Contemporary Journal of Management | *ISSN 2766-1431*
Published by ACADEMIC INK REVIEW | *https://airjournal.org/cjm*
12011 WestBrae Pkwy, Houston, TX 77031, United States
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Effect of Oil Price Fluctuations on Nigeria's Exchange Rate Movements

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Publication Process	***Date***
Received	***May 24th, 2021***
Accepted	***June 17th, 2021***
Published	***June 30th, 2021***

ABSTRACT

This study examined the effect of oil price fluctuations on the Nigerian exchange rate movements using monthly secondary data for the period from January 1997 to August, 2020. The two variables were tested and found stationary at first difference but not at second difference. Consequently, the study employed the Nonlinear Autoregressive Distributed Lag approach for the estimation. The results suggest that while both an increase and decrease of oil price will have an opposite impact on the exchange rate, only the impact created on exchange rate by a decrease in oil price is significant. Hence, a decrease in oil price has a greater and stronger impact on exchange rate than an increase in oil price in Nigeria. The results also show the existence of asymmetry between oil price changes and exchange rate movements. For policy relevance, the findings suggest that policymakers should be cognizant of oil prices in determining an appropriate exchange rate equilibrium.

Keywords: *Oil Price Fluctuation, Exchange rate Movements, Nonlinear Autoregressive Lag Model*

1. Introduction

The events in the international markets are capable of making crude oil prices low. Usually when there is a drop in oil prices, the consequences are exchange rate depreciation, significant drop in the level of foreign exchange inflows, and reserve depletion that often causes budget deficit and plummeting economic growth. The development of every economy is dependent on the operations of macroeconomic variables which are related and work together to determine economic growth, Exchange rate is one of the many macroeconomic variables that affect the economic growth of a nation. All of them are closely related as each of them is directly controlled by the volume of money in circulation. Etuk (2019) contends that the exchange rate of a national currency relative to another currency has a direct bearing on the national economy because of bilateral trade relationship between both countries. When the exchange rate of the foreign currency rises with respect to the domestic currency, more number of units of domestic currency are required for one unit of the foreign currency. The implication is that the country has to pay more for its imports - an activity that will disturb its balance of payments situation and reduce its foreign exchange reserves. This will also affect the entire economy negatively. All imports, foreign currency loan and interest payments are affected as the country has to pay more for them. Exchange rate affects the inflation rate too (Chelawat, 2019).

Nigeria's exchange rate policy has undergone a good number of changes. It developed from a fixed parity in 1960 when it was solely tied with the British Pound Sterling. By 1967, following the devaluation of the Pound Sterling, the United States (US) dollar was included in the parity exchange. In 1972, the parity exchange with the British Pound was suspended as a result of the emergence of a stronger US dollar. In 1973, Nigeria reverted to a fixed parity with the British Pound following the devaluation of the US dollar. In 1974, in order to minimize the effect of devaluation of a single individual currency, Nigerian currency was tied to both the pound and dollar. Like other low-income countries, Nigeria has adopted two main exchange rate regimes for the purpose of gaining balance both internally and externally. Umar and Soliu (2009) explain that the reason behind this practice is to maintain a stable exchange rate, since a fluctuating real exchange rate arising from volatile oil prices are damaging to non – oil sector, capital formation and per capita income (Serven and Solimano, 1993; Bagella, 2006).

According to literature, there are strong connections between exchange rates and oil prices especially in the long-run Beckmann, Czudaj, and Arora,2017). It discloses that either exchange rate or oil price is a potentially useful predictor of the other variable in the short-run. However, the effects differ strongly from time to time.

Almost throughout the 1970s, the persistent appreciation of the nominal exchange rate of the Naira coincided with some substantial increases in the price of oil in the international market. From early 1970s to late 1970s and during the oil boom era, the exchange rate of the naira was relatively stable. However, since September 1986 when the market- determined exchange rate system was introduced in Nigeria through the second-tier foreign exchange market, the naira exchange rate has exhibited the features of continuous depreciation and instability. This instability and continued depreciation of the naira in the foreign exchange market has resulted to declines in the standard of living of the citizenry and increased cost of production which also lead to cost push inflation. It has also tended to undermine the international competitiveness of non-oil exports and made planning and projections difficult at both micro and macro levels of the economy. A good number of small and medium scale enterprises have been strangled out as a result of low dollar/naira exchange rate.

Due to the significance of the effects of oil prices on exchange rate, many previous studies have attempted to examine the relationship between them. Notable among these studies are Hassan and Zaman (2012) and Tiwari and Olayeni (2013) cited in Olayungbo (2019). While Hassan and Zaman (2012), Tiwari and Olayeni (2013) and Henry (2019) concluded that there are negative relationships between oil price and exchange rate for India, the studies such as Olomola and Adejumo (2006) and Aliyu (2009) found a positive relationship between oil price and exchange rate for Nigeria. Several other studies such as Rautava (2004), Yousefi and Wirjanto (2004), Nikbakht (2010), Al-Ezzee (2011) and Benhabib, Si and Samir (2014) also examined causal relationship between oil price and exchange rate.While Rautava (2004), Yousefi and Wirjanto (2004), Nikbakht (2010), Al-Ezzee (2011) found a positive and significant relationship between oil price and exchange rate, Benhabib et al. (2014) found a negative relationship. Hence, the results of past studies have not been uniform. Moreover, apart from the inconclusiveness of the literature on the causal effects of oil price on exchange rate, a lot of previous studies have employed causal analysis in the time domain which cannot analyze causality in the short-, medium-, and long-term but only at a point in time.

According to Oluwatomisin, Ogundipea, Ojeagaa and Ogundipea (2014) as well as Olayungbo (2019) oil is the mainstay of the Nigerian economy. For Oluwatomisin, Ogundipea, Ojeagaa and Ogundipea (2014), oil accounts for over 95 percent of its foreign earnings and about 83 percent of its budgetary allocation. For this reason, changes in oil prices has implications for the Nigerian economy and, in particular, exchange rate movements. The latter is mostly significant as Nigeria is exposed to the double dilemma of being an oil exporting and oil-importing country. Despite the abundance of oil in the country, Nigeria has become a net importer of refined oil as a result of the underutilization of her existing refineries. The situation in the country is that it exports crude oil and imports refined petroleum product at higher cost. This cost implication has had a significant impact on the trade balance and the macroeconomic performance of Nigeria (Olayungbo, 2019).

As a result of the inconclusiveness of the literature on the causal effects of oil price on exchange rate, this paper is motivated to contribute to literature. Further, given the inability of monetary authorities to achieve

realistic exchange rate policy even after adopting the Structural Adjustment Program (SAP) and constant fluctuations in the value of the naira sometimes occasioned by oscillations in crude oil price in the international market (Henry, 2019), this paper seeks to find out the impact that the oil price changes has on exchange rate in Nigeria. In addition, the fact that oil dominates the Nigeria's external sector and is its major source of revenue necessitates the probe of the nexus and the magnitude of the effects of fluctuation in the oil price on exchange rate as it relates to Nigeria. Against this background, this study evaluated the effects of crude oil price fluctuations fluctuation on exchange rate movements in Nigeria. The result of this study shall be an important factor to be incorporated in foreign exchange markets (see Bützer,2015).

The rest of the paper is arranged as follows. Section 2 presents the summary of the existing literature. Section 3 concerns the methodology. Section 4 provides the discussion of results, while Section 5 concludes and provides policy recommendation

2. Literature Review

2.1 Conceptual Review

Simply put, exchange rate is the price of one country's currency in relation to that of another country; the required amount of units of a currency that can buy another amount of units of another currency. Quite often, exchange rate is referred to as the ratio at which a unit of currency of one country is expressed in terms of another currency (Jhingan, 2004). The rate is normally determined in the foreign exchange market. According to Beckmann, Czudaj and Arora (2017), the distinction between real and nominal measures of exchange rate is essential when investigating the connection between oil prices and exchange rates. The nominal spot exchange rate at a specific point in time is expressed as domestic currency per US dollar. The implication is that an increase reflects a nominal appreciation of the US dollar.

The real exchange rate equally includes price indices for both countries, and reflects the basket of domestic goods that can be purchased with one basket of US goods (Beckmann, Czudaj and Arora, 2017). An increase is a real appreciation of the US dollar as the real purchasing power of US goods goes up. It is possible to express both nominal and real exchange rates as a geometric or arithmetic trade weighted index between multiple countries, instead of just between two countries. According to Beckmann, Czudaj and Arora (2017), such effective exchange rates reflect the entire external competitiveness for an economy.

The nominal oil price is usually measured in US dollars per barrel. The real oil price is computed by adjusting the nominal oil price for any alterations in the US price level which is usually based on the US consumer price index (CPI). Instead of analyzing current or spot price dynamics, another alternative is to focus on futures price dynamics, since these also reflect expectations. There are three major types of exchange rate systems, namely the float, the fixed rate, and the pegged float.

Oil prices are denominated in US dollars and available from the US Energy Information Administration (EIA). In the crude oil market, there are various types and qualities of oil used for different purposes. The price of oil highly depends on in its grade, factors such as specific gravity, its content as well as location. 160 different blends of oil have been identified universally. However, the three primary benchmarks are WTI, Brent and Dubai. Crude oil prices are quoted in different markets all over the universe.

According to Trung and Vinh (2011), macroeconomic variables should be affected by oil shocks for two reasons First, oil increase leads to lower aggregate demand assuming that income is redistributed between net oil import and export countries. Oil price hykes can affect economic activity because that will make more household income to be spent on energy consumption. Firms will also reduce the amount of crude oil they purchase – an exercise that will lead to underutilization of the factors of production like labor and capital. Second, the supply side effects are are linked with the fact that crude oil is considered as the basic input in the production process. An increase in oil price will lead to a decrease in the supply of oil as a rise in cost of crude oil production will lead to a reduction in potential output.

Oil price fluctuations have received significant considerations for their perceived role in macroeconomic variables dynamism. Acording to Sill (2009), the aftermath of huge increases in the oil price on macroeconomic variables have been of great concern among economist, policy makers and the general public since two major oil price shocks shook the global economy in the 1970s. Several papers have suggested that oil price might have a significant influence on exchange rate.

According to Amano and Norden (1998) many researchers suggest that oil fluctuations has a significant consequence on economic activity and that the effect differs for both oil exporting countries and oil importing countries. It benefits the oil exporting countries when the international oil price is high but it poses a problem for oil importing countries. The reverse becomes the case when the crude oil price is low.

The fundamental channels derived from textbook inter-temporal models tend to suggest that a fall in oil prices should be accompanied by a real depreciation of oil exporters. However, according to Bützer (2015), things may be somewhat different in practice. While economic theory suggests that oil exporters' currencies should depreciate in the wake of negative oil price shocks (and vice versa for positive shocks), in practical situations there may be counter-balancing forces. First, monetary authorities may not favor large movements in the nominal exchange rate, and may choose to counter exchange rate pressures through the accumulation or reduction of foreign exchange reserves. Second, the international risk-sharing channel may provide an automatic stabilizer through currency exposure. Assuming that oil exporters have accumulated a large pool of foreign exchange reserves and tend to be net long in foreign currency, a decline in the oil price accompanied by a depreciation produces a positive valuation effect. This becomes a net gain for them relative to domestic Gross Domestic Product and plays a stabilizing role. What this implies is that the exchange rate does not need to depreciate quite as much to be able to ensure external sustainability (Bützer, 2015).

Even though diverse theoretical relationships between oil price and exchange rates exist in literature (Beckmann and Czudaj, 2012), theoretically, some links exist between oil prices and exchange rates. While the terms of trade channel mostly focuses on real oil prices and exchange rates, the wealth and portfolio channels show an effect from the nominal exchange rate to the nominal oil price. On the other hand, the expectations channel allows for nominal causalities in both directions. The economic literature considers three direct transmission channels of oil prices to exchange rates. The channels include the terms of trade channel, the wealth effect channel and the portfolio reallocation channel (Buetzer, Habib and Stracca,2016). According to Beckmann, Czudaj and Arora (2017), the terms of trade channel was introduced by Amano and van Norden (1998a, b). The underlying idea is to link the price of oil to the price level which affects the real exchange rate (Bénassy-Quéré, Mignon, and Penot, 2007). If the non-tradable sector of a country A is more energy intensive than the tradable one, the output price of this sector will increase relative to the output price of country B, implying that the currency of country A experiences a real appreciation as a result of higher inflation (Chen and Chen, 2007; Buetzer et al., 2016). Effects on the nominal exchange rate take place if the price of tradable goods is no longer assumed to be fixed. In this case, inflation and nominal exchange rate dynamics are related through purchasing power parity (PPP). If the price of oil increases, it is expected that the currencies of those countries with large oil dependence in the tradable sector would depreciate as a result of higher inflation. The response of the real exchange rate then depends on how the nominal exchange rate changes. However, this is relative to the effect of any changes in the price of tradable (and non-tradable) goods. The idea behind the portfolio and wealth channel introduced by Krugman (1983) and Golub (1983) hinges on a three-country framework. This has been reconsidered by Bodenstein, Erceg and Guerrieri (2011).The basic idea is that oil-exporting countries experience a wealth transfer when the oil price rises (Bénassy-Quéré et al., 2007). When oil prices rise, wealth is transferred to oil exporting countries (in US dollar terms) and is reflected as an improvement in exports and the current account balance in domestic currency terms. For this reason, it is expected that the currencies of oil-exporting countries would appreciate and currencies of oil-importers and depreciate in effective terms when there is an increase in oil prices (Beckmann and Czudaj, 2013b).

There are several theories observed in literature which explain the exchange rates movement and its relationship with external shocks, namely the purchasing power parity (PPP) model, monetary model, traditional flow model, and portfolio balance model (Rotimi, Ojo and Babatunde, 2018).

2.2 Empirical review

According to Beckmann, Czudaj and Arora (2017), the seminal work of Meese and Rogoff (1983) which indicates that exchange rate models based on economic fundamentals cannot outperform a simple random walk forecast still constitutes a benchmark result in the international finance literature. Sarno (2005) cited in Beckmann, Czudaj and Arora (2017) asserts that the resulting exchange rate disconnect puzzle remains one of the most important topics in international economics Rossi (2013) contends that the forecasting performance of fundamental exchange rate models is very sensitive to the selection of different currencies, sample periods and forecast horizons. The literature review related to this topic is summerized as follows.

Yousefi and Wirjanto (2004) studied the effect of oil price on exchange rate in OPEC Countries for the period from1970 to 1999. Novel empirical approach was employed. The results of study disclose that regional price correlations appears to be indicative of segmentation within the OPEC market structure.

Rautava (2004) conducted a similar study in Russia for the period from 1995 to 2001 using VAR. The study found that the Russian economy was influenced significantly by oil price fluctuations in both long run equilibrium and short run.

Olomola and Adejumo (2006) studied the effect of oil price on exchange rate in Nigeria for the period from 1970 to 2003 using the VAR approach. The findings show that while oil price significantly influenced exchange rate, it did not have a significant effect on output and inflation in Nigeria

Gounder and Bartleet (2007) sought to establish the effect of oil price on exchange rate in New Zealand for the period from 1989 to 2006 using the Vector Autoregression (VAR) model. Oil price was found to be having substantial effect on exchange rate in New Zealand.

In the G7 countries, Chen and Chen (2007) examined the link between oil price and exchange rate for the period from 1992 to 2005. Panel co-integration method was applied in the estimation. The study found that there is a link between oil price and exchange rate.

In another dimension, Habib and Kalamova (2007) investigated the connection between oil price and exchange rate in Russia, Norway, and Saudi –Arabia for the period from 1980 to 2006 using VAR. No significant evidence was found to maintain that the diverse exchange rate regimes of the countries might be accounting for the different empirical results on the impact of oil price.

Coudert, Valérie and Penot(2008) carried out a study in the United States to determine the relationship between the oil price and the dollar real exchange rate for the period from 1974 to 2004 using the VECM methodology. The study found that the relationship between the dollar real exchange rate and oil price appeared to be transmitted through US international investment position. Again, Coudert, Valérie and Penot (2008) repeated a similar study in the US for the poriod spanning 1974 to 2004. VECM was employed in the research.The authors found that the relationship between the dollar real exchange rate and oil price seems to be transmitted through the US international investment position.

Aliyu (2009) sought to ascertain the effect of oil price on Nigerian exchange rate for the period from 1986 to 2007 using the VECM. The outcome of the study suggests the need for the diversification of both the Nigerian infrastructure and the economy.

Nikbakht (2011) studied the effect of oil price on exchange rate among OPEC members for the period from 2000 to 2007. Panel cointegration test model was used for estimation. The result indicates that oil price may have a dominant share of real exchange rate movement.

Al-Ezzee (2011) carried out a similar study in Bahrain for the period from 1980 to 2005 using the Vector Error Correction Model (VECM). The study affirmed the existence of a long run relationship between real GDP growth, global oil price, and exchange rate.

Shafi, Liu and Nazeer (2013) investigated the relationship between oil price and exchange rate in France from 1971 to 2012 using the Error Correction Model (ECM). The study concluded that the impact of oil price on exchange rate is positive in the long run.

Benhabib, Si and Samir (2014) examined the impact of oil price on exchange rate in Algeria from 2003 to 2013 Vector Autoregression (VAR) technique. The result of the study indicates that oil price has impacted Algerian currency.

Rotimi, Ojo and Babatunde (2018) examined the long-run association of real exchange rates, real oil prices, interest rate, inflation and external debt in Nigeria using monthly data for the period, 1980-2017.The study employed various cointegration tests and observe that cointegration exists among the selected variables. The granger causality test found that oil price positively and significantly impacts exchange rates in Nigeria, suggesting that a rise in global oil prices results in exchange rate appreciation. Jungo and Kim (2019). examined the effect oil price fluctuations on exchange rates in selected sub-Saharan African (SSA) countries. To investigate the subject thoroughly, unlike previous studies thee authors took specific account of the asymmetric effects of oil price changes in their modeling process, using the nonlinear autoregressive distributed lag The results show that changes in oil prices have the asymmetric effects on the real exchange rates in the long-run; that is, the movements in the real exchange rates in selected SSA countries appear to respond mostly more to oil price increases than to decreases. In the short-run, however, the asymmetry of oil price changes was not observed.

Henry (2019) examined the impact of oil price volatility on exchange rate in Nigeria using annual time series data from 1986 to 2015. The Autoregressive Distributed Lag (ARDL) Bounds testing procedure was adopted because the variables were integrated of order I(0) and I(1). The exchange rate model showed a good fit, 99 percent of the variations in the dependent variable were explained by the independent variables and hypotheses tested at 1, 5 and 10 percent levels of significance. The results indicate a negative but significant relationship between volatility of crude oil prices and exchange rates in Nigeria in the long-run. In the short-run, however, this relationship was negative and statistically non-significant within the period of study.

In summary, from the empirical review it is evident that the results of earlier studies exhibit different evidence regarding the issue of oil price and exchange rate. In addition, it can be observed that extensive studies have been done on oil price and exchange rate in both developed and less developed countries. Most of the literature highlighted employed the time domain analysis and those studies that have applied frequency domain analysis were mainly on developed countries with few on developing countries. Further, most of the studies reviewed used annual data series. As a way of adopting a different approach to investigate the nexus between oil price and exchange rate and updating the literature as it relates to a developing country, this study applied the nonlinear autoregressive distributed lag (NARDL)estimation model on monthly data series for the period from January 1997 to August, 2020.

3. Methodology and Data Analyses

3.1 Data

This study relied on monthly historical data spanning the period from January 1997 to August 2020. Oil prices per barrel are available from the US Energy Information Administration (EIA) short-term outlook. We selected Europe Brent spot price (OP) as the explanatory variable. The monthly data on Nigeria's average monthly exchange rate (XCHR) of the Inter-bank Foreign Exchange Market (IFEM) were retrieved from the Central Bank of Nigeria (CBN)'s publications of the relevant years and were employed as the dependent variable. For the purpose of the estimation, the OP was measured in U.S. dollars per barrel while the XCHR was measured in Naira per US dollar. In the empirical estimations, all the variables were used in their logarithmic forms.

3.2. Model specification

In this study, we proposed the Nonlinear Autoregressive Distributed Lag model following Jungo and Kim (2019). Many previous studies have applied frequency domain causality to wide areas of economic research. For instance, Bayat, Saban and Selim (2015) investigated causal relationship between oil price and exchange rates in Czech Republic, Poland, and Hungary by employing frequency domain causal approach. To investigate the subject thoroughly, unlike what many previous studies did, we took specific account of the asymmetric effects of oil price changes in our modeling process.

The attraction of NARDL lies in the fact that it represents the simplest method available for modeling combined short- and long-run asymmetries (Allen andMcAleer,2020). NARDL model, which employs the bounds testing framework, can be applied to both stationary and non-stationary time series vectors, or combinations of both provided that none of the data series is of the I(2) integration order (Paseran, Shin and Smith, 2001). It has advantages over the ARDL model as its very construction allows one to incorporate the possibility of asymmetric effects of positive and negative changes in explanatory variables on the dependent variable. Further, NARDL method provides graphs of cumulative dynamic multipliers used to trace out the adjustment patterns following the positive and negative shocks to explanatory variables. NARDL model captures the nonlinear and asymmetric co-integration between variables. In addition, it distinguishes between the short-term and long-term effects of the independent variables on the dependent variable. Additionally, NARDL is the most appropriate instrument for testing co-integration among the variables in single equation. In order to capture non-linear and asymmetric relationship among the variables, the NARDL model developed by Hatami (2012) was applied

The NARDL model is specified as follows: -

$\Delta XCHR_t = \alpha_0 + \rho XCHR_{t-1} + \beta_1^+ OP^+_{t-1} + \beta^-_2 OP^-_{t-1} + \sum_{t=1}^{-p} \alpha_1 \Delta XCHR_{t-1} + \sum_{t=0}^{-p} \alpha_2 OP^+_{t-1} \sum_{t=0}^{-p} \alpha_3 OP^-_{t-1} + \mu_t$ ....(1)

In the NARDL equation as modelled above, αi represent short run coefficients while βi stand for the long-term coefficients with i = 1....4th. While the short-term analysis relates to the immediate effect of the independent variable on the dependent variable, the long-term analysis reveals the speed of adjustment towards equilibrium. The variablesXCHR t and OPt in this model represent average monthly exchange rates and Brent spot oil prices respectively; t stands for time. Wald test is run to know the long run asymmetry $\beta=\beta+=\beta-$ and for short run asymmetry $\alpha=\alpha+=\alpha-$ for the selected variables

4. Empirical Results

4.1 Descriptive statistics

Table 1 presents the descriptive statistics for the price series as well as their stochastic properties. The monthly average oil price is 57.72 USD and XCHR has an average of N159.825/USD. On a monthly basis, the XCHR and OP reached their maximum value of 381USD and N133.9/USD respectively. The two-time series are positively skewed. The Jarque-Bera test indicates the non-normality of XCHR and OP series. This is an a-priori expectation as according to economic literature, non-normality is a typical characteristic of financial data series.

Table 1: Descriptive statistics

	OP	XCHR
Mean	57.72750	159.8250
Median	55.72500	141.5018
Maximum	133.9000	381.0000
Minimum	9.800000	21.88610
Std. Dev.	32.16818	82.40168
Skewness	0.451290	0.773801
Kurtosis	2.149733	3.168227
Jarque-Bera	18.19500	28.67654
Probability	0.000112	0.000001
Sum	16394.61	45390.31
Sum Sq. Dev.	292846.1	1921581.
Observations	284	284

4.2 ARDL Unit Root Results

As a starting point, this study conducted a stationarity tests as presented in tables 2.1.a,2.1.b,2.2.a and 2.2.b in order to confirm the existence of unit root. The research employed the conventional Augmented Dickey-Fuller (ADF)tests. The standard unit root test technique is applied to both variables comprising exchange rates and oil price to test for the existence of unit-roots.

Table 2.1a Unit Root Test for Stationarity for Oil Price (OP) (At level Form)
Null Hypothesis: OP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.066324	0.2587
Test critical values:	1% level	-3.453400	
	5% level	-2.871582	
	10% level	-2.572193	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OP)
Method: Least Squares
Date: 12/04/20 Time: 07:09
Sample (adjusted): 1997M03 2020M08
Included observations: 282 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OP(-1)	-0.023666	0.011453	-2.066324	0.0397
D(OP(-1))	0.159905	0.058968	2.711706	0.0071
C	1.443707	0.757448	1.906014	0.0577

R-squared	0.036984	Mean dependent var	0.084787
Adjusted R-squared	0.030080	S.D. dependent var	6.254042
S.E. of regression	6.159262	Akaike info criterion	6.484372
Sum squared resid	10584.29	Schwarz criterion	6.523116
Log likelihood	-911.2965	Hannan-Quinn criter.	6.499909
F-statistic	5.357337	Durbin-Watson stat	2.036816
Prob(F-statistic)	0.005211		

The result of unit root test for OP (at level) in table 2.1a indicates that the t-statistic -2.066324 and the p-value is 0.2587.Since p-value is greater than 0.05, the null hypothesis that OP has a unit root was rejected .This implies that OP is not stationary at level.Consequently, the test was repeated with OP at first difference(table 2.1.b).

Table 2.1.b. Unit Root Test for Stationarity for Oil Price (OP) (inFirst Difference Form)

Null Hypothesis: D(OP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.40261	0.0000
Test critical values:	1% level	-3.453400	
	5% level	-2.871582	
	10% level	-2.572193	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OP,2)
Method: Least Squares
Date: 12/04/20 Time: 07:10
Sample (adjusted): 1997M03 2020M08
Included observations: 282 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OP(-1))	-0.850886	0.059079	-14.40261	0.0000
C	0.074333	0.368937	0.201480	0.8405

R-squared	0.425565	Mean dependent var	0.014681
Adjusted R-squared	0.423513	S.D. dependent var	8.159340
S.E. of regression	6.195120	Akaike info criterion	6.492468
Sum squared resid	10746.26	Schwarz criterion	6.518297
Log likelihood	-913.4380	Hannan-Quinn criter.	6.502826
F-statistic	207.4352	Durbin-Watson stat	2.029434
Prob(F-statistic)	0.000000		

The result of unit root test for OP at first difference shows that the t-statistic is -14.40261 while the p-valueis 0.0000.Since the p-value is less than 0.05, the null hypothesis that OP has a unit root was rejected in favor of the alternative hypothesis.This implies that OP is stationary at first difference.
As for XCHR, its unit root test at level (Table 2.2a and b) has a result showing that it also became stationary at first difference.. The finding reveals that the order of integration for both series is I(1) and none is I(2).

Table 2.2.a Unit Root Test for Stationarity for Exchange Rate (XCHR) (At level Form)

Null Hypothesis: XCHR has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on AIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.327132	0.9794
Test critical values:	1% level	-3.453483	
	5% level	-2.871619	
	10% level	-2.572213	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(XCHR)
Method: Least Squares
Date: 10/30/20 Time: 10:49
Sample (adjusted): 1997M04 2020M08
Included observations: 281 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
XCHR(-1)	0.002007	0.006134	0.327132	0.7438
D(XCHR(-1))	0.281671	0.058609	4.805925	0.0000
D(XCHR(-2))	-0.243038	0.058996	-4.119573	0.0001
C	0.894010	1.086702	0.822682	0.4114

R-squared	0.107119	Mean dependent var	1.277985
Adjusted R-squared	0.097449	S.D. dependent var	8.623053
S.E. of regression	8.192132	Akaike info criterion	7.058358
Sum squared resid	18589.76	Schwarz criterion	7.110150
Log likelihood	-987.6993	Hannan-Quinn criter.	7.079129
F-statistic	11.07725	Durbin-Watson stat	1.964206
Prob(F-statistic)	0.000001		

2.2.b. Unit Root Test for Stationarity for Exchange Rate (XCHR) (At First Difference Form)

Null Hypothesis: D(XCHR) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on AIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.19873	0.0000
Test critical values:	1% level	-3.453483	
	5% level	-2.871619	
	10% level	-2.572213	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(XCHR,2)
Method: Least Squares
Date: 10/30/20 Time: 11:10
Sample (adjusted): 1997M04 2020M08
Included observations: 281 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(XCHR(-1))	-0.957342	0.072533	-13.19873	0.0000
D(XCHR(-1),2)	0.240909	0.058542	4.115177	0.0001
C	1.210168	0.496083	2.439444	0.0153

R-squared	0.420797	Mean dependent var	0.013559
Adjusted R-squared	0.416631	S.D. dependent var	10.70845
S.E. of regression	8.178965	Akaike info criterion	7.051627
Sum squared resid	18596.94	Schwarz criterion	7.090471
Log likelihood	-987.7536	Hannan-Quinn criter.	7.067205
F-statistic	100.9851	Durbin-Watson stat	1.963541
Prob(F-statistic)	0.000000		

4.3 ARDL Optimal Lag Selection

The ideal lag length is obtained as displayed in table 3 by estimating the regressions separately and following consecutive modified LR t-statistic. Each test was carried out at 5% level of significance.This was achieved using various lag order selection criteria consisting of the Hannan-Quinn Information criterion (HQ), Akaike Information Criterion (AIC),

Final Prediction Error (FPE) and Schwarz Information Criterion (SIC).They are necessarily taken into consideration whenever the NARDL estimating technique is employed (see Raza,Shahbaz and Nguyen,2015). Lag length 3 was considered suitable for the variables as it gives the least criteria for the value of FPE, AIC, SIC, and HQ.

Table 3: The ARDL Optimum Lag Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: LINR
Exogenous variables: C LOP
Date: 11/03/20 Time: 13:51
Sample: 1997M01 2020M08
Included observations: 276

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-160.8748	NA	0.190591	1.180252	1.206487	1.190780
1	260.8082	834.1989	0.009040	-1.868175	-1.828823	-1.852384
2	365.1733	205.7051*	0.004275	-2.617198	-2.564728*	-2.596142*
3	366.4210	2.450169	0.004267*	-2.618992*	-2.553406	-2.592674
4	366.8113	0.763688	0.004286	-2.614575	-2.535870	-2.582992
5	366.8192	0.015356	0.004317	-2.607385	-2.515564	-2.570539
6	367.5964	1.509315	0.004324	-2.605771	-2.500832	-2.563660
7	367.6116	0.029474	0.004355	-2.598635	-2.480578	-2.551261
8	367.6850	0.141539	0.004384	-2.591920	-2.460746	-2.539283

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion

4.4 The NARDL Regression Model

Table 4 shows the estimation of the NARDL(short run).The regression model that underlies the NARDL equation, shown in (1) above fits well and appropriately. The model is statistically significant at 5% level.

Table 4: Dynamic Estimation of NARDL (Short Run)

Asymmetric Relationship between Variables (Effect of Positive and negative shocks)

Dependent Variable: LXCHR
Method: ARDL
Date: 11/07/20 Time: 21:48
Sample (adjusted): 1997M02 2020M08
Included observations: 283 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LOP_POS LOP_NEG
Fixed regressors: C
Number of models evalulated: 32
Selected Model: ARDL(1, 0, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LXCHR(-1)	0.959368	0.015235	62.97185	0.0000
LOP_POS	-0.019976	0.010335	-1.932906	0.0543
LOP_NEG	-0.028724	0.011291	-2.544114	0.0115
C	0.178629	0.060993	2.928699	0.0037
R-squared	0.981453	Mean dependent var		4.912849

Adjusted R-squared	0.981254	S.D. dependent var	0.651945
S.E. of regression	0.089262	Akaike info criterion	-1.980452
Sum squared resid	2.222981	Schwarz criterion	-1.928926
Log likelihood	284.2340	Hannan-Quinn criter.	-1.959792
F-statistic	4921.391	Durbin-Watson stat	1.965677
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

The outcome of this estimation indicates that one unit increase in oil price (LOP_POS) in the short run is associated with 0.01997 or (1.9%) decrease in exchange rate on average ceteris paribus. This increase in oil price does not have a statistically significant effect on the exchange rate since the p-value is 0.0543 which is greater than 0.05 level of significance. This implies that an increase in oil price has a non-significant and negative effect on the average monthly exchange rate of Nigeria

The estimation results as shown in table 4 also indicate that one unit decrease in oil price (LOP_NEG) in the short run is associated with 0.0287 or (2.8%) increase in exchange rate. This decrease in oil price has a statistically significant effect on the exchange rate since the p-value is 0.0115. With the p-value of less than 0.05, the null hypothesis that there is no significant effect of oil price decrease on exchange rate is rejected.The implication of these results is that a a decrease in oil price has a significant and negative effect on the average monthly exchange rate of Nigeria.In summary, the results show that while both an increase and decrease of oil price will have an opposite impact on the exchange rate, only the impact created on exchange rate by a decrease in oil price is significant.In other words, a decrease in oil price has a greater and stronger impact on exchange rate than an increase in oil price in Nigeria.

4.4 Long term relationship: Bounds Test

Following Pesaran and Pesaran(1997), the hypotheses to test for the Wald co-integration test are expressed as:

$Null\ Hypothesis\ (H0)$: $C(1) = C(2) = C(3) = C(4)$

$= 0$: $No\ cointegration\ among\ variables$

$Null\ Hypothesis\ (H1)$: $C(1) = C(2) = C(3) = C(4)$

$\neq 0$: $Cointegration\ exist$s among variables

The Null Hypothesis is that there is no cointegration between the variables.The regression in Table 5 shows that the F-Statistic is 4.667583 while the critical value of the lower bound I(0) is 3.1 at 5% Consequently, the Null hypothesis that there is **no *cointegration among variables*** is rejected since 4.667583 is greater than critical values of I(0). In other words,there is cointegration(long run relationship) between the variables.

Table 5: Bound test

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LXCHR)
Selected Model: ARDL(1, 0, 0)
Case 2: Restricted Constant and No Trend
Date: 11/07/20 Time: 22:07
Sample: 1997M01 2020M08
Included observations: 283

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.178629	0.060993	2.928699	0.0037
LXCHR(-1)*	-0.040632	0.015235	-2.667066	0.0081
LOP_POS**	-0.019976	0.010335	-1.932906	0.0543
LOP_NEG**	-0.028724	0.011291	-2.544114	0.0115

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOP_POS	-0.491636	0.351977	-1.396784	0.1636
LOP_NEG	-0.706933	0.389526	-1.814853	0.0706
C	4.396233	0.311213	14.12610	0.0000

EC = LXCHR - (-0.4916*LOP_POS -0.7069*LOP_NEG + 4.3962)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.667583	10%	2.63	3.35
K	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
			Finite Sample:	
Actual Sample Size	283		n=80	
		10%	2.713	3.453
		5%	3.235	4.053
		1%	4.358	5.393

4.5 Long Run Asymmetric Effect of the Response of Exchange Rate to Positive and Negative Changes in Oil Price

The results of the ARDL Long run form and Bound tests in table 5 show that one unit increase in oil price (LOP_POS) is associated with 0.491636 or (49%) decrease in exchange rate on average ceteris paribus. This increase in oil price does not have a statistically significant effect on the exchange rate since the p-value is 0.1636. One unit decrease in oil price (LOP_NEG) is associated to 0.706933 or (70%) decrease in exchange rate. This decrease in oil price does not have a statistically significant effect on the exchange rate since the p-value is 0.0706

This study attempted to determine if the difference between the coefficient of the POS and NEG(positive and negative) changes were statistically significant in order to draw conclusion on whether or not the relationship between XCHR and LOP is asymmetric.A Wald Test was carried out(see Table6).According to table 6,both positve and negative changes in LOP do not have significant impact on XCHR. But the question is whether the two impacts are of the same magnitude (symmetric effect) or are different (asymmetric effect)?

The Null hypothesis is that the two impacts are the same. i.e. no long-run asymmetry. With a p-value of 0.0075 which is less than 0.05, the null hypothesis was rejected. This means that the positive and negative impacts are not of the same magnitude. The implication is that positve and negative changes in oil price have asymmetric effect on the exchange rate

Table 6:

Wald Test:
Equation: NARDL03

Test Statistic	Value	Df	Probability
t-statistic	2.691647	279	0.0075
F-statistic	7.244964	(1, 279)	0.0075
Chi-square	7.244964	1	0.0071

Null Hypothesis: C(2)=C(3)
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2) - C(3)	0.008748	0.003250

Restrictions are linear in coefficients.

4.6 Diagnostic tests

The diagnostic tests carried out support the fitness of the model. These tests include the Jarque-Bera test serial(table 1) correlation (Breusch-Godfrey and Durbin Watson tests(table 7) and Heteroskedasticity tests(Table8).In addition, the serial correlation test conducted, using the Breusch-Godfrey Serial Correlation LM Test procedure reveals that the model is not serially correlated(Table 7).

Table 7:

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.003674	Prob. F(2,277)	0.3679
Obs*R-squared	2.036073	Prob. Chi-Square(2)	0.3613

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 11/07/20 Time: 23:17
Sample: 1997M02 2020M08
Included observations: 283
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LXCHR(-1)	0.004510	0.016279	0.277026	0.7820
LOP_POS	-0.000525	0.010379	-0.050612	0.9597
LOP_NEG	0.000242	0.011292	0.021399	0.9829
C	-0.017784	0.065051	-0.273378	0.7848
RESID(-1)	0.013273	0.062018	0.214018	0.8307
RESID(-2)	-0.085878	0.061862	-1.388217	0.1662

R-squared	0.007195	Mean dependent var	-3.18E-16
Adjusted R-squared	-0.010726	S.D. dependent var	0.088786
S.E. of regression	0.089261	Akaike info criterion	-1.973538
Sum squared resid	2.206988	Schwarz criterion	-1.896250
Log likelihood	285.2557	Hannan-Quinn criter.	-1.942548
F-statistic	0.401469	Durbin-Watson stat	2.000571
Prob(F-statistic)	0.847633		

Null hypothesis: State that residual exhibit no serial auto correlation

F-statistic has a p-value of 0.3679 so we accept the null hypothesis that there is no autocorrelation problem

Table 8:

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	4.492478	Prob. F(3,279)	0.0043
Obs*R-squared	13.04071	Prob. Chi-Square(3)	0.0045
Scaled explained SS	1003.955	Prob. Chi-Square(3)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 11/07/20 Time: 23:16
Sample: 1997M02 2020M08
Included observations: 283

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.198474	0.066453	2.986691	0.0031
LXCHR(-1)	-0.044201	0.016599	-2.662926	0.0082
LOP_POS	-0.014667	0.011260	-1.302577	0.1938
LOP_NEG	-0.021782	0.012301	-1.770745	0.0777

R-squared	0.046080	Mean dependent var	0.007855
Adjusted R-squared	0.035823	S.D. dependent var	0.099043
S.E. of regression	0.097252	Akaike info criterion	-1.808982
Sum squared resid	2.638788	Schwarz criterion	-1.757456
Log likelihood	259.9709	Hannan-Quinn criter.	-1.788322
F-statistic	4.492478	Durbin-Watson stat	2.026339
Prob(F-statistic)	0.004252		

Null hypothesis: State that residual is homoskedastic

A p-value of 0.0043 show that we reject the null hypothesis; which means that the residual is heteroskedastic

4.7 Discussion of results

This study examined the causal effects of oil price on exchange rate in Nigeria between the period from January 1997 and August,2020. We employed a

Nonlinear autoregressive lag model to capture the possible short-, medium-, and long-term causal effects between the variables of interest as well as the asymmetric nature of their relationship. The NARDL estimation was carried out after ensuring the stationarity of the variables to investigate the causal effects of oil price on exchange rate in Nigeria. Equation (1) is estimated with oil price as exogenous variable to exchange rate. This is so modeled because oil price is exogenous to Nigeria's economy.

The global oil prices are dictated by the economic conditions in the international market which are external to the sample country's economy.

The results of the study show that in the short run oil price fuctuation has a non-significant negative effect on Nigerian exchange rate as one unit increase in oil price is associated with 0.01997 or (1.9%) decrease in exchange rate on the average average ceteris paribus. However,one unit decrease in oil price is associated with 0.706933 or (70%) increase in exchange rate.The effect of the decrease in oil price on exchange rate is statistically significant effect. In addition, the results showed that positive and negative changes in oil price have asymmetric effect on the exchange rate.

Theoretical a priori expectation for an oil exporting country like Nigeria is that an increase in the international oil price should have a significant and positive effect on its exchange rate.Nevertheless, the frequent use of foreign exchange to stabilize the exchange rate level by the Central bank of Nigeria (CBN) periodically may be responsible for the weak causal effects of oil price increase on the exchange rate.Nigeria practices a managed floated exchange rate system. An exchange rate policy intervention of this kind is capable of greatly eliminating the effects of oil price on the exchange rate. Even though most of the movements in real exchange rate is due to changes in the permanent components, dynamic short run impact of oil price fluctuations on exchange rate may not hold. This may be as a result of the fact that transactions on crude oil are not primarily carried out using the naira; consequently the fluctuation in prices may not be easily transmitted to the naira exchange rate in the short run.

Our findings supported a previous study conducted by Habib and Kalamova (2007) for Russia, Norway, and Saudi Arabia that no significant causal relationship exists between oil price and exchange rate for the oil rich countries. It is also in support of a more recent paper by Bayat et al. (2015) that oil price does not have causal effect on exchange rate in Hungary with frequency domain analysis.In addition,our results agree with Benhabib et al. (2014)as well as Hassan and Zaman (2012), Tiwari andOlayeni (2013) cited in Olayungbo(2019) and Henry(2019)which concluded that there are negative relationships between oil price and exchange rate for India.Nevertheless, they are inconsistent with Akram (2004), Bergvall (2004), Rautava (2004), Amano and van Norden (1998), and Chadhuri and Daniel (1998), who each found that oil prices significantly affect the relative value of currencies in Norway, the four Nordic countries, Russia, several industrialized countries, and 16 OECD countries, respectively.

After performing the unit root tests and the cointegration test, we found short term causal effects of oil price on exchange rate. The findings suggest that short term energy policy would be appropriate for oil price-exchange rate relationship in Nigeria.

5. Conclusion

This study examined the effect of oil price fluctuations on Nigerian exchange rate.The two variables were tested and found stationary at first difference or I(1) but not at second difference or I(2). Consequently, the study employed the NARDL estimating technique covering the period from January 1997 to August 2020 to examine the impact of the oil price fluctuations on the average monthly exchange rates in Nigeria. The results show that while both an increase and decrease of oil price will have an opposite impact on the exchange rate, only the impact created on exchange rate by a decrease in oil price is significant.In other words, a decrease in oil price has a greater and stronger impact on exchange rate than an increase in oil price in Nigeria.The results also show the existence of asymmetry between oil price changes and exchange rate movements. Finally, they reveal that the model is stable and there is covariance in the oil prices and exchange rates. For policy relevance, the findings suggest that policymakers should be cognizant of oil prices in determining an appropriate exchange rate equilibrium. Thus, when oil price changes take place, relevant monetary policy measures should be employed to stabilize the unanticipated impacts on exchange rates that may distort the economy.

In addition,diversifying away from oil to other non-oil activities that would generate foreign exchange should be a continuous policy pursuit of the policy makers in the country.Also, adequate measures should be put in place to de-link long run movements of the naira exchange rate from oil price changes. This is because oil prices are highly volatile and very unsettled. If current changes in the prices of oil categorically affects long run exchange rate, then long run stability of the external sector is not guarranteed. Finally, permanent adjustment in exchange rate of the naira should be the main issue of concern when oil prices are fluctuating

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