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The influence of oil price and exchange rate on GDP in Nigeria

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ABSTRACT

This paper seeks to assess the influence of crude oil price and exchange rate on GDP in Nigeria on the basis of monthly data from 2016M1 to 2024M5. The empirical analysis starts by analyzing the time series properties of the data, which is followed by examining the nature of the variables. Furthermore, the Johansen VAR-based co-integration technique is applied to observe the sensitivity of GDP to changes in crude oil prices and the exchange rate in the long-run. Results from the ADF test show evidence of a unit root in the data revealed that all variables are stationary in first differences. Findings show that crude oil price has positive impact on real GDP in Nigeria. While, and exchange rate has an inverse relationship with real GDP. The paper recommends greater diversification of the economy through investment in key productive sectors of the economy to guard against crude oil price and foreign exchange rate volatility.

Keywords

Crude oil, GDP, Johansen VAR-based

1. Introduction

Following its independence in October 1960, Nigeria's economy was based mostly on agricultural production, which accounted for over 70% of GDP, employed roughly 70% of the working population, and provided 90% of foreign government revenue. As crude oil became more significant to the global economy, the manufacturing sector's share of GDP increased from 4.8 percent to 8.2 percent, reflecting the rapid development of industrialized capacity and output during the first post-independence period until the mid-1970s. Jin. (2008) state that when the first producible well was discovered in 1956, crude oil became an export commodity in Nigeria in 1958, and that oil's contribution to the nation's revenue. Nigeria's economy has been a mono-product economy since the commercial discovery of oil. In 2010, Nigeria's total export revenue was US\$70,579 million, with US\$61,804 million (approximately 87.6%) coming from petroleum exports. The country's high reliance on oil export revenue has made it more vulnerable to abrupt changes in the price of oil.

As demonstrated by Nigeria's experiences of a significant current account surplus and exchange rate appreciation, factors like periods of favorable oil price changes brought on by conflict in the world's oil-producing nations, increases in the demand for the commodity by consuming countries due to seasonality factors, trading positions, etc., all contribute to the country's favorable terms of trade. Conversely, Nigeria suffers from unfavorable terms of trade, as seen by a budget deficit and sluggish economic growth, when crude oil prices are low due to a variety of factors, including poor demand, seasonality, and surplus supply (Idris et al., 2024). As an illustration, consider the decline in oil export earnings during the 2009 global financial crisis. As per the 2010/2011 OPEC statistical bulletin, oil export earnings decreased from US\$133.88 in 2008 to as low as US\$39.09 in 2009.

For a few decades now, researchers and decision-makers have focused heavily on analyzing the effects of asymmetric shocks brought on by fluctuations in the crude oil price and exchange rate on economic growth. While

an appreciation of the exchange rate would discourage exports and encourage imports, it has been acknowledged in the literature that a depreciation of the exchange rate tends to increase exports and decrease imports. Therefore, a change in the terms of trade brought about by exchange rate depreciation results in the transfer of income from importing to exporting countries, which has an impact on the GDP of both countries. However, the belief that increases in crude oil prices have a detrimental impact on economies is mostly founded on the importing countries. McKillop (2004) contended that higher crude oil prices hinder economic growth, cause stock exchange panics, and cause inflation, all of which ultimately result in monetary and financial instability, while Greenspan (2004) pointed out that the impact of oil prices alone in contemporary market-based economies is difficult to infer in a way that makes policy automatically obvious. Additionally, it will result in increased interest rates and even a recession. Jin (2008) made the case that extreme exchange rate fluctuations and a fast rise in global crude oil prices are typically seen as factors that hinder economic growth. If all else is equal, an increase in the price of crude oil should be viewed as a good thing in nations that export it and a bad thing in those that import it. Conversely, a fall in the price of crude oil should be anticipated. However, the combined impact of rising crude oil prices and unstable currency rates on macroeconomic stability and GDP in oil-producing countries like Nigeria is a significant problem. In Nigeria, large inflows of oil cash are typically linked to increases in government spending, whereas periods of declining oil revenue are typically followed by budget deficits. It goes without saying that Nigeria imports a great deal of refined petroleum and other associated goods, but it also depends heavily on crude oil export earnings.

Even though there has been a period of relative quiet in the naira exchange rate since the structural adjustment program (SAP) was put into place in July 1986, the country's real sector activities have been permanently impacted by the naira's ongoing devaluation. In 1985, the value of the naira was N0.935 = \$1.00 (US dollars). By 1990, it had dropped to N2.413 = \$1.00 and then to N7.901 versus the US dollar. The directed deregulation program set the naira at N21.886 versus the dollar in 1994 in an effort to reverse the trend. However, the exchange rate dropped to N86.322 = \$1.00 in 1999 as a result of additional deregulation of the foreign exchange market. The end-period rate was N117.97 in December 2007 due to a significant increase in oil revenue brought about by the oil price increase.

Despite these changes, the country's national income accounts showed that real GDP increased by an average of 2.98% between 2023 and 2024. In light of this, the study aims to evaluate the effects of oil price increases and exchange rate fluctuations on Nigeria's GDP from 1965 to 2023. Despite these changes, the country's national income accounts showed that real GDP increased by an average of 2.98% between 2023 and 2024. In light of this, the study aims to evaluate the effects of oil price increases and exchange rate fluctuations on Nigeria's GDP for monthly data from 2016M1 to 2024M5. The rest of the paper, besides the introduction, which occupies section one, is organized in the following way. Section two dwells on literature review and theoretical issues. Section three presents the research methodology of the paper; section four contains empirical results and discussion, and finally, summary and recommendations are drawn in section five.

2. Review of literature and hypothesis development

The literature generally agrees that exchange rate stability has no effect on economic growth or the process by which changes in the price of oil influence growth. Supply and demand analysis of the effects of changes in the price of oil is employed in the latter, whereas macro and microeconomic analysis of the exchange rate system is used in the former. Theoretically, flexible exchange rates facilitate easier adjustment in response to asymmetric country-specific real shocks, according to Schnabl's 2007 macroeconomic analysis. Low exchange rate volatility under a fixed exchange rate regime has microeconomic impacts by lowering transaction costs for capital flows and international trade, which boosts GDP. Fixed exchange rates indirectly increase global price transparency for customers. Mundell (1973a, 1973b) previously believed that the main causes of uncertainty and volatility in small open economies are monetary and exchange rate policy, and that smoothing exchange rate swings promotes economic growth. According to Schnabl (2007), even big, relatively closed economies like Japan and the Euro area are susceptible to significant fluctuations in currency rates, especially when it comes to appreciation.

Jin (2008) identifies both supply and demand channels as transmission mechanisms by which oil prices impact actual economic activity. Since crude oil is a fundamental component of production, an increase in its price raises production costs, which in turn causes businesses to produce less. This is the basis for the supply-side impacts. Changes in oil prices have an impact on both investment and consumption decisions, which leads to the demand-side effect. Because rising oil prices impact disposable income and the domestic price of tradables, consumption

is negatively impacted. An increase in the price of oil has a negative impact on investment because it also raises the cost of inputs for businesses.

Strong short- and long-term negative effects of exchange rate fluctuations on economic growth performance through the trade channel have been demonstrated by empirical research. Nonetheless, the effect's nature can be either beneficial or negative. Empirical evidence supporting a systematic positive (or negative) impact of exchange rate stability on trade (and consequently growth) in small open economies has remained mixed, according to the [European Commission \(1990\)](#) and the [IMF \(1984\)](#). Based on a general equilibrium paradigm, [Bacchetta and van Wincoop \(2000\)](#) discovered that increased trade is not always linked to exchange rate stability. Particularly in the context of a monetary union, gravity models have been employed as frameworks to measure the effect of exchange rate stability on growth and commerce. Over a 120-year period, [Eichengreen and Leblang \(2003\)](#) discovered a significant inverse link between growth and exchange rate stability for 12 countries. They come to the conclusion that the time period and sample have a significant impact on the outcomes of such estimations. [Schnabl \(2007\)](#) discovered strong evidence linking increased growth in the EMU periphery to exchange rate stability. He claims that the data is compelling for Emerging Europe, which over the observation period transitioned from a highly unstable macroeconomic environment to one of macroeconomic stability. The function of the capital market in maintaining exchange stability and economic expansion was the subject of more empirical research.

The connection between changes in the price of oil and economic growth has also been the subject of several empirical investigations. [Hamilton \(1983\)](#) found that there was a negative correlation between macroeconomic activity and oil prices in the US. [Hooker \(1994\)](#) validated Hamilton's findings and showed that fluctuations in oil prices had an impact on GDP growth from 1948 to 1972. According to his findings, a 10% rise in oil prices resulted in a 0.6% decrease in GDP growth in the third and fourth quarters following the shock. Later, Granger causality tests and non-linear transformations were included in the models by [Mork \(1989\)](#), [Lee et al. \(1995\)](#), [Balke et al. \(1999\)](#), and [Lee and Ni \(2002\)](#). The findings supported both Granger causation and the prevalence of a negative correlation between changes in oil prices and economic downturns.

Using both linear and non-linear oil price transformations, [Gounder and Bartleet \(2007\)](#) have found a direct correlation between New Zealand's economic growth and net oil price shock. A shock to the price of oil was also found to have a significant impact on the exchange rate and inflation. In a comparative analysis of the effects of exchange rate volatility and oil price shock on economic growth, [Jin \(2008\)](#) found that rising oil prices have a beneficial effect on Russian economic growth while having a negative effect on China's and Japan's. In particular, a 5.16% gain in Russian GDP and a 1.07% decline in Japanese GDP are linked to a 10% permanent increase in global oil prices.

Nigeria is thought to have the tenth-biggest oil reserves in the world and the largest oil-producing country in Africa. Nigeria has profited greatly from increases in oil prices since the start of the second Gulf War, despite the fact that its production level of about 2 million barrels per day has been significantly impacted by the crisis in the oil-producing region. With more than 20 months of imports, the nation's balance of payments position is still very advantageous, translating into more than \$55 billion in reserves. While real GDP growth averaged 5.01 percent between 2000 and 2008, the exchange rate remained relatively constant during that time.

However, since local refineries collapsed in the late 1980s, the nation's oil consumption has been mostly dependent on the importation of refined petroleum and products. As a result, imports account for more than 80% of the nation's domestic oil needs. The severe lack of energy is further highlighted by the country's power generation and distribution sector's near collapse. The federal government of Nigeria cut its subsidy around nine times between 1999 and 2008 as a result of the overwhelming strain on the government to supply energy resources at a subsidized rate. Decisions about investment, consumption, and production are all significantly impacted by crude oil prices.

3. Methodology

Although there are many macroeconomic factors that influence GDP, the price of crude oil and the volatility of exchange rates are taken into account for the purposes of this study. Because of this, the model can only include the variables that were selected. Thus, real GDP is regressed against the price of crude oil and the value of the naira in relation to the US dollar.

Every variable in the study is based on monthly data from 2016 to the first five months of 2024. The Central Bank of Nigeria's (CBN) Statistical Bulletin provided the real GDP data, while the same source's consumer price index (CPI) served as a deflator when calculating the real GDP numbers. The CPI-based real exchange rate, which is calculated from the nominal exchange rate using both the Nigerian and US producer price indexes, was used to quantify exchange rate variations. The average monthly price of the globally traded type of crude (UK Brent) in US dollars was used to calculate the price of crude oil. All variables are transformed into logarithmic form for analysis (Gosh et al., 2003). Using the specification provided in Equation 1, we tested for stationarity of the series using the Augmented Dickey-Fuller (ADF) test.

$$\Delta y_t = a_0 + a_1 y_{t-1} + a_1 \text{ trend} + \sum \beta_j \Delta y_{t-j} + \mu t \dots\dots\dots 1$$

Where: Δy indicates the first difference of y_t . Equation (1) allows us to test whether the variable y_t is a stationary series. The null hypothesis in the ADF tests is that y_t is non-stationary or has a unit root.

Since the main objective of this paper is to assess the short-run and long-run dynamic impact as well, we tested for co-integration using Johansen (1988). In addition, vector error correction methodology (VECM) was applied. Economically speaking, co-integration of the variables indicates a long-term or equilibrium relationship among them, given by their stationary linear combination (called the co-integrating Equation). The Johansen co-integration test is a procedure that involves a vector autoregressive co-integration among the variables. Johansen and Juselius (1990) developed the maximum likelihood estimator for co-integration analysis. Johansen's co-integration test is used as a starting point in the vector autoregression (VAR) model. The vector autoregression model of order p (VAR (p)) is constructed as the following Equation.

$$\Delta y_t = \Phi_0 + \sum \Gamma_i \Delta y_{t-i} + \Pi y_{t-1} + \varepsilon_t \dots\dots\dots 2$$

Where: y_t is a (3×1) vector of the log of GDP ($lgdp$), the log of crude oil price ($lcoil_price$), and the log of exchange rate ($lexr$). Φ_0 is the (3×1) intercept vector, and ε_t is a vector white noise process. Γ_i denotes a (3×3) matrix of coefficients and contains information regarding the short-run relationships among the variables. The matrix Π conveys the long-run information contained in the data. If the rank of Π is r , where $r \leq n - 1$, then Π can be decomposed into two $n \times r$ matrices α and β such that $\Pi = \alpha\beta'$ and β is the matrix of co-integrating vectors; the elements of α are known as the adjustment parameters in the vector error correction model. The Johansen-Juselius procedure is based on the maximum likelihood estimation in a VAR model, and calculates the trace statistic in order to test for the presence of r co-integrating vectors. The trace statistic in the Johansen procedure tests the null hypothesis that there are at most r co-integrating vectors against the hypothesis of r or more co-integrating vectors.

The study model is given below:

$$lgdpt = a_0 + \beta_1 lcoil_pricet + \beta_2 lexrt + \varepsilon_t \dots\dots\dots 3$$

Equation (3) says that $lgdpt$, which is the log of real GDP, is a linear function of $lcoil_pricet$, that is, the log of the oil price shock, and $lexrt$, that is, the log of real exchange rate volatility. ε_t is the error term. The null hypothesis of no co-integration is rejected if it is found that the regression residuals are stationary at level.

4. Results

Unit Root and Granger Causality Tests

Numerous arguments have been made that macroeconomic data have a stochastic trend, which, if left unchecked, affects the estimators' statistical behavior. The ADF test described in the previous part is used in this section to carry out the treatment, which entails differencing the data to ascertain the degree of co-integration.

Table 1: ADF Test

Variables	ADF Test	
	Level	1 st Difference
Lgdp	2.45	8.06*
Lcoil_price	-0.59	-6.62*
Lexr	-0.31	-7.52*

Note: The benchmark for the significant level is 5%; the result statistically (*) denotes rejection of the null hypothesis at the 1% level

The findings shown in Table 1 are obtained by estimating Equation (1) with a constant and trend. According to the findings, none of the series are level or steady. At the 1 percent level of significance, the results indicate that all of the variables are I(1). In order to maintain consistency, all of the series were regarded as I(1) and analyzed at the first difference.

Co-integration Test and Vector Error Correction Model

Since the primary goal of the paper is to evaluate how real GDP in the long run responds to changes in crude oil price and real exchange volatility, we conduct a co-integration test in accordance with the Johansen test specified in Equation (2). After establishing the order of integration of our series in the previous section, the next step is to find the number of long-run equilibrium relationships or co-integrating vectors among the variables. It should be noted that when series are found to be integrated of the same order, such as I(1) as in this case, it implies that an equilibrium relationship exists among the variables. Table 2 shows the test results for the number of co-integrating vectors. The findings indicate that, at the less than 5% level, the trace statistic points to the existence of one co-integrating Equation among the three variables in the Nigerian economy. This reveals that real GDP and the variables included in the model have a long-term equilibrium connection.

Table 2: Co-integrating Relations

Hypothesized No. of CE(s)	Trace Statistics	5% Critical value
None*	45.78798*	29.79707*
At most 1	11.85217	15.49471
At most 2	0.821528	3.841465

Trace Statistic tests indicate 1 co-integrating equation(s) at less than the 0.05% level.

* denotes rejection of the hypothesis at less than 5% level

The hypotheses are stated below

H0: there is no co-integrating relationship among the integrated variables

H1: there is a co-integrating relationship among the integrated variables

As the results of the co-integration test demonstrated that LGDP, LCOIL PRICE, and LEXR have equilibrium conditions that keep them proportionate to each other over the long term, the trace test rejected the null hypothesis (H0) that there is no co-integrating relationship between the variables and revealed that there is one co-integrating Equation at the 0.05 level of significance. The following displays the co-integrating coefficients normalized to LGDP together with the precisely identifying estimates of the Johansen maximum-likelihood estimates. Understanding the long-term links between co-integrating factors is greatly aided by them.

Table 3: Normalized Co-integrating Eigenvector

1 Cointegrating Equation(s)	Log Likelihood	452.4147
Lgdp	Lcoil price	Lexr
1.000000	21.12828 (2.78848)	-9.457455 (1.55514)

The normalized co-integrating eigenvector of the model's variables is shown in Table 3. At the less than 5% level, every coefficient was statistically significant and appropriately signed. There is a positive correlation between the log of real GDP and the log of crude oil price. This is in line with the earlier hypothesis that a rise in crude oil exports would raise the nation's GDP. However, there is a negative correlation between the log of the exchange rate and the log of real GDP. This is also in line with the earlier prediction that an increase in the foreign exchange rate (in this example, the US dollar) would have a negative impact on the GDP of a nation like Nigeria.

The study derives the co-integrating Equation from the above results – with log of real GDP as the regressand while log of oil price shock and log of real exchange rate volatility as regressors, as follows:

$$lgdpt = 3.84 + 21.12828*lcoil_pricet - 9.457455*lexrt \dots\dots\dots 4.1$$

Looking critically at the numerical values of the coefficients and their respective signs, Equation (4.1) is saying that a N10 permanent increase in crude oil price internationally will cause the real GDP to increase by

approximately N21.13, and the same increases N10 in the level of real exchange rate, decreases real GDP by approximately N9.46. This shows that Nigeria's GDP increases more with a crude oil price increase, but decreases with an increase in the foreign exchange rate, and this is consistent with the expectation.

The vector error correction model

The speed adjustment factor, sometimes referred to as the ECM coefficient, indicates how quickly the system corrects itself to return to equilibrium. It records the variables' gradual reconciliation from the state of disequilibrium to the equilibrium period. Table 4 displays the outcome of the vector correction model (VECM). The fundamental standards for VECM analysis are:

1. The VECM must lie between 0 and 1
2. It must be negative for it to be meaningful

If it is positive, there is no error correction, and it diverges; the T-statistic must be significant, i.e., it must be greater than 2.

Table 4. VECM Result

Variables	ECM(-1)	T-statistics
D(Loggdp)	-0.465247	-3.77489
D(Logcrude oil price)	-0.008039	-3.49008
D(Logexchange rate)	-0.004293	-1.52039

Source: Computed by the author using EViews 12.

For Loggdp, the speed of adjustment coefficient is -0.465247. The VECM is appropriately marked and falls between 0 and 1 in magnitude. This importance demonstrates that there is a long-term, stable equilibrium between GDP and the explanatory variables, which supports co-integration. Approximately 46.5% of the errors produced between each period are associated in later periods, according to the error correction model in this Equation. The T-statistic value (-3.77489) indicates that this finding is both significant and sizable.

The primary goal of the study was to ascertain how Nigeria's GDP was impacted by the price of crude oil. The outcome is consistent with the study's expectations. It showed that a proportionate change in the price of crude oil causes a 21.13 change in GDP that is more than proportionate. This suggests that a shift in the price of crude oil globally will impact Nigeria's GDP more than anticipated. Since the coefficient is bigger than one, the long-term implication of the 21% coefficient of elasticity is that GDP is sensitive to fluctuations in the price of crude oil. The t-statistic indicates that it is statistically significant. The foundation of Nigeria's economy is crude oil. It affects all her economic activities and influences macroeconomic variables, including GDP.

The outcome demonstrated that a proportionate change in GDP follows a corresponding change in exchange rate volatility. This is consistent with the study's expectations. This implies that a shift in the US dollar's value will result in a decline in Nigeria's GDP. Since the coefficient is greater than 2, the long-term coefficient of elasticity of -9.457455 suggests that the exchange rate is elastic to changes in GDP. There is an inconsequential association between the exchange rate and GDP, according to the general rule that a variable is considered statistically significant if the absolute value of the t-statistic is around 2 or higher. Thus, a reasonable level of exchange rate is enough to reduce a country's GDP. Therefore, when the export of crude oil revenue increases, Nigeria's GDP is increased, and this can be used to reduce the exchange rate of the US Dollar against the Naira.

5. Conclusion

Through the analysis of time series data, this study aims to determine if the price and exchange rate of crude oil have an impact on Nigeria's real GDP across monthly periods from 2016 to 2024. A model was developed in order to accomplish these goals. The price of crude oil and the exchange rate were the independent variables in the model, whereas GDP was the dependent variable. Following a study of pertinent literature and the required empirical analyses, it was determined that there is a direct correlation between the price of crude oil and real GDP. Additionally, the exchange rate has an indirect correlation with actual GDP.

Last but not least, research and theory have demonstrated that the price of crude oil has an impact on Nigeria's economy in terms of both revenue and output, and that the exchange rate has a major impact on output through

investment in addition to its direct impact on international commerce. Given the significance of crude oil to the Nigerian economy, the study suggests increasing economic diversification by making prudent investments using crude oil revenue in the country's productive sectors. It is also well known that Nigeria's excess reserves serve as the main anchor for the country's exchange rate. Therefore, by making a deliberate effort to diversify the economy's export base and expand infrastructure, exchange rate stability might be attained even in the face of declining oil revenue.

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