhlanalytics.com) *Bloomberg (Bloomberg.com) |
| **Growth of economy** | First difference of the natural log of the Gross domestic product of Nigeria | *Central bank of Nigeria (statistics.cbn.gov.ng) |
| **Growth of oil price** | First difference of the natural log of the OPEC oil price basket | *United states Department of Energy via Quandl.com *OPEC (opec.org) |
| **Inflation** | Percentage change in the GDP deflator | *Central bank of Nigeria (statistics.cbn.gov.ng) |
| **Bank lending rates** | Prime lending rates of commercial banks | *Central bank of Nigeria (statistics.cbn.gov.ng) |

**TABLE 11**
**RESULTS FROM THE ESTIMATION OF THE DYNAMIC FACTOR MODEL**

| Symbol | Variable Description | Estimate | Standard Error |
|---|---|---|---|
| $\sigma_1$ | Standard deviation of the idiosyncratic component of stock market returns | 0.974 | 0.037 |
| $\sigma_2$ | Standard deviation of the idiosyncratic component of the rate of growth | 0.057 | 0.008 |
| $\sigma_3$ | Standard deviation of the idiosyncratic component of the rate of inflation | 0.324 | 0.014 |
| $\sigma_4$ | Standard deviation of the idiosyncratic component of bank lending rates | 0.290 | 0.011 |
| $\delta_1$ | Weight of common component assigned to stock market returns | 0.010 | 0.046 |
| $\delta_2$ | Weight of common component assigned to rate of growth | 0.842 | 0.033 |
| $\delta_3$ | Weight of common component assigned to the rate of inflation | 0.737 | 0.034 |
| $\delta_4$ | Weight of common component assigned to bank lending rates | 0.018 | 0.014 |
| $\mu_1$ | Drift of the idiosyncratic component of stock market returns | 0.001 | 0.050 |
| $\mu_2$ | Drift of the idiosyncratic component of the rate of growth | -0.008 | 0.091 |
| $\mu_3$ | Drift of the idiosyncratic component of the rate of inflation | -0.019 | 0.304 |
| $\mu_4$ | Drift of the idiosyncratic component of bank lending rates | 0.010 | 0.016 |
| $\beta$ | AR coefficient of common component | 0.544 | 0.045 |
| $\phi_{11}$ | First AR coefficient of idiosyncratic component of stock market returns | 0.141 | 0.053 |
| $\phi_{12}$ | Second AR coefficient of idiosyncratic component of stock market returns | 0.168 | 0.054 |
| $\phi_{21}$ | First AR coefficient of idiosyncratic component of growth rate | 0.756 | 0.008 |
| $\phi_{22}$ | Second AR coefficient of idiosyncratic component of growth rate | 0.702 | 0.010 |
| $\phi_{23}$ | Third AR coefficient of idiosyncratic component of growth rate | -0.984 | 0.008 |
| $\phi_{31}$ | First AR coefficient of idiosyncratic component of inflation rate | -0.233 | 0.048 |
| $\phi_{32}$ | Second AR coefficient of idiosyncratic component of inflation rate | 0.130 | 0.050 |
| $\phi_{33}$ | Third AR coefficient of idiosyncratic component of inflation rate | -0.641 | 0.046 |
| $\phi_{41}$ | AR coefficient of the idiosyncratic component of bank lending rates | 0.950 | 0.016 |

**TABLE 12**
**RESULTS FROM THE ESTIMATION OF THE DYNAMIC FACTOR MODEL (WITH VOLATILITY)**

| Symbol | Variable Description | Estimate | Standard Error |
|---|---|---|---|
| $\sigma_1$ | Standard deviation of the idiosyncratic component of stock market volatility | 0.466 | 0.018 |
| $\sigma_2$ | Standard deviation of the idiosyncratic component of the rate of growth | 0.571 | 0.023 |
| $\sigma_3$ | Standard deviation of the idiosyncratic component of the rate of inflation | 0.068 | 0.017 |
| $\sigma_4$ | Standard deviation of the idiosyncratic component of bank lending rates | 0.290 | 0.011 |
| $\delta_1$ | Weight of common component assigned to stock market volatility | 0.000 | N/A |
| $\delta_2$ | Weight of common component assigned to rate of growth | 0.394 | 0.041 |
| $\delta_3$ | Weight of common component assigned to the rate of inflation | 0.619 | 0.027 |
| $\delta_4$ | Weight of common component assigned to bank lending rates | 0.018 | 0.014 |
| $\mu_1$ | Drift of the idiosyncratic component of stock market volatility | 0.001 | 0.025 |
| $\mu_2$ | Drift of the idiosyncratic component of the rate of growth | -0.014 | 0.050 |
| $\mu_3$ | Drift of the idiosyncratic component of the rate of inflation | -0.026 | 0.109 |
| $\mu_4$ | Drift of the idiosyncratic component of bank lending rates | 0.010 | 0.016 |
| $\beta$ | AR coefficient of common component | 0.530 | 0.046 |
| $\phi_{11}$ | First AR coefficient of idiosyncratic component of stock market volatility | 1.059 | 0.053 |
| $\phi_{12}$ | Second AR coefficient of idiosyncratic component of stock market volatility | -0.203 | 0.053 |
| $\phi_{21}$ | First AR coefficient of idiosyncratic component of growth rate | 0.331 | 0.044 |
| $\phi_{22}$ | Second AR coefficient of idiosyncratic component of growth rate | 0.148 | 0.050 |
| $\phi_{23}$ | Third AR coefficient of idiosyncratic component of growth rate | -0.649 | 0.043 |
| $\phi_{31}$ | First AR coefficient of idiosyncratic component of inflation rate | 0.004 | 0.001 |
| $\phi_{32}$ | Second AR coefficient of idiosyncratic component of inflation rate | 0.007 | 0.001 |
| $\phi_{33}$ | Third AR coefficient of idiosyncratic component of inflation rate | -0.958 | 0.009 |
| $\phi_{41}$ | AR coefficient of the idiosyncratic component of bank lending rates | 0.951 | 0.016 |

**FIGURE 19**
**IMPULSE RESPONSE FUNCTIONS (USING STOCK MARKET RETURNS)**

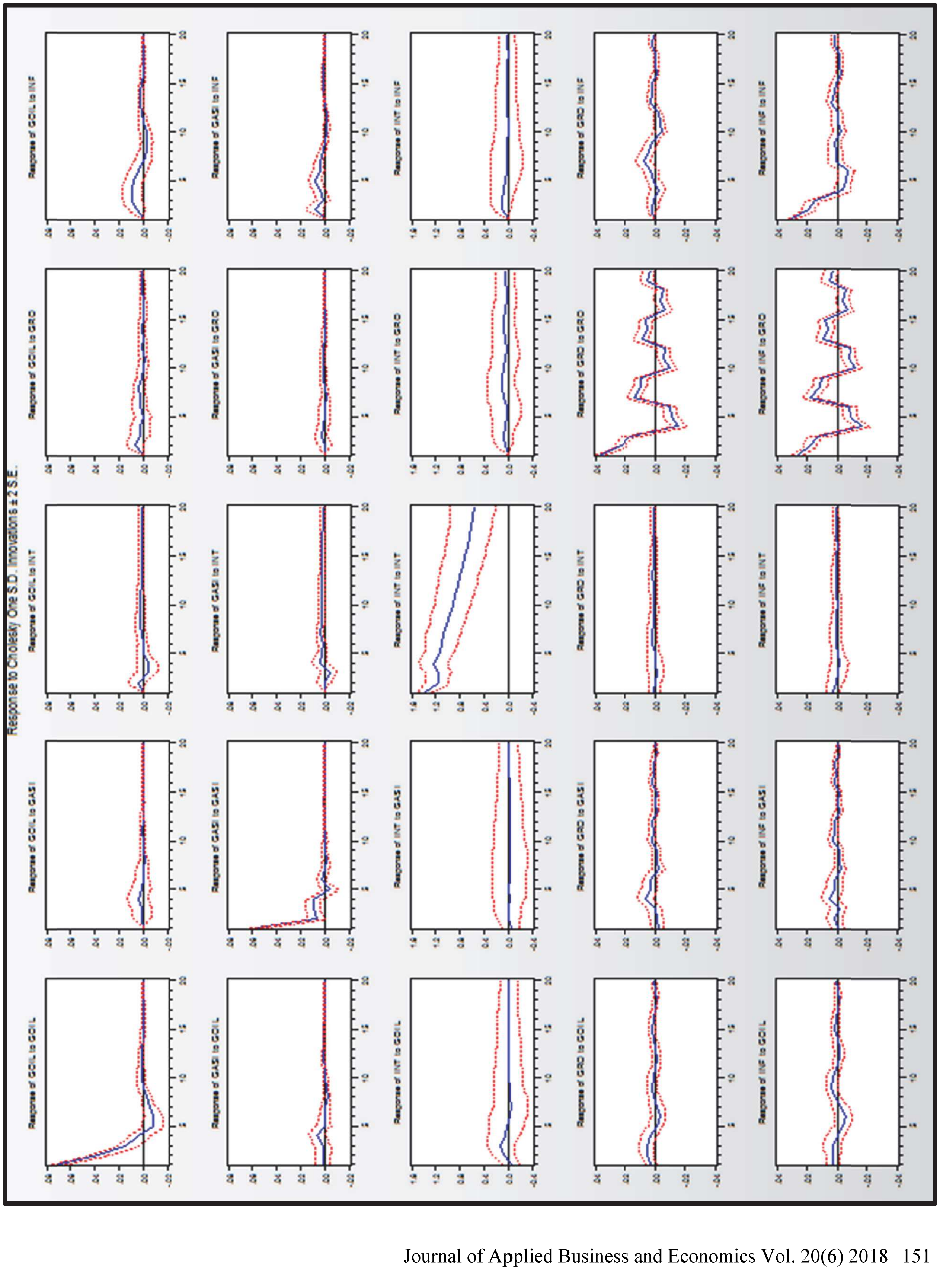

**FIGURE 20**
**IMPULSE RESPONSE FUNCTIONS (USING STOCK MARKET VOLATILITY)**