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Relationship between volatility in domestic oil production, oil price and exchange rate in Nigeria: Co-integration and Granger Causality Tests

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Relationship Between Volatility in Domestic Oil Production, Oil Price and Exchange Rate in Nigeria: Co-integration and Granger Causality Tests.

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Abstract

The paper examines the relationship between volatility in domestic oil production, oil prices, and exchange rate in Nigeria. The study employs monthly time series data, from January 2006 to August 2018. Data for the Nigerian Bonny light oil prices (COP), Domestic Oil Production (DOP) and Exchange Rate (EXC) are obtained from the Central Bank of Nigeria (CBN) website. While, dummy variable (DUM) represents stability and instability in the Niger-Delta oil-rich region was traced from historic oil disruptions in the region. Autoregressive Distributed Lag (ARDL)/bound testing method and pairwise granger causality were employed. Unit root test result shows that DOP is stationary at level, while COP, EXR and DUM became stationary at first difference. The empirical result from the ARDL, established that there is a long run co-integrating relation between DOP, COP, EXR and DUM. Pairwise granger causality test proves that the direction of causation runs from COP to DOP. However, DOP and EXR are found to granger cause each other (feedback effect). Moreover, the direction of causality between DOP and DUM runs from DUM to DOP. The result further indicated that COP granger causes EXR and not the reverse. The paper recommends fully involvement of natives and traditional rulers for dialogue and negotiations with the militants. The Nigerian government should also give diversification, the most needed attention, and with utmost seriousness it deserved.

Keywords: Oil, production, prices, exchange rate, ARDL, granger causality, Nigeria.

1.0 Introduction

Over the past four decades, Nigeria has continuously made a significant impact on the global oil exploration and production, owing to its position as the sixth largest oil exporting country in the Organization of Petroleum Exporting Countries (OPEC), and the largest producer of crude oil in Sub-Saharan Africa (NNPC business, 2015). The country has proven oil reserve of about 32 billion barrels of largely low sulphur light crude (Oladifo and Fabayo, 2012). In 2018, Nigeria was ranked as the eight largest with proven oil reserve deposit among the OPEC members (OPEC, 2018). The proven oil reserve then was 36,972 billion barrel, while, crude oil production was estimated at 1,601.6 million barrel per day (OPEC, 2019). The large quantity of proven oil and gas deposits as well as maximum oil production capacity per day has turned the country, to be one of the major players in the international oil market (NNPC business, 2015).

The varieties of crude oil reserve deposit in the country are: Qua Iboe light, Antan blend, Odudu blend, Bonny medium, Brass River, Forcados and Bonny light, to mention but few. However, Bonny light remains the best and most desirable, as it attracts market in American and European refineries. This is not unconnected with the fact that, Bonny light contents low sulphur, and is low corrosive to refinery infrastructure and less environmental impact of its bi-products in refinery effluent.

Therefore, the U.S. has been the largest buyer of Nigerian crude oil, accounted for 40% of the country total oil export. PWC's report (2013) further stated that 33 per cent of Nigeria's oil and gas exports are destined for the USA. As of March 2007, the value of the Nigeria's crude oil sold to U.S. has reached an average of 41.76 million barrels, an estimated national income of approximately 2.5 billion dollars a month (Ifedobi, 2015). Meanwhile, crude oil is being priced in American Dollar internationally, therefore, changes in oil prices directly affect exchange rate of the oil exporting countries (Smahi and Mohamed, 2018). Moreover, plethora of literatures have also reaffirmed that oil price has a significant impact on exchange rate movement, by implication, Nigerian Naira like other oil exporting countries' currency seems to be susceptible to oil price changes.

Nigeria is a mono-cultural economy, depending heavily on oil exportation, indeed crude oil is the mainstay and the driving force of the country's economic growth (Umar, 2017). The oil sector is the largest sector as it contributes to about 95 per cent of the Nigerian foreign export earnings, and 83 per cent of the federally collected revenue. Since 1970s, when the oil sector relegated the agricultural sector to background which hitherto considered to be the largest contributing sector to the Nigerian economy, crude oil has since then become the mainstay of the country economy, and one that determines the economic and political destiny of the country (Yeldu *et. al*, 2013, Etuk, 2013).

Crude oil exploration and production activities has concentrated in the Niger-Delta region, the area covers 70000sq km spread over certain ecological zones along the gulf of Guinea. The inhabitants are the minority ethnic groups in the country, the region accounts for 90 percent of the total nation's oil and gas reserve (Oyefusi, 2007). However,for over a decade, the region has engulfed into incessant violence and uprising by the so-called Niger-Delta militant groups(such as Niger-Delta Volunteer Service (NDVS), Movement for the Survival of Ogoni People (MOSOP), Movement for Emancipation of Niger Delta (MEND), Niger Delta Peoples Volunteer Force (NDPVF), Niger Delta Vigilante (NDV) etc.). The militants engaged in attacking and destroying oil facilities and foreign oil investments in the region, in their struggle for self-determination and local control of oil resources (Emmanuel,2017).

Another factor that breeds hostility and violent reactions from the militants has been the negative impact of oil exploration and production, such as pollutions and other environmental degradations affecting the communities, as well as the nonchalant attitude on the part of government and foreign firms to address these fundamental issues inimical to societal welfare.

Therefore, for quite some time now, the Nigerian oil sector has been facing enormous challenges ranging from lack of cooperation from the indigene communities, rampant vandalization of oil pipelines and infrastructures, smuggling and oil theft, severe ecological damage, activities of the militants and other security challenges in the Niger-Delta oil producing region.

This resulted to recurring oil production volatility and consequently declining oil revenue. Evidently, crude oil production level was 5100 barrels per day (bpd) in 1958, climbed up to about 2.055 million bpd in 1983,it further escalated to 2.3 million bpd in 2014. But militia activities from 2001 to 2009 led to slump in oil production activities and consequently declined output levels and foreign export earning' as well as reduction in oil revenue(Osaru and Kanwanye, 2019). Citing instance, Emmanuel (2017)

reported that in 2006 alone,MEND cuts oil production by about 30%. However, in 2010 significant improvement in oil production was recorded, owing to reduction in militia activities motivated by amnesty granted to the repentant militants by the Nigerian government. Dwindling oil production was further witnessed in 2016 attributed to the incidence of oil thefts, militant attacks on oil facilities and sea pirates in the Niger-Delta region of Nigeria (Usoro, Ikpang and George, 2019). To sum up, the issue of volatility in the Nigerian oil production due to militia activities in the Niger-Delta has persisted for over two decades.

On the relationship between oil prices shocks, conflicts and oil production, Sharma (1998), Zamani (2004), Wang et al (2005), Xie et al (2006) and Kulkarni and Haidar (2009) viewed that fluctuations in oil price is basically originated from an imbalance between supply and demand, resulted from events such as wars or conflict, political and economic factors as well as other predictable and unpredictable factors affecting supply and demand.

Specifically, ADB (2009) attributed increased crude oil prices in 2004 to the supply-side factors such as the war in Iraq, policy development in Venezuela and conflicts in the Niger-Delta region, Nigeria. More to the supply sides factors, Barsky and Kilian (2004), Nkomo (2006) and Hamilton (2009) argued that most of the previous price increases and slumps in oil production were linked with the political instabilities in the Middle East. Even the most historical oil price shocks such as the Yom Kippur war and Arab oil embargo of 1973, Iranian revolution of 1979, Iraq inversion to Kuwait in 1990, US fears of an Iraq invasion in 2003 were associated with social and political instabilities (Umar, 2017).

From the foregoing discussions, it is apparent from both empirically-based and theoretical evidences that there has been a link between conflict/militancy; volatility in domestic crude oil production, oil prices and exchange rate movements. The present study aims at empirically examining both the long run and short run relationship between the variables of interest, as well as identify the direction and their causal relation. Study of this nature is important, as it assesses how conflicts/militancy, and consequently oil supply cut affects oil prices and exchange rate movements. The study also helps to understand the inter-relationship between these variables, in oil exporting countries, like Nigeria. This will ultimately gave a policy direction that will boost the expected huge investment in the oil sector, reduce uncertainties in oil production and subsequently, improved revenue generation that will ensure faster economic growth and development.

Though, considerable number of studies have attempted to examine the relationship between oil prices and exchange rate (see Krugman 1980, Golub 1983, Olomola 2006, Iwayemi and Fawowe 2010, Adeniyi 2011, Adeniyi, Omisakin, Yaqub and Oyinlola 2012, Fratzscher *et. al* 2014, Osuji 2015, Onoja, 2015, Obioma and Charles, 2015, Smahi and Mohamed 2018, Tumba 2019 and Olayungbo 2019).Few other studies such as; Aleisa and Dibooglu (2002), Ike and Innocent (2015) investigated the interaction between crude oil production, foreign exchange rate and crude oil prices. To the best of our knowledge, none of the studies reviewed so far have attempted to study the co-integration relation between volatility in oil production (in relation to militancy), oil prices, and exchange rate in Nigeria.

Following this introduction, as section one, section two is the literature review, methodology is in section three. Section four provides presentations and

discussions of the results. Section five contains the conclusion and policy recommendations.

2.0 Literature Review

There are vast literatures that studied the relationship between oil prices and exchange rate movements. However, very few studies have attempted to examine the existing relation between volatility in the domestic oil production and militancy in Nigeria. While, an insignificant number of studies focused on analysing the interaction between crude oil production, oil price and exchange rate.

It was earlier established the existing positive relationship between oil prices and exchange rate in oil-exporting countries, while the relationship between the two were found to be negative in oil-importing countries; this was emphasized in the works of Krugman (1980) and Golub (1983). According to Krugman (1980) and Golub (1983) oil exporting countries, may experience exchange rate appreciation, when oil prices rise and depreciate, when oil prices declined. While, in oil-importing countries exchange rate depreciates, if oil price appreciates and vice versa.

However, terms of trade and wealth effect are the two major channels through which oil price affects exchange rate, that rising oil price deteriorates trade balance of the oil-importing countries, and subsequently depreciates local currency. On the other hand, higher oil price leads to transfer wealth from oil importing to oil exporting countries (Fratzscher, Schneider and Van Robays, 2014),afterward, many studies produced mixed results. Smahi and Mohamed (2018) examined the relationship between oil price and nominal US Dollar/Algerian Dinar exchange rate, using monthly data over the period of 2008-2015. Vector Error Correction model (VECM) result showed that increase oil price leads to the depreciation of Algerian Dinar against US Dollar. Result from the granger causality test has provided evidence that, there exists a bi-directional relation between oil prices and exchange rate. Fratzscher *et. al.* (2014) further examined the relationship between oil prices, the US Dollar and asset prices. Result from the study revealed that, increased oil price leads to depreciation of US Dollar exchange rate. In addition, the study found a bi-directional causality between oil prices and US Dollar.

In Nigeria, many studies have used different methods to examine the relationship between oil price and exchange rate movements. Olomola (2006), Adeniyi, Omisakin, Yaqub and Oyinlola (2012) employed Generalized Auto regressive Conditional Heteroscedasticity (GARCH) and Exponential GARCH (EGARCH) techniques to study the inter-relationship between oil prices and exchange rate in Nigeria, using daily time series data from January 2, 2009 to September 28,2010.

The empirical result found that, increase in crude oil price appreciates the Nigerian Naira against US Dollar. Osuji (2015) investigated the link between crude oil price and foreign exchange rate causality in Nigeria, using monthly data from January, 2008 to December, 2014.

The study employed Ordinary Least Square (OLS) and VAR model. Result from the study depicted that crude oil price significantly affect exchange rate. It further showed a unidirectional causality from crude oil prices to exchange rates. Again, Onoja (2015) examined the link between exchange rates and crude oil prices in Nigeria, using Error Correction Model (ECM) on a quarterly data from 1981:Q1 to 2009:Q2. The study found that oil price volatility does not affect exchange rate in the short run. Tumba (2019) applied ARDL/bound testing procedures to examine the impact of oil price volatility on

exchange rate in Nigeria, for the annual time series data from 1986 to 2015. The finding revealed a negative, but significant long run relationship between volatility of crude oil prices and exchange rates in Nigeria. However, in the short-run,negative and insignificant relationship between the variables was found. Result from the granger causality test portrayed the absence of causation between oil price volatility and exchange rate in Nigeria. In a similar studies, Iwayemi and Fawowe (2010), and Adeniyi (2011) provided evidence of a negative relationship between oil price and exchange rate. Obioma and Charles (2015) studied the interaction between crude oil price, consumer price level and exchange rate in Nigeria, through the application of Vector Auto regressive model on a monthly data from January 2007 to February 2015. The study confirmed that oil price shock has a negative impact on exchange rate. In addition, the granger causality test result showed a unidirectional causal relation, runs from crude oil price to exchange rate. Olayungbo (2019) investigated the causal relation between oil prices, exchange rate, trade balance and foreign reserves in Nigeria, using quarterly time series data from 1986Q4 to 2018Q1, the study indicated that no causal relation exists between oil prices and exchange rate.

On a relationship between oil production and Niger-Delta conflicts, study by Obi (2011) has shown evidence of the existing conflict relations between oil industry and local community, arising from mode of production, oil exploration and aftermath of oil production such as pollution, degradation and gas flaring. According to Emmanuel (2017) who undertook a survey research on oil and gas industry in Nigeria established that communal conflicts, pipeline vandalization, kidnapping, sabotage, crude oil theft, among other militant activities pose a greater challenge to oil industry, because it negatively affects both the upstream and downstream oil production. It also observed to be responsible for slower economic growth in Nigeria.

For an interaction between crude oil production, exchange rate and crude oil prices, Ike and Innocent (2015) examined the relation and direction of causality between foreign exchange rate, oil prices, oil production and oil export in Nigeria from 2006 to 2014. The study indicated that foreign exchange rate bears a positive and insignificant relation with crude oil prices. Similarly, a weak and insignificant relation exists between crude oil production and foreign exchange rate. However, no granger causality was found between crude oil production and exchange rate in Nigeria. Aleisa and Dibooglu (2002) investigated the sources of real exchange rate movement in Saudi Arabia. The study employed structural VAR model, and found that oil production shocks rather than real oil price shocks are responsible for real exchange rate movements. The study therefore recommended the Saudi Arabian authority to ensure stabilization of oil production.

3.0 Methodology

The study employs monthly time series data from January 2006 to August 2018.The periods are selected based on the availability of data from the source. Domestic oil production (DOP), Bonny light crude oil prices (COP) and exchange rate (N/$) (EXR) were obtained from the Central Bank of Nigeria (CBN) website. It was however documented that the Nigerian domestic oil production is highly influenced by external and internal factors, notable among them are OPEC policies on the output or supply decisions, extent of compliances to OPEC production quota, global macroeconomics and geopolitical conditions, oil price volatility, social and political stabilities in the oil producing region of Nigeria. Since volatility measures the dispersion or variation of some value

points from its central mean value overtime (Usoro *et.al*, 2019), then, the idea behind volatility in oil production implies high variations in oil production (falling oil production) due to militants attacks on oil installations and low variations (rising oil production) during a relative calm period.
Therefore, the study used dummy variable (DUM)to represent stability and instability in the Niger-Delta oil-rich region which was sourced from historic trend of crude oil disruptions in Nigeria. The dummy variable was categorized into four periods. First, was period between early 2006 to June 2009,when there were massive attacks of oil pipelines, piracy and kidnapping oil workers in the Niger-Delta by the militant groups, most especially Movement for the Emancipation of the Niger Delta (MEND).

Consequently, many oil companies in the region were forced to suspend or cut down production. However, the announcement by the Nigerian government on June 26, 2009 to grant amnesty and an unconditional pardon to militants in the Niger Delta, had drastically reduced the attacks of oil facilities. Second period was between July 2009 to December 2015, when the relative peace was restored, following the full implementation of presidential amnesty program by the two former Presidents Umaru Musa Yar'adua and Goodluck Jonathan administrations.

The program was considered to be successful with violence and kidnappings decreasing sharply, while, oil production and exportation increased from 700,000 barrels per day in mid-2009 to between 2.2 and 2.4 million bpd in 2011 (Wikipedia). Amnesty program ended in January, 2016, as a result, oil production and plummeted to nearly 1 million barrel per day, the lowest level since early 2003 (Tanimu, 2009). Third period was from February, 2016 to July, 2017, when the Niger Delta militants group, particularly, the Niger-Delta Avengers (NDA) resumed attacks on oil facilities (see appendix), that witnessed a sudden and substantial decline in crude oil production. However, August, 2017 to August, 2018 is considered as a stable or peaceful period, due to engagements and negotiation between the Nigerian government and militant groups in the Niger-Delta. In this study, value of 1 is assigned as a dummy denotes calm or peace period, while 0 represents a dummy for period of conflict or unrest.

The study applied the ARDL/ bound testing method to examine the long run relationship between the volatility in domestic oil production, crude oil prices (Bonny light), exchange rate (N/$) and the Dummy variable. The study further employed Pair wise granger causality to determine the direction and causal relation between the variables.

Model specification

DOP= f (COP, EXR, DUM).....(1)

$$DOP = \alpha_0 a_1 COP_t + a_2 EXR_t + a_3 DUM_t + \varepsilon_t \quad (2)$$

Where DOP stands as the domestic oil production, COP denotes Nigerian Bonny light crude oil prices. Exchange rate of Nigerian Naira to dollar is represented by EXR. In this study however, the rate of exchange used is the interbank rate and not the black market exchange rate. Dum symbolizes dummy variable, in form of 1 for the relative period of peace and 0 for the period of unrest in the Niger-Delta oil region.

ARDL parameterize equation is specified

$$\Delta DOP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta DOP_{t-i} + \sum_{j=0}^{p} \alpha_2 \Delta COP_{t-j} + \sum_{k=1}^{p} \alpha_3 \Delta EXR_{t-k} + \sum_{i=0}^{p} \alpha_4 \Delta DUM_{t-1} + \beta_1 DOP_{t-1} + \beta_2 COP_{t-1} + \beta_3 EXR_{t-1} + \beta_4 DUM_{t-1} + \varepsilon_{It} \quad (3)$$

α_0 is the constant term, α_1, α_2, α_3, α_4 and β_1,β_2, β_3, β_4 are the parameters/ coefficients of the model. Δ stands for the first difference operator, while ε_t is the error or disturbance term.
Bound testing involves computing F-test to determine the joint cointegration of the dependent variable on one or more

periods lagged value of the explanatory variables. The null hypothesis is H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$, which implies testing for the absence of long run equilibrium relationship between the variables, hence it coincides with zero coefficients for all k+1 variable. A rejection of H_0implies a long run relationship. However, there are two critical values for the bounds testing, the lower bound and the upper bounds critical values. The null hypothesis of no co-integration would be rejected, if the calculated F statistics is greater than the upper bound critical value. On the other hand, if the calculated F-statistic is less than the lower bound critical values, the null hypothesis of no cointegration cannot be rejected. Hence no long run relationship can said to exist between the variables. If on the other hand, the calculated F-statistic value fallin-between the lower and upper bound critical values, then the conclusion is that the result is inconclusive. In the presence of a long run cointegration, next is to conduct short run error correction model estimation, in order to ascertain the short run behaviour of the series and the speed of adjustment towards the long run equilibrium.

We can therefore specify the short run dynamic error correction model (ECM) as follows:)

$$\Delta DOP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta DOP_{t-i} + \sum_{j=0}^{p} \alpha_2 \Delta COP_{t-j} + \sum_{k=1}^{p} \alpha_3 \Delta EXR_{t-k} + \sum_{l=0}^{p} \alpha_4 \Delta DUM_{t-1} + \phi ECT_{t-1} + \varepsilon_t \quad \ldots\ldots(4)$$

Where α_0 is the coefficient of the constant term, α_1, α_2, α_3 and α_4 are the coefficients of the short run variables. Also is the

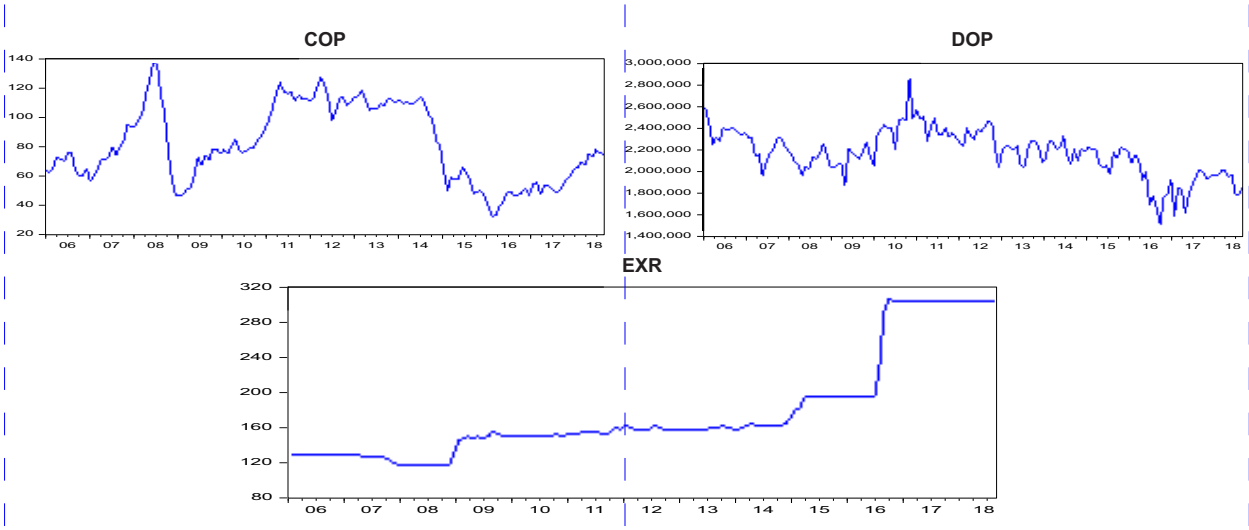


Table 1: Descriptive Statistics

	DOP	COP	EXR	DUM
Mean	2167763.	80.96671	179.3752	0.605263
Median	2195000.	75.34500	157.6500	1.000000
Maximum	2880000.	138.7400	309.7300	1.000000
Minimum	1500000.	30.66000	116.7900	0.000000
Std. Dev.	221372.0	26.68199	61.43781	0.490410
Skewness	-0.334082	0.179159	1.296306	-0.430706
Kurtosis	3.526324	1.810731	3.255612	1.185507
Jarque-Bera (JQ)	4.581907	9.770762	42.98417	25.55128
Probability	0.101170	0.007556	0.000000	0.000003
Sum	3.30E+08	12306.94	27265.03	92.00000
Sum Sq. Dev.	7.40E+12	107501.2	569965.3	36.31579
Observations	152	152	152	152

Source: Researcher's computation using EVIEWS 9.0

coefficient of the lagged error correction term (ECT_{t-1}), while, ε_t is the disturbance term.

4.0 Results and Discussions

Figure 1: Crude oil price, Domestic oil production and exchange rate ($/N).

DOP seems to have high mean, maximum and minimum values, it also has a high standard deviation compare to other variables, and this is followed by exchange rate. This is because, unlike COP, EXR and DUM, the DOP is valued in millions. However, the negative skewness of DOP and DUM signifies that the distribution has a long left tail, showing that the distribution has skewed to the left. The distribution for the variables COP and EXR however, has skewed to the right, indicating a long right tail of the distribution. The kurtosis of DOP and EXR exceeded 3, which means that the distribution is peak relative to the normal. On the contrary, Kurtoses for COP

Unit root tests results using ADF and PP

Table 2: Unit Root Results

VARIABLE	ADF				PP			
	Intercept		Trend and Intercept		Intercept		Trend and Intercept	
	level	1st Diff	Level	1st Diff	Level	1st Diff	Level	1st Diff
DOP	-2.7742	-7.3356*	-3.2410	-7.3053*	-3.4534**	-20.3112*	-4.2175*	-20.2002*
COP	-2.5242	-8.4041*	-2.6763	-8.3918*	-2.1547	-8.4041*	-2.2900	-8.3918*
EXR	0.2256	-5.9417*	-1.6071	-6.0867*	0.2527	-6.1907*	-1.6229	-6.1200*
DUM	-1.9031	-12.1927*	-1.9836	-12.1553*	-1.9304	-12.1927*	-2.0219	-12.1553*

* & **Denoted the series is stationary at 1% & 5% probability levels.

From table 2 above, none of the variable is stationary at level under ADF. However, PP has shown that Domestic oil production (DOP) is stationary at level, both with intercept, and trend and intercept. Thus, we have combination of variables (COP, EXR and DUM) which are I(1) and other variable (DOP) that is I(0). This allows the use of ARDL model to ascertain the cointegration relation among the series found to have a different order of integration.

The computed F-statistics (5.58) is greater than the

Bounds testing result

Table3: ARDL Bound test result Critical Bounds values

Test statistic	Value	K
f-statistic	5.577	3

Significance	I0 (Lower Bound)	I1(Upper Bound)
10%	2.72	3.77
5%	3.23	4.35
1%	4.29	5.61

upper bounds at 5% critical value. Thus, we reject the null hypothesis of no cointegration and conclude that there is long run cointegration relationship between DOP, COP, EXR and DUM.

Diagnostic tests

The adequacy and the stability of the model specification are determined by the diagnostic tests using Breusch-Godfrey LM test of autocorrelation and Breusch-Pagan-Godfrey test of heteroscedasticity. Further tests include Jarque-Bera Normality testand Ramsey RESET test. The results are presented in the table below.

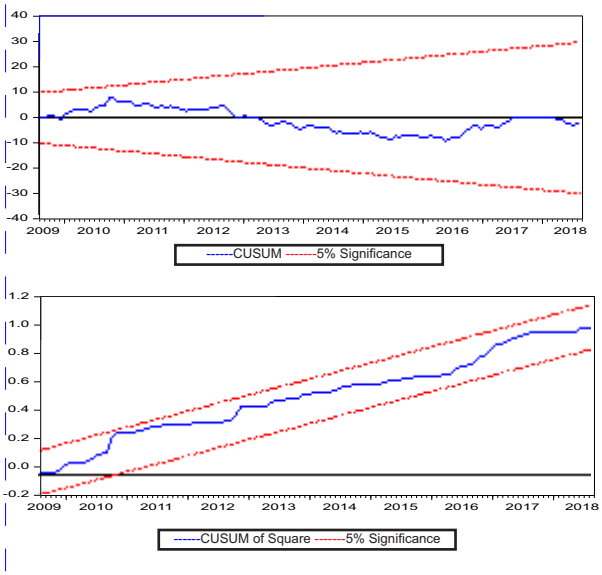
Table 4: Results of Diagnostics Statistics

Test	LM version	F-statistic
Normality (Jarque-Bera Test Statistics)	JQ= 15.20[0.0005]	Not applicable
Serial Correlation (Breusch - Godfrey LM Test)	CHSQ (2) = 2.7994 [0.2467]	F(2,141) = 1.3407[0.2650]
Heteroscedasticity	CHSQ (6) = 33.997 [0.7573]	F(6,143) = 0.5527[0.7672]
Specification Error (Ramsey RESET Test)	t(142) =2.3106[0.022]	F(1,142) = 5.3391[0.022]

Source: Researcher's computation using EVIEWS 9.0. Note: values in parenthesis are p-values.

The series are found not be normally distributed as JQ has shown to be statistically significant. Thus, we reject the null hypothesis of normally distribution and accept the alternative hypothesis that the frequency distributions of the series are not normal distributed. The serial correlation test using Breusch-Godfrey has shown that both the F version and LM version are insignificant, indicating that the series are not serially correlated. This also portends that the error terms are independents, which means that, the error term in one period does not depend on the error term of another period. Therefore, we conclude that there is no auto correlation at 5% level. The Breusch – Pagan – Godfrey is a Lagrange multiplier test of the null hypothesis of no heteroscedasticity. The heteroscedasticity test result has shown high p-value revealing that, it is statistically insignificant. This suggests that, we accept the null hypothesis, and conclude that the residuals have a constant variance (Homoscedasticity). To check if there is any recursive residual, because of the structural break, we conduct the stability test using CUSUM and CUSUMSQ charts below. The blue line does not cross the red, which means that there is no recursive residual in terms of mean in the CUSUM, and in terms of variance in the second chart (CUSUMSQ). Hence, none of the variables is sensitive to structural break. Therefore, the estimated parameters of the model are stable over the study period.

Figure 2: CUSUM and CUSUM of Square.



Estimated ARDL model

Having established a long run co-integration relationship between the variables as presented in table 3, it became imperative to estimate the long run coefficients of the ARDL model. The result is presented in table 5 below:

Table 5: Result of the estimated long run coefficients (Dependent variable: DOP)

Variable	Coefficient	Prob
COP	-72.824	0.9546
EXR	-2191.759	0.0000***
DUM	176981.14	0.0050***

*** Denote the series is stationary at 1% probability level.

From table 5 above, crude oil price (COP) has a negative coefficient and insignificant long run relation with the domestic oil production (DOP). This implies that 1 per cent increase price of Bonny light crude oil, would resulted to a declined Nigerian domestic oil production by 72.82 per cent. Therefore, there is an inverse relationship between oil price and domestic oil production in Nigeria. Again, the long run coefficient of the exchange rate shows a negative sign and statistically significant relation with the domestic oil production. This indicates that domestic oil production decreases by 2191.76 per cent, if exchange rate of the local currency to the US dollars appreciated by 1 per cent. This implies that domestic oil production tends to decrease, when the Naira to Dollar exchange rate appreciated in value. This result disputed the finding of Ike and Innocent (2015), who established a weak and insignificant relation between domestic oil production and exchange rate in Nigeria.

Direct and significant relationship also exists between DOP and dummy variable. This means that stability in the Niger-Delta boosts the domestic oil production in Nigeria. It further suggests that instabilities related to vandalization, bombing oil facilities and kidnapping oil workers by Niger Delta militants, lead to a decline level of domestic crude oil production in Nigeria. This corroborates assertion by Emmanuel (2017), who emphasized that the activities of militants groups in the oil-rich Niger Delta had inflicted untold levels of destruction on strategic oil sites, and put a serious dent into the production of crude oil and gas resources in Nigeria. Again Obi (2011) has provided evidence of the existing conflict relations between oil production and conflict in Niger Delta. In addition, Punch Newspaper (2008) has reported that, according to Funsho Kupolokun a managing Director to NNPC, Nigeria loss 600,000 barrels of oil daily, because of conflict and insecurities in the Niger Delta. According to NNPC (2009), oil losses due to militancy reached over $1 billion annually, which represent 32% of the revenue generated that year. It was further reported that between 2009 to 2011, Nigeria lost over 136 million barrels of oil, equivalent to $109 billion to oil theft, militancy and sabotage. Again, 10 million barrels valued at $894 million was also lost, due to pipeline vandalism (NEITI-EITI Core Audit Report of Oil and Gas, 2009-2011).

It was pointed out earlier that, the supply-side factors such as conflicts in Nigeria had contributed immensely in increasing crude oil prices in 2004 and declined domestic oil production. Furthermore, Umar (2017) observed that oil price volatility in Nigeria was caused not only by the happenings within the global economy, but by output shocks resulting from oil theft, pipeline vandalization and consequently falling oil production below the projected benchmark. This means that unrest in the Niger-Delta oil rich region causes output volatility that resulted to oil price volatility and dropped oil revenue to the Nigerian government. Sharma (1998), Zamani (2004), Wang et al (2005), Xie et al (2006) and Kulkarni and Haidar (2009) confirmed that the fluctuation in energy market particularly crude oil price is basically originated from an imbalance between supply and demand, resulted from events such as wars and political crisis. Therefore, it is a common knowledge that most oil price fluctuations experienced in the past were caused by war and conflicts. Studies such as Barsky and Kilian, (2004), Nkomo (2006) and Hamilton, (2009) have already supported the arguments that most of the previous price increases and dwindling oil production were associated with the economic, social and political instabilities in the oil producing countries.

Short run dynamic and error correction mechanism

The study further examined the short run dynamic behaviour of the variables, and observed the speed of adjustment towards the long run equilibrium, using Error

Correction Model (ECM).

Table 6: Result of the estimated short-run relationship and error correction mechanism variable: DOP).

Variable	Coefficient	Prob
ΔDOP(-1)	-0.162	0.0502**
ΔCOP	-693.28	0.6124
ΔEXR	-3519.13	0.0157**
ΔDUM	30149.68	0.6389
Constant	833981.88	0.0000*
ECM(-1)	-0.339	0.0000*

Source: Researcher's computation using EVIEWS 9.0

* & **Denote the series is stationary at 1% & 5% probability levels.

The result shows the existence of a negative and insignificant short run relationship between COP and DOP. EXR is also found to have a negative and statistical significant short run relationship with DOP at 5% probability level. Similarly, positive and insignificant relationship exists between DUM and DOP. Most importantly, the coefficient of ECM assumes the expected negative sign and it is statistically significant at 1% p-value. This indicates that ECM, which measures the speed of adjustment at which DOP adjusts to change in COP, EXR and DUM, before converging towards its equilibrium, is about 34%. This means that 34% of deviations from the equilibrium, due to temporary shocks from the explanatory variables, would be corrected within one month period. Thus, it would take almost 3 months for DOP to adjust to its long run equilibrium.

Pairwise Granger Causality test
The one-optimal Lag lengths Selected using SC.
Sample: 2006m01-2018m08.
Lags: 1.
Observations:151.

Table 7: Pairwise granger causality test result

Null hypothesis	F-stat	p-value	Hypothesis Accept/Reject	Causality
COP does not Granger Cause DOP	5.09308		Reject	Unidirectional
DOP does not Granger Cause COP	0.26325	0.6087	Accept	No causality
EXR does not Granger Cause DOP	6.61751	0.0111**	Reject	Bi-Directional
DOP does not Granger Cause EXR	9.70146	0.0022*	Reject	
DUM does not Granger Cause DOP	2.97110	0.0869***	Reject	Unidirectional
DOP does not Granger Cause DUM	0.05148	0.8208	Accept	No causality
EXR does not Granger Cause COP	1.3E-05	0.9972	Accept	No causality
COP does not Granger Cause EXR	4.60894	0.0334**	Reject	Unidirectional
DUM does not Granger Cause COP	0.02706	0.8696	Accept	No causality
COP does not Granger Cause DUM	1.08654	0.2989	Accept	No causality
DUM does not Granger Cause EXR	2.54663	0.1127	Accept	No causality
EXR does not Granger Cause DUM	0.82666	0.3647	Accept	No causality

Source: Researcher's computation using E-views 9.0*,**(***) denotes significant causal relationship at 1%,5% (10%) significant level.

The result presented above suggests that, the causal relation between COP and DOP runs from crude oil price (COP) to domestic oil production (DOP) and not the reverse. Therefore, the null hypothesis is rejected, since the p-value is statistically significant at 5%. This implies that COP granger causes DOP, on the contrary, DOP does not granger causes COP. On the other hand, DOP has a bi-directional relation with exchange rate (EXR), this means that both DOP and EXR granger cause each other (feedback effect). This contradicts Ike and Innocent (2015), who found no granger causality between crude oil production and exchange rate in Nigeria. It also differs from Aleisa and Dibooglu (2002), who also provided evidence that the causal relation runs from crude oil production to exchange rate, but in Saudi Arabia.

The direction of causality between DOP and DUM, runs from DUM to DOP at 10% significant level, and no other way round. This also suggests that stability (peace) and instability (violence) in the Niger-Delta represented by Dummy variable granger causes DOP. While, no causation runs from DOP to DUM. The result further found a unidirectional relationship between COP and EXR, showing that at 5% significant level COP granger causes EXR and not the reverse. Therefore, the result emphasizes that change in oil prices contain information about future movement of Nigerian exchange rate. This is consistent with the result of Obioma and Charles (2015) and Osuji (2015). Studies by Olomola (2006), Adeniyi, Omisakin, Yaqub and Oyinlola (2012) equally affirmed that increase in the crude oil prices appreciates the Nigerian Naira against US Dollar. In contrast, Olayungbo (2019) and Tumba (2019) found no evidence of causation between crude oil prices and exchange rate in Nigeria.

Similarly, Independent causal relationship exists between DUM and COP, and between DUM and EXR. In other word, neither DUM nor COP granger causes each other. Again neither DUM nor EXR granger causes each other. This is because DUM affects DOP directly, on the other hand DOP influences COP and EXR.

5.0 Conclusion and Recommendations

Empirical researches on domestic oil production are too scanty, despite the fact that the Nigerian annual budget estimate is usually prepare on the basis of projected oil production benchmark and oil price estimates in the international oil market. Likewise, studies on the impact of militancy on the domestic oil production are also very few. Much attention and considerable efforts have been devoted in studies related to oil prices volatility and exchange rate movements. Furthermore, research on the interaction between conflicts/militancy,oil production volatility, oil prices and exchange rates has not been explored, which is the main concern of this paper. From the analysis, the study has established evidence of co-integration relation between these variables of interest. Similarly, the long run and short run estimates revealed a negative and insignificant relation between domestic oil production and crude oil price. This implies that rising oil price in the international oil market does not increase domestic oil production much. The main factor determines the increase (fall) domestic oil production is peace or stability (instability) in the Niger-Delta oil region, as the result indicated a positive and significant relation between crude oil production and dummy variable both in the long run and in the short run. Again, negative and significant relation exists between crude oil production and exchange rate. On the direction and causal relation between the variables, the granger causality test result reveals a unidirectional causal relation runs from COP to DOP, DUM to DOP, and COP to EXR. This pointed out that crude oil price contributes to changes in the domestic oil production, the same way stability (instability) determines the level of oil production in Nigeria, also crude oil price influences exchange rate movements and not the reverse. The only bi-directional relation found is between DOP and EXR.

Therefore, considering the importance of the Niger Delta oil-rich region to the revival of the Nigerian economy, the paper recommends improvement in the standard of living of the Niger-Delta communities, through provision of adequate social amenities and other developmental programs. This will ensure smooth, stable and uninterrupted oil exploration, production and exportation. It is advisable that government involve the natives and traditional rulers in dialogue and negotiations with the militants, in order to ensure the sustenance of the relative peace in the Niger Delta. Government should also intensify search for oil in the Northern parts, presumed to have large and commercially viable oil reserve deposit, to grant an increase oil exploration

and production, reduce oil production volatility, boosts government revenue generation and reduce over dependence of one region for oil exploration and production activities. The Nigerian government should seriously consider diversification of the economy as the best option, through design long term policies and programs targeting the non-oil sector, especially agricultural sector that was considered neglected, though less volatile and dependable.

References

Adeniyi, O., Omisakin, O., Yaqub, J., & Oyinlola, A. (2012). Oil price-exchange rate nexus in Nigeria: further evidence from an oil exporting country. *International Journal of Humanities and Social Science, 2(8),* 113-121.

Aleisa, E.A. and Dibooglu, S. (2002). Sources of real exchange rate movements in Saudi Arabia. *Journal of Economics and Finance*. Vol 26, issue 1, Pp 101-110. March.

Barsky, R. and Kilian, L. (2004). Oil and the Macroeconomy since the 1970s. National Bureau of Economic Research (NBER) *working paper series*. October. www.nber.org/papers/w10855.

Behmiri, N. B. and Manso, J. R.P. (2013). Crude oil price forecasting techniques: a comprehensive review of literature. *Alternative analyst review* pp 30-48.

Emmanuel, A. O. (2017). Nigeria's Oil and Gas Production and Niger Delta Militant: The Need of Oil Resource to Stop Oil Reliance for Sustainable Development. *Global Journal of human-social science*: Volume 17 Issue 5. Pp 22-34 .

Etuk, E. H. (2013). Seasonal ARIMA modelling of Nigerian monthly crude oil prices. *Asian Economic and Financial Review*. 3(3): 333-340. http://aessweb.com/journal-detail.php?id=5002.

Fratzscher, M., Schneider, D., & Van Robays, I. (2014). Oil prices, exchange rates and asset prices. Working Paper Series.NO 1689 / July. *European Central Bank*

Golub, S.S. (1983): Oil Prices and Exchange Rates. *The Economic Journal*, 93, 576-593.

Hamilton, J. D. (2009). Causes and Consequences of the Oil Shock of 2007-2008. *Brookings Papers on Economic Activity,* Spring 2009: 215-261.

Ike, O.I. and Innocent, O.I. (2015). Crude oil production, prices, export and foreign exchange rate, do they interact? Evidence from Nigeria (2006 - 2014).*International Journal of developing and emerging economies*. Vol.3. No.2.Pp.24-37. June.

Kulkarni, S. and Haifar, I. (2009). Forecasting model for crude oil price using artificial neural networks and commodity futures prices. *International journal of computer science & information security.* Vol 2. no 1. June.

Krugman, P.R. (1983): Oil Shocks and Exchange Rate Dynamics. In: Frenkel, J.A. (Ed.): *Exchange Ratesand International Macroeconomics.* University of Chicago Press.

Lam, D. (2013). Time series modelling of monthly WTI crude oil returns. An MA thesis submitted Trinity, Lincoln College, University of oxford.

NEITI-EITI Core Audit Report of the Oil and Gas, 2009-2011: Financial Audit: An Independent Report Assessing and Reconciling Financial Flows within Nigeria s Oil and Gas Industry, 2009-2011.

NNPC, Nigerian National Petroleum Corporation (2009). Monthly Petroleum Information. September, Lagos, Nigeria.

Nigerian National Petroleum Corporation (2015, 2019). www.nnpcgroup.com/home.aspx ,www.nnpcgroup.com/nnpcbusiness/upstreamventurses/oilproduction.aspx

Nkomo, J.C. (2006). Crude oil price movements and their impact on South Africa. *Journal of Energy in Southern Africa*. Vol 17.No 4. November.

Obi, C. (2011).Democratising the Petro-State in West Africa: Understanding the Challenges, in *Fuelling the World – Failing the Region*.Pp. 102-120.

Obioma, B.K., and Charles, E.N., (2015). An Empirical Analysis of Crude Oil Price, Consumer Price Level and Exchange Rate Interaction in Nigeria: A Vector Autoregressive (VAR) Approach. *American Journal of Economics*. 5(3): 385-393.

Oladipo, S.O., and Fabayo, J.O., (2012). Global recession, oil sector and economic growth in Nigeria. *Asian Transactions on basic and applied sciences (ATBS)*. Vol 01.Issue 06. January. Pp. 29-41.

Olayungbo, D. O., (2019). Effects of Global Oil Price on Exchange Rate, TradeBalance, and Reserves in Nigeria: A Frequency Domain Causality Approach. *Journal of risk and financial management*. March.

Olomola, A., (2006). Oil price shock and aggregate economic activity in Nigeria. *African Economic and Business Review, 4(2),* 48-61.

Onoja, J. A. (2015). The impact of oil price volatility on the real exchange rate in Nigeria: An Error Correction Model. *An International Multidisciplinary Journal, 9(1),* 15-22.

*OPEC (2019).*www.opec.org.

Osaru,F.O.O., and Kanwanye, H.T.(2019). Nigeria beyond oil: The imperative of diversification of the Nigerian economy. *International journal of developing and emerging economies*. Published by ECRTD-UK. Vol 7. No 4. Pp.15-29.

Osuji, E. (2015). International oil prices and exchange rate in Nigeria: a causality analysis. *International Journal of Academic Research in Economics and Management Sciences,* 4(3),11-22.

Oyefusi, A., (2007). Oil-dependence and civil conflict in Nigeria. Presented at Bi-annual workshop, *AERC* June.CSAE WPS/2007-09.

Punch Newspaper, 2013. "Theft knocks Nigeria's oil output to four-year low". 28 August.

PricewaterhouseCoopers {PWC report} (2013). From promise to performance: Africa oil & gas review. *Report on current developments in the oil and gas industry in Africa.* June. www.pwc.co.za.

Ross, M.L. (2003). *Nigeria's oil sector and the poor.* Prepared for the UK department for international development "Nigeria: Drivers of change" program. May 23.

Sambo, A. S. (2009). Strategic developments in renewable energy in Nigeria. *International Association for Energy Economics.* Third quarter. Pp. 15-19.

Sharma, N. (1998). Forecasting oil price volatility. MA thesis submitted to the faculty of Virginia Polytechnic institute and State University. May.

Smahi, A. and Mohamed, K.S. (2018). Can oil prices forecast the exchange rate?: evidence from Algeria. *American Journal of Economics*, 8(4): 202-208.

Tanimu, Y. (2009). Nigeria Realizing on the Gains of Amnesty. http://www.africanews.com.

Tumba, J.H. (2019). Impact of oil price volatility on exchange rate in Nigeria. *InternationalJournal of research and innovation in social science (IJRISS*). Vol III. Issue II. February.

Umar B. F. (2017). An econometrics modelling and forecasting the Nigerian oil prices. Published Ph.D. thesis submitted to the Faculty of Economics and administration, University of Bakht AlRuda, Republic of Sudan.

Usoro, A.E., Ikpang, I.N., and George, E.U.(2019). Volatility measures of Nigeria crude oil production as a tool to investigative production variability. *African Journal of mathematics and computer science research*. Academic Journal publication. Vol 13 (1). Pp. 1-16. January-June 2020.http://www.academicjournals.org/AJMCSR

Wikipedia

Xie, W., Yu, L. Xu, S., & Wang, S. (2006). A new method for crude oil price forecasting based on support Vector Machines. Institute of systems science, academy of mathematics and system science. Chinese academy of sciences. Beijing. V.N Alexandrov eta l (2006). Pp.444-451.

Yeldu, Y.M. Shehu, L and Mukhtar, G. (2013). Modelling and forecasting Nigerian crude oil prices using Box-Jenkins technique. *Journal of physical science and innovations*. Vol 5. No 2.Pp.50-59.

Zamani, M. (2004). An econometrics forecasting model of short term oil spot price. Presented at 6th *IAEE European conference.*Zurich, 2-3 September.