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The Role of Trade Openness and Oil Price on Exchange Rate: ARDL Bound Testing Evidence from Nigeria

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Abstract
The nexus between oil price and exchange rate has been explored widely in the theoretical and empirical literatures revealing factors that influence exchange rate fluctuation. Therefore, this research examines the role of trade openness and oil price on the behaviour of exchange rate in Nigeria. We applied Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration based on annual time series data from 1982 to 2014. The variables are cointegrated indicating that they exhibit long run relationship. Also, the estimated value of the error correction term is less than one, negative but significant. Exchange rate was found to be negatively dependent on trade openness in both the short run and the long run, while oil price was found to be negative and insignificant in the long run. The policy implication of these findings is that high dependency on oil price is not favorable to exchange rate determination in Nigeria. There is need to diversify the source of foreign revenue especially to the non-oil sectors such as agriculture, mines and industry and manufacturing to reduce the extreme burden and the negative consequences of over dependence on oil and the volatility in its price on Nigeria's economy.
Keywords: exchange rate, oil price, trade openness, error correction term

1.0 INTRODUCTION

The relationship between oil price and exchange rate is important to every economy; i.e in determining whether exchange rate performs as an intermediary through which shocks penetrate to the whole economic indicators. Krugman (1983) highlights the importance of oil price in determining the appreciation or depreciation of currency. The earlier theories of exchange rate determination emphasized the role of current account or purchasing power parity as the principal basis of exchange rate fluctuation. Mundell (1963) presented the idea of capital mobility as a determinant of exchange rate value, while Dornbusch and Fischer (1980) in the trade-oriented model suggest that the volume of trade openness in a nation and its effectiveness in the world market can be influenced by exchange rate.

In every economy the fluctuation of currency in the foreign exchange market has drawn the attention of researchers and policy makers more especially when shocks occur in an economy in an asymmetric way. That is, positive and negative shocks in the same proportion may have different impact on exchange rate in an economy. It is clearly understandable that periodic balance of payments will maintain the determinants of the international economic transaction as long as exchange rate distorts the terms of trade from accomplishing a natural role in the adjustment process.

Blanchard and Galí (2007) stress that events of the past decade indicate that oil prices are not a significant source of economic fluctuations. They find that there are at least four reasons for the milder effects on inflation and economic activity of the recent increase in the price of oil. These reasons include lack of concurrent adverse shocks, smaller share of oil in production, more flexible labour markets, and improvements in monetary policy. Most of these findings are more of suggestions, and concentrate more on the supply side for a country, like Nigeria.

Kilian (2008) in his empirical study found that some countries like Italy, France and Japan have fared much better measured by cumulative inflation and growth than others like Germany when faced with exogenous oil price shocks, while Segal (2007) assesses several arguments, on why high oil prices over the past years do not appear to have led to slowing of the world economy. The most important findings are: oil prices have never been as important as commonly thought, high oil prices have not restrained growth in the past years because they no longer pass through to core inflation, which obviates the typical (growth-slowing) monetary tightening in response to a positive oil price shock.

Despite the program enlightenment of green economy, oil remains the input in the process of production and transportation i.e. valuable natural resource capable of creating wealth. A lot of effort has been made in the process of exploring the link between oil price and exchange rate. In previous literatures, some of the findings were inconclusive while some have mixed outcomes see (Camarero and Tamarit, 2002; Chen and Chen, 2007; Huang and Guo, 2007; Ghosh, 2011; Doğan, *et al.* 2012; Selmi, *et al.* 2012; Salisu and Mobolaji, 2013; Salah, *et al.* 2013; Beckmann and Czudaj 2013; J.-E. Chen *et al.* 2013; Ogundipe, et al. 2014; Fowowe, 2014; Prasad and Narayan, 2015). Therefore, this study will attempt to fill the gap in country specific analysis with evidence from Nigeria; including the role of trade openness. There are cogent reasons to empirically explore the issue of role of trade openness and oil price on exchange rate determination; given the past trend, movement and available data in the Central Bank of Nigeria website (cenbank.org).

Nigeria is a member of the organization of petroleum exporting countries (OPEC), the largest producer of crude oil in Africa, and also among the top ten largest exporters of crude oil in the world. The 2014 fall in oil price was anticipated to have impacted on Nigeria's foreign reserve and exchange rate fluctuation, which had multiplier effect on the local currency exchange rate. Oil price is a major indicator to explaining the movement of foreign exchange especially for the oil exporting countries (Huang and Tseng, 2010)

Nigeria had undergone several currency fluctuations since the implementation of the structural adjustment program (SAP) by the past military regime in 1986. Before then in 1985, Nigerian currency, the Naira (N) was exchanged to the United States Dollar (USD) at N0.935=$1:00. In 1990, it was traded at N7.901=$1:00. In 1994 the government of Nigeria pegged the currency at N21.886=$1:00. In 1999 the Naira continued to depreciate against USD and traded at N86=$1:00. In 2007, it was traded at N117.97=$1:00 (cenbank.org); despite the huge inflow of oil revenue during the period. The fall in oil price in 2014 significantly affected the exchange rate negatively even though the Central Bank devalued the currency from N168-176=$1:00 which continued to depreciate on daily basis in response to the fall in oil price at the world market.

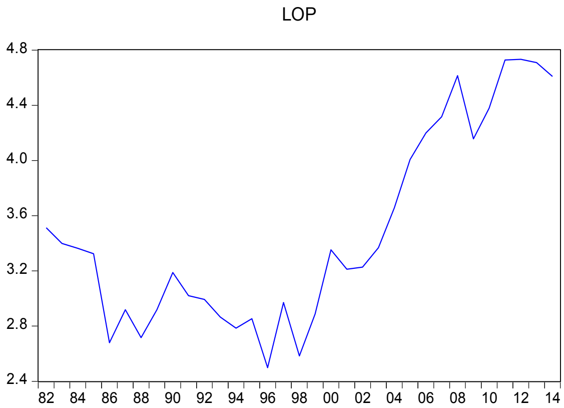


Figure1: Exchange rate movement in Nigeria: 1982-2014

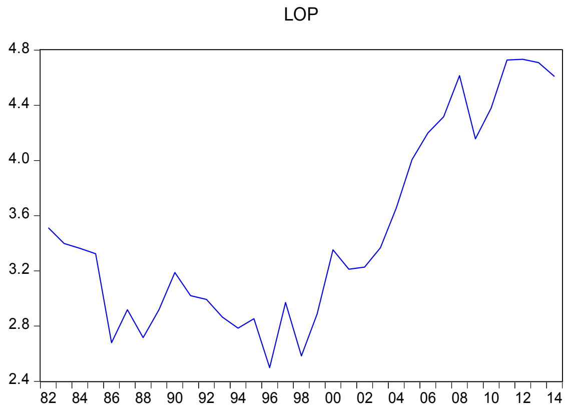


Figure 2: Trend in Oil price: 1982-2014

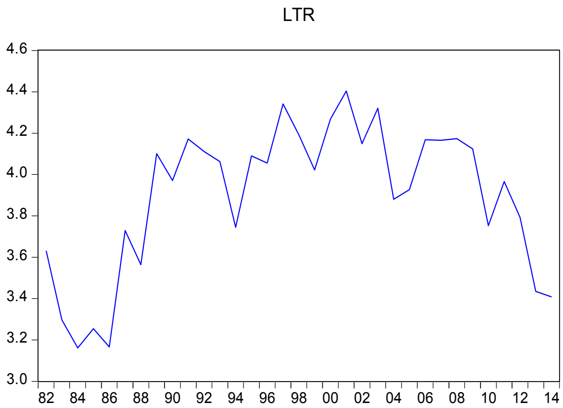


Figure 3: Degree of Trade openness: 1982-2014

Note: The data were annual series 1982 to 2014 extracted from World Bank databank.

In short, Huang and Tseng (2010) had argued that the oil exporting countries would experience appreciation in exchange rate when oil price rises while, they (oil exporting countries) would experience depreciation when oil price falls; and vice versa to the oil importing countries. Demand and supply forces are the possible indicators that will explain the effect of oil price on exchange rate.

On the supply side, oil is the fundamental input in production. Any increase in price will lead to increase in the cost of production and consequently output will reduce/prices may rise and consumption capacity reduced. Furthermore the real exchange rate will depreciate. On the demand side, the role of oil price on exchange rate is emphasized (Wang and Wu, 2012). For OPEC members to maintain their market share they adjust the oil price based on the dollar value; and to also protect their purchasing power parity of oil revenue, any fluctuation of dollar value leads them to respond to the equilibrium (Yousefi and Wir, 2005).

Chin and Chee-hong, n.d. (2013) attempt to assess the impact of trade openness on Malaysian exchange rate by applying monthly data. Their finding is consistent with the expected sign of all the variables. Also in line with the prediction of the theory; increase in trade openness will depreciate the Malaysian domestic currency and vice versa. This finding asserts the idea of threshold level; that the economy will open up at a certain level, if above that level it will depreciate the currency.

2.0 MATERIALS AND METHODS

The study examines the role of trade openness and oil price on exchange rate movement in Nigeria using the ARDL bound test approach to test for the long run and short-run relationship between the identified variables. To avoid spurious results we conducted Augmented Dickey Fuller (ADF) and Philips Perron (PP) tests to neutralize the data, free them from unit root and determine the order of integration of each series. In order to examine the role of trade openness and oil price on exchange rate determination we considered the sample period after the structural adjustment program (SAP) in 1986, and to avoid spurious results we employed data series comprising of annual observation range 1982 to 2014. Real effective exchange rate of the Nigerian currency (Naira), crude oil price (US$/barrel), and trade openness approximated by total trade/GDP obtained from World Bank data base (worldbankdatabank) were utilized for the study.

2.1 Unit Root Test

Augmented Dickey Fuller (ADF) and Philips Perron (PP) unit root tests were employed in this study to determine the existence of unit root in the variables of interest. Unit root test was implemented by Fuller (1976) and Dickey and Fuller (1979, 1981) and Philips Perron (1988), to test the null hypothesis of different stationarity to make results more perfect with the null hypothesis of non-stationarity.

Assume *X* to be any variable and the Augmented Dickey-Fuller (ADF) model can be defined as follows:

$$\Delta X_t = \beta_1 + \beta_2 t + \delta X_{t-1} + \sum_{i-1}^{m} \alpha_i \Delta X_{t-i} + \varepsilon_t$$

Where ε_t is a pure white noise error term and $\Delta X_{t-1} = (X_{t-1} - X_{t-2})$, $\Delta X_{t-2} = (X_{t-2} - X_{t-3})$, $\Delta X_{t-i} = (X_{t-i} - X_{t-j})$, and *i* represents the number of recent time and *j* as the number of previous times or years. The hypothesis of Augmented Dickey Fuller ADF is

$H_0 : \delta = 0, X_t$ is non-stationary, (unit root)

$H_0 : \delta \neq 0, X_t$ is stationary, (no unit root)

The first differencing in unit root test is to be tested if non-stationary time series *Y* need to be "differenced" at the times to make it stationary. Then the result can be stationary and correct, hence one can proceed to test for the co-integration.

Another alternative test measurement is Philips and Perron (PP) The advantage of using PP test over the ADF test is that the PP test is forceful to general forms of heteroscedasticity in the error term ε_t. Another benefit is that the user does not have to specify a lag length for the test of regression. The Phillips-Perron (PP) test offers an alternative method for correcting for serial correlation in unit root testing. Basically, it utilizes the standard DF or ADF test, but adjusts the t-ratio so that the serial correlation does not affect the asymptotic distribution of the test statistic (Philips and Perron, 1988).

2.2.0 ARDL Modeling Approach

It is recommended in the time series literature that spurious outcome may likely arise when variables are specified in levels or non-stationary form. So, to control this setback, the use of stationary or differenced variable is mandatory. However, the use of differenced variable subtracts the long-run information from the data set. It provides only partial information or short-run information. To avoid such a setback, econometricians suggest that, one must test to determine whether long run correlation exists or not among the variables in a model.

The research applied the ARDL bound testing to explain the short run and the long run relationship between trade openness and oil price and exchange rate in Nigeria. The ARDL has numerous advantages over other techniques of cointegration. One of the major advantages in this technique is that it can be applied irrespective of whether the variable is I(0), I(1) or fractionally cointegrated (Pesaran and Pesaran, 1997). It is therefore devoid of pretesting problem, and applicable to small sample size ranging from 30 to 80 observations (Narayan, 2004, 2005).

Another advantage of the model is that it takes sufficient number of lags to capture the data generating process in general to specific modelling framework (Lauranceson and Chai, 2003). Furthermore, the error correction model (ECM) can be derived from ARDL through a simple linear transformation (Banerjee et al. 1993). ECM integrates short-run adjustments with long-run equilibrium without missing long run information. Moreover, the sample properties of ARDL approach are far greater to that of the Johansen and Juselius's cointegration technique (Pesaran and Shin, 1999). ARDL approach has been generally used in research work and in some analyses related to ours, such as Jammazi, et al. (2015), Jayaraman and Choong (2009) and Bahmani-oskooee (2015).

2.2.1 ARDL Bounds Test for Cointegration

$$\Delta y_t = \alpha_0 + \sum_{i=0}^{p} b_i \, \Delta y_{t-i} + \sum_{i=0}^{p} c_i \, \Delta x_{t-i} + \sum_{i=0}^{p} d_i \, \Delta z_{t-i} + \delta_1 y_{t-1} + \delta_2 x_{t-1} + \delta_3 z_{t-1} + \delta_4 + \mu_t$$

The optimum lag is chosen by Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC) for small sample; compare the F-statistics with the critical bounds by Pesaran et al. (2001) for large sample (Narayan, 2005).

Fstat > Fcritical: Reject null – cointegrated
Fstat < Fcritical: Fail to reject null – Not cointegrated
Fstat = Fcritical: Inconclusive

The satisfaction of cointegration leads to both the long run and short run estimation.

Estimation of Long-run Coefficients

$$y_t = \alpha_0 + \sum_{i=1}^{p} b_i \, y_{t-i} + \sum_{i=0}^{p} c_i \, x_{t-i} + \sum_{i=0}^{p} d_i \, z_{t-i} + \mu_t$$

Estimation of Short-run Coefficients

$$\Delta y_t = \alpha_0 + \sum_{i=0}^{p} b_i \, \Delta y_{t-i} + \sum_{i=0}^{p} c_i \, \Delta x_{t-i} + \sum_{i=0}^{p} d_i \, \Delta z_{t-i} + \gamma ECT_{t-1} + \mu_t$$

In estimation by OLS based on re-parameterization of long run model, ECT represents the potential retreats from the long run equilibrium (Baharumshah et al, 2009). γ is the adjustment co efficient.

2.3 Econometric Method

We adopt the bivariate model between exchange rate and oil price in the research of Chaudhuri and Daniel (1998) and Chen and Chen (2007)

$$q_{it} = \alpha_{it} + \beta_2 p_{it} + \varepsilon_{it}$$

Where, q_{it} is the log of the real exchange rate and p_{it} is the log of the real oil price.

We modified to capture the role of trade openness in determining the exchange rate movement in Nigeria as:

$$re_t = \beta_1 + \beta_2 op_t + \beta_3 to_t + \mu_t$$

Where, re_t is exchange rate, op_t is oil price and to_t is total export plus total import to ratio of GDP. All variables were transformed into natural log.

The expected sign of the trade openness in Nigeria is negative, indicating that any increase in openness will depreciate the domestic currency (Lee, 2013) while the expected sign for oil price is ambiguous; it may be negative or positive given the nature of the Nigerian economy which rely heavily on oil with the attendant volatility in its price.

3.0 RESULTS AND DISCUSSION

3.1.0 Empirical Results

The ARDL cointegration approach has strengths over some methodologies that require unit root test. It does not necessarily need stationary test, although it will not valid be for I(2) variable, as it is beyond and violates the properties of using the Pesaran et al. (2001) bounds testing. We have to abide by the rules of ARDL, because it accommodates variables in the series be they stationary at I(0), I(1) or mixture of both.

3.1.1 Unit Root Test

We conducted the two prominent unit root tests using Augmented Dickey Fuller (ADF) and Phillips Perron (PP) to test for stationarity .The evidence of unit root test shows that, real effective exchange rate, oil price and trade openness were stationary at first difference that is, suitable for ARDL approach.

Table 1: ADF and PP Unit Root Tests

Variable	Augmented Dickey Fuller (ADF)		Philip Perron (PP)	
	Constant Without Trend	Constant With Trend	Constant Without Trend	Constant With Trend
LRE I (0)	-2.123925[0]	-1.851466[0]	-2.244913[3]	-2.036401[3]
I (1)	-4.2085***[0]	-3.9784***[2]	-4.1334***[4]	-4.16009**[6]
LOP I (0)	-0.439704[0]	-2.305134[0]	-0.338780[3]	-2.305134[0]
I (1)	-6.9131***[0]	-7.3831***[2]	-6.8752***[2]	-7.4876***[2]
LTO I (0)	-1.902616[0]	-.671715[7]	-1.713126[1]	-1.607717[0]
I (1)	-1.135379[0]	-4.1231**[6]	-7.8093***[0]	-13.081***[11]

Note: ***, **, *, indicate significance at 1%, 5% and 10% respectively

3.1.2 Optimal Lag Selection

The cointegration in the ARDL bound testing approach describes the long run relationship among the dependent and the independent variables in the model, required prerequisites to determine the optimal lag to avoid the hypothesis of serially correlated residual in the cointegrated equation. Schwarz Bayesian Criterion (SBC) and Akaike Information Criterion (AIC) were used in the model selection criteria. We test different lags in order to find the best model with three different lags length which are not autocorrelated and the have less value of the SBC and AIC; considered to possess the best model optimal lag. To use annual time series data, inclusion of time trend in the equation will produce better-approximated outcomes (Pesaran et al., 2001). Consequently, we limit the estimation to three lags since the possibility of serially uncorrelated residuals will occur when the numbers of lags are increased. Nevertheless, it has to be done parsimoniously to avoid over-parameterization problem (Narayan, 2005; Pesaran et al., 2001).

Table 2: Optimal Lag Selection

Lags	SBC	AIC	Serial correlation	Heteroscedasticity
1	**-17.8591**	**-14.9277**	4.6954 [0.030]**	5.3166 [0.21]**
2g	-15.7969	-10.7780	0.01279 [0.910]	1.2270 [0.268]
3	-12.3923	-6.7875	2.0983 [0.147]	0.2288 [0.632]

Note: g denotes optimal lag chosen, SBC and AIC are Schwarz Information Criterion and Akaike Information Criterion respectively.

Table 2 represents the SBC and AIC, the residual autocorrelation and Heteroscedasticity tests for first difference regression equation with trend. The rationale for these tests at different order is to check if change in lag will yield any significant results. In table 2, SBC and AIC values were minimizing in lag 1 but serial correlation and Heteroscedasticity are significant, while in lag 2 SBC and AIC values are less compared with their values in lag 3 even though we consider both lag 2, 3 which are not affected by serial correlation and Heteroscedasticity. This research chooses lag 2 as the optimal lag since increasing the number of lags from 2 to 3 will maximize the value of SBC and AIC. SBC and AIC will not provide minimum value until more number of lags is taken which may lead to over parameterization. Hence, we use SBC to choose the optimal lag for the equation with trend. Though Pesaran et al. (2001) see SBC to be more consistent and parsimonious, and recommends its use.

3.1.3 Cointegration Test

Table 3: ARDL CointegrationTest

Bounds test result	F-statistics	Lag	Level of significant	Unrestricted intercept and no trend	
			1%	6.183	7.873
$InRE_t = f(\text{InOP}_t, \text{InTO}_t)$	5.8798	2	5%	4.267	5.473
			10%	3.437	4.470

Note: F-statistics is greater than the upper bond at 5% level, which indicates the existence of long run relationship. Also, lag 2 was selected as the optimal lag length after testing different lags length suggested by Schwarz information criterion (SIC) for annual observations of 32 years. SIC was used because of its ability to minimize the loss of degree of freedom.

To determine the long run relationship in the model (cointegration) among the variables exchange rate, oil price and trade openness, unrestricted error correction model was used to generate the F-statistic value, in order to determine the cointegration, we have to reject the null hypothesis if the value of computed F-statistic is higher than the upper bound value of the Pesaran et al (2001) table at 5% level of significance. We find that our computed F-statistics is 5.8798 in lag 2, which is higher than the upper bound value in Pesaran table of 5.473.

Indicating that the variables are cointegrated i.e. there is a long run relationship among them.

3.1.4 Longrun Coefficients

Table 4: Long run coefficients

Dependent variable, lre_t		
Regressors	Coefficient	T-ratio (p- values)
lop_t	-0.28522	-1.1373[0.267]
lto_t	-1.3508	-2.5002 [0.020]**
Constant	10.8866	4.2291 [0.000]***

Note: ***, **, *, indicate significance at 1%, 5% and 10% respectively

Considering the long run relationship of the variables in the model, now we continue to determine the long run coefficients in the subsequent estimation as reported on table 4. The coefficients of oil price and trade openness are negative but only trade openness is significant while oil price is shown to be insignificant in the long run which is consistent which the findings of Chen and Chen, (2007) and Blanchard and Galí (2007).

3.1.5 Shortrun Coefficients

Table 5: Short-run Coefficients

Dependent variable, $\Delta lreer_t$		
Regressors	Coefficient	T-ratio (p- values)
LRE (-1)	1.0967	6.4285 [.000]***
LRE (-2)	-0.47960	-2.8938 [0.008]***
LOP	0.111335	.45933 [0.650]
LOP (-1)	0.42887	1.6005 [0.123]
LOP (-2)	-0.65143	-2.4361 [0.023]**
LTO	-0.51721	2.1175 [0.045]**
INPT	4.1684	2.6827 [0.013]**
ECT (-1)	-0.38289	-3.1747 [0.004]***

Note: ***, **, *, indicate significance at 1%, 5% and 10% respectively.

In the short run, the error correction model is expected to confirm the cointegration in the ARDL bound test. Short run results reveal that the coefficient of the error term is negative, less than one and also significant at 1 per cent (-1) -0.382; which shows the speed of adjustment at which the exchange rate returns to normal equilibrium after short run shock.

3.1.6 Diagnostic Test

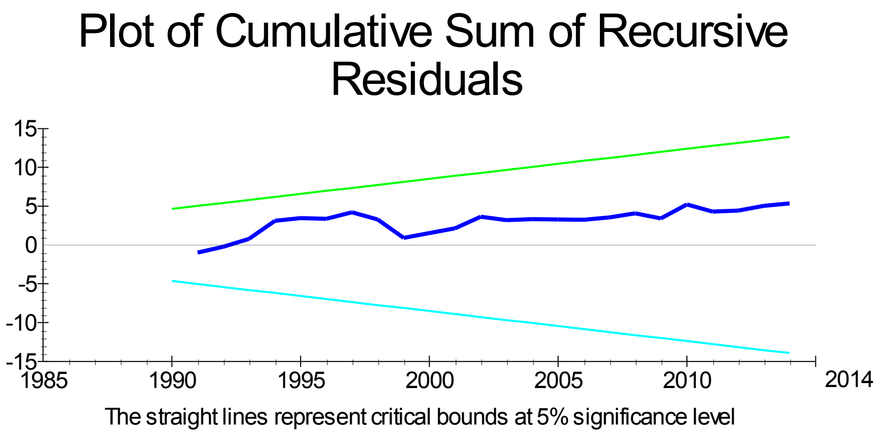
Table 6: Diagnostic Tests

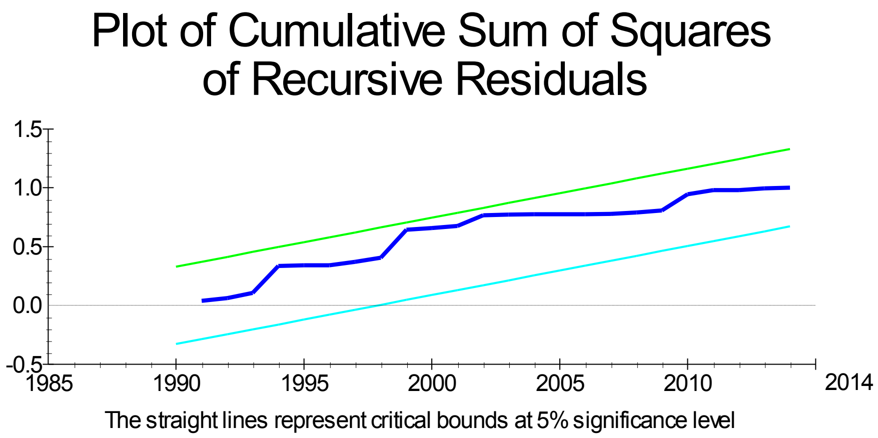
Test statistics	LM version	F version
A: Serial correlation	CHSQ (1) =0.12790 (0.910)	F (1, 2) = 0.09493(0.923)
B: Functional form	CHSQ (1) = 2.1509 (0.142)	F (1, 39) = 1.7148(0.203)
C: Normality	CHSQ (2) = 4.8100 (0.090)	Not applicable
D: Heteroscedasticity	CHSQ (1) = 1.2270 (0.268)	F (1, 90) = 1.1951(0.238)

A: Lagrange multiplier test of residual serial correlation
B: Ramsey's RESET test using the square of the fitted values
C: Based on a test of skewness and kurtosis of residuals
D: Based on the regression of squared residuals on squared fitted values

To confirm the reliability of our estimates, it is required that the diagnostic tests for the residuals should be in agreement with their respective null hypotheses. That is, the stochastic error term must be white noise with zero mean and constant variance. The result of the diagnostic tests presented in Table 6 indicates that the model has passed the entire tests for serial correlation, functional form, normality, and heteroscedasticity. Therefore we did not fail to accept our null hypotheses.

Correspondingly, there is need for us to conduct a stability test of CUSUM and CUSUM Square. The graphical results in Fig. 4 and 5 illustrate that residuals were within the critical bounds at 5% level of significance. This signifies that the ARDL estimates are stable, consistent and reliable.





4.0 SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATION

The role of trade openness and oil price on exchange rate cannot be overemphasized based on the available theories. However, there is ample evidence in the literature that validate those theories empirically while some findings are inconsistent with the theories i.e. conclusion on this issue has mixed outcomes. Nevertheless, this research attempts to examine the role of trade openness and oil price on exchange rate in Nigeria over the period of 1982-2014. Annual series data were obtained and ARDL approach to cointegration was utilised to examine the issue. Results revealed negative relationship; but the variables were cointegrated, thereby fulfilling the mandatory requirement for estimating long run relationship among the variables.

The error correction term is negative and significant but less than one; thereby indicating that the speed of adjustment or how long it will take the exchange rate to return to normal equilibrium if any shock(s) occurred. Exchange rate was found to be negatively dependent on trade openness in both short run and the long run, while the oil price was found to be negative and insignificant in the long run. Therefore trade openness play significant role in determining exchange rate movement in Nigeria while the oil price is insignificant. The model passed the entire diagnostic tests comprising serial correlation, functional form, normality, and heteroscedasticity. Consistently, stability test of CUSUM and CUSUM Square were stable, which shows the fitness, strength and reliability of the model.

The policy implication of these findings is that trade openness has to be monitored. It should be recommended that to find a threshold level, Nigerian government should open up, but beyond that level, trade openness will negatively affect the exchange rate. Also high dependency on oil and the attendant volatility in its price is not favorable to exchange rate movement in Nigeria. The country should diversify the source of its foreign exchange earnings especially to the non-oil sectors such as agriculture, mines and industries and manufacturing in order to reduce the extreme burden of oil revenue. Most importantly, Nigeria should achieve its economic vision of being among the 20 World industrialized economies by the year 2020 if this recommendation is adopted and implemented.

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