Time-Gap effects of crude oil prices on the foreign exchange rates: Evidence from Nigeria

Nenubari Ikue-John^(a) Emeka Nkoro^(a) Jeremiah Anietie^(c)

^(a,b)Department of Economics, Faculty of Social Sciences, University of Port Harcourt, Nigeria

^(c)Emerald Energy Institute, University of Port Harcourt, Nigeria

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ABSTRACT

There is a pool of techniques and methods in addressing dynamics behaviors in higher frequency data, prominent among them is the ARCH/GARCH techniques. In this paper, the various types and assumptions of the ARCH/GARCH models were tried in examining the dynamism of exchange rate and international crude oil prices in Nigeria. And it was observed that the Nigerian foreign exchange rates behaviors did not conform with the assumptions of the ARCH/GARCH models, hence this paper adopted Lag Variables Autoregressive (LVAR) techniques originally developed by Agung and Heij multiplier to examine the dynamic response of the Nigerian foreign exchange rates to crude oil prices. The Heij coefficient was used to calculate the dynamic multipliers while the Engel & Granger two-step technique was used for cointegration analysis. The results revealed an insignificant dynamic long-term response of exchange rate to crude oil prices within the periods under review. The coefficient of dynamism was insignificantly in most cases of the sub-periods. The paper equally revealed that the significance of the dynamic multipliers depends greatly on external information about both market indicators which are two-way interactions. Thus, the paper recommends periodic intervention in the foreign exchange market by the monetary authorities to stabilize the market against any shocks in the international crude oil market, since crude oil is the main source of foreign exchange in Nigeria.

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Introduction

There is a widespread argument that the fluctuation of the exchange rates in developing economies is the main source of economic instability (Babatunde, *et al.*, 2010). The effects of exchange rates fluctuation on countries' economy is driven significantly by the swing in the global prices of crude oil products and currencies of the major economic powers and trading partners of the world. That is, exchange rate is regarded as the primary channel through which the fluctuations of global oil prices traded in US dollars are transmitted to the real economy (Reboredo, 2012). It is argued that increases in the global oil prices lead to an increase (decrease) in oil-exporting (importing) country's relative price of commodities, hence an appreciation (depreciation) of exchange rates.

It is believed that the decline in foreign currency supply in the Nigeria is as result of the downward movement in international crude oil prices and shortage in the supply of crude oil due to pipeline vandalism and other vices by some Niger Delta youth. The situation has created the shortage of Foreign Exchange (FOREX) in the Nigerian economy and the Apex Bank is unable to supply the needed FOREX for contractors and government agencies for payment of foreign transactions since oil revenue accounts for over 80 percent of the country foreign exchange earnings. Higher demand for FOREX in the presence of insufficient supply continues to mount pressures on the country's exchange rate. This has led to consistent depreciation of the naira which has posed a serious challenge to the general price level and the welfare conditions in Nigeria.

* Corresponding author. ORCID ID: 0000-0002-1764-2283

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Since the 1970s oil price shocks, the global prices of crude oil and its consequences on various economic fundamentals have continued to attract interest from researchers and policy makers. Consequently, many scholars have examined the relationship between the time-varying financial series (Oil prices and exchange rates) in economics and finance using various methods. Prominent among them are the original works by Engel (1982) in AutoRegressive Conditional Heteroscedasticity (ARCH) and the Generalized AutoRegressive Conditional Heteroscedasticity (GARCH), Higgins & Lee, 1992; Nelson, 1991; Sentana, 1995; Ding, Granger & Engel, 1993; Engel, 1990; Donalson & Kamstra, 1997; Lee & Taniguchi, 2005; Klüppelbeg, Lindner & Maller, 2004).

Despite the growing amount of literature on the link between oil prices and exchange rate, the situation in the Nigerian economy has received little attention. This study seeks to address this gap by understanding the dynamics between global oil prices and exchange rate at a time when both variables show frequent fluctuations. Also, literature has shown that there are methodological issues in analyzing the dynamics between global oil prices and exchange rate, especially in the prevalent use of volatility family models. One of these issues includes non-compliance with the assumption guiding the estimation of time-varying financial series, which are volatility clustering of the returns on the time series and the model residual heteroscedastic or ARCH effects (Engel 1982, 1990). In such case, this study explores the dynamics between global oil prices and exchange rate in an innovative manner using the Lag Variables AutoRegressive (LVAR)(n, m) seemingly causal model as proposed by Agung (2009) and applied by Adams et al. (2015); Medee & Ikue-John (2017) and Ikue-John & Jeremiah (2018), where n and m are time lag and, the Heij formular (dynamic multiplier) since the assumption guiding the estimation of time-varying financial series is satisfied. Hence, this study investigates the dynamism of exchange rate and international crude oil price in Nigeria with a daily averages from 2002 to 2017. The study is guided by the following hypothesis, H_0 : the dynamism of international crude oil prices of has no significant impact on the dynamism of exchange rate in Nigeria.

The remaining section of this study is divided such that section two discusses theoretical issues and review empirical literature. Section three highlights the theoretical model employed to explain the dynamic relationship between exchange rate and international crude oil price in Nigeria. Section four gives the empirical results and the discussion of findings while the last sections proffers policy recommendations and also conclude the study.

Literature Review

Theoretical Background

Krugman (1983) and Golub (1983) were the early scholars that clearly establish the linkage between crude oil price and the foreign exchange market. They argued that appreciation of the exchange rate of oil-exporting countries may be achieved with a rise in the price of crude oil whereas they will experience exchange rate depreciation with a fall in the price of crude oil. On the other hand, oil-importing countries experience exchange rate appreciation and depreciation when crude oil exporting countries are experiencing exchange rate depreciation and appreciation respectively. The distortions in the crude oil exporting and importing countries are caused by the upward and downward movement in the global price of crude oil.

Faruqee (1995), Bloomberg & Harris (1995) and Nelson et al (1997) also explained the relationship between crude oil prices and exchange rates on the principle of *one price for tradable commodities*. Bloomberg and Harris (1995) pointed out that since crude oil is a homogeneous traded international commodity and price in the US dollar, depreciation in US dollar reduces the crude oil price to foreigners relatively to the price of their commodities in foreign currency, thus, increasing purchasing power and demand for crude oil, thereby increase the US dollar price of crude oil. Faruqee (1995) and Nelson et al (1997) suggest that shock to crude oil price is a major source of fluctuation in the foreign exchange market. Following the work of Nelson et al (1997) and Faruqee (1995), Hamilton (2003) and Kilian (2006) it is concluded that crude oil price shock can affect the economy in two ways; linear and non-linear. To this end, we can argue that the link between crude oil price shock and exchange rate have been explored in economic literature.

Empirical Review

Ahmad et al (2016) studied the Nexus between Exchange Rate Volatility and Oil Price Fluctuations within 1983-Q1 to 2014-Q2 in Pakistan. The variables employed are exchange rate, foreign exchange reserves and CPI and, examined within the frameworks of the VECM and Exponential GARCH (EGARCH). They observed that exchange rate in Pakistan is determined by real foreign exchange reserves, interest rate differential, real exports and oil prices. CPI and Real Oil Price have positive and negative effect on Real Exchange Rate Volatility respectively. The EGARCH (1, 1) model shows the presence of leverage effect in Real Oil Price Volatility and Real Exchange Rate Volatility. Hussain et al (2016) investigated Oil price and exchange rate co-movements with Daily averages from 05/21/2006 to 05/18/2016 in 12 Asian Countries (China, Hong-Kong, India, Indonesia, Japan, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka and Taiwan) using the De-trended Cross-correlation Approach (DCCA). Their results lend support to the co-movements of oil prices and exchange rate among nations examined but this co-movement is weak and negative in most the countries. Lawal et al (2016) examined the Impact of Oil Price Shocks and Exchange Rate Volatility on Stock Market Behavior in Nigeria with a Monthly Data of Jan-1985 to Dec-2014 using an Exponential GARCH framework. Their result indicates that volatility in stock price is induced by volatility in both the exchange rate and oil price within the periods examined. Ghosh (2011) used the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) and Exponential GARCH (EGARCH) models to examine crude oil prices and Exchange rate nexus in India during the period of extreme oil price volatility of 07/2/2007 and 11/28/2008. The results reveals

that there is a bidirectional relationship between oil price return and exchange rate return in India and, that positive and negative oil price shocks have similar effects in terms of magnitude on exchange rate volatility. Also, oil price shocks posit permanent effect on exchange rate volatility in India. Abraham (2016) looked at the effects of Exchange Rate Policy and Falling Crude oil Prices on the Nigerian Stock Market using the linear framework of Autoregressive Distributed Lag (ARDL) and observed that Oil prices impacted positively on the stock market, with a unidirectional relationship running from oil price to stock prices. Basher *et al* (2015) used the Markov-switching Approach to study the impact of oil shocks on exchange rates in Major oil Exporting and Importing Countries such as Brazil, Canada, Mexico, Norway, Russia, U.K, US, Korea, Japan and India in a different sample period for each countries and they observed that exchange rates are affected by shocks from global demand in both oil exporting and importing countries. Also, the results revealed that there was no systematic pattern for appreciating and depreciating of currency among the countries studied. However, the results lend support to the presence of regime switching for the effects of oil shocks on real exchange rates. Zhang *et al* (2008) result shows an insignificant transmission between oil price and US dollar Exchange Rate in China in the frameworks of VAR and ARCH_GARCH.

Reboredo (2012) modeled the co-movements of oil price and exchange rate with Canadian Dollar, Euro, Australia Dollar, US Dollar, U. K Pounds, Japan, Mexico, Norway and US Federal Reserve's Broad Trade Weighted and, observed a weak or insignificants correlation between the interdependency of exchange rate and oil price in the economies studied. Aliyu (2008) empirical work shows a unidirectional spillover transmission from oil prices to real GDP and bidirectional transmission spillover from real exchange rate to real GDP in Nigeria from 1986 to 2007. Mishra & Debasish (2017) analyzed the Volatility Spill over between Oil Price and Exchange Rate in India using GARCH model. They argued that an upward movement in crude oil price return leads to an upward movement in India rupees to US Dollar (depreciation of Indian Currency with respect to U.S. Dollar) and also, established that positive and negative shocks to crude oil price have similar effects on India Exchange rate volatility, while their magnitude and the effects tend to be permanent. Song & Li (2015) investigated Chinese Oil Price and the International Oil Price in a VAR and VEC-TARCH Approach. Empirical evidence shows that Chinese crude oil market is sensitive to international oil price, implying that managing the domestic oil market in China with external risk is difficult.

Osarumwense (2015) examined the impact of oil price shock on foreign currency and stock markets in Nigeria with daily averages from 04/02/2012 to 04/30/2015 using MEGARCH and Constant Correlation (CC) Model. The foreign currencies and oil prices were proxied with Naira/USD and Naira/GBP exchange rates and West Texas Intermediate (WTI) respectively. He argued that there is no leverage effect in oil price volatility and exchange rate in Nigeria. Unidirectional spillover runs from Oil price to Naira US dollar exchange rate while the transmission of naira British pound runs from naira to British pounds exchange to Oil price. Similarly, by modeling crude oil price volatility with structural breaks Salisu & Fasanya (2013) used Narayan-Popp (2010) and Liu- Narayan, (2010) Unit Root Test with Structural break and the GARCH Family on two types of oil price; WTI and Brent Crude Price and, they observed that structural breaks dates coincided with the period of Asian Crises (Iraqi-Kuwait conflicts) and Global Financial crises (1990s and 2008). Also, leverage effects were found to be persistence in the two crude oil prices employed. Salisu & Mobolaji (2013) modeled the returns and volatility transmission between oil price and US-Nigeria exchange rates with VAR-GARCH and CCC-GARCH and, their results revealed a bidirectional transmission spillover between oil price returns and foreign exchange rate returns in Nigeria with the evidence of hedging effects in oil price and foreign markets.

Nazlioglu *et al* (2015) examined whether there is a volatility transmission between oil prices and financial stress by means of the volatility spillover test using Toda-Yamamoto Causality Test and VAR-GARCH Toda-Yamamoto Causality Test and VAR-GARCH. The variables employed are WTI crude oil prices and Cleveland financial stress index for the period 1991–2014 and divide the sample into pre-crisis, in-crisis, and post-crisis periods due to the downward trend in oil price in 2008. Their results revealed the evidence of Long-run relationship between oil price and financial stress index. They argued that causality test lends support to risk transfer from crude oil market to financial market before the crisis periods and, risk transfer from financial market to oil market after the crises period. Their results on the analysis of the graphs of impulse response indicate that the period before crises and period after crises shows similar dynamism in the pattern of volatility transmission and, is characterized by higher and long-lived effects during the crisis. Lizardo & Mollick (2010) examined Oil price fluctuations and U.S. dollar exchange rates in major oil Exporting and Importing Countries, Russia, Canada, Mexico, UK, Euro Zone, Sweden and Japan and their results revealed that oil price is statistically significant to movement in US dollar. Increase in oil price leads to depreciation of US dollar against the currency of net-exporter of crude oil and currency of net importer depreciate relatively to US dollar. Aloui *et al* (2013) modeled the conditional dependence structure between oil prices and exchange rates of world major currency (US dollar, Canadian dollar, Swiss Franc, British pounds and Japanese Yen) in the frameworks of A Copula-GARCH and they observed that a rise in oil price brings about depreciation of US dollar exchange rate. In Tiwari *et al* (2013) result indicates a linear and nonlinear causal relationship between the real oil price and the real effective exchange rate of Indian rupee at higher time scales (lower frequency) in a VAR model.

Despite the growing amount of literature on the link between oil prices and exchange rate, the situation in the Nigerian economy has received little attention. The present study seeks to address this gap by understanding the dynamics between global oil prices and exchange rate at a time when both variables show frequent fluctuations. Also, literature has shown that there is a methodological issue in analyzing the dynamics between global oil prices and exchange rate, especially in the prevalent use of volatility family models. To overcome the non-compliance of high frequency data to the conditions for fitting the volatility family model the behaviour of the time-varying financial series (Oil price and exchange rates) is examined to see if they conformed with the assumptions

for fitting the ARCH/GARCH model. It is observed that the Nigerian foreign exchange rates behaviours did not conform with the assumptions of the ARCH/GARCH models. In such case, to explore the dynamics between global oil prices and exchange rate in an innovative manner, this study employs the Lag Variables AutoRegressive (LVAR)(n, m) seemingly causal model proposed by Agung (2009) and applied by Adams et al. (2015); Medee & Ikue-John (2017) and Ikue-John & Jeremiah (2018), where n and m are time lag and, the Heij formular (dynamic multiplier).

Research and Methodology

Data Sources and Preliminary Analysis

The study employed daily data for Brent crude oil price and exchange rate of naira to US dollar. Therefore, the study examines the dynamic relationship between exchange rate and crude oil price(proxy with West Texas Intermediate (WTI) in Nigeria using daily data from 01/01/2002 to 12/31/2017. Table 1 shows the data sources, measurement and description.

Table 1: Data Descriptions and Sources

Variables	Descriptions	Measurement	Source
OP_t	Brent Crude Oil Price	US dollar Per Barrie	Thomson Reuter Workbook
$DEXR_t$	Naira to US dollar Exchange rate	1 US dollar : Naira	CBN official website i.e, www.cbn.gov.ng

Source: Authors' Computation..

Preliminary Analysis

The fluctuations of daily naira/dollar exchange rate and the global oil prices are shown in figures 1 and 2. The analysis shows the evolution of oil prices and exchange rates over the period from 01/01/2002 to 12/31/2017. The figures show significant variations exchange rates and crude oil prices and with different intensity within the period under review.

Figure 1: Volatility in International crude Oil Price

Figure 2: Volatility in the Naira/US Dollar Exchange Rate

Table 2: Heteroscedasticity Test

Model	F-statistic	Obs*R-squared	Prob. Chi-Square(1)
$DEXR_t = \alpha + \beta DCOPT_t$	0.0125(0.9109)	0.0125	0.9109
$DEXR_t = \alpha + \beta DEXR_{t-1}$	0.0017(0.9667)	0.0018	0.9667
$DCOPT_t = \alpha + \beta DCOPT_{t-1}$	357.96(0.0000)	329.35	0.0000

Source: Authors Computation. Note that, t represent exchange rate or oil price at time t and $t-1$ represent the previous day exchange rate or oil price

Specifically, figures 1 show that the graph of international crude oil price has a clustering volatility which is revealing the presence of heteroskedasticity while figure 2 shows that the volatility of the exchange rates of the Naira to the US Dollar is not clustered but is homoscedastic. Hence, the volatility family model is not suitable for modeling and forecasting the relationship between the Naira exchange rate to the US Dollar and international crude oil price in Nigeria, especially when considering daily averages since the conditions were not satisfied in the cases of exchange rates. Table 2 shows that there is an ARCH effect in international crude oil price and, this is contrary to the exchange rates of the Naira to the US Dollar.

It was observed in 2003 that irrespective of the fluctuations in the prices of international crude oil the naira tend to be increasing with a higher acceleration in the third quarter of the year as shown in figure 6a and figure 6b. The series from the both markets moved in an opposite directions in 2004, 2005, 2007 and 2014 as shown in figure 7a and 7b, figure 8a and 8b, figure 10a and 10b, and figure 17a and 17b respectively. It shows that in these sub-periods naira tend to appreciate against the US Dollar with an increased in the prices of international crude oil. The reminder of the figures shows that the series moves in the same directions indicating a depreciation of the naira to the US Dollar irrespective of the increased in the prices of international crude oil. However, the figures show that the sub-periods of 2008, 2014, 2015 and 2016 the naira was fixed (pegged) periodically to the US Dollar.

Daily Oil Price and the Naira/US Dollar, 2002-2017

Fig.3a: Graph of Crude Oil Price
Daily Oil Price and the Naira/US Dollar, 2002

Fig.3b: Graph of Naira/US Dollar
Daily Oil Price and the Naira/US Dollar, 2017

Fig.4a: Graph of Crude Oil Price

Fig.4b: Graph of Naira/US Dollar

Fig.5a: Graph of Crude Oil Price

Fig.5b: Graph of Naira/US Dollar

Fig.6a: Graph of Crude Oil Price

Fig.6b: Graph of Naira/US Dollar

Fig.7a: Graph of Crude Oil Price

Fig.7b: Graph of Naira/US Dollar

Graph of Daily Oil Price and the Naira/US Dollar, 2005

Daily Oil Price and the Naira/US Dollar, 2006

Fig.8a: Graph of Crude Oil Price

Fig.8b: Graph of Naira/US Dollar

Fig.9a: Graph of Crude Oil Price

Fig.9b: Graph of Naira/US Dollar

Fig.10a: Graph of Crude Oil Price

Fig.10b: Graph of Naira/US Dollar

Fig.11a: Graph of Crude Oil Price

Fig.11b: Graph of Naira/US Dollar

Fig.12a: Graph of Crude Oil Price

Fig.12b: Graph of Naira/US Dollar

Fig.13a: Graph of Crude Oil Price

Fig.13b: Graph of Naira/US Dollar

Fig.14a: Graph of Crude Oil Price

Fig.14b: Graph of Naira/US Dollar

Fig.15a: Graph of Crude Oil Price

Fig.15b: Graph of Naira/US Dollar

Fig.16a: Graph of Crude Oil Price
Fig.16b: Graph of Naira/US Dollar

Fig.18a: Graph of Crude Oil Price
Fig.18b: Graph of Naira/US Dollar

Fig.17a: Graph of Crude Oil Price
Fig.17b: Graph of Naira/US Dollar

Fig.19a: Graph of Crude Oil Price
Fig.19b: Graph of Naira/US Dollar

Method of Analysis

Since the volatility family is not suitable for modeling and forecasting the relationship between the Naira exchange rate to the US Dollar and international crude oil price in Nigeria, especially when considering daily averages since the conditions were not satisfied in the cases of exchange rates, the study now followed the Lag Variables AutoRegressive (LVAR)(n, m) seemingly causal model proposed by Agung (2009) and, Ender (2004) multiplier to estimate the dynamic relationship between Nigeria exchange rate and international crude oil price. The dynamic relationship of the variable is estimated using LVAR (n, m) model as proposed by the Agung (2009) and as applied by Adams et al. (2015); Medee &Ikue-John (2017) and Ikue-John &Jeremiah (2018), where n and m are time lag thus;

$$Y_t = \alpha_0 + \sum_{i=1}^n \alpha_i Y_{t-i} + \sum_{j=0}^m \beta_j X_{t-j} + \varepsilon_t \quad (1)$$

Where

Y_t is the natural log of exchange rates, X_t is the natural log of crude oil price, n and m are time lag and ε_t is the error term at time t . Equation 2 was proposed by Enders (2004) to account for the forcing process in the dynamic model. He defines Z_t as the quarter forcing Process as $\sum_{j=0}^m \beta_j X_{t-j} + \varepsilon_t Z_t$ can be the one or the sum of several days in $\sum_{j=0}^m \beta_j X_{t-j} + \varepsilon_t$. The daily error correction can be added to model 1 and 2 if the trends of the series in the models are co-integrated. A variable of Error correction (ECM) will be added to equation 2 if the residual of the both series is co-integrated in any group as explained below.

$$Y_t = \alpha_0 + \sum_{i=1}^n \alpha_i Y_{t-i} + Z_t \quad (2)$$

According to Heij *et al.*(2004), the dynamic multiplier coefficient (δ) of the effect of independent variable (crude oil price) on the dependent variable (exchange rates) for the causal model is determine by:

$$\delta = \frac{\sum_{i=1}^n \beta_i}{1 - \sum_{j=0}^m \alpha_j} \quad (3)$$

The nature of the relationship between international crude oil price and the Nigerian exchange rate can be negative or positive depending on the sign of the coefficient of δ . If the coefficient of $\delta > 0$, the dynamics of relationship is positive, while $\delta < 0$ implies negative dynamic relationship.

The series for this analysis are divided into 17 groups to capture the analysis of short-term relationships among the series. The pooled data from 2002 to 2017 explained the long-term dynamic relationship between Nigeria exchange rate and crude oil prices. Two stages were followed to complete the analysis of the dynamic relationship between Nigerian exchange rates and international crude oil prices. In stage one, we observed the behaviors of the series included in the model using Dickey-Fuller (1979) test method for unit root while the two step method of co-integration testing for single equation by Engel-Granger (1988) was employed for test of any possible long-term relationship between the both series and the both test methods are well established in literature. Stage two involves the estimated models diagnostic and robustness check.

The LVAR (n, m) seemingly causal models follow the Ordinary Least Square (OLS) method (Agung, 2009). The selection of the models was done with the help of Akaike Information Criteria, while the parameter estimates were interpreted based on statistical, econometrics and economic criteria. The statistical criteria make do with the t-test, and P-value, while the econometric criteria make do with the estimated R^2 and Durbin-Watson statistics to check for spurious regression and, the explanatory power of the selected models. Finally, the sign and magnitudes of the parameter estimates are used to define the nature of the dynamic relationship between underlying variables.

Result and Discussion

We summarize the result for unit root for international crude oil price and Nigerian foreign exchange rate to US dollar on table 3. The unit root test results show the failure for the acceptance of the null hypothesis when the series were 1st difference. Because the series employed in the model were all I(1), the two step cointegration techniques by Engel-Granger (1988) was used to check for cointegrating relationship between the series in the long and sub-period.

Table 3: Unit Root Test

Periods	Variables	Calculated Values	CriticalValues
2002-17	$DlnEXR_t$	-62.913***	-3.4318
	$DlnCOP_t$	-66.5861***	-3.4318
2002	$DlnEXR_{2002}$	-20.5624***	-3.4557
	$DlnCOP_{2002}$	-16.4079***	-3.4557
2003	$DlnEXR_{2003}$	-4.4002***	-3.4562
	$DlnCOP_{2003}$	-7.6684***	-3.4560
2004	$DlnEXR_{2004}$	-24.7833***	-3.4555
	$DlnCOP_{2004}$	-16.8361***	3.4555
2005	$DlnEXR_{2005}$	-16.0696***	3.4556
	$DlnCOP_{2005}$	-19.2586***	-3.4557
2006	$DlnEXR_{2006}$	-16.2192***	-3.4559
	$DlnCOP_{2006}$	-17.6953***	-3.4557
2007	$DlnEXR_{2007}$	-16.1203***	-3.4564
	$DlnCOP_{2007}$	-15.0294***	-3.4567
2008	$DlnEXR_{2008}$	-5.0759***	-3.4565
	$DlnCOP_{2008}$	-16.0951***	-3.4563
2009	$DlnEXR_{2009}$	-8.7509***	-3.4567
	$DlnCOP_{2009}$	-13.4499***	-3.4565
2010	$DlnEXR_{2010}$	-18.5718***	-3.4564
	$DlnCOP_{2010}$	-15.8308***	-3.4564
2011	$DlnEXR_{2011}$	-16.1091***	-3.4564
	$DlnCOP_{2011}$	-19.7684***	-3.4564
2012	$DlnEXR_{2012}$	-5.5038***	-3.4568
	$DlnCOP_{2012}$	-20.8098***	-3.4564
2013	$DlnEXR_{2013}$	-6.9428***	-3.4574
	$DlnCOP_{2013}$	-14.5182***	-3.4564
2014	$DlnEXR_{2014}$	-5.1410***	-3.4570
	$DlnCOP_{2014}$	-8.8085***	-3.4563
2015	$DlnEXR_{2015}$	-15.9300***	-3.4560
	$DlnCOP_{2015}$	-14.3958***	-3.4560
2016	$DlnEXR_{2016}$	-15.6787***	-3.4560
	$DlnCOP_{2016}$	-15.7859***	-3.4560
2017	$DlnEXR_{2017}$	-14.6507***	-3.4559
	$DlnCOP_{2017}$	-16.4534***	-3.4559

Source: Author's Computatioons. **Note:** The lag order (k) was selected using the Akaike information criterion. T-statistics or Critical values are reported. *, ** and *** denote rejection of the null hypothesis at Significant of 10%, 5% and 1% level, respectively for Null Hypothesis for Unit Root , null hypothesis for co-integration and for the significance of the parameters estimated.

Table 4: Co-Integration Test Results

Periods	Variables	Calculated Values	Critical Values	Prob. Values
2002-17	ECM_t	0.8420	-2.86	0.99
2002	ECM_{2002}	-1.8311	-2.87	0.36
2003	ECM_{2003}	-0.3139	-2.87	0.92
2004	ECM_{2004}	-2.96**	-2.87	0.04
2005	ECM_{2005}	-1.3192	-2.87	0.62
2006	ECM_{2006}	-2.91**	-2.87	0.05
2007	ECM_{2007}	-1.5806	-2.87	0.49
2008	ECM_{2008}	-2.3410	-2.87	0.16
2009	ECM_{2009}	-6.9***	-2.87	0.00
2010	ECM_{2010}	-3.17**	-2.87	0.02
2011	ECM_{2011}	-1.6179	-2.87	0.47
2012	ECM_{2012}	-2.3485	-2.87	0.16
2013	ECM_{2013}	-3.5***	-2.87	0.01
2014	ECM_{2014}	-3.5***	-2.87	0.01
2015	ECM_{2015}	-2.66	-2.87	0.08
2016	ECM_{2016}	-1.54	-2.87	0.51
2017	ECM_{2017}	-2.82	-2.87	0.06

Source: Author's Computations. **Note:** The lag order (k) was selected using the Akaike information criterion. T-statistics or Critical values are reported. *, ** and *** denote rejection of the null hypothesis at Significant of 10%, 5% and 1% level, respectively for Null Hypothesis for Unit Root, null hypothesis for co-integration and for the significance of the parameters estimated.

Table 4 summarizes the cointegrating result for international crude oil price and the Naira/US Dollar exchange rates. The ECM is the residual from each equation estimated (sub-period equations and the joint (long-period) equation). The results indicates that there is a cointegrating relationship between international crude oil prices and the Naira/US Dollar exchange rates within the sub-periods of 2004, 2006, 2009, 2013 and 2014. There are no cointegrating relationship between the series in the joint period of 2002 to 2017 and the sub-periods of 2002, 2003, 2005, 2007, 2008, 2010, 2011, 2012, 2015, 2016 and 2017 as shown on table4. The coefficients of the cointegrating relationship were very small (i.e., 3%, 11%, 6%, 11% and 3% in 2004, 2006, 2009, 2013 and 2014 respectively). It implies that the rates of adjustment of the disequilibrium from the short-term to equilibrium in the long-term are quiet slow. We observed that short-term relationships are predominant between the crude oil price and the naira/US Dollar exchange rates, and where there are long-term relationships, the speed of adjustments are very weak.

Table 5: The dynamic relationship between international crude oil price and Exchange Rate

Periods	Variables	Cal. Values	Prob. Values	R ² and DW
2002-17	$DlnEXR_{t-1}$	0.13**	0.0215	R ² =0.0018
	$DlnCOP_t$	-0.009**	0.0452	DW=2.002
2002	$DlnEXR_{t-1}$	-0.22***	0.0002	R ² =0.2004
	$DlnEXR_{t-5}$	0.01***	0.0007	DW=1.945
	$DlnCOP_{t-9}$	-0.02**	0.0340	
2003	$DlnEXR_{t-3}$	0.22***	0.0003	R ² =0.2004
	$DlnEXR_{t-4}$	0.20***	0.0014	DW=1.945
	$DlnEXR_{t-5}$	0.17***	0.0063	
	$DlnCOP_{t-6}$	0.001**	0.0180	
2004	ECM_{t-1}	-0.03***	0.0011	R ² =0.2294
	$DlnEXR_{t-1}$	-0.41***	0.0000	DW=2.049
	$DlnEXR_{t-2}$	-0.13**	0.0001	
	$DlnEXR_{t-5}$	0.23***	0.0331	
	$DlnEXR_{t-6}$	0.13**	0.0063	
	$DlnCOP_{t-6}$	0.0023**	0.0198	
2005	$DlnEXR_{t-1}$	-0.201	0.4049	R ² =0.0329
	$DlnCOP_{t-1}$	-0.003**	0.0451	DW=2.000
	$DlnEXR_{t-8}$	0.25***	0.00013	R ² =0.1219
(Table Cont'd) 2006	$DlnCOP_{t-1}$	-0.005**	0.04860	DW=1.979

2007	$DlnEXR_{t-3}$	-0.21***	0.0021	$R^2=0.0370$
	$DlnCOP_{t-2}$	-0.015**	0.0501	DW=2.005
2008	$DlnEXR_{t-2}$	0.13**	0.0239	$R^2=0.2634$
	$DlnEXR_{t-3}$	0.45***	0.0000	DW=1.995
	$DlnCOP_t$	-0.02**	0.0484	
	$DlnCOP_{t-3}$	0.03***	0.0017	
2009	ECM_{t-1}	-0.1***	0.0000	$R^2=0.4397$
	$DlnEXR_{t-1}$	0.29***	0.0000	DW=1.949
	$DlnEXR_{t-2}$	0.19**	0.0000	
	$DlnEXR_{t-3}$	0.18***	0.0000	
	$DlnEXR_{t-4}$	-0.26***	0.0000	
	$DlnCOP_{t-2}$	-0.02**	0.0131	
2010	ECM_{t-1}	-0.06**	0.0111	$R^2=0.0829$
	$DlnEXR_{t-1}$	-0.14**	0.0318	DW=1.985
	$DlnCOP_{t-2}$	0.01**	0.0350	
2011	$DlnEXR_{t-2}$	-0.26**	0.0375	$R^2=0.0673$
	$DlnEXR_{t-3}$	0.13**	0.0397	DW=2.006
	$DlnCOP_{t-7}$	0.03**	0.0160	
2012	$DlnEXR_{t-4}$	0.18***	0.0036	$R^2=0.0817$
	$DlnEXR_{t-3}$	0.18***	0.0044	DW=1.926
	$DlnCOP_{t-13}$	0.002**	0.0160	
2013	ECM_{t-1}	-0.11***	0.0002	$R^2=0.3521$
	$DlnEXR_{t-2}$	0.45***	0.0000	DW=1.949
	$DlnEXR_{t-3}$	0.23***	0.0002	
	$DlnEXR_{t-5}$	-0.33***	0.0000	
	$DlnCOP_{t-6}$	0.001**	0.0431	
2014	ECM_{t-1}	-0.03***	0.0022	$R^2=0.3269$
	$DlnEXR_{t-1}$	-0.13**	0.0220	DW=1.994
	$DlnEXR_{t-2}$	0.3***	0.0000	
	$DlnEXR_{t-3}$	-0.48***	0.0000	
	$DlnCOP_{t-3}$	-0.03**	0.0169	
2015	$DlnEXR_{t-5}$	0.027	0.0407	$R^2=0.0386$
	$DlnCOP_{t-4}$	-0.07***	0.0093	DW=2.036
2016	$DlnEXR_{t-4}$	0.17**	0.0127	$R^2=0.1386$
	$DlnEXR_{t-6}$	0.097**	0.0410	DW=2.00
	$DlnCOP_{t-3}$	-0.12**	0.0113	
2017	$DlnEXR_{t-3}$	0.14**	0.0323	$R^2=0.0386$
	$DlnCOP_{t-2}$	-0.16***	0.0501	DW=1.989

Source: Author's Computations. **Note:** The lag order (k) was selected using the Akaike information criterion. T-statistics or Critical values are reported. *, ** and *** denote rejection of the null hypothesis at Significant of 10%, 5% and 1% level. The Heij formula was used for the determination of the magnitudes of dynamic multipliers, the study did not depend on the magnitude and sign of the estimated coefficients reported on table5 for interpretations but rather used the estimated coefficients to computes the Heij multiplier, see Heij (2004) and Adam et al., (2015). The study reported only the significant parameters from the estimated models.

The causal relationship between international crude oil price and exchange rate of the Naira/US Dollar are summarized in table5. The coefficients of $DlnEXR_{t-1}$ and $DlnCOP_t$ in the joint period (2002-2017) was statistically significant at the 5% level, the model have a very low R^2 but was free of autocorrelation given a relatively strong Durbin-Watson Statistics. The computed multiplier is +0.13 suggesting a positive dynamic relationship between international crude oil price and the Naira/US dollar exchange rate of the joint period. The positive sign equally suggested that increase in oil prices increases the units of naira required to purchase a unit of the US Dollar within the financial periods. The magnitude of the dynamic multiplier is small, implying an insignificant rate of naira depreciation to the US Dollar within the joint period. The results did not support the theory of Krugman (1983) and Golub (1983) that proposed domestic currency appreciation for oil exporting country in the periods of increased crude oil prices.

In the sub-period we found a mixed direction of dynamism between international crude oil prices and the exchange rate of the Naira to US dollar, the multiplier are negative in the sub-period of 2002, 2004, 2005, 2007, 2010, 2011 and 2014, the respective dynamic multiplier for the sub-periods are -0.21, -0.18, -0.20, -0.21, -0.14, -0.13, and -0.30 respectively; it shows that the naira appreciated to the US Dollar in these periods. The smaller magnitudes of the multiplier show that the appreciation of naira to the US Dollar in these periods was highly insignificant. Whereas a positive multiplier coefficient were observed in the sub-periods of 2003, 2006, 2008, 2009, 2011, 2012, 2013, 2015, 2016 and 2017, and they are 0.59, 0.25, 0.61, 0.39, 0.36, 0.34, 0.03 and 0.12 respectively; it shows that the naira depreciated against the US Dollar in these sub-periods. The depreciating rates were only significant in the sub-periods of 2003, 2008 and 2009. The results show that the computations of the Heij multiplier highly depend on previous information about the Nigerian FOREX and the forcing process. The higher the significant lags of the dependent variables and forcing process included in the models the larger the magnitudes of multiplier. The strong positive relationship found in the year 2008 and 2009 which coincide with the period of global financial crises shows that the Nigerian foreign exchange markets was heavily affected by the global crises even though crude oil prices were relatively higher within this periods (Gbosi 2015 and Medee & Ikue-John, 2017). The study shows that a time lag of 13 days are needed for the dynamic relationship between international crude oil price and exchange rate to occur in Nigeria, for instance it takes about 13 days break in 2012 for dynamic relationship between international crude oil price and exchange rate to occur whereas the sub-period of 2005 required no break days for the dynamic relationship between international crude oil price and the exchange rate to occur in Nigeria.

Conclusions

This paper examined the dynamic relationship between international crude oil price and the Naira exchange rate in Nigeria using daily averages (data) from 1st January 2002 to 31st December 2017. The study originally intended to use any of the models in the volatility family to model the dynamic relationship between the series but discovered that the daily exchange rate of the naira to US dollar did not meet the underlining condition for employing any of the models in the volatility family since there was no ARCH effect and volatility clustering. Hence, this study used Agung (2009) LVAR model and Ender (2004) multiplier to model the dynamic relationship between the both series. The data employed in the model are divided into 17 groups in order to examine the short-run and long-run effect of international crude oil price on the Naira US dollar exchange rate in Nigeria. Based on the analysis the following findings are made:

- i. *The behavioral test shows that the series were I(1) and, cointegrating relationship was observed in the sub-period 2004, 2009, 2013 and 2014 whereas the trend in the series shows evidence of no cointegrating relationship in the long-term and in the sub-periods outside 2004, 2009, 2013 and 2014.*
- ii. *The dynamic multipliers are very small, except in 2003, 2008 and 2009, implying a weaker relationship between international crude oil prices and the behaviour of the foreign exchange index (Naira/US Dollar exchange) in Nigeria. It was equally observed that in 2003, 2008 and 2009 previous information about oil price and exchange rates were included in the model. That is, previous information about the crude oil market and exchange rates should be the main factors to be considered in modeling the the dynamics of oil prices and exchange rates in Nigeria.*
- iii. *The overall models show that the dynamic relationship between international crude oil price and the Naira exchange rate in Nigeria was not significant both in the long-run and the sub-period. The coefficient of dynamism was positive and insignificant in the long-run but show a mixed coefficient and insignificant dynamic relationship in the sub-periods.*

Since Nigeria is a mono-product-export economy and the main source of foreign exchange in the economy is gotten from crude oil which is the mono-product, a disturbance in the prices of crude oil is expected to have impacted significantly on the exchange rate but the study shows otherwise. Thus, the study recommends periodic intervention in the FOREX market by the monetary authorities as to stabilize the market against any shocks in the international crude oil market.

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