International Reserve and Oil Price Movement: Evidence from Nigeria

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The impact of oil price changes on aggregate economic activities has been a focal point of research since the 1970s and the research has often produced mixed results. For a small, open oil-exporting country like Nigeria, the effect of oil price changes is expected to be strong on international reserves accumulation. This paper examines the relationship within the Mundell-Fleming framework with special focus on Nigeria. Using a Vector Autoregressive (VAR) Model, this study explores the linkage over the period 1960-2011 and finds that oil price affected reserve holding in the long-run with relatively minimal effects in the short-run. While results of the impulse response functions showed that oil price affected external reserve holding, variance decomposition analysis revealed a marginal impact.

Keywords: Reserves, Vector Autoregression (VAR), Interest Rate, Inflation, Impulse Response Function, Forecast Error Variance Decomposition.

JEL Classification: F31, Q41.

Introduction
External reserves accumulation is determined by governments in line with their macroeconomic objectives and associated cost involved. Since 2004, Nigeria has experienced phenomenal growth in foreign exchange reserves traceable to rising global crude oil prices. Over-reliance on crude oil for over 90 percent of Nigeria’s foreign exchange earnings makes its external balance susceptible to oil price fluctuations. Nigeria’s reserve stock has risen from a mere US$0.15 billion in 1970 to over US$51 billion in 2007, equivalent to 1.7 and about 29 months of import cover respectively. However, this remarkable feat was reversed as reserve stock declined from about US$53bn in 2008 to about US$42bn, US$32bn and US$33 in 2009, 2010 and 2011 respectively. This trend, relative to the high accumulation experienced in the first half of the last decade, may be attributed basically to unfavorable global crude oil market conditions, high import financing, and foreign exchange market intervention (Bankole et al., 2013 and Shuaibu and Mohammed, 2013).

Evidently, the boom- and bust-like patterns of reserves accumulation put great pressure on fiscal and monetary policies thus hindering the attainment of desired macroeconomic stability and growth particularly via the nominal anchor and price mechanism. The transmission mechanism of oil price variations on countries vary from the supply to demand
effect to the terms-of-trade effect (Lardic and Mignon, 2006; Sill, 2007; Ibir and Zouari-Ghorbel, 2009). On the supply side, higher oil prices imply a reduction in factor inputs leading to a precipitous slowdown of output. On the demand side, higher oil prices increase the general level of prices and with a reduction in real income available for consumption, demand falls (Farzanegan and Markwardt, 2009).

This study is motivated by the need for improved empirical estimates of external reserves determinants as well as oil price movements, in view of its critical role in sound macroeconomic policy formulation particularly for a resource-dependent economy like Nigeria. While researches conducted for Nigeria (See Adamu, 2000; Osamwonyi, 2002; Oaikhenan and Umoru, 2008; Bankole et al. 2011; Shuaibu and Ibrahim, 2013; Abdullateef and Waheed, 2010 amongst others), none of the previous studies has used a Vector Auto Regression (VAR) model to analyse this critical linkage. Rather, the focus of these studies has been on the use of cointegration and error correction modelling approach which often ignore the role of these variables in explaining reserve accumulation particularly within a system.

Further, the use of this technique is motivated by its atheoretical nature and the fact that the relationships being investigated are not theoretically directly related. It is pertinent to note that none of the studies is focusing on Nigeria and data used for most of the cross-country and groups of country studies did not include Nigerian data. Apart from the non-inclusion of Nigeria in prior cross-section studies, differences in structural and institutional characteristics of Nigeria as a predominantly oil-exporting country is important to warrant this country case analysis. As noted by Usman (2005), the vulnerability of key macroeconomic variables to international oil price turbulence is reflected in the rise and fall of Nigeria’s foreign reserves. This makes the inclusion of international crude oil price as an explanatory variable in a model of reserves movement within an open economy framework crucial.

This paper seeks to contribute to the debate by offering empirical explanation to the question; “to what extent do certain macroeconomic factors such as interest rate, exchange rate and inflation not captured by traditional international reserve models explain observed holding of international reserves?” Specifically, this paper seeks to estimate the effect of global crude oil prices on external reserve accumulation in Nigeria. The rest of the paper is organized as follows. Section 2 presents stylized facts about foreign reserve and oil prices, among other explanatory variables while Section 3 reviews related theoretical, methodological and empirical literature on factors influencing international reserves behaviour. Modelling issues and empirical analysis are explored in Section 4. The paper is concluded in Section 5.

II. Foreign Reserves, Crude Oil Price, Interest Rate, Inflation and Exchange Rate in Nigeria

The issue of foreign reserve management in Nigeria began with the emergence of the First National Development Plan (1962-68) and the 1967-70 Civil war which was characterised by massive fiscal expenditures and the resultant persistent depletion of external reserves and declining international trade. Crude oil has, since its discovery in commercial quantity, contributed significantly to reserve accumulation and dominated the revenue-expenditure-foreign exchange profile of Nigeria. As a major oil producer and the sixth largest exporter of crude oil among the Organization of Petroleum Exporting Countries (OPEC), prolonged oil glut led to current account deficits and subsequent economic turbulence experienced in the 1980s and 1990s.

Accumulation of reserves occasioned by the increasing crude oil prices led to a steady decline in the balance of payment deficits in the 2000s. Hence, two phases of reserve accumulation and depletion have occurred contemporaneously with the major oil price shocks and economic imbalances namely inflation and unstable exchange rates over the period of 1970-2007. During the periods 1970-1971, 1973-1975, 1979-1980, the net performance of the external sector occasioned
by increased oil export and crude oil prices resulted in significant accumulation of foreign reserves whereas in the year 1972 and the periods 1976–78 and 1981–82 balance of payments crisis induced primarily by a decrease in crude oil prices culminated in a rapid depletion of external reserves. Due to the boom-bust cycle, Nigeria’s earnings from petroleum exports dramatically fell from over US$25 billion in 1980 to US$6.4 billion in 1986.

Recently, despite disruptions in crude oil extraction due to unrest in the Niger-Delta and vandalisation of oil pipelines and other installations, persistent and unprecedented rise of international crude oil prices in addition to other economic reforms have led to phenomenal growth in external reserves position of US$1.3 billion in 2006 (equivalent to about 20 months of import cover) to approximately US$53 billion in 2008 (16 months of import cover). While a sharp decrease to about US$43.2 billion was recorded in 2009, international reserves further fell to US$32.3 billion and US$32.6 billion in 2010 and 2011, respectively. The weak performance observed in recent times may be attributed to the global economic slowdown occasioned by the Euro Zone crisis as well as reduced demand by the for Nigeria’s crude oil exports by the European Union and United States of America (USA).

External reserve registered a sharp rise in the 1973-1974 periods due to the first oil price shock influenced by the oil embargo in October 1973. The 1980s represent the period of the oil glut which reduced oil export earnings and reserves. The period was also characterized by external indebtedness. Increase in oil exports in the 1990s raised reserve holdings to levels higher than in the 1970s and 1980s. The trend of external reserves in the 1990s was relatively stable except for 1992 which saw a sharp decline from US$4.15 billion in 1991 to a mere US$1.55 billion and then rose sharply to US$42 billion in 2009. Since 1999, external reserves witnessed a relatively stable and gradual pile up attributable to government’s tight fiscal stance and reduced debt service burden induced by the debt relief program.

Figure 1 depicts annual percentage variations in external reserves of Nigeria and in world crude oil price. The figure shows that international reserves holding in Nigeria moves in tandem with global crude oil price movements as they both took a similar trend albeit slight fluctuations over the period 1960 to 2011 are discernable. This co-movement is more glaring in the last decade except for the mid-2000s during which foreign reserves movement departed from the regular pattern. This was perhaps due to reduced crude oil production occasioned by militant activities in the Niger-Delta area. Figure 2 shows the trend of international reserves, interest rate, inflation and exchange rate. It reveals fluctuations in exchange rate while interest rates variation was minimal. Corroborating Figure 1, a co-movement between external reserve accumulation and crude oil price is observed in Figure 2. A significant upward movement in exchange rate can be seen in the last quarter of the 1990s while interest rate and the general price level maintained a similar trend.
Review of Literature

In the post-1973 period, most countries shifted from fixed to flexible exchange rate regime. Consequently, attention focused on examining the implication of such policy shift on external reserve holding with reference to the stability of domestic macroeconomic variables. Also, other studies examined the stability of the demand for reserve function particularly with respect to the oil price shocks after 1973, that is, whether the deviation of the prices influenced reserve holding behaviour (Bahmani-Oskooee, 1988). Sudden increments in world oil prices could lead to contemporaneous jump in the value of imports and the variability of the balance of payments. This alters reserve holding behaviour of oil importing countries and distorts domestic macroeconomic fundamentals such as prices and money supply.

Over 90% of Nigeria’s foreign exchange inflows and outflows are denominated in the US dollar (Usman, (2005), Tella (2007), Obaseki (2007)) as its crude oil receipts and other non-oil exports are invoiced in the US dollar while most of its obligations such as external debt service and foreign exchange market intervention are carried out with the US dollar and require some level of foreign reserves depletion. This suggests that Nigeria’s external reserves act as a buffer against unforeseen exigencies (See Nda, 2006). Bankole et al. (2011) found that both the precautionary and mercantilist motives explain holding of foreign reserves in Nigeria.

In a review of Nigeria’s foreign reserve management, Obaseki (2007) showed that the country’s reserves have been managed over the years by correspondent banks abroad as well as reputable international investment companies. The author concludes that apart from the exchange rate mechanism, other factors influence the design of a framework for reserves management in Nigeria and they are the state of the money market and balance of payments. This lends support for the need to assess macroeconomic determinants of external reserves taking into cognisance the simultaneous role of internal and external factors such as domestic prices, interest rates and exchange rates amongst others. Abdullateef and Waheed (2010) went further to examine the implication of investment, inflation and exchange rate for Nigeria’s external reserve holding using Ordinary Least Squares (OLS) and Vector Error Correction (VEC) and found that changes in reserves influence foreign direct investments and exchange rates but found no influence on reserves over domestic investments and inflation rates.

Some studies on the behaviour of international reserves have estimated functions that take into account the volume of imports or income, the marginal propensity to import, the opportunity costs of holding reserves and a variability measure of the balance of payments (Badinger, 2004; Parent and Gosselin, 2005; Nor, Azali and Law, 2011). These variables are inadequate for understanding reserve behaviour especially within the context of an open oil-exporting country that is susceptible to external shocks and which requires internal adjustments via the nominal anchor and pursuit of price stability. Shuaibu and Ibrahim (2013) estimated a demand for reserve model for Nigeria using the error correction mechanism in the bounds testing approach to cointegration within an autoregressive distributed lag framework. The empirical estimates reveal that expected export receipts, variability of export earnings and the one period lagged value of external reserve significantly affect reserve holding in Nigeria.

Bahmani-Oskooee (1988) used Quandt’s log-likelihood ratio technique and the Chow test to show that the shift in the pattern of demand for reserves in 17 less developed economies could have also been caused by the 1973 oil price shock in addition to
exchange rate regime changes. Because oil is an international commodity consumed by every trading country in the world, an increase in its price could have implications on international reserves as well as on the function’s structural stability. Pereira (2008) showed that the rise in oil prices in 2008 reduced the import cover of foreign reserves in Samoa from 4.0 months to 3.6 months. According to the author, the pressure on reserves was relieved by growth in tourism receipts and private remittances, while the exchange rate remained pegged to a basket of four currencies (Australian dollar, New Zealand dollar, Fijian dollar and Euro pound). Thus, monetary policy was kept tight to protect the economy from second-round effects of the rise in imported fuel prices and to ease the pressure on foreign exchange reserves whilst considering possible adverse effects of higher interest rates and prices on private investment.

Most empirical researches on international reserves establish a relatively stable long-run demand function for reserves based on a limited set of explanatory variables. In a recent study, Bahmani-Oskooee and Hegerty (2011) tested the stability of the reserve demand function using panel data, without incorporating any adjustment process into the testing procedure when providing evidence of instability in reserve demand. The authors utilised the bounds testing approach to error correction modelling that incorporates the adjustment process, to show that reserve demand function is stable in 20 of the 22 Organization for Economic Co-operation and Development (OECD) countries. According to Gosselin and Parent (2005) there is a relatively stable long run reserve demand function that depends on five categories of explanatory variables: economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility and the opportunity cost. Reserve holding is expected to increase with economic size and the volume of international transactions. Thus, in view of the nature of commodity base production and oil export in Nigeria, both the level and growth rate of output are expected to influence reserve accumulation. Increased current and capital account vulnerability should motivate Central banks to hold more reserves, while exchange rate flexibility reduces demand for reserves. Economic theory predicts that the higher the opportunity cost of holding reserves the lower would be the demand for reserves.

ECB (2006) asserted that the unprecedented accumulation of official foreign currency reserves can be seen as the outcome of oil price hikes. While there has been a significant surge in oil prices, which has been particularly strong since 2004, resource dependent economies have had a remarkable increase in the volume of their oil exports. The study suggested the use of oil wealth funds and sovereign wealth funds as supplements to external reserve accumulation. They argued forcefully that the main rationale for setting up oil funds as supplements to reserves in recent years is that oil prices are highly volatile and unpredictable. Moreover their role towards domestic stability and sustainable confidence-building in the economy cannot be over-emphasized.

Oomes and Kalcheva (2007) examined whether the effect of oil prices on the real effective exchange rate is significantly positive after controlling for, amongst other variables, international reserves position. They presented evidence of a stable long run relationship between the real exchange rate, the oil price, the productivity differential, government consumption, international reserves, and the corruption index. Their results also suggested that real appreciation is negatively associated with foreign reserves accumulation as a one percent increase in reserves is associated with a reduction in the level of the real exchange rate by 0.18 percent in their baseline cointegrating equation. The long-run effect of foreign exchange interventions on the real exchange rate should theoretically be zero, because unsterilized foreign exchange interventions should lead to inflation that eventually, as prices fully adjust, offsets the negative short-run effect on the real exchange rate.

Aizenman and Sun (2010) studied the degree to which emerging markets adjusted to the global liquidity
crisis by drawing down their international reserves. They find that only about half of the emerging market economies depleted their reserves as part of the adjustment mechanism. The authors go further to compare pre-crisis demand for foreign reserves of countries that experienced sizable reserve depletion, to that of countries that did not, and find that trade related factors (such as trade openness, primary goods export ratio, especially large oil export) seem to play a significant role in accounting for the pre-crisis reserve/GDP ratio of countries that experienced a sizable usage of reserves during the first phase of crisis. Their findings suggested that countries that internalized their large exposure to trade shocks before the crisis used their reserves as a buffer stock in the first phase of the crisis. They also found that in the case of countries that refrained from a sizable reserves depletion during the first phase of crisis, financial factors seem more important than trade factors in explaining the initial reserve/GDP ratio.

Rizvi, Naqvi, Ramzan and Rizavi (2011) analyzed the economy of Pakistan during the period of 2001-2006 with reference to the probable use of reserves accumulation as a monetary tool and found convincing evidences that reserves were being accumulated excessively in that period which impacted positively on GDP, export and import growth; thereby stabilising exchange rate; and reducing debt burden and deficits.

There are different perspectives as to why countries hold international reserves and this is often driven by the macroeconomic objectives and peculiarity of a particular economy. While for example Aizenman and Riera-Crichton (2007) viewed foreign reserves as a self insurance mechanism, Dooley, Folkerts-Landau, and Garber (2003) and Aizenman and Lee (2007) view international reserves as a driver of export-led growth. These notions have been examined by some studies that have estimated long-run demand for reserves models to examine the long- and short-run factors that determine reserve accumulation (See Nor, Azali and Law, 2011; Ball and Reyes, 2006; Badinger, 2004; Sehgal and Sharma, 2008; and Khan and Ahmed, 2005 amongst others).

**Methodology**

**Conceptual Framework**

This paper is based on the open economy macroeconomic framework as we consider a Mundell-Fleming model under a managed floating exchange rate system in which money stock plays a key role, indirectly affecting the balance of payment (BOP) through its effects on interest rate, capital movement, exchange rate and real output. The open economy framework utilised is based on the assumption that prices are rigid. Three equilibrium states are considered; real equilibrium, monetary equilibrium and external balance. These markets are governed by the following equations:

\[
\begin{align*}
y &= \varphi(y, i) + x_0(\pi, e) - m(i) \quad \cdots \quad (1) \\
M &= \varphi(y, i) \quad \cdots \quad (2) \\
x_0 - m(y, i) + K(i - i^*) &= 0 \quad \cdots \quad (3)
\end{align*}
\]

Equations 1, 2 and 3 show the real, monetary and balance of payment equilibrium. \( y \) is aggregate demand, \( \varphi \) is absorption, \( x_0 \) implies export, \( \pi \) is domestic price level, \( e \) is the exchange rate, \( m \) is import, \( M \) is money stock and \( K \) denotes net capital inflow/outflow. Equation (1), aggregate demand is a positive function of income. With respect to interest rate, an increase causes aggregate demand to change in the opposite direction via a possible fall in investment and presumably also consumption while the opposite applies for a fall in interest rate. Furthermore, the model takes into account, the fact that a higher interest rate involves a decrease in demand for both domestic and imported goods. This implies that \( \varphi(i) - m(i) < 0 \) because \( \varphi(i) - m(i) \) is the effect of an interest rate increase on domestic demand for commodities. Equation (2) shows equilibrium in the money market. Equation (3) is the BOP equilibrium and it implies that net capital flows is an increasing function of interest rate differential. The greater the domestic interest rate with
The Model
We specify an empirical model for estimation in which we relax the assumption of international reserves being stationary at equilibrium based on the notion that the monetary authorities will intervene in the foreign exchange market to stabilise the exchange rate. The assumption that prices are rigid is also relaxed due to the fact that prices are responsive to interest rate changes. The model is stated as follows:

\[ R_t = f(OP_t, IR_t, INF_t, ER_t) \]  

Where \( R_t \) is international reserves at time \( t \), \( OP_t \) is international crude oil price, \( IR_t \) is interest rate while \( INF_t \) and \( ER_t \) denote inflation and exchange rate, respectively. A priori, we expect the coefficients of oil price and interest rate to have positive signs while that of inflation rate is expected to be negative when viewed in terms of the automatic adjustment mechanism under fixed exchange rates.

Estimation Technique
Vector Auto Regression (VAR) Specification
The VAR model proposed by Sims (1980) is used to capture the impact of oil price, interest rate and inflation on Nigeria’s external reserve. Based on the assumption of simultaneity between a set of variables, they should be treated on the same level in that there should not be any a priori distinction between exogenous and endogenous variables. The use of VAR is based on the fact that VAR models consider the dependence of the current level of each variable on its past movement and all other variables in the system inclusive. Analogous to traditional macro econometric models, VAR systems make few assumptions about the economy and focus entirely on deriving a good statistical representation of the past interaction between variables. The integrated order of \( K \)-dimensional VAR of order \( p \) is given by:

\[ y_t = \theta + \sum_{i=1}^{p} \Pi_i y_{t-i} + \mu \]  

Where a vector of dependent variables within the system is denoted by \( y_t = (y_{1t}, \ldots, y_{mt}) \), \( \Pi_i \) are \((K \times K)\) coefficient matrices, \( \mu = \mu_1, \ldots, \mu_m \) is a vector of non-serially correlated errors with zero mean and contemporaneous variance matrix \( \sum \Pi \mu \). \( \prod \Pi \) is a matrix of polynomials in the lag operator.

Equation (5) is decomposed to give the individual equation that takes the following form:

\[ y_{mt} = \alpha_m + \sum \Pi y_{mt} + \sum \Pi y_{mt} + \cdots + \sum \Pi y_{mt} + \mu \]  

Where \( (\prod \Pi)_{mn} \) indicates the \((m, y)\) element of \( \prod \Pi \)

The \( p^{th} \) order VAR can be represented as first order VAR below:

\[ y_t = \theta + \sum_{i=0}^{p} \Pi_i y_{t-i} + \mu \]  

\( Y_t \) is a \((5 \times 1)\) vector of observations at time \( t \) for the variables (\( R = \) Reserves, \( OP = \) Oil Price, \( IR = \) Interest Rate, \( ER = \) Exchange Rate and \( INF = \) Inflation) utilised in the analysis. The VAR equation earlier outlined (From equation (5)) can be compactly represented becomes:

\[ Y_t = \theta + \sum_{i=0}^{p} \prod_i y_{t-i} + \mu \]  

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Where \( \mathbf{\alpha} = (\alpha_1, \ldots, \alpha_4) \) is the (4x1) intercept vector of the VAR, \( \prod \) is a sequence of (5x5) matrix of autoregressive coefficients for \( i = 1, \ldots, p \), while \( \mathbf{\mu}_i = (\mu_{i1}, \ldots, \mu_{i5}) \) is the (5x1) generation of a vector of shocks or disturbances to the system. The Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC) will be used to choose the lag length (p) of the VAR. The rule of thumb is usually to choose the AIC or SIC with the lowest value.

The dynamic behaviour of \( Y_t \) is controlled by the equation 9;

\[
\prod(L)Y_t = \mathbf{\alpha}^t + \mathbf{\xi}_t \tag{9}
\]

Where \( \prod(L) \) is an nth or 4th order matrix of polynomials in the lag operator (p) such that;

\[
B(L) = B_0 - B_1 L - B_2 L^2 - \ldots - B_p L^p \tag{10}
\]

\( B_0 \) is the non-singular matrix normalized to have one on the diagonals and covers the short run interaction between the variables in the vector \( y_t \) and \( \mathbf{\xi}_t \) is a vector of structural disturbances and is serially uncorrelated.

**Identification of Restrictions**

There are different approaches of specifying the restrictions in a bid to identify the structural parameters. A simple way is to orthogonalise reduced form errors by Cholesky Decomposition as applied by Sims (1980). This technique for identification requires that the system of equations follow a recursive scheme. Cholesky Decomposition is used to construct the variance decomposition and impulse responses. This technique decomposes the residuals from each equation in the VAR system to a linear combination of residuals from the other equations and an orthogonal element. The structure is as follows;

\[
\begin{bmatrix}
\mathbf{\alpha}_0 \\
\mathbf{\alpha}_1 \\
\mathbf{\alpha}_2 \\
\mathbf{\alpha}_3 \\
\mathbf{\alpha}_4 \\
\end{bmatrix}
= 
\begin{bmatrix}
R_t \\
OP_t \\
IR_t \\
ER_t \\
INF_t \\
\end{bmatrix}
+ 
\begin{bmatrix}
b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\
1 & 0 & 0 & 0 & 0 \\
b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\
0 & 1 & 0 & 0 & 0 \\
b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \\
0 & 0 & 1 & 0 & 0 \\
b_{41} & b_{42} & b_{43} & b_{44} & b_{45} \\
0 & 0 & 0 & 1 & 0 \\
b_{51} & b_{52} & b_{53} & b_{54} & b_{55} \\
0 & 0 & 0 & 0 & 1 \\
\end{bmatrix}
\begin{bmatrix}
\mathbf{\xi}_1 \\
\mathbf{\xi}_2 \\
\mathbf{\xi}_3 \\
\mathbf{\xi}_4 \\
\mathbf{\xi}_5 \\
\end{bmatrix} \tag{11}
\]

Here, \( R_t \), \( OP_t \), \( IR_t \), \( ER_t \) and \( INF_t \) represent the vector of constants of the five variables while \( b_i \) stands for the coefficients.

**Empirical Analysis and Results**

**Unit Root Test**

AugmentedDickey Fuller (ADF) and Philips-Perron (PP) tests are employed to check for unit root. For both tests, an intercept, trend and intercept and an exclusion of both constant and trend are included in the test equation. The null hypothesis in both the ADF and PP test is the presence of a unit root. The maximum lag length of 9 was automatically selected on the basis of the Schwarz Information Criteria (SIC).

The ADF test revealed that the variables considered are stationary at first difference in all three assumptions. Some of the variables were also found to be stationary at levels under the assumption of constant and none. Specifically, INF under the assumption of constant and none is integrated of order 1. The result also shows that OP and R are stationary only at first difference under the three assumptions while all the other variables are I(1).

**Cointegration Analysis Result**

The cointegration analysis provides information about the long term equilibrium relationship amongst the variables in the model. The Engle and Granger (EG) procedure of testing for co-integration is applied.

The result reveal that foreign exchange reserves behaviour is best explained by interest rate while other variables seem to be insignificant even though oil price and exchange rate were found to be positively linked to external reserves(see Table 1). Inflation was found...
to be negatively related to international reserve holding. The result indicates an R-square value of 0.88, meaning that the explanatory variables explain approximately 88% of the systematic variations in international reserves (R) during the period 1960 to 2011. The adjusted R-square used in the model suggests that the regressors explain about 87% of the changes in external reserves. The F-statistic which can be used to determine the overall significance of the model shows that the model employed is statistically significant with a value of about 0.000 which is highly significant at the 5% level. This result shows that there exist a long-run relationship between international reserves, oil price, exchange rate, interest rate and inflation in Nigeria given the probability value of 0.000 which is significant at the 5% level.

Vector Auto Regression (VAR) Estimation Results
Utilising five different information criteria; sequential modified LR test statistic (LR), Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwarz information Criteria (SIC) and Hannan-Quinn Information Criteria, we conclude that the optimal lag length of the five models (inflation, international reserves, oil price, exchange rate and interest rate) is one.

Table 1: Long-Run Reserves equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>8.539</td>
<td>1.678</td>
<td>5.090</td>
<td>0.00</td>
</tr>
<tr>
<td>ER</td>
<td>0.007</td>
<td>0.009</td>
<td>0.738</td>
<td>0.465</td>
</tr>
<tr>
<td>INF</td>
<td>-0.008</td>
<td>0.006</td>
<td>-1.337</td>
<td>0.188</td>
</tr>
<tr>
<td>OP</td>
<td>0.014</td>
<td>0.010</td>
<td>1.433</td>
<td>0.159</td>
</tr>
<tr>
<td>IR</td>
<td>-0.064</td>
<td>0.029</td>
<td>-2.180</td>
<td>0.035</td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.909</td>
<td>0.072</td>
<td>12.646</td>
<td>0.000</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.879</td>
<td></td>
<td></td>
<td>7.731</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.866</td>
<td>S.D. dependent var</td>
<td>1.838</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.674</td>
<td>Akaike info criterion</td>
<td>2.158</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>20.420</td>
<td>Schwarz criterion</td>
<td>2.385</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-49.026</td>
<td>Hannan-Quinn criter.</td>
<td>2.245</td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>65.474</td>
<td>Durbin-Watson stat</td>
<td>1.841</td>
<td></td>
</tr>
<tr>
<td>Prob(F-statistic)</td>
<td>0.000</td>
<td>Inverted AR Roots</td>
<td>0.910</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors' Computation using Eviews 7.
Notes: 51 observations were included after adjustments while convergence was achieved after 8 iterations. The adjusted sample period is between 1961 and 2011 and least square method was used for estimation.
Table 2: Unit root test of the residual

<table>
<thead>
<tr>
<th>Augmented Dickey-Fuller test statistic</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irest critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-6.485</td>
<td>0.000</td>
</tr>
<tr>
<td>5% level</td>
<td>-2.612</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-1.948</td>
<td></td>
</tr>
</tbody>
</table>

Source: Author's Computation using Eviews 7.
Notes: Automatic lag selection based on Schwarz Information Criteria (SIC) was used to arrive at zero (0) lag having considered ten (10) lags. The null hypothesis is that ECT (the residual) has a unit root. Mackinnon (1996) one-sided p-values.

Table 3: VAR lag order selection criteria

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-883.70</td>
<td>na</td>
<td>39000000000.00</td>
<td>36.27</td>
<td>36.47</td>
<td>36.35</td>
</tr>
<tr>
<td>1</td>
<td>-721.47</td>
<td>284.72*</td>
<td>14493667*</td>
<td>30.67*</td>
<td>31.83*</td>
<td>31.11*</td>
</tr>
<tr>
<td>2</td>
<td>-702.77</td>
<td>29.01</td>
<td>19364590.00</td>
<td>30.93</td>
<td>33.05</td>
<td>31.74</td>
</tr>
<tr>
<td>3</td>
<td>-675.92</td>
<td>36.17</td>
<td>19552087.00</td>
<td>30.85</td>
<td>33.94</td>
<td>32.03</td>
</tr>
</tbody>
</table>

Source: Author's Computation using Eviews 7.
Notes: * indicates lag order selected by the criterion.

Table 4: Results from VAR estimation

<table>
<thead>
<tr>
<th>ER(-1)</th>
<th>INF</th>
<th>R</th>
<th>OP</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.849165</td>
<td>-0.264046</td>
<td>3.65E-05</td>
<td>0.17309</td>
<td>0.03242</td>
</tr>
<tr>
<td>-0.07091</td>
<td>[-2.58890]</td>
<td>[0.00782]</td>
<td>[2.72059]</td>
<td>[-0.02363]</td>
</tr>
<tr>
<td>[11.9757]</td>
<td>[-1.01129]</td>
<td>[0.40583]</td>
<td>[-0.08388]</td>
<td>[1.37217]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INF(-1)</th>
<th>R(-1)</th>
<th>OP(-1)</th>
<th>IR(-1)</th>
<th>C</th>
<th>R-squared</th>
<th>Adj. R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.354263</td>
<td>1.697801</td>
<td>0.036061</td>
<td>1.160187</td>
<td>-15.04812</td>
<td>0.969922</td>
<td>0.963325</td>
</tr>
<tr>
<td>0.089355</td>
<td>1.50889</td>
<td>-0.12011</td>
<td>-0.45684</td>
<td>[-2.53957]</td>
<td>0.964924</td>
<td>0.374834</td>
</tr>
<tr>
<td>-0.08836</td>
<td>-1.50889</td>
<td>-0.12011</td>
<td>-0.45684</td>
<td>[-2.53957]</td>
<td>0.969922</td>
<td>0.963325</td>
</tr>
<tr>
<td>[-2.78744]</td>
<td>[1.64195]</td>
<td>[0.42510]</td>
<td>[1.93276]</td>
<td>[-1.19756]</td>
<td>0.969922</td>
<td>0.374834</td>
</tr>
<tr>
<td>[-1.01129]</td>
<td>[0.40583]</td>
<td>[-0.08388]</td>
<td>[1.37217]</td>
<td>[3.67698]</td>
<td>0.969922</td>
<td>0.963325</td>
</tr>
<tr>
<td>[0.30024]</td>
<td>[0.42510]</td>
<td>[7.08850]</td>
<td>[-0.56332]</td>
<td>[1.37217]</td>
<td>0.969922</td>
<td>0.374834</td>
</tr>
<tr>
<td>[1.12520]</td>
<td>[0.40583]</td>
<td>[-1.35387]</td>
<td>[-0.50277]</td>
<td>[1.03509]</td>
<td>0.969922</td>
<td>0.963325</td>
</tr>
<tr>
<td>[-1.01129]</td>
<td>[0.40583]</td>
<td>[-1.35387]</td>
<td>[-0.50277]</td>
<td>[1.37217]</td>
<td>0.969922</td>
<td>0.963325</td>
</tr>
<tr>
<td>[1.64195]</td>
<td>[7.90148]</td>
<td>[0.71868]</td>
<td>[1.29580]</td>
<td>[3.67698]</td>
<td>0.969922</td>
<td>0.374834</td>
</tr>
<tr>
<td>[-1.01129]</td>
<td>[0.40583]</td>
<td>[-1.35387]</td>
<td>[-0.50277]</td>
<td>[1.37217]</td>
<td>0.969922</td>
<td>0.963325</td>
</tr>
<tr>
<td>[0.30024]</td>
<td>[0.42510]</td>
<td>[7.08850]</td>
<td>[-0.56332]</td>
<td>[1.37217]</td>
<td>0.969922</td>
<td>0.374834</td>
</tr>
<tr>
<td>[1.12520]</td>
<td>[0.40583]</td>
<td>[-1.35387]</td>
<td>[-0.50277]</td>
<td>[1.37217]</td>
<td>0.969922</td>
<td>0.963325</td>
</tr>
<tr>
<td>[-1.01129]</td>
<td>[0.40583]</td>
<td>[-1.35387]</td>
<td>[-0.50277]</td>
<td>[1.37217]</td>
<td>0.969922</td>
<td>0.963325</td>
</tr>
</tbody>
</table>

R-squared 0.969922
Adj. R-squared 0.963325

79
The results indicate that external reserve (R) is positively related to the one-period lagged value of oil price (OP) and its own one-period lagged value as the estimated coefficients were expectedly positive. The one-period lagged value of exchange rate, interest rate and inflation were found to be positively related to international reserve. It is pertinent to note that inflation coefficient was unexpectedly positive. These results may be attributed to the highly dependent nature of the Nigerian economy on crude oil prices. To add, the contemporaneous response of domestic prices to monetary policy fine-tuning may also be a plausible reason. The estimated VAR model is dynamically stable as indicated by the inverse root of the AR characteristic polynomial as no root lies outside the unit circle.

### Variance Decomposition of VAR Results

The results from the variance decomposition of interest rate (IR), external reserves (R), exchange rate (ER), inflation (INF) and oil price (OP) in Nigeria within a 10 period time horizon is presented in Table 5.

**Table 5: Variance Decomposition**

#### Panel 1: Variance Decomposition of ER:

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>ER</th>
<th>INF</th>
<th>R</th>
<th>OP</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.451</td>
<td>100.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>26.549</td>
<td>80.870</td>
<td>3.052</td>
<td>2.063</td>
<td>0.007</td>
<td>14.008</td>
</tr>
<tr>
<td>10</td>
<td>40.018</td>
<td>67.970</td>
<td>3.438</td>
<td>6.956</td>
<td>0.021</td>
<td>21.615</td>
</tr>
</tbody>
</table>

#### Panel 2: Variance Decomposition of INF:

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>ER</th>
<th>INF</th>
<th>R</th>
<th>OP</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15.032</td>
<td>8.602</td>
<td>91.398</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>17.913</td>
<td>12.033</td>
<td>70.333</td>
<td>6.410</td>
<td>0.020</td>
<td>11.204</td>
</tr>
<tr>
<td>10</td>
<td>18.615</td>
<td>14.692</td>
<td>65.184</td>
<td>9.103</td>
<td>0.032</td>
<td>10.989</td>
</tr>
</tbody>
</table>

#### Panel 3: Variance Decomposition of R:

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>ER</th>
<th>INF</th>
<th>R</th>
<th>OP</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.688</td>
<td>2.526</td>
<td>5.122</td>
<td>92.352</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>1.148</td>
<td>2.210</td>
<td>3.994</td>
<td>81.158</td>
<td>0.190</td>
<td>12.448</td>
</tr>
<tr>
<td>10</td>
<td>1.432</td>
<td>7.975</td>
<td>3.670</td>
<td>67.494</td>
<td>0.153</td>
<td>20.710</td>
</tr>
</tbody>
</table>

#### Panel 4: Variance Decomposition of OP:

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>ER</th>
<th>INF</th>
<th>R</th>
<th>OP</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.377</td>
<td>11.795</td>
<td>1.929</td>
<td>1.654</td>
<td>84.622</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>14.992</td>
<td>10.038</td>
<td>3.901</td>
<td>6.927</td>
<td>77.681</td>
<td>1.453</td>
</tr>
<tr>
<td>10</td>
<td>20.689</td>
<td>32.433</td>
<td>5.231</td>
<td>9.867</td>
<td>44.747</td>
<td>7.723</td>
</tr>
</tbody>
</table>

#### Panel 5: Variance Decomposition of IR:

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>ER</th>
<th>INF</th>
<th>R</th>
<th>OP</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.482</td>
<td>23.271</td>
<td>0.679</td>
<td>2.340</td>
<td>0.116</td>
<td>73.594</td>
</tr>
<tr>
<td>5</td>
<td>4.852</td>
<td>29.989</td>
<td>0.719</td>
<td>4.204</td>
<td>1.134</td>
<td>63.954</td>
</tr>
<tr>
<td>10</td>
<td>5.631</td>
<td>31.346</td>
<td>1.144</td>
<td>8.710</td>
<td>1.161</td>
<td>57.640</td>
</tr>
</tbody>
</table>

Source: Author's Computation using EViews.
Notes: Cholesky Ordering: ER INF LR OP IR
The result presented in Table 4 corroborates the VAR estimation result. For instance, the oil price movement account for only a small amount of forecast variation for international reserve in the model. The panel 3 of Table 4 contains the variance decompositions when international reserve measure (R) is the linear benchmark and it is seen that oil price variations contributed an insignificant amount to variation in international reserve in the first period and this marginally increased to 0.19% in the 5th period and dropped slightly to 0.15% in the 10th period. Exchange rate accounted for about 2.53%, 2.21% and 7.98% respectively, in the first, fifth and tenth year variation in international reserves while inflation accounted for 5.12% in period 1, 3.99% in period 2 and 3.67% in the tenth period.

The effect of domestic price, interest rate and exchange rate variations on external reserve were relatively more glaring compared to the oil price effect. A possible explanation is that global crude oil price is exogenously determined by not only demand and supply dynamics of the global crude oil market but by the Organisation of petroleum Exporting Countries (OPEC) as well. Evidently, while oil price can exert a huge effect on the direction of domestic policy measures and invariably, macroeconomic variables in the short run, they in turn have no effect on global oil price.

**Results from Impulse Response Function**

Figure 3 contains the response of external reserve holding and other variables considered to a shock in the linear benchmark measure of oil price movement (OP). The response of foreign reserves (LR) to shocks in the benchmark oil price (OP) measure is positive varying around zero from the first to the tenth year after the shock to external reserves, thus indicating that oil price has a marginally positive effect on international reserves in the long-run. Exchange rate (ER) exhibit a similar pattern as its response from the first to the tenth year hovered around zero. Specifically, exchange rate (ER) responds negatively to oil price variations from year 1 to year 4 but recording marginal increments above zero from the fifth year onwards.

Inflation on the other hand responded negatively from the first to the tenth period. Interest rate (IR) response to oil price changes first results in a very low positive response which increases over the period with higher magnitudes observed over the long-term.
Figure 3: Results from Impulse Response
Concluding Remarks

Despite the fact that the significance of international reserve holding is by and large identified and accentuated for the purpose of serving as a buffer against unforeseen contingencies, the critical role that important macroeconomic variables such as exchange rate, domestic prices and the nominal anchor rate play is often ignored in the process of policy making and implementation. This study examined the linkage between international reserve, oil price fluctuations, exchange rate, interest rate and inflation dynamics in Nigeria.

The study revealed that positive (negative) crude oil price shocks were found to impact positively (negatively) on external reserve accumulation while interest rate was found to be insignificant in determining reserve holding in Nigeria. This may be attributed to lower rates and the low return and insecurity that characterises government liabilities in the international market as well as the import dependent nature and huge reliance on crude oil exports for foreign exchange. Thus, for a small open economy like Nigeria, a huge amount of international reserves is necessary for the country’s overall macroeconomic policies, assessment of its credit worthiness, external debt servicing obligations and the insulation of the domestic economy against contagion and spill over effects in the event of abrupt capital flight.

While this study may be consistent with the view that oil price and exchange rate are significant drivers of international reserve accumulation, the monoculture nature of the Nigerian economy makes it imperative to fine-tune fiscal and monetary policies in a manner that enhances sustainable reserve accumulation. The significant influence of oil price on international reserves we observed makes a case for diversifying the country’s export base in a bid to reduce its vulnerability to global crude oil price volatility. Finally, some shortcomings from this paper serve as important qualification for investigating amongst others, the impact of exchange rate and domestic price volatilities on external reserves movement using a Generalised Autoregressive Conditional Heteroscedastic (GARCH) model, as well as international reserve volatility and asymmetric shock effects for the money market. These could provide more explanations on the monetary transmission mechanism.

References


Biographical Note

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