Binus Business Review, 7(1), May 2016, 1-7
DOI: 10.21512/bbr.v7i1.1427
P-ISSN: 2087-1228
E-ISSN: 2476-9053

FOREIGN TRADE-FOREIGN EXCHANGE NEXUS IN NIGERIA: A VECTOR ERROR CORRECTION MODELLING APPROACH

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Received: 25th February 2015/ **Revised:** 6th March 2015/ **Accepted:** 6th April 2016

How to Cite: Awe, O.O., Akinlana, D.M., & Adesunkanmi, S.O. (2016). Foreign Trade-Foreign Exchange Nexus in Nigeria: A Vector Error Correction Modelling Approach, *Binus Business Review, 7*(1), 1-7.
http://dx.doi.org/10.21512/bbr.v7i1.1427

ABSTRACT

Article investigated trade foreign exchange nexus in Nigeria. This study was also done with a view to detecting the kind of relationship that exists between the two and also to investigate their co-integration. Annual time series data for the period 1996 – 2010 was used for the study. The Vector Correction Model (VECM) approach was employed to determine both the short and long run relationships. Results show that the series becomes stationary after second difference. The co–integration test reveals five co–integrating vectors in the model, implying the variables have the same stochastic drift. The study concludes that a long-term relationship exists between foreign trade and exchange rates implying that foreign trade flows have a strong link with exchange rates in Nigeria.

Keywords: foreign trade, foreign exchange, vector error correction model

INTRODUCTION

The world is in a globalised state and the economy of all the countries of the world are linked directly or indirectly through assets, goods and services. Thus, it suffices to state that there is rarely any country in absolute a closed economy with other countries. This linkage between the world economies is made possible through the activities of trade and foreign exchange. The potential of the Nigerian market like many other low-income open economies in international trade participation has been a growing subject of interest among policy makers and researchers as the subject of foreign trade perceived as a vital tool for economic development. The immense benefits of this subject have been realized in many countries of the world, both developed and developing countries alike. Trade has been accepted as a tool for economic growth due to its potential for improving the standard of living and increasing the per capita income, as well as Gross Domestic Product (GDP) of the economy (Afaha & Oluwatobi, 2012). However, trade is not only a desirable tool for economic growth but also inevitable as countries have to provide for the continuous needs of their economies. Foreign trade is an engine of economic growth and it provides coherent ways to create alliances with other nations (Azeez et. al., 2014).

Moreover, until the mid50's, the agricultural community-mainly cocoa, round nuts, palm oil and palm kernels make up the most important exports commodity for most developing countries, especially for the Nigerian economy before the discovery of oil.

However, the oil boom of the 70's result in neglecting other sectors such as agriculture and manufacturing by an unhealthy overdependence on crude oil and thus reducing the overall productivity of the Nigerian economy. Although, up to the end of 2004, oil and gas contributed an increasing proportion of exports accounting for more than 98% of export earnings and about 90% of Federal Government revenue. According to Centre for Intelligence Agency (CIA), oil and natural gas are still the most important export products for the Nigerian economy and over dependence on these commodities made Nigeria particularly vulnerable to world price fluctuations.

As a result of this, economic and trade reform have been put in place by the Nigerian government to diversify the export base and to ensure that foreign trade serves as a driving force for the economic growth engine. Foreign currencies in terms of a local currency, that is, foreign exchange is an important factor to understand the growth rate of all countries of the world and the recent devaluation of naira in 2014 as announced by the governor of Central Bank of Nigeria (CBN) served as a part of measures aimed at strengthening the nation's economy.

The importance of foreign trade in the development process has been of interest to economists and policy makers. Imports and exports are key parts of foreign trade and the import of capital goods, in particular, is vital to economic growth. The oil boom of the 1970s was accompanied by a huge inflow of foreign exchange revenues and thus diverted the attention of the Nigerian government from its traditional agricultural commodities to crude oil exploitation. A substantial number of the producers of these agricultural commodities moved into activities aimed at exploiting the economic opportunities created by increased oil revenues. This development not only brought about the decline in agricultural production, but also the resultant drop in both volume and value of export commodities. The resultant effect of this is a mono-product economy with the national revenue more than eighty percent of crude oil earnings alone (Osisanwo & Okuneye, 2015).

From 1970 to 1985 before the oil boom, Nigeria operated a controlled exchange rate regime where exchange rate of the naira was pegged to the dollar. Following the oil glut of the early 80's, another era in the history of Nigerian Exchange Rate system began in 1986.It then became clear that Nigerian economy could not sustain the fixed exchange regime because its foreign reserves were not only depleted but foreign debt had also mounted. As an integral part of the Structural Adjustment Programme introduced in 1986 by the Babangida administration, the country adopted a flexible exchange rate through the Second Tier Foreign Exchange Market (SFEM). As evident, in the study of Isard (2007), the right positioning of exchange rates has a critical influence on the rate of growth of per capita output in low-income countries. Thus, it should not be relegated, to this submission, we considered the dollar-naira and pounds-naira exchange rates for this study because the UK and the United States are the two largest trade partners in Nigeria.

Onafowora and Owoye (2008) examined the impact of exchange rate volatility on Nigeria's exports to its most important trading-partner– the United States using quarterly data from January 1980 to April 2001. They employed the cointegration and vector error correction (VECM) framework. Their results show the presence of a unique cointegrating vector, in the long run, linking real exports, real foreign income, relative export prices and real exchange rate volatility. Also, increased volatility of the real exchange rate raised uncertainty about profits to be made which exert significant negative effects on exports both in the short- and long-run. Their results also show that improvements regarding trade (represented by declines in the real exchange rate) and real foreign income exert positive effects on export activity.

Obiora-Ilouno and Mbegbu (2013) suggested multivariate linear regression technique to examine the effect of foreign trade on foreign exchange rate of Naira using bootstrap approach. Their result shows that exchange rate of dollar and pounds sterling contributed 68% effect on the Nigerian foreign trade while the rest may be attributed to chance. Several methodologies have been used to characterize the relationship between foreign trade and foreign exchange rate in literature. While some of them are quite simplistic in nature, others are conceptually quite complex. All of them, however, involve some conceptual simplifications.

It is an established fact that developing economies of the world, Nigerian inclusively has experienced an increased trend lately concerning the relationship between foreign trade and exchange rate and few studies have been done in this light. Article aims to contribute to related studies; by applying time series techniques on the Nigerian data set in determining the long-run relationship between exchange rate behavior and trade balance. Given this, the nexus that exists between foreign trade and foreign exchange rates takes a central place in the literature as it is a question of concern for governments and policy makers. Hence, we examined the relationship and co-integration that exists between these variables using Vector Error Correction Modelling (VECM) Approach.

Methodology of Gunes (2013) was adopted on the Turkish data; that is the co- integration and Vector Error Correction Model (VECM) procedures on monthly Nigerian data covering the period of 1960 to 2010. The VECM methodology applied in this work is expected to establish in clear terms the stable long-run relationship between foreign trade and exchange rate in Nigeria, to investigate the nature of this relationship and provide policy suggestions on short-term and long-term exchange rate trade nexus in Nigeria. The rest of the paper is structured as follows: section 2 presents the method used to achieve the set objectives; section 3 reports the results and discussion of the results while section 4 renders the conclusions.

METHODS

Usually, most economic variables are non-stationary. The first step in this research is to test for stationarity (unit root test) between the variables before generalising any relationship. Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) tests were applied to test for the presence of unit roots. For the ADF test, the test regression is given as:

$$y_t = \beta y_{t-1} + \varepsilon_t \quad (1)$$

The hypothesis is written as:

$$H_0 : \beta = 1$$

There is a unit root, implying that y_t is non-stationary

$$H_0 : \beta < 1$$

There is no unit root; therefore, the series is stationary

The null hypothesis is rejected if the calculated t-value (ADF statistics) lies to the left of the relevant critical value. However, the Phillips-Perronunit root test differs from the ADF tests mainly in how they deal with serial correlation and heteroscedasticity. In particular, where the ADF tests use a parametric autoregression to approximate the ARMA structure of the errors in the test regression, the PP tests ignore any serial correlation in the test regression. The test regression for the PP tests is given as:

$$\Delta y_t = \beta^{'} D_t + \pi y_{t-1} + \varepsilon_t \quad (2)$$

Where ε_t is I(0) and may be heteroscedastic. The PP test statistics have the same asymptotic distributions as the ADF statistics and one advantage of the PP tests over the ADF tests is thatthe PP tests are robust to general forms of heteroscedasticity in the errorterm ε_t.

Granger and Newbold (1974) pointed out that a test of linear regression on non-stationary variables leads to the spurious result and may often suggest a statistically significant relationship between variables where none in fact exists. When the data is non-stationary purely due to unit roots, they could be brought back to stationarity by the linear transformation of differencing. If a series must be differenced d times before it becomes stationary, then it contains d unit roots and is said to be integrated of order d, denoted by I (d). Let y_t be an n×1 set of I (1) variables. In general, any linear combination will also be I (1) for arbitrary a ≠ 0. This concept, introduced by Granger (1980) has turned out to be extremely important to economist and financial analyst to test plausible economic relationships under the hypothesis of a long-run equilibrium between non-stationary economic time series.

The non-stationarity of most econometric variables often result in spurious results, unreliable inference and even misleading reports, thus the need to apply techniques in econometric analysis such as error correction modelling is expedient. While co-integration captures equilibrium long-run relationships between variables, error correction mechanism is a means of reconciling the short-run behaviour of an economic variable with its long-run behaviour (Gujarati & Sangeetha, 2007). Engle and Granger (1987) popularised the error correction model (ECM) as a test that treats the error term as an equilibrium error. That is, it uses this error term to tie the short run behaviour of a variable to its long-run value.

In an error correction model, the changes in a variable depend on the deviations from some equilibrium relation. Suppose, for instance, that y_t represents the price of a commodity in a particular market and x_t is the corresponding price of the same commodity in another market. Assume furthermore that the equilibrium relation between the two variables is given by $y_t = \beta x_t$ and the changes in y_t (i.e. Δy_t - y_t - y_{t-1}) depend on the deviation from this equilibrium in period (t-1). The ECM is given by:

$$\Delta y_t = \alpha_1 \left(y_{t-1} - \beta_1 x_{t-1} \right) + u_{yt} \quad (3)$$

A similar relation may hold for x_t:

$$\Delta x_t = \alpha_2 \left(y_{t-1} - \beta_1 x_{t-1} \right) + u_{xt} \quad (4)$$

In a more general error correction model, the Δy_t and Δx_t may also depend on previous changes in b oth variables as given in the models below:

$$\Delta y_t = \alpha_1 \left(y_{t-1} - \beta_1 x_{t-1} \right) + \gamma_{11} \Delta y_{t-1} + \gamma_{12} \Delta x_{t-1} + u_{yt} \quad (5)$$

$$\Delta x_t = \alpha_2 \left(y_{t-1} - \beta_1 x_{t-1} \right) + \gamma_{21} \Delta y_{t-1} + \gamma_{22} \Delta x_{t-1} + u_{xt} \quad (6)$$

In this study, we employed vector error correction models on the selected six Nigerian economic variables: Naira-US dollars exchange rate (USD), Naira-Pounds exchange rate (GBP), Oil Import (OI), Non-Oil import (NO), Oil Export (OE) and Non-Oil Export (NE) to determine the short run relationship between the variables.

RESULTS AND DISCUSSIONS

The data used in article were obtained from the Central Bank of Nigeria Bulletin 2010. Specifically, we used the same data analysed in Obiora-Ilouno and Mbegbu (2013).The data were analysed using E-views 7 software.

Figure 1 is supplied in order to get a prior idea about the six different variables considered in the article before any unit root test was performed. Interestingly enough, it can be seen that the US dollars and non-oil importation move quite together in an upward trend. Figure 1 however, also shows that increased exportation of non-oil products that is locally produced goods is not significant in the Nigerian economy.

For the ADF and PP tests, the null hypothesis is rejected if the calculated t-value (statistics) is less than the critical value. The results in Table 1 below show that the existence of unit root (i.e., nonstationarity) can't be rejected when all the series are in levels.

This means that none of the variables are stationary in levels, however, when the variables are converted to their second differences, they become stationary and can be considered as integrated of order two, I(2).

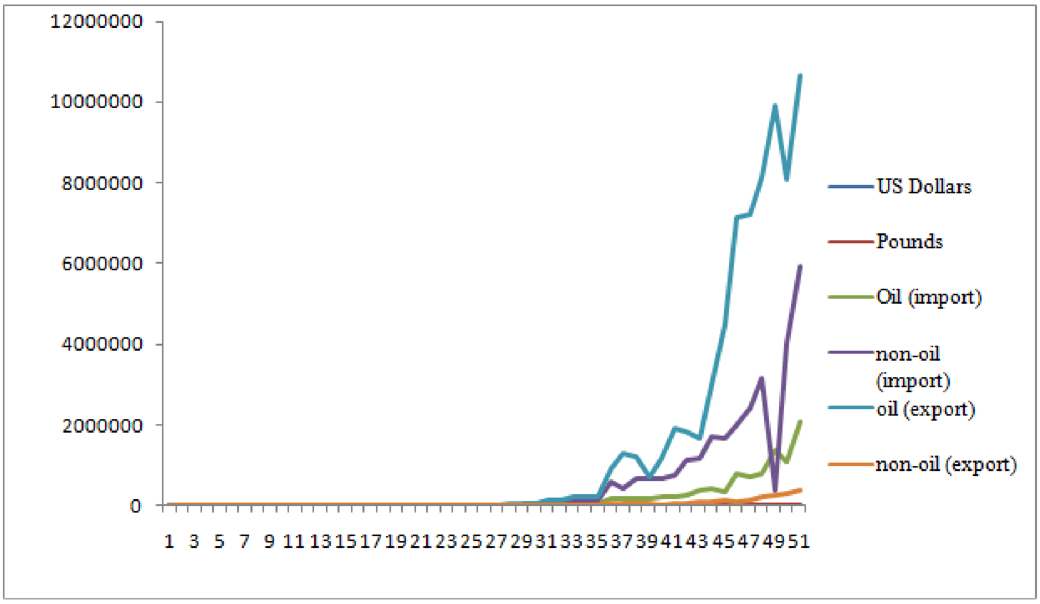

Figure 1 Plot of Each Variable

Table 1 Unit Root Test Results

Variables	Form	ADF TEST				PP TEST			
		P-value	Test statistics	Critical-Value		P-value	Test statistics	Critical-Value	
				1%	5%			1%	5%
US Dollar	Level	0.9959	0.9869	-3.5683	-2.9212	0.9942	0.8670	-3.5683	-2.9212
	1stDiff.	0.0203	-3.3007	-3.5744	-2.9238	0.0000	-6.9436	-3.5713	-2.9224
	2n^{d}Diff.	0.0006	-4.6083	-3.6105	-2.9389	0.0001	-21.5395	-3.5744	-2.9238
Pounds	Level	1.0000	2.4356	-3.6056	-2.9369	0.9847	0.4886	-3.5683	-2.9212
	1stDiff.	0.0066	-3.7304	-3.5744	-2.9238	0.0000	-7.4203	-3.5713	-2.9224
	2ndDiff.	0.0001	-5.3015	-3.5847	-2.9281	0.0001	-58.9053	-3.5744	-2.9238
Oil import	Level	1.0000	3.6923	-3.5885	-2.9297	1.0000	8.7656	-3.5683	-2.9212
	1stDiff.	1.0000	3.6381	-3.5811	-2.9266	0.0000	-10.5251	-3.5713	-2.9224
	2ndDiff.	0.0482	-2.9442	-3.5847	-2.9281	0.0001	-34.5368	-3.5744	-2.9238
Non oil import	Level	0.9977	1.2019	-3.5885	-2.9297	1.0000	2.7263	-3.5683	-2.9212
	1stDiff.	0.6614	-1.2121	-3.5811	-2.9266	0.0000	-8.3583	-3.5713	-2.9224
	2ndDiff.	0.0000	-5.6242	-3.5847	-2.9281	0.0000	-17.9165	-3.5744	-2.9238
Oil export	Level	0.9999	2.3037	-3.6055	-2.9369	1.0000	3.5959	-3.5683	-2.9212
	1stDiff.	1.0000	5.8796	-3.6105	-2.9389	0.0000	-7.3396	-3.5713	-2.9224
	2ndDiff.	0.0000	-6.7108	-3.5847	-2.9281	0.0001	-31.8450	-3.5744	-2.9238
Non oil export	Level	1.0000	5.3183	-3.5885	-2.9297	1.0000	33.4206	-3.5683	-2.9212
	1stDiff.	1.0000	6.7055	-3.6056	-2.9369	0.6900	-1.1462	-3.5713	-2.9224
	2ndDiff.	0.0018	-4.1978	-3.5847	-2.9281	0.0000	-11.0893	-3.5744	-2.9238

Next, we performed a co-integration test to see the possible long-run relationship among the variables. Following the test, if the series are found to be co-integrated, a Vector Error Correction Model (VECM) was constructed to further check on the behaviour of the series.

In this work, Johansen and Juselius (1990) testing procedures was applied on the differenced data.The procedure of the analysis involves two test statistics to detect the number of co-integrating vectors.They are called trace andmaximum eigenvalue test statistics. Given that T represents the sample size and λ_j, the largest canonical correlation under trace, the trace statistics is given as:

$$\lambda_{trace} = T \sum_{i=r+1,n} \ln(1-\lambda_i)t \tag{7}$$

The null hypothesis for the trace test states that there are at most r number of co-integration against the alternative of n co-integrating vectors. However, the maximum Eigen value test uses the relationship:

$$\lambda_{\max} = -T \ln(1-\lambda_{r+1}) \tag{8}$$

with the null hypothesis same as that of trace above against the alternative hypothesis of r+1.

From the results of Johansen-Juselius co-integration tests for the series given in Tabl e 2 above, the trace and maximum eigen value test statistic leads to the rejection of the null hypothesis of r = 0 (no co-integrating vectors) against the alternative hypothesis of r > 0 (one or more co-integrating vectors) since the trace test statistic of 643.4053 is greater than its 5% level of 95.7536. This also follows from the null hypothesis of r ≤ 1, r ≤ 2, r ≤ 3 and r ≤ 4 respectively, which has to be rejected for the alternative hypothesis of r = 2, r = 3, r = 4 and r = 5. At the 0.05 level of significance, both the trace and maximum Eigen value test indicate 5 CE's (co-integrating equations). From the previous, therefore, it can be deduced that there are at least five co-integrating vectors in the model, implying that the variables considered for this study (US dollar, Pounds, Oil import, Non-oil import, Oil export and Non-oil export) share the same stochastic drift and tend to move together. This means that there is a long-run relationship between the variables (Enders & Lee, 2004).

Engle and Granger (1987) clearly pointed out that co-integrated series have an error correction representation, and as such, the possibility of the estimated regression being spurious is ruled out. Since the variables considered for this study are co-integrated, we proceed to determine the short-run properties of the series and the direction of causality, in Granger sense, among the variables by utilising some vector error correction equations. The related vector error correction model (VECM) is table 3.

Table 2 Johansen-Juselius Co-integration Test Results

No of CE's		λ_{trace}			λ_{max}		
Null Hypothesis	**Alternative Hypothesis**	**Test stat.**	**C.values**	**p-values**	**Test stat.**	**C.values**	**p-values**
$r = 0$	$r = 1$	643.4053	95.7536	0.0001*	267.5813	40.0776	0.0001*
$r \leq 2$	$r = 3$	225.2198	47.8561	0.0001*	123.1137	27.5843	0.0000*
$r \leq 3$	$r = 4$	102.1061	29.7971	0.0000*	66.2709	21.1316	0.0000*
$r \leq 4$	$r = 5$	35.8352	15.4947	0.0000*	33.2386	14.2646	0.0000*
$r \leq 5$	$r = 6$	2.5966	3.8415	0.1071	2.5966	3.8415	0.1071

*denotes rejection of the Hypothesis at 5% significance level.

The test indicates five co-integrating equation(s) at the 5% significance level.

$$\Delta \ln USD_t = \beta_0 + \beta_1 \ln GBP_t + \beta_2 \ln OI_t + \beta_3 \ln NO_t + \beta_4 \ln OE_t + \beta_5 \ln NE_t + \beta_6 E_{t-1} + \varepsilon_{1t} \tag{9}$$

$$\Delta \ln GBP_t = \alpha_0 + \alpha_1 \ln USD_t + \alpha_2 \ln OI_t + \alpha_3 \ln NO_t + \alpha_4 \ln OE_t + \alpha_5 \ln NE_t + \alpha_6 E_{t-1} + \varepsilon_{2t} \tag{10}$$

$$\Delta \ln OI_t = h_0 + h_1 \ln GBP_t + h_2 \ln USD_t + h_3 \ln NO_t + h_4 \ln OE_t + h_5 \ln NE_t + h_6 E_{t-1} + \varepsilon_{3t} \tag{11}$$

$$\Delta \ln NO_t = \delta_0 + \delta_1 \ln GBP_t + \delta_2 \ln USD_t + \delta_3 \ln OI_t + \delta_4 \ln OE_t + \delta_5 \ln NE_t + \delta_6 E_{t-1} + \varepsilon_{4t} \tag{12}$$

$$\Delta \ln OE_t = \varphi_0 + \varphi_1 \ln GBP_t + \varphi_2 \ln USD_t + \varphi_3 \ln NO_t + \varphi_4 \ln OI_t + \varphi_5 \ln NE_t + \varphi_6 E_{t-1} + \varepsilon_{5t} \tag{13}$$

$$\Delta \ln NE_t = \phi_0 + \phi_1 \ln GBP_t + \phi_2 \ln USD_t + \phi_3 \ln NO_t + \phi_4 \ln OE_t + \phi_5 \ln OI_t + \phi_6 E_{t-1} + \varepsilon_{6t} \tag{14}$$

Where Δ is the first difference operator, E is the error correction term, $\beta, \alpha, h, \delta, \varphi, \phi$ are parameters to be estimated. The coefficients of E_{t-1} capture the speed of adjustments of Δ 1n *USD*, Δ 1n *GBP*, Δ 1n *OI*, Δ 1n *NO,* Δ 1n *OE*, and Δ 1n *NE* towards long-run equilibrium levels. Since it E_{t-1} is derived from the long run co-integrating relationships, the error correction terms provide long run causal relationships in the equations.

The result presented in Table 3 showed the estimated error correction terms in all the cases.

The significant and negative signs cases indicate that the convergence to the equilibrium state is achieved in the long run. This implies that there is a negative and statistically significant relationship between the following variables; US dollar and oil exports, US dollar and non-oil exports, pounds and US dollar, pounds and oil imports, pounds and non-oil imports, pounds and oil exports, pounds and non-oil exports, oil import and US dollar, oil import and non-oil import and oil import and non-oil export. The result explains an increase in US dollar rate (depreciation or devaluation) by one percentage point, the oil export depreciates by -6.47E-18 and -8.39E-19 percentage points in the first and second year lag periods respectively.

Table 3 Results from the Vector Error Correction Model (VECM)

Coefficients of all VEC Equations

variables	Eqn.1	Eqn.2	Eqn.3	Eqn.4	Eqn.5	Eqn.6
E_{t-1}	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
USD(-1)	-2.63E-13	-5.42E-16	-2.55E-10	-1.93E-10	-3.05E-09	-1.46E-10
USD(-2)	-8.81E-13	-8.36E-14	1.90E-09	1.25E-08	-6.72E-09	-4.62E-10
GBP(-1)	1.65E-13	-1.01E-14	2.01E-10	1.03E-09	2.87E-09	7.37E-11
GBP(-2)	6.36E-13	5.15E-14	-1.40E-09	-8.76E-09	4.68E-09	3.51E-10
OI(-1)	3.97E-17	-8.75E-19	-2.10E-14	-1.95E-13	-4.36E-13	2.62E-14
OI(-2)	4.20E-17	7.47E-18	-6.51E-14	-3.39E-13	4.51E-13	2.00E-14
NO(-1)	-2.42E-18	-7.73E-19	-2.59E-16	-4.95E-14	1.46E-13	-4.97E-15
NO(-2)	-5.04E-18	-1.27E-18	4.55E-15	-1.08E-13	-7.22E-14	2.65E-16
OE(-1)	-6.47E-18	6.69E-19	1.13E-14	9.69E-14	1.23E-14	-3.16E-16
OE(-2)	-8.39E-19	-9.47E-19	-2.39E-15	1.06E-14	-1.33E-13	-1.38E-15
NE(-1)	-2.32E-17	2.67E-17	-2.16E-13	7.77E-14	3.02E-12	-4.02E-15
NE(-2)	-2.19E-16	-4.88E-17	3.79E-13	2.32E-12	-2.49E-12	-1.04E-13
C	-3.37E-13	-5.10E-14	5.55E-10	4.92E-09	-3.72E-09	-2.05E-10

CONCLUSIONS

Article examined foreign trade nexus foreign exchange in Nigeria using vector error correction modelling approach proposed by Engle and Granger (1987) and corresponding test for co-integration. ADF and PP unit root test results show that the series were non-stationary in levels, but were stationary after differencing twice. The co-integration test results reveal that all the six variables; US dollar, pounds, oil import, non-oil import, oil exports and non-oil exports are co-integrated. The Vector Error Correction Model (VECM) estimates from equations in section error correction model indicate that most of the explanatory variables' estimated coefficients, showing short run dynamics, are statistically significant. Our results for the Nigeria data support that of Gunes (2013) for the Turkish economy.

Strategic policies should be put in place to enable the Nigerian economy to maintain a stable foreign currency exchange rate with the US dollar and pounds since there is a negative relationship between the exchanges rates (pounds and US dollar) and international trade (import and export). This means that oil and non-oil importation and exportation depend on dollar-naira and pound-naira exchange rates. It is suggested for the government to initiate measures to ensure that exportation of oil has an appreciable exchange rate with dollars. Furthermore, it is recommended that policies and measures should be put in place to check excessive importation which is not good for the economy. Nigeria's refinery should be resuscitated to aid production of natural gas since oil import negatively affects oil and non-oil export. Also, non-oil export has a negative relationship with oil export, hence, it is suggested that the policies should be implemented to encourage exportation of non-oil products as this would make the economy buoyant and increase foreign exchange rate. In the long run, t he effects of exports and imports on exchange rates need some closer consideration, as the estimated results show the presence of such relationship.

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