

## Economic Effects of Oil Price Volatility on Developing Countries: A Case Study of an Oil Exporting Country

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### Abstract

Nigeria's dependence on oil revenue has been a cause for concern, especially as oil is an internationally traded commodity whose price is subject to unpredictable changes. The volatility in price of oil has various implications for both oil importing and exporting countries alike. However, oil export revenue dependent nations are more prone to the consequences, especially during periods of negative volatility. Nigeria's economy is highly dependent on crude oil export revenue, hence, fluctuations in oil prices affects Nigeria's macroeconomics. This study empirically investigated the economic effects of oil price volatility on Nigeria's economy using some macroeconomic indicators such as gross domestic product (GDP), exchange rate (EXR), interest rate (INR), Foreign Direct Investment (FDI), and balance of payment (BOP). Ordinary Least Square (OLS) estimation was used to assess the impact of oil price fluctuation (independent variable) on the macroeconomic indicators listed above (dependent variables). The result of the study shows that the macroeconomic variables respond to changes in the price of oil (volatility), although at varying extent/degrees. This result underscores the contribution of oil as the major foreign revenue earner for the country. Based on the result of the study, it is concluded that oil price volatility is linearly related to the macroeconomic variables investigated, and that price volatility has an effect on interest rate, balance of payment, gross domestic product and foreign direct investment. Consequently, it is recommended that Nigerian economy should be diversified to guarantee non-dependence on oil revenue as the major source of foreign income earner, and that investment in local production to encourage export, while discouraging over importation is imperative.

**Keywords:** Balance of payment; Exchange rate; Foreign direct investment; Gross domestic product; Interest rate; Regression; Oil price; Volatility

### Introduction

Crude oil is a vital commodity for both oil importing and exporting nations, as it is a major source of income and input factor for many countries. A rise or fall in price is of interest to these economies as it can affect various macroeconomic variables [1]. Oil price has been highly volatile since the end of World War II, and has become even more serious in recent times. This has implications on the economies of oil exporting countries especially oil dependent nation like Nigeria [2,3]. Nigeria's economy is largely dependent on crude oil export, as most of its revenue is generated from petroleum export [4,5]. This high level of dependency on crude oil and neglect of other sectors has resulted in what is known as the Dutch Disease Syndrome-the structural economic imbalance resulting from mismanagement of oil revenue which results in negative impacts on the economy and causing the country's other product to command less price in the competitive market [6]. The wave of oil price volatilities has taken a toll on the economic standing of the nation. The plunge in the price of oil and its volatile behaviour currently has resulted in the depletion of our foreign reserves, devaluation of naira amongst other. Hence, a need to critically investigate the extent to which oil price volatilities negatively affects the Nigerian economy. This work will employ least square estimation method to assess how macroeconomic variables respond to volatility in the price of oil.

### Macroeconomic Variables

#### Gross domestic product (GDP)

Gross Domestic Product is the monetary value of the market value of all final goods and services produced in a geographical region in a period of time. It is normally measured on annual basis [7,8]. GDP also indicate the economic health of a nation.

#### Exchange rate (EXR)

Foreign exchange is the exchange of one currency for another or the conversion of one currency into another currency. It also refers to the global market where currencies are traded virtually around the clock [9].

#### Foreign direct investment (FDI)

FDI is an investment made by a company or individual in one country of business interest in another country, in the form of either establishing business operations or acquiring business assets in the other country (such as ownership of controlling interest in foreign company) [10]. It provides developing countries with the needed capital for investment and also enhances job creation, managerial skills, and transfers of technology and contributes to economic growth and development [11].

#### Interest rate (INR)

Interest rate is the amount charged, expressed as a percentage of principal, by a lender to a borrower for the use of assets. The asset borrowed could include cash, consumer goods, and large assets, such as a vehicle or building. The total interest on an amount lent or borrowed depends on the principal sum, the interest rate, the compounding

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frequency and the time or period, over which it is lent, deposited or borrowed [12].

### Balance of payments (BOP)

Balance of payments also known as balance of international payments is the record of all economic transactions between the residents of the country and the rest of the world in a particular period of time. It summarizes an economy's transactions with the rest of the world [13].

## Materials and Methods

### Design of the study

This research is an empirical study of the effect of oil price fluctuation on the Nigerian economy. Some indicators which would serve as proxies for the dependent and independent variables were defined under the model specification. This research adopted least square method, an econometric technique which correlates the changes in one variable (dependent variable) to one or more variables (explanatory variables). The demonstration of the relationship between the variables is described as linear regression model. It was identified linear, because the association is linearly preservative [8].

### Justification for the design

Several literature exists, which adopted similar methodology for assessing the impact of oil price changes on the economy. Thus, it is a generally accepted methodology for studying the relationship between the variables under discussion. There are also other very sophisticated methods. However, such methods may not lend good applicability in this particular study.

### Model specification

The various econometric specification of the models that was estimated are presented in eqns. (1)-(5):

$$GDPPC_t = \alpha_1 + OILP_t + \epsilon_t \quad (1)$$

$$EXR_t = \alpha_2 + OILP_t + \epsilon_t \quad (2)$$

$$FDI_t = \alpha_3 + OILP_t + \epsilon_t \quad (3)$$

$$INR_t = \alpha_5 + OILP_t + \epsilon_t \quad (4)$$

$$BOP_t = \alpha_4 + OILP_t + \epsilon_t \quad (5)$$

Where:

$\alpha$  is a parameter estimate to be determined from the model, GDPPC=Gross Domestic Product per Capita, OILP=Oil Price, EXR=Exchange Rate, BOP=Balance of Payments, FDI=Foreign Direct Investment, INR=Interest rate,  $\epsilon_t$ =Error term, t indicates the data used are time series data.

### Data and sources

Principally, this study used secondary data on the parameters. The data was sourced from both international organisations such as World Bank, British Petroleum and US Energy Information Administration (US EIA), as well as from First Bank of Nigeria and Nigerian Bureau of statistics. Time series data on the macroeconomic variables defined above and crude oil (brent) price for the period 1990 to 2015 was used in this study. Additionally, the data and results was subjected to diagnostic test, using econometric methodologies, which includes - test for linearity of the model, heteroscedasticity, and normality test.

### Method of data analysis

The data was subjected to econometric analysis based on the result which was obtained from the simple linear regression specified for this study. Trends and charts as well as some test statistic was used to discuss the result of this study.

## Results and Discussion

To normalize the values, the equations were transformed to log-log expression, so as to be able to account for the relationship between the variables in terms of percentages. The result of the various estimations is presented in this section.

### Gross domestic product (GDP)

Eqn. (6) shows the results of the model estimate for Gross Domestic Product per Capita (GDPPC) and Oil Price (OILP).

$$GDPPC_t = \alpha_1 + OILP_t + \epsilon_t \quad (6)$$

$$\text{Log}(GDPPC_t) = 1.491 + 1.373 \text{log}(OILP_t)$$

$$P = (0.000) \quad (0.000)$$

$$R^2 = 0.88; \text{F-Stat} = 181.765 \quad (0.000)$$

The result of the model for Gross Domestic Product per Capita (GDPPC) and Oil Price (OILP) shows a positive linear log relationship exists between them. In addition, the coefficient of the estimate ( $\alpha_1 = 1.491$ ) and probability (P) show that oil price significantly impacts GDPPC. Furthermore, the result of the regression indicates that a percentage change in the oil price lead to a 1.4% change in the GDPPC of Nigeria within the period of 1990 through 2015 reviewed in this study. The coefficient of regression ( $R^2 = 0.88$ ) indicates that about 88% of changes in GDPPC is accounted for by changes in oil price. This result is expected, especially as Nigeria depends mostly on oil revenue, and thus is exposed to oil price volatility. The F-Statistics further lends credence to the explanatory power of the model. Figure 1 shows the impact of oil price on Nigerian gross domestic product per capita.

From Figure 1, changes in crude oil price affected GDP per capita. Although, not very marked fluctuation is observed, compared to oil price impact on exchange and interest rates, there is noticeably a fluctuation in GDP per Capita in 2008 and 2014 respectively, as these periods showed an observable change (volatility) in the price of crude oil in the international market. It may be that the less impact on GDP per capita, could have resulted from the fact that, even though crude oil provides over 85% of foreign revenue to Nigeria, it accounts for less than 20% of the GDP [14].

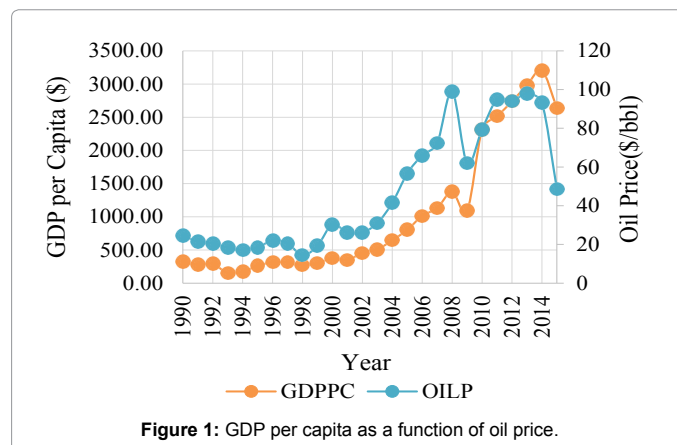


Figure 1: GDP per capita as a function of oil price.

### Exchange rate

Eqn. (7) shows the result of the model estimate for exchange rate (EXR) and oil price (OILP).

$$EXR_t = \alpha_2 + OILP_t + \epsilon_t \quad (7)$$

$$\text{Log}(EXR_t) = -0.05 + 1.167 \log(OILP_t)$$

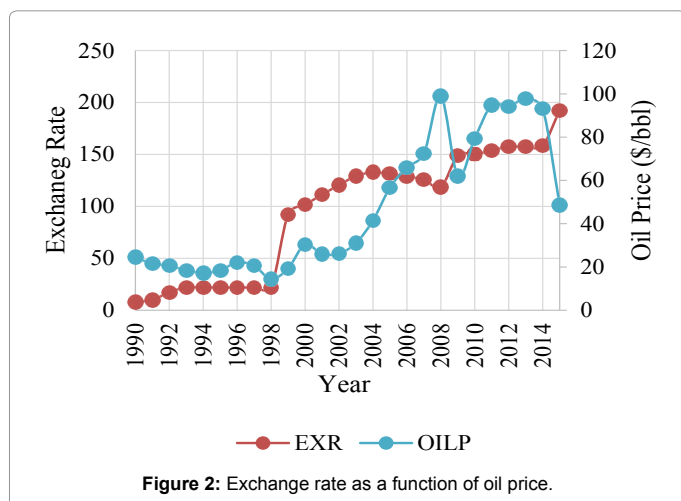
$$P = (0.948) (0.000)$$

$$R^2 = 0.57; F\text{-Stat} = 32 (0.000).$$

The result of the model for exchange rate (EXR) and oil price (OILP) indicates that there is a positive linear relationship between EXR and OILP. In addition, the coefficient of the estimate ( $\alpha_2 = -0.05$ ) and probability (P) show that changes in oil price significantly affects Nigeria's exchange rate, relative to the dollar. The result of the regression further shows that a 1% change in the oil price lead to a 1.2% change in the exchange rate within the period reviewed. This result substantiates the fact that Nigeria's dependence on oil is a major factor affecting instability in exchange rate. The coefficient of regression ( $R^2 = 0.57$ ) indicates that the model is able to explain about 57% of changes in exchange rate. This implies that other factors which may impact exchange rate, other than oil price changes are not captured in the model specified. The F-statistic value of 32 is a testament to the models explanatory power.

Figure 2 shows exchange rate (primary vertical axis) as a function of crude oil price (secondary vertical axis) for the period of 1990 through 2015. There are observable fluctuations in the exchange rates, especially when there is a spike in the oil price. The trend is understandable, given that crude oil is the major foreign revenue earner and also a major determinant of the country's exchange rate, as the price of oil is denominated in dollar. Consequently, any sharp decline or increase in the price of oil, as is observed during periods of volatility, would affect the exchange rate of Naira to dollar.

It could be seen from the Figure 2 that between 2004 through 2008, as the oil price increased, the exchange rate was on the decline. Similarly, in 2008 and 2014, where there was a major decline in the price of oil (volatility) as a result of the global financial crash as well as the increased supply from shale oil producers, the exchange rate increased accordingly. The result further substantiates the fact that oil price volatility impacts exchange rates, especially for Nigeria, which is an oil revenue dependent economy.



### Foreign direct investment

Eqn. (8) presents estimates of the relationship between Foreign Direct Investment (FDI) and oil price (OILP):

$$FDI_t = \alpha_3 + OILP_t + \epsilon_t \quad (8)$$

$$\text{Log}(FDI_t) = -3.372 + 1.170 \log(OILP_t)$$

$$P = (0.000) (0.000)$$

$$R^2 = 0.81; F\text{-Stat} = 108.52 (1.050)$$

Estimates of the relationship between Foreign Direct Investment (FDI) and oil price (OILP) as shown in eqn. (8), indicates that there is a positive linear relationship between FDI and OILP. The coefficient of the estimate ( $\alpha_3 = -3.372$ ) and probability show that changes in oil price significantly affects the inflow of Foreign Direct Investment to Nigeria. The result of the regression shows that a 1% change in the price of oil lead to a 1.2% change in the level or amount of foreign direct investment in Nigeria within the period reviewed. The model showed a high explanatory power ( $R^2 = 0.81$ ), indicating that 81% of changes in foreign direct investment in Nigeria is accounted for by changes in the price of oil. Off course, this is expected, given that, oil price fluctuation significantly affects other macroeconomic variables, which would otherwise incentivize investment in the country. Although, other factors which may affect foreign direct investment, such as stability of polity and level of corruption, are not accounted for in this model. Perhaps, these other factors unaccounted for, may be subsumed in the 19%. Figure 3 illustrates how changes in crude oil price influences Foreign Direct Investment (FDI) in Nigeria.

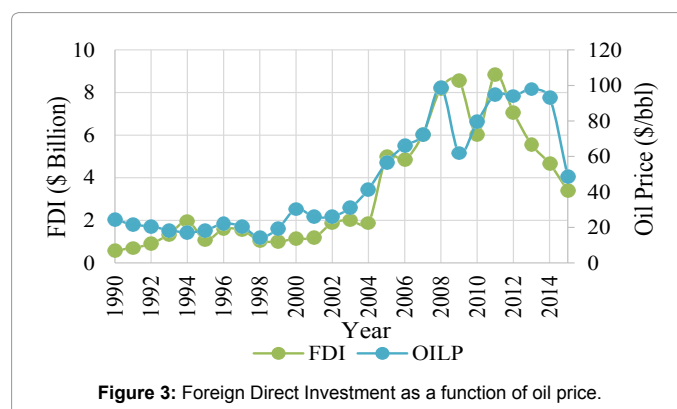
Figure 3 shows both parameters (OILP and FDI) trending in the same direction. In other words, there is more foreign investment in Nigeria during periods of higher or stable oil prices as opposed to periods of lower oil prices. A marked fluctuation in the price of oil, as observed from 2008 led to decline in FDI in Nigeria. This trend is understandable, given that investors are weary of interest rate issues which may be occasioned by volatility in the price of oil. In the same vein, appreciating oil prices as observed between 2000 to 2008 saw increasing foreign direct investment in Nigeria.

### Balance of payments

Eqn. (9) indicates the relationship between balance of payments and oil price.

$$BOP_t = \alpha_4 + OILP_t + \epsilon_t \quad (9)$$

$$\text{Log}(BOP_t) = -26.134 + 9.562 \log(OILP_t)$$



P=(0.001) (0.000)

R<sup>2</sup>=0.45; F-Stat=19.714 (0.000).

The relationship between balance of payments and oil price as shown in the estimate in eqn. (9). The result indicates that there is a direct linear relationship between balance of payments and oil price. The coefficient of estimate ( $\alpha_4 = -26.134$ ) and probability (P) show that changes in oil price significantly affects the balance of payment. In other words, an increase in the global oil price will improve the balance of payment position of Nigeria. The result of the regression further shows that a 1% change in the price of oil price lead to a 9.6% change in the balance of payments position, within the period reviewed. This result is important in that it captures Nigeria's import dependence. It is expected, because, with decline in oil price, the nation's foreign reserves declines due to increased withdrawals, and hence, with continuous importation, the balance of payments position diminishes. Although, the R<sup>2</sup> of 0.45 shows that the model is only able to account for 45% of the changes in balance of payments as a function of oil price changes. In other words, other factors which were not captured in the model could also impact the BOP on Nigeria. The response of balance of payments to crude oil prices as further illustrated in Figure 4 indicates that Nigeria's balance of payments responds directly to fluctuations or volatility in the price of crude oil. Figure 4 shows that appreciation in oil price as observed from 2003 to 2007 correlated an improvement in the BOP position of Nigeria within same period. This may mean that the country boosted her foreign reserves from the increase in revenue accrued from crude oil sales. Also, from the figure, there is a marked decline in BOP corresponding to the drop in oil price in 2008. Similar trend in positive relationship is observed from 2010 through 2012.

It is also important to acknowledge that as crude oil accounts for more than 80% of government foreign revenue, with Nigeria being a dominantly import dependent nation, when oil prices drop expectedly, the balance of payments will drop as we tend to import more than we export, thus withdrawing more dollars from our foreign reserves. This result underscores the negative consequences of being an import dependent country.

### Interest rate

The estimates of interest rate as a function of oil price change are shown in the model in eqn. (10).

$$INR_t = \alpha_5 + OILP_t + \epsilon_t \quad (10)$$

$$\text{Log}(INR_t) = -4.435 + 0.493 \text{ log}(OILP_t)$$

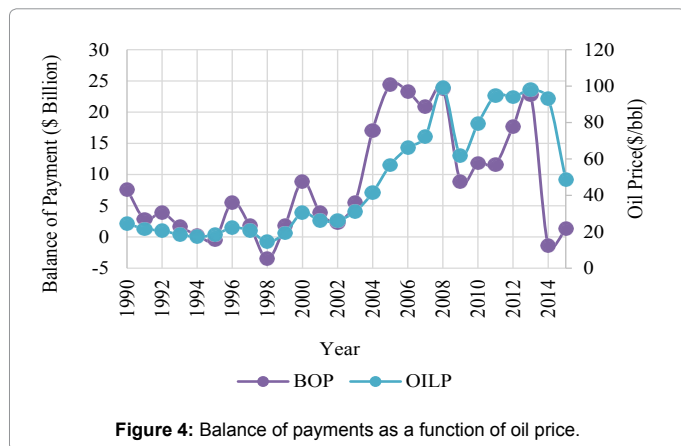


Figure 4: Balance of payments as a function of oil price.

P=(0.000) (0.018)

R<sup>2</sup>=0.21; F-Stat=6.437(0.018).

The model indicates that there is a positive linear log relationship between Interest Rate (INR) and Oil price (OILP). Oil price is a major factor which significantly affects interest rate ( $\alpha_5 = -4.435$ ). The results of the regression indicate that a unit change in oil price led to about 0.5% change in the interest rate between 1990 and 2015. In addition, the R<sup>2</sup> shows that 21% of the changes in interest rate are accounted for by oil price changes. This is a lower explanatory power however, compared to others factors explained earlier. This further implies that changes in oil price are not the only factor that influences interest rate changes in Nigeria. Figure 5 shows an observed increase as well as a sharp drop

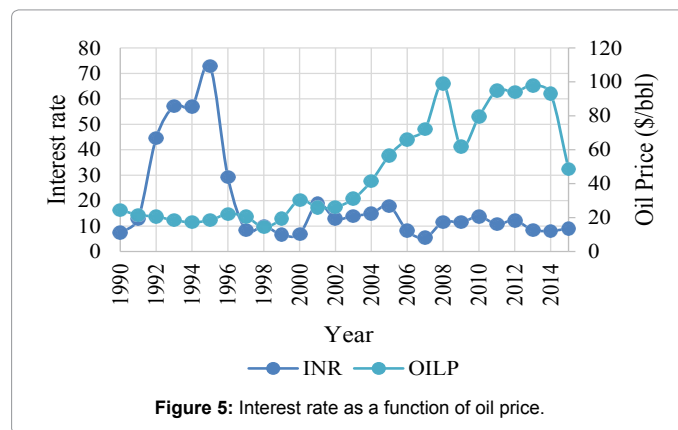


Figure 5: Interest rate as a function of oil price.

in interest rate between 1990 through 1997, even though there were not much of observed changes in the price of crude oil within that period. However, from 2000, with increasing oil price, interest rate did not show marked changes. Also, the sharp drop in 2008 did not affect interest rate commensurately. This could be explained by the fact that the financial crisis did not impact very negatively on the interest rate in Nigeria. It is however, pertinent to acknowledge that interest rate responds to changes in oil price.

### Conclusions

This study focused on the impact of oil price volatility on economic performance of Nigeria. Various macroeconomic variables, including foreign exchange rate, interest rate, and balance of payments, gross domestic product per capita and foreign direct investment were regressed against oil price. The period covered in the study was from 1990 to 2015. Ordinary least square method was used to establish the relationships. From the result of the study, the conclusions are as follows:

- i. Oil price volatility is linearly related to the macroeconomic variables investigated.
- ii. Oil price volatility has an effect on foreign exchange rate, interest rate, balance of payments, gross domestic product per capita and foreign direct investment.

### Recommendations

It is recommended that Nigerian economy should be diversified to guarantee non-dependence on oil revenue as the major source of foreign income earner for the country, and that investment in local products to encourage export, while discouraging over importation is imperative.

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