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Article

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The Asymmetric Effect of Oil Price on the Exchange Rate and Stock Price in Nigeria

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ABSTRACT

The study examines the asymmetric effect of oil price on the exchange rate and stock price using the nonlinear autoregressive distributive lag (NARDL) technique on the time-series data spanning from January 1996 to September 2020. The multivariate cointegration test showed evidence of a long-run relationship among the stock price, exchange rate, and oil price. The linear Granger causality test showed that stock price is granger caused by oil price and exchange rate, and oil price is granger cause by stock price and exchange rate. The nonlinear granger causality showed evidence of nonlinearity using the BDS test. The Dick-Panchenko non-parametric and nonlinear Granger causality test in a contrary to the linear Granger causality test showed a unidirectional nonlinear causality from exchange rate to stock price at 10% level, and from oil price to exchange rate at 1% and 10% levels respectively. The result from the nonlinear ARDL revealed that change in oil price impacted asymmetrically on the exchange rate and stock price both in the short-run and long-run. The study recommends that the revenue generated from increasing oil price should be used for developing and reinstalling decayed infrastructure and oil-exporting countries should develop mechanisms and strategies that will ensure fair stability in the capital markets irrespective of the shocks in oil price.

Keywords: Exchange Rate, Oil Price, Nonlinear Model, Stock Price

JEL Classifications: E52, L61, F31, C32, G15

1. INTRODUCTION

Nigeria is the world's tenth producer and largest reserve of global oil. Before the discovering of oil in 1958, it has been the highest and major source of revenue accounting for about 90% of total export and not less than 70% of total revenue as well as the most contributors of gross domestic product in Nigeria (Madugba et al., 2016). Downward fluctuation in oil price reduces the price of non-traded goods, reduces real exchange rate and nominal exchange rate depreciation, falls stock prices, causes an imbalance in the current account, reallocation of the portfolio, reduction in foreign reserve, and stunted growth in GDP or otherwise. Investors usually become more uncertain about the outlook for corporate earnings during periods of high oil prices, which, in turn, may result in higher equity risk, putting downward pressure on stock prices and rises exchange rate.

Theoretically, oil prices can affect stock prices directly by impacting future cash flows or indirectly through an impact on the interest rate used to discount the future cash flows (Basher et al., 2012). Likewise, in the absence of factors of production substitution, increasing oil prices rises the cost of doing business and reduces the profits of non-oil companies. This is passed on to consumers in terms of higher prices which reduces demand for final goods and services, thus reduce profits. On the other hand, the policy-makers see rising oil prices as inflationary and the central banks respond to its pressures by raising interest rates which affect the discount rate used in the stock pricing formula.

A considerable piece of literature has emerged examining the connections between oil price, exchange rate, and stock price. The empirical studies of (Kelikume and Muritala, 2019; Umaid

et al., 2020), established that positive oil price shocks tend to decrease exchange rates and stock prices in an emerging market. Other studies like (Chang et al., 2013; Hussain et al., 2017), prove that crude oil prices and the exchange rate have a long-run equilibrium relationship and its fluctuation will result in change in the exchange rate. Similarly, Degiannakis et al. (2017) suggest that the response of the stock market towards change in oil price depends upon factors such as a change in oil price, emerging economy, oil-exporting, oil-importing, developed economy, etc. Also, Sathyanarayana and Gargsha (2018); Singhala et al. (2019); Kumar (2019), observed that oil price fluctuation influences shock in the stock market significantly. Therefore, the majority of global economies depends on crude, so, its prices are expected to affect the various fundamental of an economy, especially the exchange rate and stock market.

The interrelation and interaction between the commodity markets (oil price), exchange rate, and the stock market are very important in Nigeria. This is because Nigeria is a major exporter of oil as well as a major importer of petroleum products. Likewise, the world's tenth producer and largest reserve of global oil as well as the exporter. Since the discovering of oil in 1958, it has been the highest and major source of revenue accounting for about 90% of total export and not less than 70% of total revenue, more so the most contributors of gross domestic product in Nigeria (Madugba et al., 2016), making fluctuation of oil prices a significant influence on the country's exchange rate and the stock market. The oil price is taken as a paramount indicator of the exchange rate movements in Nigeria because both exportation and importation of oil transactions are carried out largely in US Dollars (\$) hence greater oil demand results in depreciation of the Nigeria currency, Naira (₦). For example, according to the World Bank indicator (2020); National Bureau of Statistics (2019), in 1985, Nigeria's oil price was valued at \$27 billion at an exchange rate of ₦0.89 to a dollar, and the stock price was traded at ₦117.28 billion. With the little slash down in the price of oil from \$16.33 billion in 1993 to \$15.53 billion in 1994, the Naira appreciated by ₦0.16 over the US dollar, from ₦22.05 to ₦21.89 and stock price floor positively from ₦42.37 billion to ₦52.64 billion respectively. However, from 2016 to 2019, Nigeria's oil price fluctuates between an average of \$65 billion with an average exchange rate of ₦306 to ₦360. However, a lower-valued currency makes imports more expensive and export cheaper in the international market leading to more capital inflow, increase export demand, high GDP growth, etc.

Nigeria plays a significant role in the global oil market and has the largest economy in the Africa sub-region. However, due to the current economic situation finds herself with a mono-cultured economy, over-dependence on oil, a depleting reserve of foreign currency, unguarded public domain information, a volatile macroeconomic environment that makes stock market planning or decisions difficult, and bewitched exchange rate difficulty. So for these, it becomes imperative to study the link between oil price, exchange rate, and stock price, to know the appropriate policy option to apply at different phases of oil price fluctuation to reduce its eminent effect on the economy as well to improve investors portfolio selection decision making and help policymakers in analyzing the transmissions

channel between the variables, hence aid sound and better policy formulation. It was also noticed that previous studies in Nigeria only attempt to investigate the relationship between oil price and exchange rate on stock price (Lawal et al., 2016; Abraham, 2016) and oil price and exchange rate (Ogundipea et al., 2014). Therefore, this study is the first to examine the asymmetric effect of oil price on the exchange rate and stock price in Nigeria. Our results demonstrate that there are long-run and short-run asymmetric impacts of oil price on the exchange rate and stock price in Nigeria.

The fundamental question is does oil price volatility asymmetrical exert on the exchange rate and stock price in Nigeria? This is the issue that this paper wants to address. This study aims to analyze the asymmetric effect of oil prices on exchange rates and stocks in Nigeria. The study's contributions to the knowledge are thus: First to empirically investigate the effect of oil price on the exchange rate and stock price in Nigeria. Secondly, the study applied an asymmetric model to determine both the positive and negative effects of oil price fluctuation on the exchange rate and stock price. Thirdly, the study makes use of time series data spanning from 1996 to 2020 which provides robust findings. Fourthly, the study evaluates the model using nonlinear autoregressive distributive lag methods (NARDL). Fifth, this study contributes to the controversy and debate on the global effect of oil price on the exchange rate and stock price which would assist the monetary policy regulators to have a clear understanding of the possible relationships between these variables to model dynamic export-import and exchange rate policies that will suit and promote economic growth and development. Sixth, it also provides bases that widen the understanding of policymakers, capital market investors, government, and managers in risk management of portfolio diversification and how to manage inflation in volatile oil prices.

2. LITERATURE REVIEW

Oil is the most significant input that countries use in their production process. For this reason, changes in its price affect economic growth, which is the most important macroeconomic performance indicator. According to Hamilton (2003), an oil price shock is a net oil price increase, which is the log change in the nominal price of oil relative to its past 3 years high if positive, or zero otherwise. The few accessible works of literature that contributed to the ongoing impact of oil price on the exchange rate and stock prices, includes Basher et al. (2012), they employed the structural vector autoregression and found that positive shocks to oil prices tend to depress emerging market stock prices and US dollar exchange rates in the short run. Shadab and Gholami (2014) employed the vector autoregressive (VAR) technique and discovered that in the long-run and short-run oil shocks and the exchange rate has no significant effect on stock price except exchange. Similarly, Lawal et al. (2016) studied the impact of oil price shocks and exchange rate volatility on stock market behavior in Nigeria using EGARCH estimation analytical and that oil price and exchange rate induced stock price. Mongi and Aymen (2017), found an inverse relationship between oil and stock prices, and positively with the dollar exchange rate.

Furthermore, Sathyanarayana and Gargsha (2018) found that the exchange rate and Crude prices significantly transmit shock on Sensex and Nifty50. Singhala et al. (2019) employed the autoregressive distributive lag (ARDL) estimation technique and the findings suggest that oil prices negatively affect the stock price and exchange rate in the long run. The contrary view was the findings of Kumar et al. (2019) using VAR and obtains that none of the variables (oil, exchange rate, and stock prices) influence each other. Nurmakhanova and Katenova (2019) findings demonstrated that stock prices and exchange rate are affected by oil price in Kazakhstan using the Granger causality test. Kumar (2019), who confirmed an asymmetric impact of oil prices on exchange rates and stock prices and a bidirectional relation between oil and exchange rate, and between oil and stock price. Similarly, Umaid et al. (2020) found the asymmetric relationship between oil prices, exchange rate, and stock prices in Pakistan.

3. METHODOLOGY

From different and reliable sources, monthly data that span the period of January 1996 to September 2020 were obtained on the three variables of interest in this study. The data on the Oil price is obtained from the World Bank data catalog, and it is the average spot price of Brent, Dubai, and West Texas Intermediate which is equally weighed, and measured in dollar per barrel. However, the data on Real Effective Exchange Rate (REER) and Stock Prices (All Share Index) are obtained from the CBN online data catalog.

This study adopts the model of Kumar (2019) which examined the Asymmetric impact of oil prices on the exchange rate and stock price in India. The ARDL model which was extended into a non-linear version state;

$$\Delta Y_t = \alpha_t + \alpha_1 Y_{t-1} + \alpha_2 X_{t-1} + \sum_{i=1}^k \beta_i \Delta Y_{t-i} + \sum_{j=1}^l \theta_j \Delta X_{t-j} + \varepsilon_t \quad (1)$$

Where, Y_t is the logarithm of the target variables; exchange rate and stock prices, and X_t the logarithm of the policy variable; Oil prices. The long-run coefficients are represented by α_1 and α_2 , while β_1 and θ_1 represent the short-run coefficients of the policy variable. Also, the optimal lags as suggested by the AIC and SIC are represented by k and l .

However, in this study, a similar model is employed to explore the asymmetric impact of Oil prices on the exchange rate and stock prices in Nigeria. Therefore, since the Nonlinear ARDL model is an extension of the autoregressive distributed lag (ARDL) model, it is necessary to state the ARDL model before proceeding to show the asymmetric and nonlinear version, as such, the ARDL model for this study is specified as follow;

$$\Delta Y_t = \delta_t + \delta_1 Y_{t-1} + \delta_2 X_{t-1} + \sum_{i=1}^p \gamma_i \Delta Y_{t-i} + \sum_{j=1}^q \vartheta_j \Delta X_{t-j} + \varepsilon_t \quad (2)$$

Where, Y_t is the logarithm of the endogenous variables i.e. exchange rate and stock prices, and X_t is the logarithm of the exogenous variable i.e. Oil prices. The long-run coefficients are represented

by δ_1 and δ_2 , while γ_i and ϑ_i represent the short-run coefficients of the exogenous variables. Also, the optimal lags obtained following the AIC and SIC criteria are represented by p and q .

In this study, we employed the Diks and Pancheko (2006) Nonlinear Granger Causality test to examine if the lagged value of a variable is significant in explaining the present value of another variable. Given two stationary time series say X_t and Y_t , the scalar form of which can be stated as $\{X_t, Y_t, t \geq 1\}^2$. If the variable X 's previous and contemporaneous values are statistically significant in predicting the future values of variable Y , then the former Granger causes the latter. In line with this, let's assume $F_{X,t}$ and $F_{Y,t}$ represent the set of past observations of variables X_t and Y_t for time (t), such that \sim implies equivalence in the distribution. Therefore, $\{X_t\}$ Granger causes $\{Y_t\}$ if $k \geq 1$:

$$(Y_{t+1}, \dots, Y_{t+k}) | (F_{X,t}, F_{Y,t}) \sim (Y_{t+1}, \dots, Y_{t+k}) | F_{X,t} \quad (3)$$

However, presenting the nonlinear nonparametric Granger causality test of Diks and Panchenko (2006) requires the introduction of delay vectors which can be stated as;

$$X_t^{l_x} = (X_{t-l_x+1}, \dots, X_t) \text{ and } Y_t^{l_y} = (Y_{t-l_y+1}, \dots, Y_t), (l_x, l_y \geq 1)$$

. Therefore, the Granger causality test verifies that the previous observations of $X_t^{l_x}$ do not have predictive power about Y_{t+1} as follows:

$$H_0 : Y_{t+1} | (X_t^{l_x}; Y_t^{l_y}) \sim Y_{t+1} | Y_t^{l_y} \quad (4)$$

As such, in a model with two stationary variables, the hypothesis in equation (4) depicts the invariant distribution of $(X_t^{l_x}, Y_t^{l_y}, Z_t)$, such that $Z_t = Y_{t+1}$. Also, the conditional distribution of Z given variable $(X, Y) = (x, y)$ is the same as that of Z given $Y = y$, under the condition that $l_x = l_y = 1$ while neglecting the time index. Furthermore, the hypothesis stated in equation (4) can be represented in its ratio term of joint probability density function (JPDF) as;

$$\frac{f_{X,Y,Z}(x, y, z)}{f_Y(y)} = \frac{f_{X,Y}(x, y)}{f_Y(y)} \cdot \frac{f_{Y,Z}(y, z)}{f_Y(y)} \quad (5)$$

They prove that equation (5) implies:

$$q_g = E\left[\left(\frac{f_{X,Y,Z}(X, Y, Z)}{f_Y(Y)} - \frac{f_{X,Y}(X, Y)}{f_Y(Y)}\right) \cdot \frac{f_{Y,Z}(Y, Z)}{f_Y(Y)} g(X, Y, Z)\right] = 0, \quad (6)$$

Such that $g(X, Y, Z)$ depicts a positive weight function. Where the weight function $g(x, y, z) = f_Y^2(y)$ and this function is reduced to;

$$q_g = E[f_{X,Y,Z}(X, Y, Z) f_Y(Y) - f_{X,Y}(X, Y) f_{Y,Z}(Y, Z)] = 0$$

Now, let a local density estimator of a d_w -variate random vector W at W_i be denoted by $\hat{f}_w(W_i)$. Therefore, the local density estimator is presented as;

$$\hat{f}_w(W_i) = (2\varepsilon_n)^{-d_w} (n-1)^{-1} \sum_{j,j \neq i} I_{ij}^w, \quad (7)$$

Such that

$I_{ij}^w = I(\|W_i - W_j\| < \varepsilon_n)$, $I(\cdot)$ indicates function ε_n and denotes the bandwidth.

Sequel to the above, the test statistic for the non-linear Granger causality test is given as:

$$T_n(\varepsilon_n) = n - \frac{1}{n(n-2)} \cdot \sum_i \hat{f}_{X,Z,Y}(X_i, Z_i, Y_i) \hat{f}_Y(Y_i) - \hat{f}_{X,Y}(X_i, Z_i) \hat{f}_{Y,Z}(Y_i, Z_i) \quad (8)$$

Then, under the condition that $l_X = l_Y = 1$ and $\varepsilon_n = Cn^{-\beta}$ ($C > 0, \frac{1}{4} < \beta < \frac{1}{3}$), the test statistic is distribution is said to be;

$$\sqrt{n} \frac{(T_n(\varepsilon_n) - q)}{S_n} \sim N(0,1) \quad (9)$$

Where S_n depicts the estimator of the asymptotic variance of $T(\cdot)$ and \rightarrow denotes the convergence in the distribution (Diks and Panchenko, 2006).

3.1. Nonlinear Autoregressive Distributed Lag (NARDL) Model

In furtherance to equation (2) and its explanation, the NARDL is an asymmetric extension of ARDL, and as such, it is possible to build an asymmetric cointegration model using the positive and negative partial sum decompositions to explore the asymmetric effects in the short run and long run. As stated by Shin et al. (2014), the nonlinear cointegrating regression model is shown as;

$$Y_t = \delta^+ X_t^+ + \delta^- X_t^- + \varpi_t \quad (10)$$

Such that, δ^+ and δ^- represents the associated long-run parameters and X_t is a $k \times 1$ vector of regressors, and it is decomposed as follows;

$$X_t = X_0 + X_t^+ + X_t^- \quad (11)$$

Such that, X_t^+ and X_t^- denote the partial sums of positive and negative changes in X_t as;

$$X_t^+ = \sum_{i=1}^t \Delta X_i^+ = \sum_{i=1}^t \max(\Delta X_i, 0) \quad (12)$$

$$X_t^- = \sum_{i=1}^t \Delta X_i^- = \sum_{i=1}^t \min(\Delta X_i, 0) \quad (13)$$

In line with Shin et al. (2014), equations (11) and (13) reveals that the linear ARDL model in equation (2) can be modified to show the following nonlinear ARDL model:

$$\Delta \frac{1}{2} s Y_t = \delta_0 + \delta_1 Y_{t-1} + \delta_2^+ X_{t-1}^+ + \delta_2^- X_{t-1}^- + \sum_{i=1}^p \gamma_i'' Y_{t-i} + \sum_{j=0}^q \vartheta_j^+ \Delta X_{t-1}^+ + \vartheta_j^- \Delta X_{t-1}^- + \varepsilon_t \quad (14)$$

Such that; ε_t is the error term and Δ is the first difference operator, $\vartheta_j^+ = -\varphi \omega_j^+$ and $\vartheta_j^- = -\varphi \omega_j^-$.

In the NARDL framework, the short-run ($\vartheta_j^+ = \vartheta_j^-$) and long-run ($\delta_1 = \delta_2^+ = \delta_2^-$) asymmetries are examined using the standard Wald test, unlike in the ARDL framework in which the long-run cointegration between the variables is examined by testing the null hypothesis of no cointegration i.e. $\delta_1 = \delta_2^+ = \delta_2^-$. However, the asymmetric cumulative dynamic multiplier effect of a unit change in the decomposed version of the variable X_t i.e. X_t^+ and X_t^- on the target variable Y_t is examined as;

$$Z_t^+ = \frac{\sum_{i=0}^{\tau} \beta Y_{t-i}}{\beta X_t^+}, Z_t^- = \frac{\sum_{i=0}^{\tau} \beta Y_{t-i}}{\beta X_t^-}, h = 0, 1, 2 \quad (15)$$

Such that $\tau \rightarrow \infty$, $Z_t^+ = \delta^+$ and $Z_t^- = \delta^-$. However, it is worthy of note that δ^+ and δ^- are the asymmetric related long-run parameters which can be measured as $\frac{\alpha_2^+}{\alpha_1}$ and $\frac{\alpha_2^-}{\alpha_1}$ respectively.

4. RESULTS AND DISCUSSION

Figure 1 shows the monthly price movements of the stock price, oil price, and exchange rate from January 1996 to September 2020. Figure 1 reveals that there is a steep fall in the price of oil in the year 2008 whereas the exchange rate shows a sudden trend reversal. Likewise, in 2015 down till 2016, while there was a downfall in oil prices, the exchange rate rises sharply. Stock prices in Nigeria follow an upward trend continuously except for a small downward movement during the 2016 recession. There is no doubt that the pattern of the movement of these variables indicates their volatile nature. Also, it can be deduced that the variables possess stochastic trends, and the unit root test is conducted to check for this.

Table 1 above establishes the descriptive statistics for the stock price, exchange rate, and oil price respectively. The second column shows the means values for the variables and is all positive. The third column shows the coefficient of variation which shows the relative dispersion of the variables. It can be deduced from the coefficient of variation that the exchange rate has little variation than the others; whereas oil price has many variations than the other variables. The financial implication of this result is that the exchange rate is less volatile than the other prices as suggested by the coefficient of variation (0.42 is less than 0.56 and 0.55). The oil price is shown to be highly volatile than the others. The Jarque-Bera probability values in the fourth column are significant except for the exchange rate and this signifies that only the exchange rate follows a normal distribution. The Min-Max reveals that the values of each variable are everywhere positive.

Table 2 presents the pairwise correlation between stock price, exchange rate, and oil price. The oil price is decomposed to shows show the positive and negative cumulative sums. It can be deduced that there is a significant positive correlation between the variables, except the correlations with the oil price negative cumulative sum.

Table 3 above shows the ADF and the PP unit root test results for the stock price, exchange rate, and oil price (and the positive and

Table 1: Data statistical properties

Variables	n	Mean	C.O.V	J-B	Min	Max
Stock	297	23855.09	0.55	10.10***	4890.80	65652.38
Exchange rate	297	85.99	0.42	0.99	17.27	162.81
Oil price	297	54.84	0.56	20.49***	10.41	132.83

Source: Authors computation (2020). ***P<0.01; **P<0.05; *P<0.1

Table 2: Data pair-wise correlations

Variables					
Stock price	1.000				
Exchange rate	0.54***	1.000			
Oil price	0.73***	0.33***	1.000		
Oil price(+)	0.61***	0.24***	0.59***	1.00	
Oil price(-)	-0.53***	-0.20***	-0.45***	-0.99***	1.00

Source: Authors computation (2020). ***P<0.01; **P<0.05; *P<0.1

Table 3: Unit root test result

Variable	ADF			Phillips-Perron		Critical values			Remark
	Level	First diff.	Remark	Level	First diff.	1%	5%	10%	
Stock	-2.75	-6.87***	I (1)	-2.28	-15.89***	-3.99	-3.43	-3.14	I (1)
Exchange rate	-1.78	-15.85***	I (1)	-1.83	-15.80***	-3.99	-3.43	-3.14	I (1)
Oil price	-2.08	12.74***	I (1)	-1.68	-12.24	-3.99	-3.43	-3.14	I (1)
Oil price(+)	-2.52	-13.27***	I (1)	-2.47	-13.35***	-3.99	-3.43	-3.14	I (1)
Oil price(-)	-1.93	-9.60***	I (1)	-1.74	-9.06***	-3.99	-3.43	-3.14	I (1)

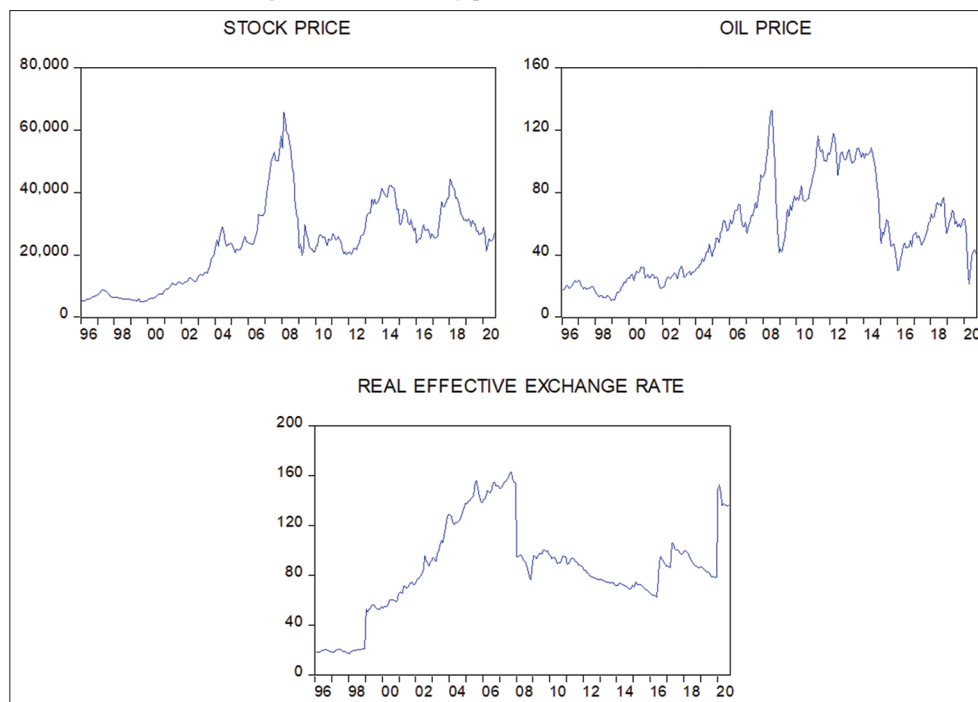
Source: Authors computation (2020). ***P<0.01; **P<0.05; *P<0.1

negative cumulative sums) respectively. We can see from the table that all the variables are integrated of order one and the statistical implication of this is that estimation using the variables in level will not follow the standard distribution, and the issue of spuriousity is feasible. A Johansen multivariate cointegration test is first adopted to test for cointegration among the stock price, exchange rate, and oil price to circumvent the problem of spuriousity and bias in the causality test.

Table 4 above shows the result for the cointegration test. It can be seen that the null hypothesis of no cointegration is rejected at 5% level for the trace test and 10% for the max Eigen statistics. A VEC model is estimated with one lag and assuming that one cointegrated vector binds stock price, exchange rate, and oil price with the stock price as the normalized variable. The block-exogeneity granger causality is thus conducted and the result is presented in Table 5.

The first block of results in Table 5 revealed that oil price and real effective exchange rate granger cause the stock price. The second block shows that the stock price and oil price failed to granger cause real effective exchange rate. The stock price and the real effective exchange rate is shown to granger cause oil price. However, the result presented in Table 5 assumes the relationship between the variables to be linear. Therefore, a nonlinear test is

Figure 1: The monthly price movement of variables



Source: Authors computation (2020)

performed on the residuals from the VEC model and the BDS test is employed to carry out the test. Table 6 shows that the null hypothesis that there exist linear dependencies in these variables is rejected at a 1% level of significance.

The results in Table 6 confirmed the existence of nonlinearity in the variables and a non-linear Granger causality test between the variables using the Dicks and Panchenko non-parametric technique and the result is presented in Table 7. The result is markedly different from the result of the linear Granger causality test in Table 5. The result in Table 7 shows that a unidirectional nonlinear causality exists from exchange rate to stock price at a 10% level. Also, there exist a unidirectional nonlinear causality from oil price to exchange rate at 1% and 10% levels respectively.

Table 8 shows the short and long runs asymmetric impacts of oil price on the exchange rate and stock price. The superscript “+” and “-” show the positive and negative cumulative sums, respectively. The estimated long-run coefficients associated with positive and negative changes in the oil prices are expressed in the lagged level, while the estimated short-run coefficients associated with positive and negative changes in the oil prices are expressed in the lagged changes. W_{LR} and W_{SR} stand for the Wald test for long-run symmetry and additive short-run symmetry respectively.

Table 4: Maximum-likelihood Johansen cointegration tests

Cointegration order	Trace Statistic	CV at 5%	Max Eigen Stat.	CV at 5%
None	39.05	35.19**	21.14	22.30*
At most 1	17.911	20.26	11.58	15.90
At most 2	6.33	9.16	6.33	9.16

Source: Authors computation (2020). ***P<0.01; **P<0.05; *P<0.1

Table 5: Results of linear VECM based Granger causality test

Dependent variable	Excluded variable (s)	Chi-sq.	df	Prob.
ΔSP_t	ΔOP_t	3.192	1	0.074*
	ΔER_t	6.960	1	0.008***
	$\Delta OP_t + \Delta ER_t$	9.733	2	0.001***
ΔER_t	ΔSP_t	0.267	1	0.605
	ΔOP_t	1.522	1	0.217
	$\Delta SP_t + \Delta OP_t$	1.601	2	0.450
ΔOP_t	ΔSP_t	8.663	1	0.003***
	ΔER_t	4.359	1	0.037**
	$\Delta SP_t + \Delta ER_t$	12.568	2	0.002***

Source: Authors computation (2020). ***P<0.01; **P<0.05; *P<0.1

Table 6: Results of BDS statistics from VECM residuals

Dimension	BDS statistics		
	Stock price (SP)	REER (ER)	Oil price (OP)
2	0.013***	0.018***	0.022***
3	0.021***	0.033***	0.032***
4	0.025***	0.043***	0.035***
5	0.021**	0.045***	0.031***
6	0.018*	0.043***	0.027***

Source: Authors computation (2020). ***P<0.01; **P<0.05; *P<0.1

The result of the Bound tests for the two models shows that there is evidence of asymmetric cointegration between exchange rate and oil price, and exchange rate and stock price respectively.

Looking first at the exchange rate equation, it can be seen that both positive and negative oil price movements impacted negatively on the exchange rate both in the short-run and long-run. However, only the positive price movement is significant. It can be deduced that oil price inflation is shown to bring about an appreciation (Dollar falls against Naira) of the exchange rate both in the short-run and long-run. This finding supported the empirical results of (Delgado et al., 2018; Nurmakhanova and Katenova, 2019), that oil price negatively affected the exchange rate but was the discovery of (Ogundipea et al., 2014). The error correction term is correctly signed, and it shows that about 8% of disequilibrium in the exchange rate due to 1-time temporary shock is corrected within a month. There is significant evidence of long-run and short-run asymmetric impacts of oil price on the exchange rate as the t-stat for the computed statistics (-1.08 and -0.08) are significant at 1%.

On the other hand, it can be seen that both positive and negative oil price movements impacted positively on the stock price both in the short-run and long-run. However, only the negative price movement is significant. It can be deduced that oil price deflation is shown to bring about stock price inflation both in the short-run and long-run. Kelikume and Muritala (2019), obtains a similar result that oil price hurts stock markets while a contrary view was reported by Basher et al. (2012). The error correction term is correctly signed, and it shows that about 6% of disequilibrium in the stock price due to a 1-time temporary shock is corrected within a year. There is significant evidence of long-run and short-run

Table 7: Nonlinear Granger causality between crude oil, exchange rate and stock price

Lag	SP→OP	OP→SP	SP→ER	ER→SP	OP→ER	ER→OP
k=q	t-stat.	t-stat.	t-stat.	t-stat.	t-stat.	t-stat.
1	-0.358	0.027	-0.463	1.403*	2.654***	-1.324
2	-1.345	0.008	-1.978	0.044	1.515*	-0.106
3	0.140	-0.582	-1.575	-0.985	0.301	1.109
4	-1.009	-0.598	-1.356	-1.287	0.899	0.924
5	-0.590	-0.673	-0.305	-0.270	1.733	0.331

Source: Authors computation (2020). ***P<0.01; **P<0.05; *P<0.1

Table 8: NARDL results for the asymmetric impact of crude oil on the exchange rate and stock prices

Variable	Dependent Variable ΔER_t		Dependent Variable ΔSP_t	
	Coeff.	t-stat.	Coeff.	t-stat.
OP_{t-1}^+	-1.21	-6.40***	21.90	0.25
OP_{t-1}^-	-0.13	-0.83	222.62	3.30***
ΔOP_{t-1}^+	-0.10	-3.03**	1.40	0.80
ΔOP_{t-1}^-	-0.01	-0.84	14.20	2.53**
Const.	-0.35	-0.46	-248.87	-1.06
Trend	0.18	4.17***	28.27	4.17***
Ecm_{t-1}	-0.08	-4.22***	-0.06	-4.40***
Bound (F-stat)	6.41	5.22*	5.91	5.22*
W_{LR}	-1.08	-6.52***	-200.72	-3.30***
W_{SR}	-0.08	-2.89***	-12.81	-2.99***

Source: Authors computation (2020). ***P<0.01; **P<0.05; *P<0.1

asymmetric impacts of oil price on the stock price as the t-stat for the computed statistics -200.72 and -12.81) are significant at 1%.

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study empirically investigates the impact of oil prices on the exchange rate and stock prices in Nigeria. Monthly data spanning from January 1996 to September 2020 has been used in the regression analysis. The multivariate cointegration test showed evidence of a long-run relationship among the stock price, exchange rate, and oil price. The linear Granger causality test showed that stock price is granger caused by oil price and exchange rate, and oil price is granger cause by stock price and exchange rate. However, there is no evidence of causality running towards the exchange rate. The nonlinear granger causality is used on the other hand for robustness checking after the residuals from the VEC model showed evidence of nonlinearity using the BDS test. The Dick-Panchenko non-parametric and nonlinear Granger causality test in a contrary to the linear Granger causality test showed a unidirectional nonlinear causality from exchange rate to stock price at 10% level, and from oil price to exchange rate at 1% and 10% levels respectively. The result from the nonlinear ARDL revealed that change in oil price impacted asymmetrically on the exchange rate and stock price both in the short-run and long-run. The results show that oil price inflation brings about an appreciation (Dollar falls against Naira) of the exchange rate both in the short-run and long-run whereas oil price deflation is shown to bring about stock price inflation both in the short-run and long-run.

The following policy recommendations are given based on the findings of this study;

Appreciation in Naira against the dollar means increase exports hence more revenue, cheaper imports, lower inflation and interest, favorable terms of trade, etc. Therefore, the government is advised to use the revenue generated from increasing oil prices for developing and reinstalling decayed infrastructure.

Nigeria being an oil-exporting country should develop mechanisms and strategies that will ensure fair stability in the capital markets irrespective of the shocks in oil price. Since oil price deflation was found to have an inflationary effect on the stock price.

The monetary authorities in Nigeria should consider financial market implications in attaining the exchange rate policy objective.

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