Oil price Volatility and Exchange rate Dynamics in Nigeria: A Markov Switching Approach

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ABSTRACT

The paper examines the spillover effect of crude oil price shocks to exchange rate movement of appreciation and depreciation in Nigeria using monthly data ranging from January 2004- June 2019. The study employed a two stage heteroskedastic Markov switching model. Results from preliminary investigations reveal that both Crude oil prices and exchange rate series are characterized with non- normal distribution, presence of unit root and ARCH effects. Also the BDS, Bai-Perron and Cusum Q tests are conducted to figure out the nonlinearities and structural breaks in the data. The result obtained from the estimated model indicated a positive relationship between oil prices and exchange rate in regime 1(depreciation regime) and negative relationship in regime 2 (appreciation regime). Further analysis reveals that low volatility appreciation regime is more persistent than high volatility deprecation regime with transitional probabilities 0.97 and 0.39 respectively. Consistently the expected duration of stay reveals that duration of stay in the appreciation regime is higher than in the depreciation regime at 35.92 months and 1.6 months respectively. Further, analysis of volatility spillover between oil prices and exchange rate reveals that a rise in oil prices leads to appreciation of the Naira and conversely negative shock in oil prices cause a consequent deprecation of the local currency. Certainly the findings are shall be of utmost relevance to monetary authorities.

Keywords*:* Markov switching model, exchange rate, appreciation, deprecation, volatility

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1.0 INTRODUCTION

Several investigations were undertaken by different scholars to capture and fathom the nature as well as volatility trend of both oil price and exchange rate, essentially because of the critical bearing of both variables to economic policies that guide and moderate the performance of the macroeconomic system over a period of time. Both variables possess the potency to either spur or inhibit economic growth and financial development in an economy. The macroeconomic impacts of oil price shocks became vividly apparent in the 1970s and 1980s which then influenced inflation rates, unemployment indices, stock market performance, exchange rate, aggravates balance of payment position and other economic activities in the country.

However during the 1970s and 1980s some economies were favored while others were adversely affected, reason why because both periods are otherwise termed as periods of Oil boom and Oil shook, at the 1970s oil market was booming, crude oil exporting economies sees it as a heaven came close i.e. periods of prosperity while oil importing countries sees it as periods of economic stagnation/turbulence, contrarily reverse was the case in the 1980s during the period of low oil prices where many oil exporting economies slumped into recession and subsequently stagflation.

Generally oil price hike affects both the supply and demand side of the economy, for the supply side an increase in oil price will lead to increase in input cost which will thereby raise the cost of production and ultimately affect the volume of output of production. The effectiveness or sensitivity of aggregate output to oil price hike depends on energy intensity in the production process while on the demand side increase in the oil price will affect the price level due to shortages in output produced at that particular period of time which subsequently breeds inflation. In order to counter rising inflation the central bank might hike interest rates. Also at micro level oil price hike affects individual consumers through tempering with their purchasing power where they might not be able secure same amount of goods and services as pre inflation period.

Relatively in Nigeria, Oil price's paramountcy cannot be overemphasized in determination of exchange rate movement and overall macroeconomic performance as it constitutes a significant portion of the country's foreign receipts and a larger volume in its export. However Oil price is stochastic and highly volatile in nature as its deviation high likely to affect exchange rates given the direction of change either increase or decrease.

For oil exporting countries like Nigeria higher oil price translates to higher foreign currency earnings and revenue through sales of crude oil thereby so as a result domestic currency appreciates and reverse is the case when oil prices falls in the global commodity market. However fortunes of high forex inflows realized through exportation of crude oil are substantially slashed away through importation of petroleum products (refined crude) which is made imperative due to incapability of our local refineries to meet local demand in the country.

(Mork, 1989) in his study on the role of oil price shocks on economic activity, finds oil price increases to affect economic growth negatively while a decline in oil price does not have the opposite effect. Where the coefficients on oil price increases turn out to be negative and highly significant, the coefficients on price declines tend to be positive, but small and not statistically significant.

Facts and figures suggested that Nigerian economy was fully plunged into recession due to sudden decline in crude oil prices, accumulated government deficits, depleting foreign reserves and couple of other factors which collectively slump the real growth rate to -0.36 and -2.06 percent in the first and second quarters of 2017 following a marginal real GDP growth of 0.55% (NBS, 2017). This was made possible through the implementation of Economic Recovery and Growth plan (ERGP) and the sustained supply of forex into the economy realized from improved crude oil prices. Jin (2008) posited that sharp increase in the international oil prices and violent fluctuation of the exchange rate are generally regarded as factors discouraging economic growth.

Oil prices, exchange rate and other volatile macroeconomic variables might possess nonlinearties in their dynamic patterns which might encompassed asymmetry, amplitude dependence and volatility clustering.

Due to the existence of the fact of presence of nonlinearities in the data thereby necessitated the evolution and development of nonlinear time series model to those inherent asymmetries. In the literature the most used nonlinear models are Nonlinear ARDL, Threshold regression, ARCH and GARCH and Markov switching models.

In the course of this paper the Markov switching model (MS) developed by (Hamilton, 1989)also known as the regime switching model is one of the most popular nonlinear time series models in the literature. Primarily the work of (Quandt, 1958) pioneered the modelling of time series variables for identifying regime shifts where he introduces the switching regression model. Subsequently Goldfeld and Quandt (1973,1976) extended the switching regression to allow regime shifts to follow Markov chain and later on the model was put into its present day version as Markov Switching model based on the work of Hamilton (1989 & 1990).

Initially the MS model focuses only on the conditional mean behavior of variables. The model and its variants have been widely applied to analyze economic and financial time series the likes of Hamilton (1988, 1989), Engel and Hamilton (1990) (Lam, 1990), Garcia and Perron (1996) and host of others. Subsequently due to the recorded success of MS model of Conditional mean, the consideration of incorporating conditional variance into the model surfaces. The leading model for the conditional variance model is the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) introduced by (Engle, 1982) and (Bollerslev, 1986).

Mechanically the model encompass multiple structures (equation) that characterize/describe a series behavior in different regimes, by warranting switching between the structures, the model is able to capture more complex dynamic patterns. A unique feature of the model is that switching mechanism is controlled by an observable state variable that follows a first order Markov chain. Practically the MS model coordinate the current value of the state variables to depend on its immediate past value. This feature distinguishes it with the random switching model of Quandt (1972) in which switching are independent of past values. Also the MS differs from the family of structural change models while the former allows for frequent changes at random time points, the latter admits only occasional and exogenous changes. Notably Rano and Wambai (2018) was the only study found relatively about Nigeria that employed the Markov Switching model in their analysis.

The rest of the paper is organized as follows: following the introduction, section two dwells on literature review and theoretical issues. Sections three outlines the data requirements and the econometric model employed by the paper. Section four conducts the empirical analysis and interpretation of results while section five presents the summary and conclusion.

2.0 THEORETICAL FRAMEWORK

Apparently there are numerous theories attributed to exchange rate determination the likes of the Mint parity theory, Purchasing power parity (PPP), Balance of payment theory (BOP), Monetary Approach, Portfolio Balance Approach , law of one price, Mundell-Fleming Models, Salter-Swan (Dependent-economy) Models, Three-Good Model and Edward's Theoretical Models. However in the cause of this research work we shall only concentrate on few amongst them.

2.0.1 The Purchasing power Parity (PPP)

This theory was developed by the school of Salamanca in the 16th century and was augmented into its modern form by Swedish Economist Gustav Cassel in 1918.

This theory states that the equilibrium rate of exchange is determined by the equality of the purchasing power between the currencies of two nations. It emphasized that the rate of exchange between two paper currencies is determined by the internal price levels in two countries. There are two versions of the purchasing power parity theory**:**

(i) The Absolute Version and

(ii) The Relative Version.

2.0.2 The Balance of payment Theory (B.O.P)

The balance of payments theory of exchange rate maintains that rate of exchange of the currency of one country with the other is determined by the factors which are independent of internal price level and money supply. It emphasized that the rate of exchange is influenced, in a significant way, by the balance of payments position of a country. The relative sizes of export and import conjointly determine exchange rate of between two currencies.

A deficit in the balance of payments of a country signifies a situation in which the aggregate demand for foreign goods exceeds the aggregate supply of domestic goods in the international market. In other words, the excess of demand for foreign exchange over the supply of foreign exchange is coincidental to the BOP deficit. The demand pressure results in an appreciation in the exchange value of foreign currency. As a consequence, the exchange rate of home currency to the foreign currency undergoes depreciation. Whilst A balance of payments surplus signifies an excess of aggregate supply of foreign goods over the aggregate demand for it. In such a situation, there is a depreciation of foreign currency but an appreciation of the currency of the home country.

They are number of approaches to correcting BOP disequilibrium in an economy the Marshal-Lerner’s elasticity approach and absorption approach.

2.0.3 The Portfolio Balance Approach

In view of the deficiencies in the monetary approach, some scholars have attempted to explain the determination of exchange rate through the portfolio balance approach which is more realistic monetary approach.

The portfolio balance approach brings trade explicitly into the analysis for determining the rate of exchange. It considers the domestic and foreign financial assets such as bonds to be imperfect substitutes. The essence of this approach is that the exchange rate is determined in the process of equilibrating or balancing the demand for and supply of financial assets out of which money is only one form of asset.

This approach postulates that an increase in the supply of money by the home country causes an immediate fall in the rate of interest, which consequently leads to fall in returns of domestic denominated assets as it leads to a shift in the asset

Portfolio from domestic bonds denominated in home currency to foreign bonds. The substitution of foreign bonds for domestic bonds results in an immediate depreciation of home currency. This depreciation, over time, causes an expansion in exports and reduction in imports. It leads to the appearance of a trade surplus and consequent appreciation of home currency, which offsets part of the original depreciation.

2.1 EMPIRICAL LITERATURE

Mendy and Tri (2018) investigated Indonesia rupiah per US dollar turning points using a regime switching model specifically the two Stage Markov switching model and the found in the transitional probabilities that the appreciation regime tends to be more persistence than depreciation regime. Also based on expected duration, the appreciation regime has an average duration 22.43 months while depreciation has only 5 months duration.

A study conducted by (Aliyu S. , 2009) using quarterly data from 1986-2007 in Nigeria via the Johansen VAR-based cointegration technique observed that oil price shock and appreciation in the level of exchange rate exert positive impact on real economic growth in Nigeria. The study further showed that Nigeria's GDP increases more by oil price increase than by exchange rate appreciation.

In another related study by Rano and Wambai (2018) analyzed exchange rate dynamics and stock market performance in Nigeria using daily data from 2010-2017 employed Markov Switching model. The empirical result in the transitional probabilities reveals that bear market is more persistent than bull market while in terms of duration of stay in the regime is higher in the bull market than in the bear market. Further analysis of volatility spillover between exchange rate and stock returns reveals that returns increases due to appreciation in the exchange rate in the bear market and diminishes in response to exchange rate depreciation in the bull market.

Similarly using quarterly data, (Mehmet Balcilar, Reneé van Eyden, Josine Uwilingiye and Rangan Gupta, 2015) in their study of the effect of oil price shock on GDP growth and by extension the business cycle in South Africa using a

Markov Switching model found a higher growth, low oil volatility regime to be more persistent than a low growth, high volatility regime.

Moreover, Balcilar, Gupta and Miller (2014) examined the relationship between US crude oil and stock market prices, using a Markov-Switching vector error-correction model and a monthly data set from 1859 to 2013. They found that the high-volatility regime more frequently exists prior to the Great Depression and after the 1973 oil price shock caused by the OPECs. The low-volatility regime occurs more frequently during the period of time from the end of the Great Depression to the first OPEC oil price shock, where the oil markets fell largely under the control of the major international oil companies.

Relatively, Walid and Nguyen (2014) use a regime-switching model approach to investigate the dynamic linkages between the exchange rates and stock market returns for the BRICS countries (Brazil, Russia, India, China and South Africa). Results of their analysis of a univariate model indicate that stock returns of the BRICS countries evolve according to a low volatility and a high volatility regimes and evidence from the Markov switching VAR models suggests that stock markets in the BRICS have more influence on exchange rates during both calm and turbulent periods.

(Kuan, 2002) In his study examined both the conditional mean and conditional variance of a two regime switching model using different data sets. In the analysis of conditional mean he employed a quarterly data of Taiwan's real GDP and employment whilst in analyzing conditional variance he adopted weekly data Taiwan's interest rates.

3.0 METHODOLOGY

This section discusses the methodology adopted in the paper. The researcher begins by taking the unit root tests on the series to ascertain their order of integration. Moreover, the test for the ARCH effects, Bai-Perron Test will also be conducted to test for structural break in the data and finally the BDS Test to determine the suitability of linear/nonlinear models based on the data will be carried out to avoid running into econometric misspecification of the model. However, after the estimation of the Bivariate Markov switching model with two regimes, statistical diagnostic tests, namely serial correlation and multicollinearity tests will be carried out to ascertain the statistical adequacy of the model.

3.1 Data and Sources

The data used for the purpose of this paper covers the period from January, 2004 to June, 2019 and this yields a total of 186 monthly observations on the Naira / Dollar exchange rate and crude oil price. The data was sourced from Central Bank of

Nigeria (CBN) and EIA (U.S Energy Information Administration) website. It is noteworthy that the series, namely; the crude oil prices and the exchange rate (Naira vis-à-vis dollar) were transformed into their respective returns / percentage changes by taking first differences and multiplying by 100.

3.2 Test of Nonlinearity

To test for a nonlinear effect of Crude oil price volatility on Nigeria's Naira (₦)| per US dollar ($) exchange rate, this paper used the nonparametric method known as the BDS test. The BDS test developed by Brock, Dechert and Scheinkman (1987) (Brock, 1987). To determine whether a nonlinear model is suitable for the data. According to (Brooks, 2008), the decision should come from the financial theory; nonlinear model should be used where financial theory suggests that the relationship between the variable requires a nonlinear model. Notwithstanding, linear vs. nonlinearity choice can be made partly on statistical grounds deciding whether a linear specification is sufficient to describe all of the most important features of the data at hand. Although there are quite some tests for detecting a nonlinear pattern in time series data for researchers. According to (Zivot and Wang, 2006) BDS is unarguably the most popular test for nonlinearity.

The econometric specification of the test can be expressed below as

$$BDS_{m.M}(r) = \sqrt{M}\ \frac{c_{m\,(r)} \ -C1^{r}\,(r)}{(\sigma_m \,.\, M^{(r)})} \text{ --------------------------------- (1)}$$

Where M is the surrounded points of the space with m dimension, r denotes the radius of the sphere centered on the,

Thus, the null and alternative hypothesis of the BDS test for detecting nonlinearity is as follows;

H_0: The series are linearly dependent

H_1: The series are not linearly dependent

3.3 Bai-Perron Test

This is a structural break test that peculiarly tests for multiple structural breaks. The model was developed by Bai and Perron in 1998,

Macroeconomic time series can contain more than one structural break. To that effect, they provide a comprehensive analysis of several issues in the context of multiple structural change models and develop some tests which preclude the presence of trending regressors.

Following Ben Arissa and Jouni, 2003 and Ben Aissa et. al., 2004, the model and test statistics of the Bai-Perron (BP) procedure are briefly discussed below. The BP) methodology considers the following multiple structural break model with m breaks (m+1 regimes). The econometric specification of the model is given below

$$\gamma_t = x_t{}' \beta + z_t{}'\delta_1 + u_t \ , t = 1, \ldots . T_1$$

$$\gamma_t = x_t{}' \beta + z_t{}'\delta_2 + u_t \ , t = T_1 + 1, \ldots , T_2 \quad \text{--------------------------- (2)}$$

$$\gamma_t = x_t{}' \beta + z_t{}'\delta_{m+1} + u_t \ , t = T_m + 1, \ldots . T$$

where yt is the observed dependent variable at time t; xt is px1 and zt is qx1, and β1 and δj (j=1,….., m+1) are the corresponding vectors of coefficients; and ut is the disturbance term at time t. the break points (T1, …., Tm) are treated as unknown, and are estimated together with the unknown coefficients when T observations are available. The purpose is to estimate the unknown regression coefficients and the break dates (β, δ1, δm+1, T1.,.Tm)when T observations on (yt, xt, zt) are available. The above multiple linear regression models can be expressed in matrix form as

$$\gamma_t = X\beta + Z\delta + U \quad \text{-- (3)}$$

This is a partial structural change model, in the sense that β does not change, and is effectively estimated over the entire sample. If β=0, this becomes a pure structural change model where all coefficients are subject to change.

Another test for detecting structural breaks is the CUSUM of squares test developed by Brown, Durbin and Evan (1975) based on a plot of the cumulative sum of the squared one-step-ahead forecast error resulting from recursive estimation between two critical lines. In which any movement outside the critical line is an indication that the parameter or variance is unstable.

In the course of this paper both statistical test shall be employed to determine possible structural breaks and their respective dates.

3.4 The Econometric Model

Following Mendy and Tri (2018) Aliyu and Wambai (2018) and Kuan (2002), The Markov switching (MS) model pioneered by Hamilton (1989). A Markov switching autoregressive (AR) model (MS-AR) of states with an AR process of order can be expresed as follows;

$$\gamma_t = \begin{cases} c_1 + \alpha_{11} \gamma_{t-1} + \cdots + \alpha_{p1} \, \gamma_{t-p} + \varepsilon_t & s_t = 1 \\ c_2 + \alpha_{12} \, \gamma_{t-1} + \cdots + \alpha_{p2} \, \gamma_{t-p} + \varepsilon_t & s_t = 1 \end{cases} \text{-------------} (1)$$

Where the regime in equation (1) are index by. In this model, the parameters of the autoregressive part and the intercept are dependent on the regime at time. The regimes are assumed to be discrete unobservable variable. Thus, in this study, regime one (1) describes the periods of downward trending of the exchange rate and regime two (2) denotes period of upward trending of the exchange rates. The transition between the regimes is assumed to follow an ergodic and irreducible a first order Markov process. This implies influences of all past observations for the variables and the state is fully encapsulated in the current observation of the state variables denoted below:

$$\rho ij = Pr(S_{t=} j / S_{t-1} = i) \qquad \forall i, j = 1, 2, \sum_i^2 = 1 \; \rho ij = 1 \text{-------------} (2)$$

The probability of switching is captured in the matrix P known as transition matrix

$$p = \begin{bmatrix} \mathbb{IP}(s_t = 0 \,|s_{t-1} = 0) & \mathbb{IP}(s_t = 1 \,|s_{t-1} = 0) \\ \mathbb{IP}(s_t = 0 \,|s_{t-1} = 1) & \mathbb{IP}(s_t = 1 \,|s_{t-1} = 1) \end{bmatrix}$$

$$p = \begin{bmatrix} \text{p11} & \text{p12} \\ \text{p21} & \text{p22} \end{bmatrix} \text{--} (3)$$

Where the P11+ P12 = 1 and P21 + P22 = 1 and in each case, the probability is non-negative.

3.5 Estimation

Conventionally, regime switching models are estimated via two approaches, namely by the Gibbs sampling technique and by maximum likelihood technique (Kuan, 2002). In this paper, the maximum ikelihood technique has been employed to estimate the model. Hence, following (Kuan, 2002), the quasi log likelihood function upon which the estimation is based is given as:

$$\lambda_{T\,(\theta)} = \frac{1}{T} \sum_{t=1}^{T} log \;\; f(Z_t | Z^{t-1} \;\; ; \theta) \text{------------------------------} \textbf{(4)}$$

and the full log likelihood function to be maximized is :

$$\lambda(\beta, \gamma, \sigma, \delta) = \sum_{i=1}^{T} \log \left\{ \sum_{m=1}^{M} \frac{1}{\sigma_m} \, \psi \, \left(\frac{y_t - \mu_{t(m)}}{\sigma(m)} \right) \cdot P\big(S_t = m | \xi_{t-1,\delta}\big) \right\} \text{-----} \textbf{(5)}$$

4.0 Empirical Result

Table 1- Descriptive Statistics of the Returns

Statistic	EXCHR	CRUDE_OIL_PRICE
Mean	180.3161	75.87366
Median	156.8300	72.16500
Maximum	309.7300	138.7400
Minimum	116.7900	30.66000
Std. Dev.	65.03016	27.07100
Skewness	1.210513	0.366001
Kurtosis	2.875507	1.981905
Jarque-Bera	45.54568	12.18567
Probability	0.000000	0.002259
Sum	33538.79	14112.50
Sum Sq. Dev.	782350.5	135575.2
Observations	186	186

Source: Authors' computation

The Table 1 above provides the descriptive statistics of the growth rate of exchange rate and the crude oil prices, it can be observed from table that both exchange rate and crude oil prices are positively skewed and consistently both variables have a platykurtic distribution. From Jacque-Bera statistic both variables are non-normal as indicated by their respective probability in which their null hypothesis are rejected. Furthermore, the standard deviations show that the volatility of the two series is considerably distinctive, though with exchange rate returns series being substantially more volatile than the crude oil prices, that is, the values are 65.03 and 27.07, respectively.

Table 2 reports the results of the unit root tests. It can be observed from the results that unit roots cannot be rejected in the levels of the two series. Hence, the two series, namely returns of crude oil prices and exchange rate. These two series have been found to be non-stationary at level but stationary at their first differences using both Augmented Dickey Fuller (ADF) and Phillips Perron test.

Table 2- Unit Root Tests

Variable	ADF		PP	
	With constant	constant & Trend	With constant	constant & Trend
Oil Price	9.547076	9.574449	9.629741	9.65531
Exchange Rate	6.231462	6.355119	6.902472	6.839747

Source: Authors' computation

To detect Heteroskedasticity of the data the ARCH-LM test was employed. The test for the ARCH-effects has been carried out on the returns. Ignoring ARCH effects, could lead to misspecification of the model. Presence of ARCH effects in time series is an important guide and a justification for analysis of volatility effects on the series. The autoregressive conditional heteroskedasticity Lagrange multiplier (ARCH-LM) test was carried out on the two returns series. Results presented on Table 3 indicate that the null hypothesis of homoskedasticity can be rejected and hence reveals evidence of ARCH effects. Probability of both F and Chi-squared statistics are less than the 5% threshold.

Table 3-ARCH-LM Test

F-statistic	11.75238	Prob. F(1,186)	0.0008
Obs*R-squared	11.08116	Prob. Chi-Square(1)	0.0009

Source: Authors' computation

Table 4- BDS Test- Nonlinearity Test

Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
2	0.036719	0.006931	5.297724	0.0000
3	0.062090	0.011070	5.608887	0.0000
4	0.078270	0.013250	5.907132	0.0000
5	0.090055	0.013883	6.486943	0.0000
6	0.093280	0.013459	6.930785	0.0000

Authors' computation

The BDS test results in Table 1 indicates that there is nonlinear effect of Crude oil price volatility on Nigeria's Naira (₦)| per US dollar ($) exchange rate. Table 4 shows that the probabilities are less than 5%, thus implying a rejection of the null hypothesis that the series is linearly dependent. This affirmed the eligibility and appropriateness of employing a nonlinear estimation model in the analysis.

Table 5- Regime Heteroskedasticity Markov Switching Results

Variable	Coefficient	Std. Error	z-Statistic	Prob.
		Regime 1		
Log Crude Oil Price	31.03309	3.643651	8.517031	0.0000
μ_1	4.579748	14.32698	0.319659	0.7492
$Log\sigma_1$	3.484893	0.273572	12.73851	0.0000
		Regime 2		
Log Crude Oil Price	-1.551989	1.153296	-1.345700	0.1784
μ_1	143.1057	4.166474	34.34697	0.0000
$Log\sigma_2$	0.208283	0.055992	3.719859	0.0002
		Common		
AR(1)	1.000278	0.001220	820.1026	0.0000
		Transition Matrix Parameters `		
P11-C	-0.275638	0.784415	-0.351393	0.7253
P21-C	-3.760757	0.525591	-7.155297	0.0000

Authors' computationTable

6- Transitional Probabilities

Transitional Probabilities		1	2
All periods	1	0.391955	0.608045
	2	0.027832	0.972168

Authors' computation

Table 7- Expected Duration

Constant expected durations:		
	1	2
All periods	1.644614	35.92928

Authors' computation

From table 5 above which presents the result of the Heteroskedasticity Markov Switching model estimated, the regime dependent intercepts for appreciation regime and depreciation regime are positive. As such, it is hard to make economic interpretation using the regime dependent intercepts. From regime 1(depreciation regime) a change in oil price leads to depreciation of naira per USD exchange rate this implies a positive and statistically significant relationship, contrarily a negative and statistically insignificant relationship was found in regime 2 (appreciation regime) where a change in oil price leads to an appreciation of the naira. The log standard deviation are both significant, 3.50 and 0.21 for regime 1 and 2 respectively. The values further reinforce the existence of high volatility (regime 1) and the low volatility regime (regime 2).

Sequentially in table 6 where transitional probabilities are presented, it indicated that appreciation regime is more persistent than depreciation regime. When in depreciation regime Exchange rate switches to appreciation regime at a 60% speed while during appreciation regime exchange switches to depreciation regime at 27%.

Consistently table 7 reports the duration of stay across the two regimes, the duration of stay in the appreciation regime is higher than in the depreciation regime at 36 months and 1.6 months, respectively.

Table 8-Multicollinearity Test

Variable	Coefficient	UNCentered VIF	Centered VIF
Regime 1			
Log Crude Oil Price	5.634502	288.2788	1.313398
μ_1	87.04387	272.9696	NA
$Log\sigma_1$			
Regime 2			
Log Crude Oil Price	1.415178	86.71597	12.52503
μ_1	18.28080	69.45069	12.14993
$Log\sigma_2$	0.004371	1.113214	1.112534
Common			
AR(1)	1.41E-06	1.023112	1.008881
Transition Matrix Parameters			
P11-C	0.582701	1.017791	1.017791
P21-C	0.263009	1.078555	1.078324

Authors' computation

From table 8 above it can be observed that adding the autoregressive term AR (1) alternatively used as non-switching regressors to check for serial correlation in the residuals. Furthermore it did not violate the model's orthogonality property as presented in the Table where all the values of the variance inflation factor (VIF), both centered and uncentered, reveal that the regressors are non-multicollinear.

Table 9- Bai-Perron Test

Sequential F-statistic determined breaks:			3
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	761.9838	1523.968	11.47
1 vs. 2 *	330.3128	660.6255	12.95

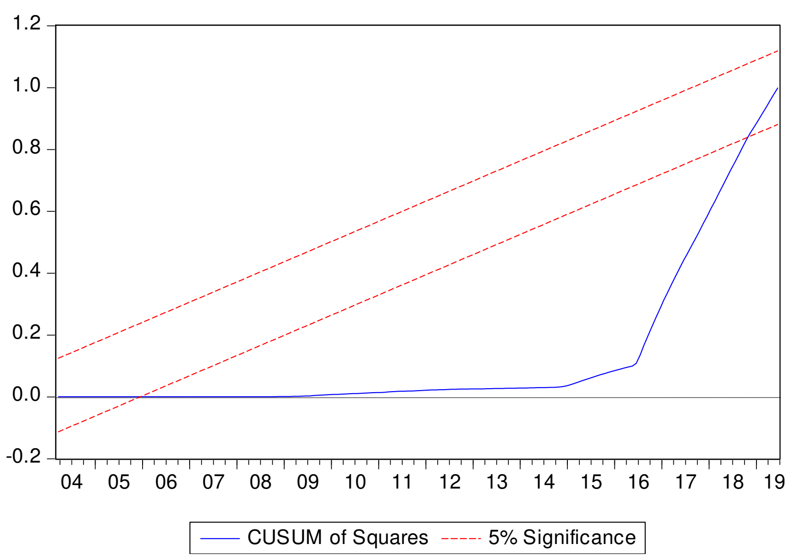
2 vs. 3 *	53.72572	107.4514	14.03
3 vs. 4	5.902329	11.80466	14.85
Break Date :			
:			
	Sequential	Repartition	
1	2016M06	2008M09	
2	2010M12	2011M09	
3	2008M09	2016M07	

Source: Authors' computation

Table 9 above reports the multiple structural break test using the Bai-Perron test. It can be observed that three break periods were indicated values whose F-statistic exceeds their respective critical values. And sequentially their break date are also highlighted in the lower panel, more specifically 2016M06, 2010M12 and 2008M09.Interestingly, the breaks particularly for the exchange rate in 2016 seem to have coincided with the period of perpetual depreciation which may be linked to the recent precipitous movement in the international crude oil prices. Also for the 2008 break it can be linked to global financial crisis that adversely affect all spheres and sectors of economic, financial and business activities.

Finally, in Fig 1, the results indicate that some the cumulative sums of squares are outside the boundary of 5%significant level which implies instability.

Figure 1- CUSUM Q- Structural Break Test



5.0 Conclusion and Recommendation

This paper examines the oil price volatility and exchange rate dynamics through analyzing the regime shift behavior in means and variances of exchange rate due to the spillover effect of oil prices that leads to appreciation and depreciation in the value of Naira. The paper applied the regime heteroskedastic Markov switching model on the basis of monthly data ranging from January 2004 to June 2019 making a total of 186 0bservations. Results from preliminary investigations reveal that the series are characterized by a non-normal distribution, presence of unit root and ARCH effects in stock returns. Moreover the BDS, Bai-Perron and CUSUM tests were conducted and their results reveals presence of nonlinearity and presence of structural breaks in the data. Further, the regime heteroskedastic Markov switching model reveal evidence of two regimes, that is, regime 1 and 2 (depreciation and appreciation) respectively. Furthermore it was observed that low volatility appreciation regime is more persistent than high volatility deprecation regime with transitional probabilities 0.97 and 0.39 respectively. Consistently the expected duration of stay reveals that duration of stay in the appreciation regime is higher than in the depreciation regime at 35.92 months and 1.6 months respectively.

The study will like to urge the Federal Government to intensify efforts to further diversify the economy from oil dominant economy to a robust agricultural, service oriented and financially developed economy that possess the potency to mitigate oil price shocks on exchange rate vulnerability and the economy in general.

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