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Transmission Channel of Oil Supply Disruption on the Nigerian Economy

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Abstract:
The impact of oil and gas supply disruption on Nigerian economy has been various studied. The importance of such studies derives from the key role of oil and gas in the Nigerian economy. However, it remains to be established, the channel through which oil and gas supply disruption affects the Nigerian economy. Consequently, this study is intended to bride this knowledge gap. We use the Structural Vector Autoregressive model to assess the transmission channel of oil supply disruption on the Nigerian economy, using government expenditure and revenue as proxies. The study revealed that government expenditure does not respond significantly to oil supply disruption. Also, the result showed that government revenue channel of transmission of the effect of oil supply disruption to the Nigerian macroeconomic environment do not exist, even in the recent time.

Keywords: *Transmission channel, Oil supply disruption, Nigerian economy*

1. Introduction

On the average, the cumulative effects of supply disruptions are expected to be felt in terms of the price changes at the international market. The ripple effect of such changes is an issue open for empirical scrutiny. According to a section of the literature, there are various transmission channels through which oil price changes impact the economy; the supply-side shock effect; inflation effect; sector adjustment effect; and uncertainty effect (Chanda et al., 2015). The supply-side shock effect sees oil as a production input and therefore specifies that when oil prices change, they affect national outputs due to the changes in the cost of production. This shock effect appears to apply more to oil importing countries which rely majorly on the commodity to facilitate the production process. On the other hand, the supply-side shock can also be explained form the perspective of oil-exporting economies. In this case, for instance, increase in oil prices often lead to higher revenues that boosts investment capabilities of the economy, the rate of economic output and reduction in the level of unemployment. The inflation effect is obtainable where oil serves as production input and hence, in the event of oil price increases, production costs rises and so the price pressures in the economy.

In Nigeria, there appears to be an exclusive reliance on fossil fuels for foreign exchange and other economic activities such as electricity generation, transportation and domestic purposes. Nigeria is said to blessed with abundant energy resources; oil, natural gas and coal; the largest petroleum producer in the Africa. As at 2010 figures, Nigeria possessed about thirty-five billion barrels of oil, around one hundred and eighty-seven trillion barrels cubic feet of natural gas and close to three billion tonnes of coal (Parimal et al., 2010). Oil and gas sector accounts for about eighty percent of government revenues, about ninety percent export revenues and foreign exchange earnings, and about sixty-four percent of the country's electricity generation (Borok et al., 2013). Thus, since petroleum has remained the major source of foreign revenue, supply disruptions are bound to have attendant negative consequences on the economy.

In essence, losses in terms of revenue shortfalls due to supply disruption would represent a significant problem for the Nigerian economy (Okoli and Orinya, 2013). These disruptions are majorly carried out on the oil and gas facilities in the Niger Delta region of the country. The disruptions come in form of attacks on oil and natural gas infrastructure in the region (Onyibe and Ejim, 2016; Omojeghen, 2016).

Arguably, vandalism of oil and gas transportation infrastructure has no direct linkage with the economy except through the activities of government. Apparently, vandalism of oil and gas transportation infrastructure affects government activities by reducing government revenue or by increasing government expenditure. Oil export is the major source of government revenue in Nigeria; hence, with vandalism of oil and gas transportation infrastructure, net export of Nigeria reduces and eventually government revenue. On the other hand, vandalism of oil and gas transportation

infrastructure results as result of agitations from Niger Delta people. Government will expend more in the short term by fixing the affected infrastructure and responding to agitations of Niger Delta people which is usually cost inclusive.
The study by Ahuru and James (2013) examines the direct impact (the direct effects of oil price volatility on macroeconomic variables) and the indirect effects (the impact of oil price volatility on macroeconomic variables via public expenditure) of oil price volatility on the Nigerian macro economy. With the aid of Vector Auto regression and variance decomposition functions, the study finds that oil price volatility significantly largely influences the macroeconomic variables and the country's public expenditure and the latter exert significant impacts on most of the macroeconomic variables. Also adopting the VAR framework, Hodo et al. (2013) adopts time series spanning 1970 to 2010 to assess whether oil price shocks have nonlinear (asymmetric) effects on Nigeria's domestic investment and its exchange rate volatility.

Hence, this study recognizes government revenue and government expenditure as the channels through which vandalism of oil and gas transportation infrastructure affect macroeconomic fundamentals. The object of this study therefore is to determine the transmission channel between oil supply disruption/vandalism of oil & gas transportation infrastructure and the Nigerian macroeconomic fundamentals (exchange rate, interest rate, inflation rate and economic growth). These two channels will be examined and compared to identify the stronger channel.

2. Methodology

2.1. Estimation Procedure for SVAR Model

The methodology used in this study is the Structural Vector Autoregressive (SVAR) model. SVAR has been consistently used to analyse the effect of structural shock on an economic system.

2.2. Test the Stationarity of the Variables

Estimation procedure for SVAR, like some other time series econometric models, usually starts with unit root test. As stated earlier, this is to avoid the problem of spurious regression. Unit root test define the nature of stationarity of the series, and conclude whether the variables are I(0) or I(1).

2.3. Estimation of Unrestricted VAR Model

After the unit root result, the next step is to specify unrestricted VAR model and estimate it. For the current study, the unrestricted VAR model is specified as:

$$z_t = B_1 z_{t-1} + \ldots + B_p z_{t-p} + e_t \qquad (1)$$

where $z_t = \left(nos,\ gop,\ \text{int},\ brm,\ \text{inf},\ exr,\ exr,\ egr\right)'$, e_t is the 7x1 vector of the z_t variables and B_j is 7x7 matrix of the coefficients of lagged values of z_t .For simplicity, assuming are dealing with 3x3 matrix, the unrestricted VAR model will be;

$$\begin{pmatrix} z_{1t} \\ z_{2t} \\ z_{3t} \end{pmatrix} = \begin{pmatrix} b_{11}^1 & b_{12}^1 & b_{13}^1 \\ b_{21}^1 & b_{22}^1 & b_{23}^1 \\ b_{31}^1 & b_{32}^1 & b_{33}^1 \end{pmatrix} \begin{pmatrix} z_{1t-1} \\ z_{2t-1} \\ z_{3t-1} \end{pmatrix} + \begin{pmatrix} b_{11}^2 & b_{12}^2 & b_{13}^2 \\ b_{21}^2 & b_{22}^2 & b_{23}^2 \\ b_{31}^2 & b_{32}^2 & b_{33}^2 \end{pmatrix} \begin{pmatrix} z_{1t-2} \\ z_{2t-2} \\ z_{3t-2} \end{pmatrix} + \begin{pmatrix} b_{11}^3 & b_{12}^3 & b_{13}^3 \\ b_{21}^3 & b_{22}^3 & b_{23}^3 \\ b_{31}^3 & b_{32}^3 & b_{33}^3 \end{pmatrix} \begin{pmatrix} z_{1t-3} \\ z_{2t-3} \\ z_{3t-3} \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \end{pmatrix} \qquad (2)$$

The assumptions made about the shocks e_t allow for them to be correlated, in that $E(e_{1t}) = 0;\ E(e_{2t}) = 0;\ E(e_{3t}) = 0$; $\text{var}(e_{1t}^2) = \sigma_{11}$, $\text{var}(e_{2t}^2) = \sigma_{22}$ and $\text{var}(e_{3t}^2) = \sigma_{33}$. Usually, the basic VAR model is estimated using maximum likelihood method; however, this gives the same result with OLS method when there is no restriction. Therefore, eq. 1 can be estimated with OLS.

On important issue when estimating an unrestricted VAR is the selection of optimal lag length. It has been confirmed that more lags improve the fitness of the model but it reduces the degrees of freedom and increases the danger of over-fitting. This study used the minimum of lag selected by Akaike Information criterion (AIC) and the Schwarz-Bayesian criterion (SBC). These two statistics are measures of the trade-off fit against loss of degrees of freedom so that the best lag length is the one that minimise the two.

2.4. VAR Identification/Restriction

More generally, SVAR could be written as $A_0 z_t = A_1 z_{t-1} + B\eta_t$, with $\text{var}(\eta_{it})$ set to unity and with A_0 and B chosen to capture the contemporaneous interactions among the z_t, and along with the standard deviations of the shocks.

Unfortunately, we cannot estimate this equation directly due to identification issues, but instead we can an unrestricted VAR of the form: $A_0^{-1}C(L)z_t + A_0^{-1}B\eta_t$, To obtain the actual solution, there is need to impose restrictions on our VAR to identify an underlying structure. There are three types of restrictions, these are: (i) making the system recursive, (ii) imposing parametric restrictions on the A_0 matrix and (iii)imposing parametric restrictions on the impulse responses to the shocks ε_t. In this study, we employ the first method, based on different economic theories. The final equation after necessary restrictions is

$$Ae_t = B\eta_t \qquad (3)$$

The restriction condition for identification stated that, if there are k variables, the symmetry property above imposes k(k+1)/2 restriction on the $2k^2$ unknown elements in A and B. Hence an additional k(3k-1)/2 restrictions must be imposed. In this study, considering eq. 7, A and B matrix can be defined as below:

$$A=\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{67} & 1 \end{bmatrix} B=\begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & a_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & a_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & a_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & a_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & a_{77} \end{bmatrix}$$

Hence, with seven (7) endogenous variables, we will require 7*[(3*7)-1]/2 = 70 restrictions. With adoption of recursive restriction as in this study, identification problem is resolved, as the model will be exactly identified

2.5. Estimation

The structural equation model (eq. 3) will be estimated using maximum likelihood estimation (MLE) technique. The appropriate log likelihood for an SVAR(p) is defined as:

$$L(\theta) = cnst + \frac{T-p+1}{2}\left\{\ln\left|A_0\right|^2 + \ln\left|\Omega_s^{-1}\right|\right\}$$
$$-\frac{1}{2}\sum_{t=p+1}^{T}\left(A_0z_t - A_1z_{t-1} - \ldots - A_pz_{t-p}\right)'\Omega_s^{-1}\left(A_0z_t - A_1z_{t-1} - \ldots - A_pz_{t-p}\right). \qquad (4)$$

where A_0 is the parameter to be estimated. Alternative method of estimation is the instrumental variable (IV) method; this gives similar results as MLE when model is exactly identified as proposed in this study.

2.6. SVAR Impulse Response Function (IRF)

SVAR Impulse response function defined the time path of the response of a particular variable to own shock and shock from other variables in the SVAR system. Impulse responses to structural shocks is achieved by using the relation between the VAR and SVAR shocks of $e_t = A_0^{-1}\eta_t$, where the use of η_t as against ε_t indicates an un-normalized form, i.e. the standard deviations of the shocks are absorbed into the diagonal elements of A_0. The MA representation for a VAR specified in eq. 18 is defined as $z_t = D(L)e_t$, which will produce $z_t = D(L)A_0^{-1}\eta_t = C(L)\eta_t$ as the MA form for SVAR. This implies that $C(L) = D(L)A_0^{-1}$. Therefore, the impulse responses D_l can be regarded as the weights attached to e_t in a Moving Average (MA) representation for z_t, and can be resolved recursively. For example,

$$\begin{aligned} D_0 &= I_n \\ D_1 &= B_1D_0 \\ D_2 &= B_1D_1 + B_2D_0 \qquad (5) \\ &\vdots \\ D_j &= B_1D_{j-1} + B_2D_{j-2} + \ldots + B_pD_{j-p} \end{aligned}$$

Eq. 5 is the MA representation for VAR. As $C(L) = D(L)A_0^{-1}$, MA representation for SVAR can be defined as follows;

$$
\begin{aligned}
C_0 &= A_0^{-1} \\
C_1 &= D_1 A_0^{-1} = B_1 D_0 A_0^{-1} = B_1 C_0 \\
C_2 &= D_2 A_0^{-1} = \left(B_1 D_1 + B_2 D_0 \right) A_0^{-1} = B_1 C_1 + B_2 C_0 \\
&\;\;\vdots \\
C_j &= D_j A_0^{-1} = \left(B_1 D_{j-1} + \ldots + B_p D_{j-p} \right) A_0^{-1} = B_1 C_{j-1} + \ldots + B_p C_{j-p}
\end{aligned} \qquad (6)
$$

Finally, since D_j can be computed by knowing just the VAR coefficients $B_1 \ldots B_p$;they do not depend on the structure of the model. Thus, once a structure is proposed that determines C_0 ; all the components of C_j can be found. This presupposes that the key issue for structural impulse responses is how C_0 is to be estimated.

3. Result and Discussion

The essence of this study was to examine whether oil supply disruption affects the Nigerian macroeconomic fundamentals through fiscal channel. Basically, oil supply disruption may be expected to reduce government revenue significantly and thereby affect economic growth and other macroeconomic fundamentals negatively. On the other hand, oil supply disruption may be expected to increase government expenditure significantly, as government tend to allocate fund towards re-installation and repair of vandalized oil and gas pipeline and renegotiation with the local stakeholders in the oil rich region. As increase expenditure in the area tend to crowd-out funding for other sectors of the economy, and thereby influence other macroeconomic fundamentals adversely.

Tables 1 and 2 present the results for examining whether oil supply disruption affect the Nigerian macroeconomic fundamentals through the fiscal channel. Basically, Table 1 presents government revenue channel under full sample while Table 2 presents government revenue channel under full sample. Partial sample is also considered to examine the dynamics of the relationship changes with the recent oil supply disruption. The outcomes of these are presented in Tables 3 and 4. For concise presentation, only the relevant coefficients are reported. These are the effect of oil production shock on oil price and government revenue/government expenditure, C(1) and C(2), respectively, and the effect of government revenue/government expenditure shock on the macroeconomic fundamentals such as interest rate, broad money supply, inflation rate, exchange rate, and GDP. The parameter identification for the effect of government revenue/government expenditure shock on the macroeconomic fundamentals; C(9), C(10), C(11), C(12) and C(13), reported in the table and other SVAR parameters that are not directly related to the objective of this study are reported in Appendix 3a, 3b and 3c.

The tables also present result for the three models and likewise their respective log-likelihood to determine the optimal model. Evidently, from Table 4.8, it appears that model with oil supply disruption 2 is the optimal model, having gained relatively highest log-likelihood. Nonetheless, the result is similar to the one obtained from models with oil supply disruption 1 and 3, as the all revealed that oil supply disruption does not have significant impact on government revenue, and government revenue does not have significant impact on the Nigerian macroeconomic fundamentals. This summarizes that oil supply disruption does not transmit to the economy through government revenue. In other words, government revenue channel of transmission of the effect of oil supply disruption to the Nigerian macroeconomic environment do not exist.

Variables	Parameters	Oil disruption 1		Oil disruption 2		Oil disruption 3	
		Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Oil price	-(C1)	0.0819	0.2015	0.2434	0.2698	0.1979	0.1985
Govt. Revenue	-(C2)	0.1423	0.1095	0.0245	0.1490	0.0354	0.1093
Interest rate	-(C9)	-0.0232	0.0439	-0.0276	0.0436	-0.0288	0.0435
Broad Money	-(C10)	0.0384	0.0333	0.0287	0.0333	0.0304	0.0333
Inflation	-(C11)	-0.0028	0.0230	-0.0097	0.0229	-0.0069	0.0229
Exchange Rate	-(C12)	-0.0080	0.0839	-0.0087	0.0831	-0.0117	0.0830
GDP	-(C13)	-0.0143	0.0389	-0.0047	0.0392	-0.0090	0.0385
Model Evaluation							
Log. likelihood		1162.167		1197.205		1154.441	

Table 1: SVAR Estimates (Oil Supply Disruption and Macroeconomic Fundamentals through Government Revenue) - Full Sample
Source: Compiled by the Researcher

Note: The parameters describe the effect of oil supply disruption of oil price and domestic macroeconomic fundamentals. The full result of the SVAR parameters under the three models is presented in Appendix 3a, 3b and 3c. Log likelihood evaluates model performance and the best model based on log likelihood statistics is the one with maximum log likelihood. Asterisks, ***, ** and * indicate 1%, 5% and 10% level of significance respectively.

Surprisingly, the results remain unchanged even as partial sample of post 2002 militant strike in the Niger Delta region are observed. Considering the results presented in Table 2, it presents the results under the three models consisting of oil supply disruption 1, 2 and 3. The log likelihood results shows some level of consistency, as model 2 also emerge as the optimal model. The result nonetheless, revealed that there is no significant effect of oil supply disruption on Nigerian government revenue. This result is also supported by the remaining two models. Ultimately, it can be confirmed that government revenue channel of transmission of the effect of oil supply disruption to the Nigerian macroeconomic environment do not exist, even in the recent time.

Variables	**Parameters**	**Oil disruption 1**		**Oil disruption 2**		**Oil disruption 3**	
		Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Oil price	-(C1)	-0.1925	0.7673	0.9651	0.8715	0.0947	0.7576
Govt. Revenue	-(C2)	0.3533	0.2533	0.2605	0.2846	0.3837	0.2464
Interest rate	-(C9)	-0.0038	0.0557	-0.0146	0.0555	0.0049	0.0550
Broad Money	-(C10)	-0.0102	0.0514	0.0067	0.0508	0.0145	0.0511
Inflation	-(C11)	-0.0150	0.0147	-0.0148	0.0141	-0.0123	0.0147
Exchange Rate	-(C12)	0.0064	0.0197	0.0076	0.0179	0.0018	0.0195
GDP	-(C13)	-0.0570	0.0711	0.0070	0.0601	-0.0364	0.0718
Model Evaluation							
Log. likelihood		685.3988		702.4575		686.0753	

Table 2: SVAR Estimates (Oil Supply Disruption and Macroeconomic Fundamentals through Government Revenue) –Post-2002 Militant Strike in the Niger Delta
Source: Compiled by the Researcher

Note: The parameters describe the effect of oil supply disruption of oil price and domestic macroeconomic fundamentals. The full result of the SVAR parameters under the three models is presented in Appendix 4a, 4b and 4c. Log likelihood evaluates model performance and the best model based on log likelihood statistics is the one with maximum log likelihood. Asterisks, ***, ** and * indicate 1%, 5% and 10% level of significance respectively.

As the result shows that government revenue channel does not exist, it may be interesting to examine whether government expenditure channel exist; in other words, whether the transmission of the effect of oil supply disruption to the macroeconomic fundamentals is through increase in government expenditure. The result examining the validity of government expenditure channel under full sample is presented in Table 3, while under partial sample of the post-2002 militant strike in the Niger Delta is presented in Table 4, under the full sample model, oil supply disruption 2 still appears the optimal model will highest log-likelihood, even though it obtained similar results other models. Evidently, the result revealed that government expenditure does not respond significantly to oil supply disruption. And again, macroeconomic fundamentals do not respond significantly to changes in government expenditure on impulses from oil supply disruption. This implies that the transmission through government expenditure does not also exist.

Variables	**Parameters**	**Oil disruption 1**		**Oil disruption 2**		**Oil disruption 3**	
		Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Oil price	-(C1)	0.1164	0.2041	0.2438	0.2753	0.1823	0.2017
Govt. Expend.	-(C2)	0.1336	0.0850	0.1688	0.1153	0.0912	0.0846
Interest rate	-(C9)	0.0023	0.0394	0.0006	0.0393	-0.0005	0.0395
Broad Money	-(C10)	0.0410	0.0309	0.0358	0.0310	0.0376	0.0310
Inflation	-(C11)	0.0073	0.0217	0.0034	0.0218	0.0044	0.0217
Exchange Rate	-(C12)	0.0774	0.0802	0.0752	0.0798	0.0730	0.0800
GDP	-(C13)	-0.0207	0.0364	-0.0128	0.0369	-0.0174	0.0364
Model Evaluation							
Log. likelihood		1193.740		1231.609		1187.421	

Table 3: SVAR Estimates (Oil Supply Disruption and Macroeconomic Fundamentals through Government Expenditure) - Full Sample
Source: Compiled by the Researcher

Note: The parameters describe the effect of oil supply disruption of oil price and domestic macroeconomic fundamentals. The full result of the SVAR parameters under the three models is presented in Appendix 5a, 5b and 5c. Log likelihood evaluates model performance and the best model based on log likelihood statistics is the one with maximum log likelihood. Asterisks, ***, ** and * indicate 1%, 5% and 10% level of significance respectively.

It may also be interesting to examine whether this result holds in recent time, particular since the 2002 militant strike in the Niger Delta region. Hence, testing for the existence of government expenditure channel for the impact of oil supply disruption on macroeconomic fundamentals was conducted on partial sample. Considering the results partial sample presented on Table 4, it appears oil production disruption does not have significant impact on government expenditure, irrespective of how oil supply disruption is defined. This result is similar to the obtained for government expenditure channel under the full sample analysis. Apparently, it can be concluded that oil supply disruption does not transmit to Nigerian macroeconomic fundamentals through the fiscal channel. This happens as the channel of transmission fail to exist over long term period and in the recent time, and irrespective of how oil supply disruption is defined.

Variables	Parameters	Oil disruption 1		Oil disruption 2		Oil disruption 3	
		Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Oil price	-(C1)	0.1088	0.8050	1.4300	0.8734	0.2301	0.7836
Govt. Revenue	-(C2)	0.0721	0.1328	0.0909	0.1554	0.1019	0.1331
Interest rate	-(C9)	-0.0323	0.0520	-0.0339	0.0524	-0.0142	0.0518
Broad Money	-(C10)	0.0351	0.0479	0.0356	0.0480	0.0526	0.0482
Inflation	-(C11)	-0.0112	0.0135	-0.0096	0.0132	-0.0103	0.0137
Exchange Rate	-(C12)	0.0050	0.0199	0.0051	0.0182	0.0049	0.0202
GDP	-(C13)	-0.0962	0.0661	-0.0236	0.0590	-0.0651	0.0684
Model Evaluation							
Log. likelihood		717.5349		731.3109		716.7931	

Table 4: SVAR Estimates (Oil Supply Disruption and Macroeconomic Fundamentals through Government Expenditure) –Post-2002 Militant Strike in the Niger Delta
Source: Compiled by the Researcher

Note: The parameters describe the effect of oil supply disruption of oil price and domestic macroeconomic fundamentals. The full result of the SVAR parameters under the three models is presented in Appendix 6a, 6b and 6c. Log likelihood evaluates model performance and the best model based on log likelihood statistics is the one with maximum log likelihood. Asterisks, ***, ** and * indicate 1%, 5% and 10% level of significance respectively.

4. Conclusion

The result revealed that government expenditure does not respond significantly to oil supply disruption. And again, macroeconomic fundamentals do not respond significantly to changes in government expenditure on impulses from oil supply disruption. This implies that the transmission through government expenditure does not also exist. Additionally, the result of this study showed that government revenue channel of transmission of the effect of oil supply disruption to the Nigerian macroeconomic environment do not exist, even in the recent time.

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