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Econometric Study of the Link between Nigeria's Foreign Reserves and Oil Prices

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Abstract

The paper analyses link between external reserves and oil prices using unrestricted VAR estimation from 1996 to 2016. The results reveal that movement in oil prices deteriorates reserves level and causes deep fluctuations in government expenditure in Nigeria. However, such effect on foreign reserves is rather delayed and more prominent on the long-run. At any rate the price of oil, Nigeria's battle with propensity of foreign reserves may end up an exercise in vainness except the nation diversify from one foremost source of funding, oil. Based on findings, we recommend need for Nigeria to devise additional basis of revenue.

Keywords: unrestricted VAR, external reserves, Nigeria, oil prices, factor error decomposition, standard error movement to oil prices.

1. Introduction

In 2008, Nigeria had reserves of about US$62 billion, as at this period, oil price was trading at about US $ 103 per barrel [2]. In April 2011, oil price rose to US$129 per barrel and the volume of reserves was just US $ 32.8 billion. In February 2013, the level of Nigeria's reserves was US $ 47.3 billion, oil price only traded at US $ 118.81 [3].

With analysis of preceding data, the statement of the problem for this empirical study becomes evident. Notwithstanding high oil prices, Olowe (2009) upholds that Nigeria's excess trust on oil for its foreign exchange wants is unsustainable [8]. Juxtaposing this occurrence to the infrastructural deficit in Nigeria, the situation becomes even shoddier. Hitherto, many studies in Nigeria have been conducted on the impact of oil price shocks on national output without regards most often for its effect on macroeconomic aggregates such as external reserves and government expenditure etc.

Hence, the researcher would ask, what is the effect of oil prices on foreign reserves and government expenditure in Nigeria? In line with the research question, our objective in this study is to ascertain the effect of unstable oil prices on foreign reserves in Nigeria. The study will act as a policy document for reserve management and expenditure control in Nigeria.

2. Empirical Review

There are numerous studies on oil price effect on different economies but we intend to make our review laconic. For example, Apere and Ijomah (2013) and Oriakhi and Osaze (2013) recorded negative effect of oil price movement on Nigerian economy, a positive effect on Russia. To Ebrahim, Inderwildi and King (2014), oil price shocks affect macroeconomic variables and

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lowers cumulative demand given that income is redistributed between net oil import and export countries [1, 4, 10].

Guo and Kliesen (2005) found unidirectional relationship between macroeconomic variables and oil price with direction from oil prices [5]. To, Hamilton (2005), a factor that has diminished the rate of growth in some economies was the swift increases in international price of oil (Jin, 2008) [6]. The empirical study by Narayan and Narayan (2007) shows mixed results for both increase and decrease in oil prices on Nigerian economy [7].

Empirical research of Omojolaibi (2013) suggest oil price serves as a major determinant of real exchange rate led to puzzling results for nations exporting oil. The study by Salisu and Fasayan (2013) showed that escalating oil prices is the basis for exchange rate appreciation in nations exporting oil [9, 11].

Taiwo, Abayomi and Damilare (2012) found significant effect of oil price movements on exchange rate and that the Balassa-Samuelson working through productivity changes may be present though its economic significance is not large. Relating this instability to Nigeria, Wilson, David, Inyiama and Beatrice (2014) empirical evidence holds that oil price movement explains colossal GNP growth [12, 13].

Empirically, the consensus holds that while oil price changes have direct significant relationship with many macroeconomic variables, it does affect output growth. However, dearth of empirical literature exists regarding oil price effect on external reserves at least for the Nigerian economy. This is the gap the study seeks to close.

3. Unrestricted VAR Model, Data and Methods

Specifying the VAR model in moving average, we have vector moving average depiction of the VAR:

$$Z_t = \alpha + \sum_{i=0}^{\infty} Q_i y_{t-1} + \sum_{i=0}^{\infty} \Phi_i \mu_{t-i} \qquad (1)$$

The *Qi* matrices are the dynamic multiplier functions and moving average coefficients Φ_i are impulse-responses at horizon *i*. We orthogonalize the vector of shocks by P^{-1} to obtain a pure VAR without exogenous variables as:

$$Z_t = \alpha + \sum_{i=0}^{\infty} \Phi_i \mu_{t-i} \qquad (2)$$

$$Z_t = \alpha + \sum_{i=0}^{\infty} \Phi_i P P^{-1} \mu_{t-i} \qquad (3)$$

$$Z_t = \alpha + \sum_{i=0}^{\infty} \phi_i P^{-1} \mu_{t-i} \qquad (4)$$

$$Z_t = \alpha + \sum_{i=0}^{\infty} \phi_i s_{t-i} \qquad (5)$$

Using a lagged vector zt with index variables, we have:

$$Z_t = By_t \qquad (6)$$

Where *B* is a $(d \times k)$ aggregation matrix with $d < k$ so our VAR model

$$y_t = A(L) y_t + \mu_t, \; A(0) = 0 \qquad (7)$$

becomes:

$$y_t = D(L) Z_t + \mu_t \qquad (8)$$

$$A(L) = D(L) B, \; D(0) = 0$$

Forecasting zt by defining $G(L) = BD(L)$ to obtain:

$$Z_t = G(L) Z_t + \varepsilon_t \qquad (9)$$

Given that there exists a non-singular matrix H of which:

$$H \Sigma H' = I$$

$$\Sigma^{-1} = H' H$$

Such that

$(H \otimes I)(\Sigma \otimes I)(H' \otimes I) = I \otimes I = I$

Then, defining

$y^* = (H \otimes I)y$

$\mu^* = (H \otimes I)\mu$

We would have the derivation:

$y^* = (H \otimes X)\ell + \mu^*$ (10)

Eqn (4) becomes the Mundlak's starting point and the ensuing estimator is:

$$\hat{\ell} = [(H' \otimes X')(H \otimes X)]^{-1}(H' \otimes X')y^*$$

$$= [\Sigma \otimes (X'X)^{-1}](H' \otimes X')]y^* \quad (11)$$

$$Cov(\hat{\ell}) = V$$

$$= \Sigma \otimes (X'X)^{-1}$$

By construction,

$W = V^{-1} = \Sigma^{-1} \otimes (X'X)$

$\hat{\ell} = W^{-1}(H' \otimes X')y^*$ (12)

With *J* being the orthogonal matrix and elements of the diagonal matrix, that is, eigenvalues of *W*, we have:

$J'W \quad \forall \quad J = \Lambda_W$

Since $JJ' = J'J = I$

Eqn (4) is re-specified as:

$y^* = [(H \otimes X)J]J'\ell + \mu^*$ (13)

Empirically, VAR model estimated becomes:

$$pol_t^* = \alpha_1 + \alpha_{1,1} pol_{t-1}^* +$$

$$\alpha_{1,2} gxp_{t-1}^* + \alpha_{1,3} res_{t-1}^* + u_{1,t}^* \quad (14)$$

$$gxp_t^* = \alpha_2 + \alpha_{2,1} pol_{t-1}^* +$$

$$\alpha_{2,2} gxp_{t-1}^* + \alpha_{2,3} res_{t-1}^* + u_{2,t}^* \quad (15)$$

$$res_t^* = \alpha_3 + \alpha_{3,1} pol_{t-1}^* +$$

$$\alpha_{3,2} gxp_{t-1}^* + \alpha_{3,3} res_{t-1}^* + u_{3,t}^* \quad (16)$$

Where *pol* is oil price, *gxp* is government expenditure, *res* is foreign reserves, *t* is current period, *t-1* is one year lag. The factor error decomposition of variance from VAR framework was utilized to study the adjustment mechanism of series to exogenous shocks to long-run relations and the importance of hypothesized determinant factors in influencing Nigeria's external reserves. The research data were sourced from Nigeria's Central Bank statistical bulletin.

4. Empirical Results

The results of the impulse response functions are presented in graphical form as shown in figures 1 and 2 below. The figure displays the impulse-response functions of the responses each of other variables exhibits to a standard error movement to oil prices over the targeted period. These results reveal the marginal direction of movements each of the variables will make in a given quarter subsequent to a standard error movement in oil prices.

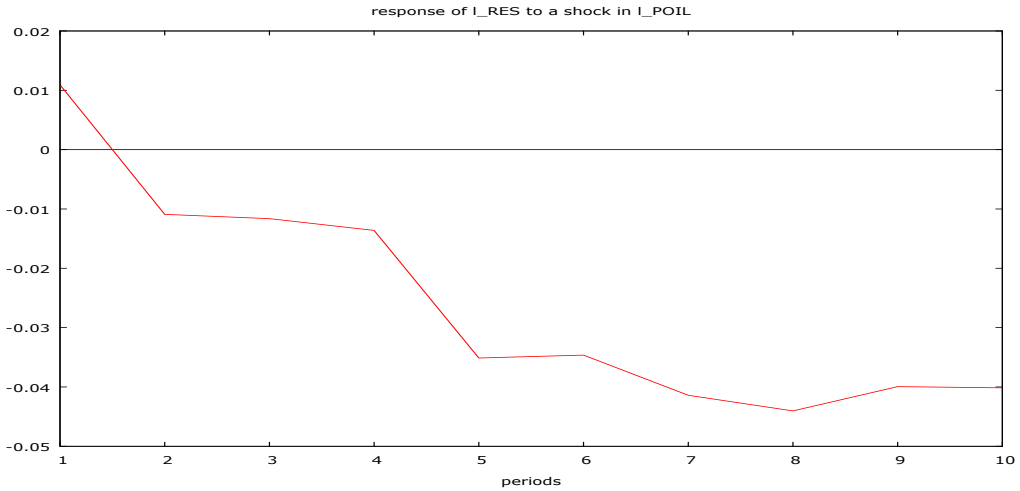

Fig. 1. Responses of External Reserves to Oil Price Movement
Source: Authors' Results

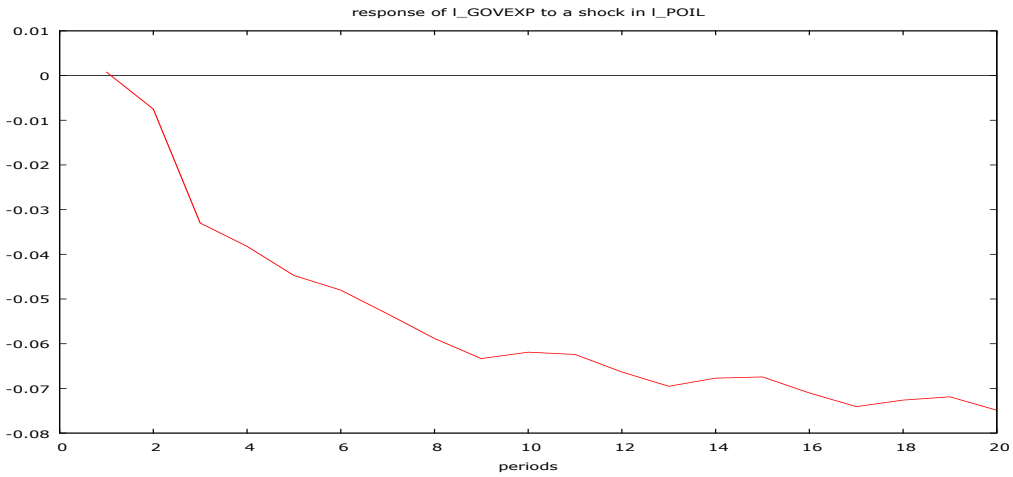

Fig. 2. Responses of Government Expenditure to Oil Price Movement
Source: Authors' Results

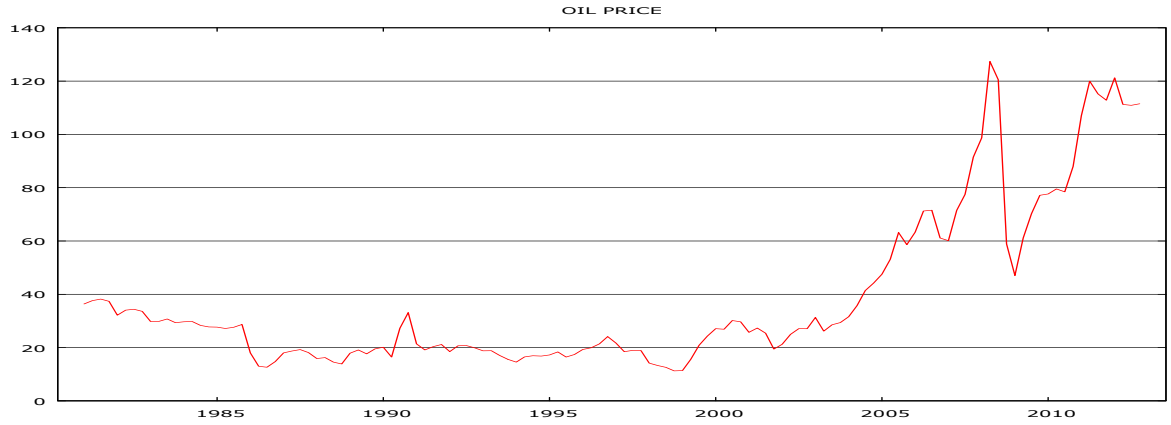

Fig. 3. Oil Price Movement
Source: Authors' Work

Oil price movement diminishes public spending and foreign reserves for period of study. This result affirms that oil price oscillation and its movements exert clear deleterious effects on the 'macroeconomic variables' in Nigeria. Apparently, this empirical findings from VAR analysis lays credence to theoretical expectations and modeling techniques.

Table 1. Results of Unrestricted VAR Output

Variables	Log(pol)	Log(gxp)	Log(res)
Constant	-1.186a	-1.143c	1.751c
Log(res)1	0.971a	0.372c	1.132b
Log(res)2	0.135	0.167	0.462a
Log(res)3	-0.291b	-0.291b	0.116a
Log(pol)1	0.125b	-0.106a	-0.276b
Log(pol)2	0.131a	-0.167b	-1.034b
Log(pol)3	0.194a	-0.198a	-1.425a
Log(gxp)1	0.026	0.928b	-0.728c
Log(gxp)2	0.378c	0.562b	-0.069
Log(gxp)3	0.075	0.079c	0.083b
Adj. R-squared	0.931	0.925	0.96
F test of zero restrictions on all VARs	0.66 [0.05]	0.95 [0.00]	0.36 [0.87]
Maximum Lag.	3	3	3
a(b)(c) indicate significance @1%(5%)(10%) respectively			

Source: Authors' Results

The VAR results are pictured in Table 1 below and it can be seen that the first lag of foreign reserves also impacted positively on current reserves. Also, foreign reserves lagged two periods is significant and is positive. This affirms that reserves in Nigeria significantly respond to their past value which is a distributed lags application. Thus, the movement in oil price tends to affect pattern of public spending plus reserves in Nigeria.

Table 2. Forecast Error Variance Decomposition of the Variables

Decomposition of variance for Log(pol)				
Period	Std. error	Log(pol)	Log(gxp)	Log(res)
1	0.45	100	0.00	0.00
4	0.34	45.24	2.67	8.49
8	0.91	69.52	5.22	2.65
10	0.37	57.14	7.53	3.73
Decomposition of variance for Log(gxp)				
1	0.24	0.31	99.99	0.00
4	0.30	4.65	93.84	0.26
8	0.19	25.12	72.51	0.55
10	0.22	35.22	65.75	0.24
Decomposition of variance for Log(res)				
1	0.14	0.19	4.52	95.29
4	0.27	19.61	10.28	69.57
8	0.38	39.64	14.36	41.50
10	0.43	44.29	15.47	26.58

Source: Authors' Results

The error decomposition results shown in Table 2, reveals oil price movement plays a momentous role in the decomposition of government spending. The decomposition of government spending shows that oil prices explain a very proportion of the variances especially from the eight quarter. The value of the variation due to oil price movement reached 35 % in the tenth quarter. Oil prices also played a significant task in explaining error variances in foreign reserves. Government

spending also explains enormously variation in foreign reserves. Indeed, after tenth quarter only 26.58 percent of variation in foreign reserves was explained by itself.

5. Conclusion

This study empirically explored the association between oil price movement and external reserves in Nigeria utilizing unrestricted VAR method of estimation. The analysis and results showed that the movement in oil prices deteriorates the reserves level and causes deep fluctuations in government expenditure in Nigeria. The movement in oil prices seems to be a persistent factor in its trend over the targeted period. Hence, it is not usually the general oscillation in oil prices that raises questions about its relationship with other macroeconomic variables; it is rather its deep fluctuations.

Apparently, the over reliance on oil for most macroeconomic and fiscal operations has significantly tied the Nigeria's economy to a knife-edge in its prices which are mostly exogenously determined. At any rate the price of oil, Nigeria's battle with propensity of foreign reserves may end up as an exercise in vainness except the nation diversify from one major source of funding government expenditure, oil.

The study so recommends need for Nigeria to devise additional basis of revenue other oil. In fact, macroeconomic internal balance is essential for improvement in the reserve base of Nigerian nation. The Nigerian government should preserve fiscal discipline in its spending to improve real sector of the economy. Discreet foreign reserves policy should be implemented.

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УДК 33

Эконометрическое исследование взаимосвязи между валютными резервами Нигерии и ценами на нефть

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Аннотация. В статье анализируется связь между валютными запасами и ценами на нефть с использованием неограниченной оценки VAR за период 1996 по 2016 гг. Результаты показывают, что изменение цен на нефть ухудшает уровень запасов и вызывает сильные колебания государственных расходов в Нигерии. Однако такое влияние на валютные резервы является довольно сдержанным и более заметным только в долгосрочной перспективе. Исходя из полученных данных, авторы рекомендуют Нигерии разработать дополнительную основу доходов.

Ключевые слова: неограниченный VAR, внешние запасы, Нигерия, цены на нефть, факторная погрешность декомпозиции, стандартная погрешность в ценах на нефть.

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