Asymmetric Effect of Oil Price Volatility, Oil Price Revenue, and Some Other Macro-Economic Variables on Economic Growth

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Abstract: **Globally, aside from the economic effect, the process of price fluctuation and high uncertainty associated with crude oil inclusively affects the gross domestic product, import bills, and inflation. The study evaluated the asymmetric effect of oil price volatility, oil price revenue, and some other macro-economic variables on economic growth. Secondary data were used for this study and were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletins and World Development Indicator from 1983 to 2019. The data were analyzed using descriptive (Graphs and tables) and inferential statistics (Ordinary least square, Co-integration test, Vector Error Correction Model, and Granger Causality Test) to evaluate the study hypothesis.**

The result of regression indicated that the calculated value related to probability (F (5, 31) = 175.60, Prob> F = 0.0000) and its adjusted value of R^2 (0.9604), showed that oil price revenue (β =0.640034), foreign exchange (β =0.9539687) and oil price volatility (β =0.7080817) have a positive effect on Gross Domestic Product (GDP) at p≤0.05. Moreover, the granger causality test indicated that there is independence or no causation among gross domestic product (LNGDP) and interest rate (LNINTR), oil price revenue (LNOPR), gross domestic product (LNGDP) oil price volatility (LNOPV), going by the p-values which are greater than 0.05 or 5% at a lag difference of 2. Finally, t-statistics, f-statistic, and chi-square of 2.107337, 4.440867, and 4.440867 with the probability value of 0.05, 0.05, and 0.0351 indicated that F-statistic probability value implies there is long-run asymmetry among the variables

In conclusion, the finding of the analysis, therefore, showed a statistically asymmetric effect of oil price volatility, foreign exchange rate, and the interest rate on Nigeria's economic activities. This implies that macro-economic indicators performance such as interest rate, foreign exchange rate, and oil prices influenced economic growth and found out that increases in oil prices may depress the supply of other goods by raising their cost of production because prices of oil have a direct impact on the prices of goods produced from petroleum products. Based on the above result, it is recommended that the policymakers should reduce the pressure on exchange rates and interest rates by diversifying the economy to reduce the pressure on oil, which in turn promotes economic growth. Also, there should be a review of monetary policy by the Central Bank of Nigeria (CBN) with the use of a contractionary monetary policy that would help to reduce the inflation rate.

Keywords: **Oil price, volatility, oil price revenue, economic growth, macroeconomic variables, Gross Domestic Product, foreign exchange rate, co-integration.**

I. INTRODUCTION

Globally, oil price fluctuations are a significant cause of global crises and negative economic growth (Motunrayo & Nicholas (2020). As a result, oil prices are highly unpredictable and generate a great deal of controversy among decision-makers and academia. Muhammad and Ghulam (2017) posited that the increase in oil prices not only influences economic activities but also forecasts future instability in oil prices. Oil exporting countries have benefited tremendously as oil prices grow and they make big profits. Governments are making money and using that money to benefit their own country. New investment programs are being initiated and all other spending is funded by these results (Rafiq, Salim & Bloch, 2008). As observed by Sunday (2019), crude oil has developed and remains one of the global economy's single most important defining forces, with oil markets becoming more volatile after the end of World War II. But the instability in oil prices has been much more extreme lately.

Mory (1993) argued that oil price has an asymmetric effect and needs to be decomposed into oil prices increase and decrease. He stressed that declines in oil prices do not inherently stimulate economic growth. The volatility of oil prices was examined by Narayan and Narayan (2007), and evidence of asymmetry was found. Most research on developing countries, however, are few and inconclusive and mostly comprise many-countries analysis. These studies include Motunrayo and Nicholas (2020) on low-income oil-importing countries, Umar and Lee (2018) on African OPEC Member Countries and Zied, Khaled, Frédéric & Slim (2016) on the United Arab Emirates, Kuwait, Saudi Arabia, and Venezuela. Most time-series studies that exist have been done without considering the asymmetric effect of oil price volatility, oil price revenue, and other macro-economic variables on economic growth in Nigeria, and most common to developed countries.

This study measures whether economic growth reacts to changes in real oil prices asymmetrically. While numerous studies have been conducted on the subject, particularly with panel data, this paper is one of the pioneering studies to broaden discussions on real oil price asymmetry, oil price revenue, and economic growth using time series data in

Nigeria. In different ways, this research is novel. First, unlike previous studies such as Englama, Duke, Ogunleye, and Ismail (2010) and Oriakhi and Iyoha (2013), which used the standard deviation as an oil volatility measurement, This paper employs a time-series study analysis on an oil-importing developing country like Nigeria and will further improve the literature on oil price and economic growth in the region by employing the higher predictive power generalized Non-Linear Autoregressive Distributed Lag Model (NARDL) measure of volatility. Second, this analysis uses data in this field over a longer sampling duration than any previous research, thereby taking into account the different occurrences of oil price volatility that have occurred over the years. Third, this research used the technique of co-integration and error correction model aimed at providing both long-run and short-run dynamics. Hence, in order to define the direction of the relationship between the variables, the analysis also used Granger causality tests. With the recent drop in oil prices expected to hit Nigeria hard, there was a significant dent in government revenues and the feasibility of upstream projects were threatened. As it has not completely recovered from the previous crash in 2014, the country is especially vulnerable at present and this paper fills the knowledge gap of oil price fluctuations by researching oil-importing developing countries like Nigeria.

Research Hypothesis

Ho_1**:** Oil price volatility, oil price revenue, and some other macro-economic variables have no significant influence on economic growth

II. LITERATURE REVIEW AND CONCEPTUAL EXPLANATION

Theoretical Review

This paper reviews the following theories: theory of economic growth, linear/symmetric relationship theory of growth, asymmetry in-effects theory of economic growth, and Dutch illness Theory

Theory of Economic Growth

The mainstream theory of economic growth postulates that output is the most important determinant of any economy's growth, and energy is needed for output, which is in some way the transformation of matter (Moradi, Salehi & Keivanfar, 2010). This theory categorizes capital, labour, and land as primary production factors; they occur at the beginning of the time of production and are not explicitly used (although they can be degraded or added to) in production.

Although energy resources (such as oil and gas, fuels, coal) are classified as intermediate inputs, they are produced during the phase of production and are fully exploited during the process of production. In deciding the marginal product of oil as an energy resource useful in deciding economic growth or development, this theory takes into account, on the one hand, its ability to perform work, its cleanliness, its storage capacity, its versatility of use, its protection, its cost of conversion, and so on, on the other, other characteristics, such as the type of capital, labour or materials used in conjunction with it.

Symmetric/Linear Relationship Theory of Growth

Hamilton (1983), Gisser (1985), Goodwin (1985), Hooker (1986), and Laser (1987) postulated as their proponents that volatility in GNP growth is driven by volatility in oil prices. They based their hypothesis on the events in the oil market between 1948 and 1972 and their impact on the economies of countries that export and import oil respectively. After comprehensive empirical studies, Hooker (2002) found that the oil price level and its improvements had a major impact on GDP growth between 1948 and 1972. Laser (1987), who was a late entrant to the symmetrical school of thought, confirmed the symmetrical relationship between oil price fluctuations and economic development. After an empirical analysis of her own, she concluded that a rise in oil prices requires a decrease in GDP, while the impact of a decrease in oil prices on GDP is unclear since its effects vary from country to country.

Asymmetry-in-Effects Theory of Economic Growth

This theory indicated that the association between decreases in crude oil prices and economic activity in an economy is substantially different, and maybe zero. Mork, Olsen & Mysen (1994) reported the asymmetry in the impact on the economic growth of oil price volatility. The asymmetric mechanism between the effects of oil price fluctuations and economic growth was also clarified by Ferderer (1996) by focusing on three potential methods: counter-inflationary monetary policy, sectoral shocks and uncertainty. He finds a significant link between rises in oil prices and responses to counter-inflationary policies. Balke (1996) supported the position of Federer. He argued that monetary policy alone could not fully justify the actual impact of the fluctuations of oil prices on real GDP.

Dutch illness Theory

Corden and Neary (1982) developed the Dutch disease model. The Dutch disease is an adverse effects-related condition that arises from the discovery of new natural resources. The production and sale of natural resources contribute to an overvaluation of the country's currency and, as a result, produces negative externalities in other sectors of tradeable goods and services. The Dutch disease model assumes that the economy consists of three sectors: the natural resource trading sector, the manufacturing trading sector, and the non-trading sector.

Besides, the Dutch disease emerges when the boom in the market for natural resources (e.g. oil) leads to an increase in domestic profits, availability of cash, and demand for products. This, in turn, brings about high real currency inflation and appreciation. In the meantime, higher domestic prices and a stronger domestic currency make it less competitive for the country to export other products in the tradeable manufacturing and agricultural sectors. The 'spending effect' is referred to as this detrimental effect (Corden and Neary, 1982). Another adverse effect ('pull effect') also exists that squeezes the non-resource manufacturing and agricultural sector (Badeeb, Lean and Clark, 2017). The 'pull effect' is correlated with the situation when domestic input prices rise as a result of the boom in natural resources and produce an increase in the cost of the output of other tradable sectors such as manufacturing and agriculture. In particular, this hampers the overall growth of the tradable non-resource market. However, it should be added that the Dutch disease may contribute to an expansion of the non-traded market. Higher domestic income and higher personal income are contributing to a rise in demand and price rises for non-traded goods. It is favourable for the growth of that sector, mainly during the era of a boom in the market for natural resources when the availability of money increases.

This research paper is also related to the influence of volatility in oil prices, exchange rate, fiscal policy, and economic growth and all the above theories encourage this research work.

2.2 Empirical Review

Mehrara (2008) found that positive shocks in oil sales have a positive and significant short-term effect on economic growth. On the other hand, negative oil shocks have negative and substantial effects. Mehrara (2008) showed, however, that the impact of negative oil revenue shocks is more than twice the impact of positive shocks. He pointed out that the oil market bust is seriously hampering economic growth, while the oil boom is having a positive, but they mostly contemporary, and irrelevant effect on economic growth. The overall effect of oil revenue shocks on the economic development of the country is, therefore, most often negative and is seen as a symptom of the Dutch disease.

Korhonen & Mehrotra (2009) evaluated the impacts of oil price shocks on real exchange rates and production in four major energy-producing countries: Kazakhstan, Venezuela, Iran, and Russia. 4 variables auto-regressive structural models were estimated using normal long-term restrictions. The study discovered that increase in real oil prices is associated with increasing output. Nevertheless, the study found that the prices of oil shocks are the major economic driver of real output in all the four countries, possibly due to ongoing transition and recovery. Likewise, oil shocks do not account for a large share of exchange rate changes, although they are more important for Iran and Venezuela than for other countries.

Motunrayo & Nicholas (2020) examined the effect of oil prices on economic growth in seven low-income Sub-Saharan African (SSA) oil-importing countries, namely Ethiopia, Gambia, Mali, Mozambique, Senegal, Tanzania, and Uganda using Auto Regressive Distributive Lag (ARDL-screen) screen. The oil price does not have a major effect on the Group's economic growth in the short-run but has a significant negative impact in the long-run. However, the coefficients of short-run countries indicate that oil prices have a major but mixed effect on economic growth in all seven countries. Use the Non-linear approach. The asymmetric effect of oil prices on economic growth was also explored by the Autoregressive Distributed Lag (NARDL) model, by decomposing oil prices into negative and positive shifts.

Sunday (2019) investigated the nexus between oil price volatility and infrastructural growth in Nigeria, utilizing the cointegration and error correction modeling approach for the period 1981-2015. His findings suggested that both oil price volatility and inflation rate tend to exert a negative impact on infrastructural growth, while the appreciation of the real exchange rate tends to trigger investment in infrastructure. The result of the study emphasised that that volatility in oil price is negative and statistically significant, while that of interest rate was also negative but statistically insignificant. Also, inflation exerted a negative and statistically significant impact on infrastructural growth

III. APPROACH/METHODOLOGY

The research adopted for this study employed both descriptive and inferential analysis. The Ordinary Least Square (OLS) regression analysis method, Co integration test, Vector Error Correction Model, and Granger Casualty Test were also used to analyze the data from Central Bank of Nigeria Statistical Bulletin and Security and Exchange Commission for the relevant years covering 1983 to 2019 with the aid of STATA 12.0. The data used in this research work is secondary data. The interest rate, inflation rate, and the exchange rate were used as proxies for macro-economic variables while gross domestic product (GDP) was used to proxy economic growth. The independent variables were Oil Price Volatility (OPV), Oil Price Revenue (OPR), Interest rate (INTR), the Foreign Exchange (FOREXC), and Inflation rate (INFR) while the dependent variable is Gross Domestic Product (GDP)

Model Specification (Developing a Regression Model)

The model of this study was expressed as the ordinary least square regression model and estimated using the log values of the variables. The log transformation made the estimated coefficients to serve as elasticity:

$$\boldsymbol{Y} = \beta_o + \beta_1 \boldsymbol{X_1} + \beta_2 \boldsymbol{X_2} + \ldots \beta_n \boldsymbol{X_n} +$$

Where Y is economic growth proxied by Gross Domestic Product (GDP) (dependent variable), X_1-X_n are independent variables proxied by Inflation rate (INFR), Interest Rate (INTR), Oil Price Volatility (OPV), Foreign Exchange (FOREXC), Oil Price Revenue (OPR), β_0 is constant and β_1-β_n represents the coefficient of independent variables.

Model:

The model specified as:

GDP = f (INFR, INTR, OPR, FOREXC, OPV)

Specifically, the model is given as:

$LNGDP_t = \beta_0 + \beta_1 LNINFR_t + \beta_2 LNINTR_t + \beta_3 LNOPR_t + \beta_4 LNFOREXC_t + \beta_5 LNOPVC_t + \boldsymbol{\mu}_t$

LNGDP-Logarithm of Gross Domestic Product

LNINFR- Logarithm of the Inflation rate

LNINTR- Logarithm of Interest Rate

LNOPR- Logarithm of Oil Price Revenue

LNFOREXC- Logarithm of Foreign Exchange Rate

LNOPV- Logarithm of Oil Price volatility

t= time subscript

μ_{t}- White noise residual /Error term in time t.

β_0 and β represent the regression constant and regression coefficient of the variables.

IV. RESULTS AND DISCUSSIONS

Unit root test

The Augmented Dickey-Fuller (ADF) was used to examine the stationarity of the data set. The test result shown in Table 1 suggested that all series are combined with the difference of order "I(1)." Thus, the relationship of the sequence would be false if the presence of the unit root test was defined at the level of the test.

Table 1: Unit Root Test

Unit root test			
Variables	Order of Stationarity	Augmented Dickey-Fuller test statistics	Decisions
LNGDP	0	-1.854	Stationary
LNGDP	1	-1941	Stationary
LNINFR	0	-4.711	Stationary
LNINFR	1	-5.019	Stationary
LNINTR	0	-2.935	Stationary
LNINTR	1	-2.326	Stationary
LNOPR	0	-1.991	Stationary
LNOPR	1	-2.196	Stationary
LNFOREXC	0	-2.613	Stationary
LNFOREXC	1	-2.903	Stationary
LNOPV	0	-0.939	Non-stationary
LNOPV	1	-0.982	Non-stationary

Test critical values: ADF test are 1%, -2.449, 5% -1.694, 10% -1.309
Source: Researcher computation, 2020

Co-integration Test

The conclusion is given in Table 2 for trace statistics either reject the null hypothesis of no co-integration between variables or rejects the null hypothesis that there are co-integration relationships between variables. Start at Ho: r = 0. If rejected, repeat for Ho: r= 1. If the test is accepted, stop the test and the value of r is the approximation used for the number of co-integrating relationships. In this test, Ho:= 3 which is not rejected at the 5% (29.1879<29.68). Assuming two lags, the number of co-integration is 3, i.e. rank of n=3

Since the rank is equal to 3 which is greater than zero and less than the number of variables, the sequence is co-integrating between the variables and this implies a long-term relationship between the variables.

Table 2: Johansen Co-integration Test using trace statistics

Maximum rank	params	LL	eigenvalue	Trace statistic	critical value 5%
0	42	24.981649	.	135.8545	94.15
1	53	51.644618	0.78207	82.5286	68.15
2	62	67.614625	0.59851	50.5885	47.21
3	69	78.314949	0.45743	29.1879*	29.68
4	74	88.205082	0.43173	9.4076	15.41
5	77	92.183723	0.20336	1.4503	3.76
6	78	92.908895	0.04059		

* means 3 cointegration equation
Source: Researcher computation, 2020 using STATA version 12

Vector Error Correction Model (VECM)

The presence of co-integration implies that VECM can be used. This analysis, therefore, continues with the Vector Error Correction Model (VECM) to test the short-term effects of the co-integrated array.

All the coefficients of the Vector Error Correction Model were significant at a 1% confidence interval as shown in Table 4. If more than one co-integrating vector is measured, automatically the coefficient can be termed as to long-run elasticity. Thus, with a 1% rise in foreign exchange rate and oil price volatility, GDP is likely to rise by 4.721238 and 3.057721 and it was statistically significant. For a 1% rise in the inflation rate, interest rate, and oil price revenue, gross domestic product is reduced by -4.482615, -1.286163, and -6.037687. These coefficients were statistically significant at a 5% level of significance.

Table 3: Vector Error-Correction Model (VECM)

Co-integrating equations			
Equation	Parms	chi2	P>chi2
_ce1	5	161.3245	0.0001

Identification: beta is exactly identified
Johansen normalization restriction imposed

Beta	Coef.	Std. err.	Z	Pr>|z|	95% conf.	Interval
_ce1						
Lngdp	1	.	.	.	.	.
lnifr	-4.482615	.5882514	-7.62	0.000	-5.635567	-3.329664

lnintr	-1.286163	2.106188	-0.61	0.541	-5.414215	2.841889
lnopr	-6.037687	1.355317	-4.45	0.000	-8.694059	-3.381315
lnforexc	4.721238	1.577347	2.99	0.003	1.629695	7.812781
lnopv	3.057721	1.448613	2.11	0.035	.2184923	5.89695
_cons	13.63811					

Source: Researcher computation, 2020 using STATA version 12R

Granger Causality Wald Test

Granger causality refers to a statistical principle of causality focused on prediction. This connotes that if variable X "Granger-causes" a variable Y, then past values of X will contain information that helps predict Y above and beyond the information found in past values of Y alone. Its mathematical formulation is based on a linear regression modeling of stochastic processes (Granger, 1969). The rule of thumb is to reject the null hypothesis if the probability value (p-value) is less than 5 percent (i.e. 0.05) and consider the null hypothesis if the probability value (p-value) is greater than 5 percent (i.e. 0.05). Depending on the probability value stated in Table 4.1, the assumption that LNGDP does not granger cause LNIFR cannot be rejected, but the assumption that LNIFR does not granger cause LNGDP can be rejected.

Thus, Granger's causality runs one way, that is, from LNIFR to LNGDP, but not the other way. Meaning that LNGDP Granger triggers LNIFR but LNIFR does not granger cause LNGDP. The p-values shown in Table 4.2 indicated that LNGDP does not trigger Granger LINTR cannot be rejected because it is less than 5% and vice versa. Based on the probability value reported in Table 4.3, the hypothesis that LNGDP does not Granger cause LNOPR cannot be rejected, and the hypothesis that LNOPR does not Granger cause LNGDP cannot also be rejected. Thus, Granger causality runs neither way. The p-values are shown in Table 4.4 also revealed that the hypothesis that LNGDP does not Granger cause LNFOREXC can be rejected with p-value (0.001) which is less than o.05 or 5%. However, the hypothesis that LNFOREXC does not Granger cause LNGDP cannot be rejected with a p-value of 0.07. On the contrary, the hypothesis that LNGDP does not Granger cause LNOPV cannot be rejected with a p-value of 0.234 which is greater than 0.05 or 5%. Also, the hypothesis that LNOPV does not Granger cause LNGDP and cannot be rejected in the same vein with p-value 0.098. Thus, LNGDP does not Granger cause LNOPV, and LNOPV also does not granger cause LNGDP. More so, the result in the table below suggests that the hypothesis that LNINTR does not Granger cause LNOPV can be rejected. Hence, the hypothesis that LNOPV does not Granger cause LNINTR cannot be rejected implying that Granger causality is bidirectional.

Conversely, there is independence or ‘no causation’ among LNGDP and LNINTR, LNGDP and LNOPR, LNGDP and OPV as well as LNOPR and LNOPV, going by the p-values shown in Table 4.5 which is greater than 0.05 or 5% at a lag difference of 2.

Table 4.1: Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob > chi2
lngdp	lninfr |	1.1291	2	0.569
lngdp	lnintr	1.856	2	0.395
lngdp	lnopr	.45582	2	0.796
lngdp	lnforexc	13.112	2	0.001
lngdp	lnopv	2.9086	2	0.234
lngdp	ALL	33.611	10	0.000

Table 4.2: Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob > chi2
lninfr	lngdp	8.5479	2	0.014
lninfr	lnintr	.66602	2	0.717
lninfr	lnopr	6.8838	2	0.032
lninfr	lnforexc	13.839	2	0.001
lninfr	lnopv	16.799	2	0.000
lninfr	ALL	30.21	10	0.001

Table 4.3: Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob > chi2
lnintr	lngdp	.03933	2	0.981
lnintr	Lninfr	4.3378	2	0.114
lnintr	lnopr	7.1232	2	0.028
lnintr	lnforexc	1.9155	2	0.384
lnintr	lnopv	8.826	2	0.012
lnintr	ALL	23.71	10	0.008

Table 4.4: Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob > chi2
lnopr	lngdp	.72336	2	0.697
lnopr	lninfr	2.5611	2	0.278
lnopr	lnintr	13.583	2	0.001
lnopr	lnforexc	10.775	2	0.005
lnopr	lnopv	2.2509	2	0.325
lnopr	ALL	34.703	10	0.000

Table 4.5: Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob > chi2
lnforexc	lngdp	5.2283	2	0.073
Lnforexc	lninfr	6.0652	2	0.048
Lnforexc	lnintr	.04409	2	0.978
Lnforexc	Lnopr	4.9723	2	0.083
Lnforexc	lnopv	15.907	2	0.000
Lnforexc	ALL	32.79	10	0.000

Table 4.6: Granger Causality Wald Tests

Equation	Excluded	chi2	df	Prob > chi2
Lnopv	lngdp	4.6468	2	0.098
Lnopv	lninfr	8.6845	2	0.013
Lnopv	lnintr	17.204	2	0.000
Lnopv	Lnopr	5.6341	2	0.060
Lnopv	Lnforexc	14.994	2	0.001
Lnopv	ALL	44.1	10	0.000

Source: Author's Research, 2020

Analysis of the influence of oil price volatility, oil price revenue, other macro-economic variables, on the growth of Nigeria economically.

Table 5 showed the effects of oil price volatility on the growth of the Nigerian economy. A unit rise in oil price revenue (lnopv), foreign exchange rate (lnforexc), and oil price volatility (lnopr) increases the level of Gross Domestic Product (lngdp) by .0640034, 0.9539687, and 0.7080817 units, indicating that there is a positive relationship between lngdp and each of lnopr, lnforexc, and lnopr. The result is significant for all the above variables except for oil price revenue (lnopr) since their p-value is less than 0.05 but greater than 5% for oil price revenue. The relationship between inflation rate (lnifr), interest rate (lnintr), and gross domestic product (lngdp) is negative suggesting that if gross domestic product increases, inflation rate and interest rate reduces.

The adjusted R^2 coefficient (0.9604) which is the coefficient of determination indicates that the explanatory variables accounted for 96% of the variation in the influence of Gross Domestic Product on Inflation rate (lninfr), Interest rate (lnintr), Oil price revenue (lnopr), Foreign exchange rate (lnforexc) and Oil price volatility (lnopv) in Nigeria for the period under review. The result remains robust as indicated by the high value of adjusted R^2, which is 0.9604 (i.e. ≈ 96%). Thus, the regression has a good fit.

Table 5: The Regression Result of the influence of oil price volatility, oil price revenue, and other macro-economic variables on the growth of Nigeria economy

Dependent variable	Independent variables	Coefficient	Standard Error	T	P>|t	[95%Conf. interval]
lngdp	*Lninfr*	-.0269267	.061756	-0.44	0.666	-.1528789 .0990255
	Lnintr	-.7040081	.3323183	-2.12	0.042	-1.381776 -.0262404
	Lnopr	.0640034	.2033952	0.31	0.755	-.3508238-.4788306
	Lnforexc	.9539687	.2282227	4.18	0.000	.4885054 1.419432
	Lnopv	.7080817	.2450548	2.89	0.007	.2082892 1.207874
	constant	4.192556	1.23822	3.39	0.002	1.66719 6.717922
R-squared = 0.9659	Adj R- squared = 0.9604	Prob> F = 0.0000	F(5, 31) = 175.60	Root MSE = .4516		

Source: Researcher computation, 2020

Asymmetric Test (Non-Linear Autoregressive Distributed Lag Model)

Asymmetric Test (Non-Linear Autoregressive Distributed Lag Model)
This study employed a Non-linear Autoregressive Distributed Lag (NARDL) model recently advanced by Shin, Yongcheol, Byungcheol, and Greenwood-Nimmo (2011) to jointly examine the long- and the short-run asymmetric effect between Oil price volatility, oil price revenue, and economic growth. According to Pesaran and Shin (1999), Pesaran, Shin, and Smith (2001), the general linear autoregressive distributed lag (ARDL) co-integration model with series, X_tand Y_t (t = 1, 2, . . ., T) has the following structure:

$$\Delta Y_t = \alpha + \omega Y_{t-1} + \theta X_{t-1} + \delta Z_t + \sum_{i=0}^{p=1}(\varphi_i \Delta Y_{t-i}) + \sum_{i=0}^{q=1}(\gamma_i \Delta X_{t-i}) + \mu_t \quad \text{------1}$$

where Z_t denotes regressors vector with fixed lags and μ_t is an iid stochastic process. Equation (2) assumes linear adjustment in the long- and short-run. However, the linear ARDL model becomes inappropriate when there is an asymmetric (nonlinear) relationship between series. Shin, Yongcheol, Byungcheol, and Greenwood-Nimmo M (2011) developed a nonlinear, self-regressive, distributed lag model by decomposing the regressors into positive and negative values through a partial decomposition process:

$$X_t = X_0 + X_t^+ + X_t^- \quad \text{---------2}$$

Where

$$X_t^+ = \sum_{i=1}^{t} \Delta X_t^+ = \sum_{i}^{t} max(\Delta X_0^+, 0),$$

$$X_t^- = \sum_{i=1}^{t} \Delta X_t^- = \sum_{i}^{t} min(\Delta 0 X_0^-, 0) \quad \text{---------3}$$

The long-run equilibrium relationship than can be derived as:

$$Y_t = J^+ X_t^+ + J^- X_t^- + \mu_t \quad \text{-----------------4}$$

Where J^+ and J^- are long-term asymmetric parameters that are consistent with positive and negative changes in X_t, respectively. Combining equations (4) and (2), the following asymmetric ECM, known as the NARDL (p, q) model, is proposed by Shin et al (2011)

$$\Delta Y_t = \alpha + \omega Y_{t-1} + \theta^{+}X^{+}_{t-1} + \theta^{-}X^{+}_{t-1} + \delta Z_t + \sum_{i=0}^{p=1}(\varphi_i \Delta Y_{t-i}) + \sum_{i=0}^{q=1}(\gamma_i^{+}\Delta X^{+}_{t-1} + \gamma_i^{-}\Delta X^{-}_{t-1}) + \mu t \qquad \text{-------------5}$$

where $\theta^{+} = -\omega J^{+}$ and $\theta - = -\omega J^{-}$ are long-term effects of positive and negative changes in x on y, while short-term effects of changes in x on y are calculated by $\sum_{i=0}^{q=1} \gamma_i^{+}$ and $\sum_{i=0}^{q=1} \gamma_i^{-}$

Thus, the NARDL model enables one to capture the asymmetrical long-term and short-term effects of changes in the underlying exogenous variables on the dependent variable. If asymmetry has been established, the cumulative dynamic multiplier associated with the unit changes X^{+}_{t-1} and X^{-}_{t-1} can be extracted as:

$$M_h^{+} = \sum_{i=0}^{h} \frac{\partial y_{t+1}}{\partial x^{+}_{t-1}}, \quad ,$$

$$M_h^{-} = \sum_{i=0}^{h} \frac{\partial y_{t+1}}{\partial x^{-}_{t-1}}$$

In an econometric sense, recent studies on non-linear co-integration were primarily based on regime-switching models. However, the NARDL approach has several advantages over the existing class of regime-switching techniques Greenwood-Nimmo, Shin, and Till (2011). First, the NARDL (p, q) model can be estimated simply by the OLS. Second, the test for the asymmetrical (nonlinear) co-integration relationship between variables can be easily carried out using the boundary-testing technique proposed by Pesaran, Shin, and Richard (2001) based on the updated F-test, which remains true regardless of whether the regressors are I(0), I(1) or co-integrated. Third, long and short-term asymmetries can be calculated using standard Wald tests. In particular, the associated joint null hypotheses for the long-run symmetry is $\theta{+}{=}\theta{-}$ whereas for short-run symmetry, the joint null hypotheses are $\sum_{i=0}^{q=1} \gamma_i^{+}$ and $\sum_{i=0}^{q=1} \gamma_i^{-}$

The non-linear functional form of our equation is:

$$\text{L\_GDP} = f(\text{L\_FOREXC\_POS}, \text{L\_FOREXC\_NEG}, \text{L\_INFR\_POS}, \text{L}_{\text{IN FR}_{\text{NEG}}}, \text{L}_{\text{INTR}_{\text{POS}}}, \text{L}_{\text{INTR}_{\text{NEG}}}, \text{L\_OPR\_POS}, \text{L\_OPR\_NEG}, \text{L\_OPV\_POS}, \text{L\_OPV\_NEG})$$

Table 6: F-Test

Test	Value	Signif.	I(0)	I(1)
Statistic				
		Asymptotic: n=1000		
F-statistic	17.96050	10%	1.76	2.77
K	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61

F-Test greater than the upper bound limit at 1% level establishes a long-run relationship

Table 7: Asymmetry Test

Test Statistic	Value	Probability
T-statistic	2.107337	0.0500
F-statistic	4.440867	0.0500
Chi-Square	4.440867	0.0351

F-Statistic Probability implies there is long-run asymmetry

Source: Researcher computation, 2020

V. CONCLUSION AND RECOMMENDATIONS

The study investigated an asymmetric effect of oil price volatility, oil price revenue, and some other macro-economic variables and their influence on economic growth using annual aggregate country-level data from World Bank Development Indicator and Central Bank of Nigeria spanning from 1983 to 2019. The study used the Ordinary Least square approach and Non-Linear Autoregressive Distributed Lag Model (NARDL) to achieve the stated hypothesis through STATA 12 software.

However, from the result of the analysis, it was discovered that there is a positive relationship between oil price volatility and the economy as a whole. It was revealed that all the independent variables have a positive influence on GDP except the inflation rate and interest rate. The findings showed a statistically significant effect of oil price volatility, foreign exchange rate, and the interest rate on the development of the Nigerian economy. This implies that macro-economic indicators' performance such as interest rate, foreign exchange rate, and oil prices influence economic growth and found out that increases in oil prices may depress the supply of other goods by increasing the cost of producing them because Petroleum prices directly affect the prices of goods made from petroleum products. The Augmented Dickey-Fuller test result indicated that all variables were fixed stationary. The Johansen co-integration test result showed that a long-term relationship exists between variables and a short-term relationship has been developed using the Vector Error Correction Model (VECM)

The co-integration result was conducted using the Johansen trace statistic method. The pair-wise correlation matrix was used in the analysis to determine the relationship between the variables. Trace statistic value co-integration measurements were used to check for co-integration. Based on the above, the following policy recommendations are being suggested.

i. The study suggests that policymakers should reduce the pressure on exchange rates and interest rates by diversifying the economy to reduce the pressure on oil, which in turn promotes economic growth.
ii. Also, there should be a review of monetary policy by the Central Bank of Nigeria (CBN) with the use of a contractionary monetary policy that would help to reduce the inflation rate.

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