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OIL PRICE VOLATILITY AND BUSINESS CYCLES IN NIGERIA

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Abstract:

The effect of oil price volatility on the business cycle (measured as fluctuations in real GDP) in Nigeria is investigated, while controlling for effects of other variables such as inflation, exchange rate, money supply, trade openness and foreign direct investment. Volatility in real GDP and oil price is generated through the EGARCH process. The ARDL approach to cointegration and error correction modeling is employed for analysis of data covering the period from 1970 to 2015. The study finds positive and significant short-run effect of oil price volatility on real GDP volatility, and no significant long-run effect. The short-run and long-run effects of other variables on business cycle (real GDP volatility) in Nigeria are not statistically significant. This suggests that short-run fluctuations in real GDP are engendered mainly by oil price volatility. This could be attributed to the precarious dependence of the country on oil export. The paper recommends channeling of efforts by the government towards diversifying the productive base and exports of the country as measure to reduce volatility in the real GDP.

Key words: *Oil Price Volatility, Business Cycle, EGARCH*

1. Introduction

Over the last four decades, oil has been the main driver of Nigeria's economy. Nigeria's oil sector accounts for over 90% of total export earnings and over 30% of the country's GDP. The discovery of oil and the exploitation and export of same in commercial quantities which began in the early 1970s led to the neglect of virtually other sectors of the economy particularly agriculture and manufacturing, turning the economy into a near mono-product economy.

The precarious dependence of Nigeria's economy on the crude oil sector has tended to retard the growth of the economy as the price of crude oil in the international crude oil market is highly volatile. Nigeria's economy being driven by the crude oil sector is adversely affected by the volatility in oil price. Oil price volatility engenders

uncertainty and macroeconomic volatility. Macroeconomic volatility adversely affects investment, economic growth and other key macroeconomic variables.

Oil price volatility attenuates business cycles in Nigeria mainly through its affects on the national budget. Budgeting in Nigeria is hinged on expected price per barrel of crude oil. Uncertainty of crude oil prices adversely affects the budgetary process. Consequently, government revenue and expenditure are also adversely affected. Considering that the government is the largest spender in Nigeria's economy, oil price volatility engenders instability and uncertainty in government spending (capital and recurrent). Favourable crude oil prices impacts positively on the nation's budget, while unfavourable crude oil prices adversely affect the budget and its implementation.

For a country as Nigeria which is a net exporter of oil and which is also highly dependent on revenue from same, volatility in oil price invariably engenders volatility in other components of expenditure or income such as private consumption, private investment and the balance of trade. While previous studies have focused on the effect of oil price volatility on exchange rate and economic growth, quite a few, to the best of our knowledge, have empirically investigated the relationship between oil price volatility and business cycle in Nigeria. The objective of this study is to investigate the effect of oil price volatility and other variables (acting as control variables) on business cycles in Nigeria with a view to recommending policy or policies that would help mitigate the cycles.

2. Analytical Framework, Theoretical Framework and Model Specification

2.1. Analytical Framework

Burns and Mitchell (1946) define business cycle as fluctuations in aggregate economic activities of economies that organize their works mainly in business enterprises, characterised by expansion (in economic activities) at some point in time followed by general recessions, contractions and revival which translates into expansion phase of the next cycle. Considering that the level of economic activities per time is measured as the real GDP at that particular time, business cycle can simply be referred to as fluctuations in the real GDP. In the study, business cycle is measured as real GDP volatility.

We present briefly a framework based on theories and empirical evidence to analyse the effect of oil price volatility on business cycles in Nigeria. In doing this, we adopt the Keynesian aggregate expenditure model which relates income to expenditure. For an open economy, it is expressed mathematically as:

$$Y = C + I + G + (X - M) \qquad [1]$$

Where C = Private consumption expenditure

I = Private Investment Expenditure
G = Government Expenditure;
X = Export Earnings
M = Import Payments
(X – M) = Net exports

Considering that Nigeria's economy is highly dependent on crude oil exports, and consequently affected by oil prices, we assume that that all the components of aggregate expenditure or national income are affected by oil price volatility. Thus,
C, I, G, X, M = f (Oil price volatility).

Beginning with government expenditure, we hinted earlier that revenue from crude oil export is the main determinant of government expenditure in Nigeria. Undoubtedly, the volatility in crude oil price translates into unstable government revenue, which in turn engenders instability in government expenditure. Instability in government expenditure translates into output volatility, which actually is the definition of business circles. The study by Oriakhi and Iyoha (2013) buttresses this assertion as the researchers find that changes in oil price affects government expenditure and this in turn affects economic growth. However, the study by Aregbeyen and Fasanyan (2017) finds no asymmetric effect of oil price shock on government expenditure.

For a country that is heavily dependent on oil, the oil price volatility also adversely affects investment in not just the oil sector, but also in other sectors of the economy. This has been demonstrated in several empirical researches. Wadud and Ahmed (2016) found that oil price volatility dampens sectoral and aggregate investment in Thailand. The study by Wiafe, Barnor and Quaido (2014) on oil price shocks and private investment in Ghana finds that oil price shock negatively affects investment in Ghana.

However, Henriques and Sadorsky (2011) find a U shaped relationship between oil price volatility and firm strategic investment and this relationship is robust to a number of different estimation techniques with oil price volatility inflection point ranging from 32.45% to 33.60%. Sharma and Narayan (2012) also find that oil price volatility increases firms returns for majority of sample of 560 firms listed in the stock exchange in the period from 2000 to 2008. These findings seem to suggest that for developed countries that consume large proportion of world oil production, oil price volatility positively affects investment.

On the effect of oil price volatility on private consumption, the study by Usman, Nawaz and Qayyum (2011) on the Pakistani economy finds oil price volatility adversely affects private consumption.

The effect of oil price volatility on trade (export and import) is investigated in Chen and Hsu (2012). The study involving 84 countries finds that international trade flows is adversely affected by oil price volatility. Adam *et al* (2015) also finds that increase in world oil price adversely affects Indonesia's trade balance. This could be attributed to increase in expenditure on, or demand for imports consequent on the rise

in oil export earnings as a result of the rise in oil export. Volchkova (2015) also demonstrates that for oil exporting Russia, oil price shocks negatively affects international trade. Volchkova therefore suggests that the negative effect of oil price shock could be averted through export diversification.

Abdulkareem and Abdulkareem (2016) employ the GARCH modeling technique with its variants to examine the effect of oil price volatility on macroeconomic volatility in Nigeria in the using monthly, daily and quarterly data. The study finds that real GDP, interest rate, exchange rate and oil price are volatile and that oil price volatility is a major cause of volatility in the macroeconomic variables. The paper concludes that Nigeria's economy is vulnerable to both internal shock (interest rate volatility and real GDP volatility) and external shock (oil price volatility and exchange rate volatility).

2.2. Theoretical Framework and Model

To achieve the objective of this study which is to investigate the effect of oil price volatility on business cycles in Nigeria, we adopt and expand the monetary theory of business cycles postulated by Hawtrey which attributes business cycles to changes in money supply. In consideration of the foregoing links established between oil price volatility and components of income, basic model of the monetary theory of business cycle is augmented by inclusion of oil price volatility and other variables which may affect volatility of real GDP (that is, business cycle) such as inflation, exchange rate, trade openness and FDI serving as control variables. Thus, our model is specified in functional form as:

$$RGDPV = f(OILPV, INFL, EXRT, MS, TOPEN, FDI) \qquad [2]$$

Where RGDPV represents real GDP volatility, OILPV represents oil price volatility, INFL represents inflation, EXRT represents exchange rate, MS represents money supply measured as money and quasi money as a percentage of GDP, TOPEN represents trade openness measured as trade as a percentage of GDP, FDI represents net FDI flows (FDI inflow minus FDI outflow) as a percentage of GDP.

Oil price and real GDP volatility are generated from the exponential generalized autoregressive conditional heteroskedastic (EGARCH) process. The choice of the EGARCH process is informed by the fact that it captures the leverage effect of past shock on the conditional variance and also ensures positive values for the conditional variance irrespective of the signs on the volatility parameters. The EGARCH model is specified as:

$$X_t = a_0 + \sum_{i=1}^{q} a_i X_{t-i} + \ell_t \quad [3]$$

$$\ln(\delta_t)^2 = w + \alpha \left| \frac{e_{t-1}}{\delta_{t-1}} - \sqrt{\frac{2}{\pi}} \right| + \gamma \left| \frac{e_{t-1}}{\delta_{t-1}} \right| + \beta \ln(\delta_{t-1}^2) \quad [4]$$

Equation 4 is the conditional mean equation from which the residuals (ε_t) are generated to estimate the conditional variance equation (i.e. equation 5), from which the volatility (conditional variance) series are generated.

Where X represents real GDP or oil price, δ^2_t represents conditional variance or volatility of oil price and real GDP in current period and α, β and γ are the volatility parameters. The leverage effect which is the asymmetric effect of past shock on conditional variance is captured by γ which is usually negative. The implication of the negative sign on γ is that all things being equal, positive shocks generate less volatility than negative shocks (Olowe, 2009). However, positive coefficient of γ implies that positive shock/innovation to the variable generates more volatility than negative shock. If γ is equal to zero, the implication is that that shock to a variable generates no volatility. The model is therefore said to be symmetric. Volatility persistence is measured by the magnitude of β. The more the magnitude tends to 1 (unity), the more the persistent is the volatility (Miyakoshi, 2005). If β is low, volatility is not persistent, that is, it does not last, but smoothens out speedily. Where it is greater than 1, then volatility is explosive. α is the magnitude effect and it is used to determine the presence or otherwise of volatility clustering. If α is positive, then volatility clustering is indicated. This implies positive correlation between conditional volatility and the absolute value of the standardized residuals. Where α is not statistically significant, then it is inconclusive (Miyakoshi, 2005; Olowe, 2009).

The ARDL approach to cointegration and error correction modeling approach adopted to investigate the long-run and the short-run effects of the explanatory variables on the dependent variable. The choice of this methodology is informed by the fact that it can be applied to data series that are of mixed order of integration and it is quite efficient in cases of small and finite data sample size. Moreover it yields consistent long-run estimates with valid t-statistics even in the presence of endogenous regressors. Application of this methodology distinguishes this study from previous studies and marks one of its contribution to the extent literature. Another major contribution of this paper to the extent literature is that it empirically tests the validity of the monetary theory of business cycle in Nigeria.

The empirical specification of the long-run model is expressed as:

$$LRGDPV_t = \beta_0 + \beta_1 LOILPV_t + \beta_2 LINFL_t + \beta_3 LEXRT_t + \beta_4 LMS_t + \beta_5 LTOPEN_t + FDI_t + \mu_t \quad [5]$$

The variables are as previously defined. μ is the error term. We note that net FDI as a percentage of GDP is not 'loged' because of some negative observations in the series.

To obtain the short-run effects of the explanatory variables on the dependent variable, we specify the error correction (short-run) model as:

$$\Delta LRGDPV_t = \alpha_0 + \alpha_1 \Delta LRGDPV_{t-1} + \sum_{v=0}^{r} (\pi_v \Delta LOILPV_{t-v}) + \sum_{l=0}^{m} (\lambda_l \Delta LINFL_{t-l}) + \sum_{j=0}^{n} (\theta_j \Delta LMS_{t-j}) + \sum_{k=0}^{p} (\theta_k \Delta LTOPEN_{t-k}) + \sum_{l=0}^{q} (\phi_l \Delta LFDI_{t-l}) + \Omega ECT_{t-1} + \xi_t \quad [6]$$

L stands for natural logarithm, α, π, λ, Ϭ, θ, ϕ are parameters indicating the short-run effects of the respective explanatory variables on the dependent variable. *r, m, n, p, q* are appropriate lags of each variables introduced into the model to obtain optimal short-run estimates. Ω is the error correction term included in the model to play the role of error correction, that is, to reconcile short-run dynamics with long-run (equilibrium) position. ξ_t is the residual (error) term.

Data for the estimation are annual time series data covering the period from 1970 to 2015 from the World Bank's World Development Indicators (WDI and the Organisation of Petroleum Exporting Countries (OPEC)'s database. Specifically, data for oil price was obtained from the OPEC's database, while data for real GDP and other variables were obtained from the WDI.

3. Results and Discussion

3.1. Unit Root and cointegrationTests

The results of the unit root test for the variables involving the ADF and PP tests are presented in Table 1.

Table 1. Unit Root Test Results

Augmented-Dickey Fuller (ADF) Test							
Variables	**Levels**			**First Difference**			**Order of Integration**
	ADF test stat	**Test Critical Value (5%)**	**Inference**	**ADF test stat**	**Test Critical Value (5%)**	**Inference**	
LRGDPV	-6.0121	-2.9314	S	-	-	-	I(0)
LOILPV	-0.5494	-2.9297	NS	-6.8025	-2.9314	S	I(1)
LINF	-3.7910	-3.5131	S	-	-	-	I(0)
LEXRT	-1.6206	-3.5131	NS	-5.3204	-3.5155	S	I(1)
LMS	-3.2442	-3.5181	NS	-5.4731	-3.5181	S	I(1)
LTOPEN	-2.2582	-3.5155	NS	-8.5562	-3.5181	S	I(1)
FDI	-3.6603	3.5155	S	-	-	-	I(0)

Phillips-Perron Test							
Variables	Levels			First Difference			Order of Integration
	PP test stat	Test Critical Value (5%)	Inference	PP test stat	Test Critical Value (5%)	Inference	
LRGDPV	-6.0360	-2.9314	S	-	-	-	I(0)
LOILPV	-1.1634	-2.9297	NS	-7.8136	-2.9314	-	I(1)
LINF	-3.5402	-3.5131	S	-	-	-	I(0)
LEXRT	-1.8892	-3.5131	NS	-5.3241	-3.5155	S	I(1)
LMS	-2.1075	-3.5155	NS	-5.5667	-3.5181	S	I(1)
LTOPEN	-2.1048	-3.5155	NS	-8.5562	-3.5181	S	I(1)
FDI	-3.5915	-3.5155	S	-	-	-	I(0)

NS = Non-stationary; S = Stationary

We observe that the variables are of mixed order of integration. Both ADF and PP test results indicate that the (natural logarithms of the) conditional variance (or volatility of) of real GDP, inflation and net FDI inflows are stationary at levels (implying that they are integrated of order zero) while the natural logarithms of conditional variance of oil price, exchange rate, money supply and trade openness are stationary at first differences, implying that they are integrated of order one. The observation that the variables are of mixed order of integration necessitates the choice of the ARDL bounds test approach to testing for cointegration (long-run) relationship between the variables. The result of the bounds test for cointegration is presented in Table 2.

Table 2. Bounds Test for Cointegration

Null Hypothesis: No Long-run Relationships Exist		
Test Statistic	Value	K*
F-Statistic	5.82	6
Critical Value Bounds		
Significance	Lower Bound	Upper Bound
10%	1.99	2.94
5%	2.27	3.28
2.5%	2.55	3.61
1%	2.88	3.99

*K represents number of explanatory variables

The result shows that the null hypothesis of no long-run relationship between the explanatory variables and dependent variable is rejected at the reported significance levels as the computed F-statistic is greater than the upper bound critical values. Thus the variables are likely to converge in the long-run.

3.2. Models Estimation Results

The results of estimation of the error correction (short-run relationship) model and the long-run model are presented in Table 3.

Table 3. Estimated Error Correction and Long-run Model

Dependent variable: Log(RGDPV)			
Selected Model: ARDL (1, 2, 0, 0, 0, 0, 0)			
Sample: 1970 to 2015			
Included Observations: 42			
Cointegrating Form (Error Correction Model)			
Variable	Coefficient	t-stat.	Prob
DLOG(OILPV)	0.5614	2.2893	0.0288
DLOG(OILPV(-1))	0.4879	2.3721	0.0239
DLOG(INF)	0.0167	0.0966	0.9236
DLOG(EXRT)	0.3439	0.7812	0.4404
DLOG(MS)	-0.9500	-1.3098	0.1996
DLOG(TOPEN)	0.0345	0.0649	0.9486
FDI	0.0733	1.1932	0.2416
CointEq(-1)	-1.0406	-6.7712	0.0000
Long Run Coefficients			
LOG(OILPV)	-0.1664	-0.7344	0.4681
LOG(INF)	-0.0693	-0.3245	0.7477
LOG(EXRT)	0.0676	0.5832	0.5639
LOG(MS)	-0.3381	-0.6243	0.5369
LOG(TOPEN)	-0.3497	-0.5284	0.6009
FDI	0.0314	0.4134	0.6832
C	47.0726	16.1559	0.0000
R-squared = 0.6049; F-stat. = 5.4424, Prob (F-stat.) = 0.0001; DW-stat = 1.8827			

Table 4. Test for Multicolinearity (Variance Inflation Factor)

Variance Inflation Factors	
Sample: 1970 2015	
Included observations: 42	
Variable	Centered VIF
LOG(RGDPV(-1))	1.2126
LOG(OILPV)	4.4061
LOG(OILPV(-1))	5.9349
LOG(OILPV(-2))	4.3259
LOG(INFL)	1.4890
LOG(EXRT)	4.3382
LOG(MS)	1.6546
LOG(TOPEN)	2.9015
FDI	1.9035
C	NA

The error correction results show that oil price volatility has been the main factor engendering volatility of real income (or business cycle) in the country. This is hardly contentious considering that Nigeria's economy is highly dependent on the crude oil sector, with oil export accounting substantially for her total exports. This

observation is a confirmation of the Presbisch-Singer hypothesis which states that export concentration *inter alia* engenders income volatility. The positive and significant effect of oil price volatility on real GDP volatility is attributed to the fact that Nigeria's export is concentrated in crude oil and hence the economy is affected by the vagaries in the international crude oil market. Oil price volatility translates into real income volatility (or business cycles).

The monetary theory of business cycle is violated as the study finds no significant effect of money supply on real income volatility. Interestingly, other factors incorporated in the model also have no significant short-run and long-run effects on real income volatility. These observations reveal that the main source of business cycle in Nigeria is oil price volatility.

The observations that the long-run effects of the explanatory variables on the dependent variable (real GDP volatility) are statistically not significant suggest that real GDP volatility in Nigeria is a short-run phenomenon, caused by short-run fluctuations in oil prices.

The error correction coefficient has the expected negative sign and it highly significant even at the 1% level. However, its coefficient which lies outside the range of 0 to -1 indicates that adjustment towards equilibrium in the event of short-run displacement there-from is oscillatory. The coefficient of determination (R-squared) value of the ARDL model estimated to test the long-run relationship reported in the third panel of Table 3 indicate that over 60% of the systematic variation in the dependent variables is explained by the model. The F-statistic easily passes the test of statistical significance, indicating that the explanatory variables are jointly significant in the determination of the dependent variable, though individually, some of them are not. The Durbin-Watson statistic of 1.8827 indicates absence of problem of positive first order autocorrelation in the model.

The result of the variance inflation factor (VIF) test employed to test for multicolinearity problem in the estimated model reported in Table 4 indicates that the estimated models are not affected by this problem as the centered VIF are all less than 10.

On the strength of these diagnostic checks, the estimated model can be reliably deployed for policy formulation.

4. Conclusion and Recommendation

The study empirically investigates the effect of oil price volatility on real income volatility (or business cycle) in Nigeria. The effects of other variables such as money supply, trade openness, net foreign direct investment, exchange rate and inflation on the business cycle are also investigated. The study finds that oil price volatility positively and significantly affects real GDP volatility in the short run. It also finds that the short-run and the long-run effects of the other variables on the volatility of real

income are statistically significant. On the strength of these findings, it could be reasonably concluded that the main cause of business cycle or fluctuation in real GDP in Nigeria is volatility in oil price, and this is as a result of the precarious dependence of the economy on the crude oil sector.

Based on the empirical evidence from this study, it is recommended that Nigeria's government intensifies effort at economic and export diversification so as to enhance and stabilize its export earnings and real income.

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