International Journal of Commerce and Management Research
ISSN: 2455-1627; Impact Factor: RJIF 5.22
Received: 12-11-2018; Accepted: 13-12-2018
www.managejournal.com
Volume 5; Issue 1; January 2019; Page No. 70-76

Exchange rate volatility and Nigeria's trade balance: New evidence from VECM

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Abstract
This study investigates the impact of Exchange rate fluctuations on trade balance in Nigeria over the period of 1981-2016 using time series data. The study uses trade balance, exchange rate and inflation as variables for the model. The Vector Error Correction framework is employed to empirically investigate the relationship between exchange rates and trade balance. The co-integration test confirms that there is a long run relationship between trade balances and exchange rates. The findings from the Vector Error Correction Estimate indicate that exchange rate volatility positively and significantly impacted Nigeria's trade balance over the period of analysis. This could be interpreted as an evidenced-based rationalization of the current managed- float system in Nigeria. Based on the findings from the study, proper management of the exchange rate is therefore recommended to ensure exchange rate stability that will support development in the tradable goods sector.

Keywords: trade balance, exchange rate volatility, Nigeria, VECM

1. Introduction

The exchange rate is an important macroeconomic variable that is used as a parameter for determining international trade competitiveness of any economy. The fluctuation of the exchange rate can lead to currency appreciation or depreciation with important implication for a country's external reserve position. Globally, the world's total external reserves grew to \$9.7 trillion in 2010 and then to \$12.2 trillion in 2014. Within the same period, Nigeria's reserves peaked at \$64 billion in 2008 before the global financial crisis and dropped to \$31.7 billion in late 2011 and dropped to lowest at \$23.7 billion in late 2016. In terms of the naira-dollar exchange rate during the period, the U.S dollar increased to 165.80 Nigerian naira in October 2014 from 163.85 naira in September of 2014. The naira averaged 122.44 between 1960 and 2014, reaching an all-time high of 165.80 in October 2014 and a record low of 0.53 in September of 1980. More recently, one dollar is exchanged for as high as NGN360 in the parallel market and 280 naira as the official rate (CBN 2004, 2017). The indication is that volatility in the naira exchange rate under the current managed float may have become a prominent stylized feature in the currency market but not without exchange rate risk or worse still, uncertainty. Historically, fluctuation in the naira exchange rate had resulted partly from the implementation of the World Bank-designed Structural Adjustment Program (SAP) that required free-market adjustments in the foreign exchange market. The main objective of SAP was to restructure the production base of the economy with a positive bias for the production of agricultural exports. The foreign exchange reform that facilitated a cumulative depreciation of the effective exchange rate was expected to increase the domestic prices of agricultural exports and therefore boost domestic production (Adeniran *et al*, 2014) [1].

Expectedly, the strength of the Nigerian currency (naira) depends primarily on the productive capacity of the country. Foreign currency is required for making payments to other countries for goods and services, and for interest payments on loans. Thus, Nigeria's demand for US dollars, British sterling, French Francs and Japanese Yen is largely derived from Nigeria's demand for American, British, French and Japanese goods respectively. Nigeria's supply of these currencies is earned by its exports to those countries. Under the flexible exchange system, the exchange rate is determined by the interplay of the forces of demand and supply – with an increase in imports leading to increasing demand for the foreign currency of the exporting country while an increase in exports leads to increase in the supply of that foreign currency. The level of foreign exchange of a given nation is said to be an important indicator of the pattern of its economic development (Loto, 2011) [21]. Developing economies are consistently facing an important policy issue with respect to the fluctuations of exchange rates and its subsequent impact on the trade balance. Large trade deficits imply choosing between exchange rate devaluation and the internal or external financing of the deficit, which are challenging policy decisions to undertake, manage or sustain, especially in the long run for a developing country like Nigeria (Agbola, 2004) [11].

These problems appear to be compounded by the risk created by exchange rate volatility [38]. However, the arguments abound that the effects of exchange rate fluctuations on trade balances can be minimized. In modern cross-border transactions, in particular, firms often decide to hedge against the risk in the exchange rate or to bear the cost associated with possible exchange rate fluctuations as part of their export strategy. Regrettably, the spot and forward market in Nigeria has been found to be weak and incapable of providing a substantial cushion against any such risks. Therefore, since currency crisis and crashes in the stock market are potential consequences of the real risks and transaction cost associated with exchange rate volatility, endeavouring to understand the interplay between exchange rate volatility and trade balance becomes imperative and apt.

The objective of this paper is to investigate the impact of exchange rate volatility on Nigeria's trade balance. A study of this nature is important in some folds. Given the contemporary wave of economic (trade and financial) globalization sweeping across developing countries of the world, understanding the impact of exchange rate volatility on Nigeria's trade relationships becomes compelling as it will supply lessons for policy.

Following the introduction, the balance of the paper is structured as follows. Section two presents an eclectic review of literature – focusing particularly on the relationship between exchange rate volatility and trade balance. In section three, we lay out the methodology – including the specification of the VAR, VECM and Granger causality frameworks used for the empirical analysis. Section four discusses the result while section five concludes the paper with some lessons for policy.

2. Brief Literature

The literature on the impact of exchange rate on trade, according to Damoense and Agbola (2005), can be broadly classified into three categories; the Elasticity approach, the Monetary Approach and the Absorption Approach. While the elasticity approach focuses on the role of exchange rate as the major determinant of trade balance, the absorption approach stresses the role of income and postulates that an increase in home income relative to the income of trading partners would lower the trade balance due to increased demand for imports. The monetary approach emphasizes the role of money, particularly the effect resulting from devaluation. In the monetary approach, devaluation decreases the real supply of money, resulting in an excess demand for money which leads to hoarding and an improvement in the trade balance. The monetary approach also points out the role of interest rates in the domestic economy and its influence in attraction of capital. Lower real interest rates lead to a reduction in domestic investment by foreigners, resulting in a decrease in demand for the nation's currency. (see Khan and Hossain, 2010).

The elasticity approach according to Robinson (1947) [34] and Meltzer (1948) and popularized by Kreuger (1983) posits that transactions under contract completed at the time of devaluation or depression may dominate a short-term change in trade balance, causing it to deteriorate in the short term. In the long run (as elasticities of exports and imports rise), the adjustment in export (increases) and import (fall) quantities causes the demand for imports to fall after substantial lags and subsequently results in an improvement in the trade balance of devaluating country.

The Monetary approach according to Mundell (1971) [24] and Dornbusch (1973) [12] and popularized by Frienkel and Rodrigue (1975), is based on the argument that devaluation reduces the real value of cash balances and/or changes in the relative price of traded and non-traded goods, and causes the trade balance to improve. However, higher import prices after devaluation may contribute to higher overall domestic prices of non-traded goods and consequently impact negatively on the trade balance Williams (1985) [37], Upadhaya and Dhakah (2004). Also, according to an alternative monetarist view, an increase in money supply raises real incomes and simulates import demand and consequently deteriorates the trade balance, income absorption effect.

The absorption approach according to Alexander (1952) [5] and Johnson (1967) [20] and popularized by Miles (1979) [23] posits that the devaluation of a country's currency may cause the terms of trade to deteriorate, scratching expenditure away from foreign goods to domestically produced ones, and thereby improve the trade balance of that country.

Regarding empirical literature**, s**cholars have shown an appreciable level of interest trying to unravel the interaction between exchange rate fluctuations and trade balance in Nigeria, Ojo (1978) [28] on the effect of exchange rate on the country's trade balance suggested that exchange rate changes do not play any significant role in the explanation of Nigerian import-export balance. Rano-Aliyu (2010) [33] quantitatively assessed the impact of exchange rate volatility on non-oil export flows in Nigeria, employing fundamental analysis where the flow of non-oil exports from the Nigerian economy is assumed to be predicated on fundamental variables: the naira exchange rate volatility, the US dollar volatility, Nigeria's Terms of Trade (TOT) and Index of Openness (OPN). The co-integration results revealed that non-oil exports and the fundamental variables had a stable long-run equilibrium relationship. With the use of quarterly data for a twenty year period, it was shown from the vector co-integration estimates that the naira exchange rate volatility decreased non-oil exports by 3.65%, while the same estimate for the US dollar volatility increased export of non-oil in Nigeria by 5.2% in the year 2003.

Onafowora and Owoye (2008) [30] 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 co-integration and vector error correction (VECM) framework. The empirical analysis points to the presence of a unique co-integrating 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 in the terms of trade (represented by declines in the real exchange rate) and real foreign income exert positive effects on export activity. Most importantly, they found that the trade liberalization and economic reform policies implemented in the post-1986 structural adjustment period contributed to Nigeria's export performance. Overall, the findings suggest that Nigeria's exporting activities can be further boosted by policies aimed at achieving and maintaining a stable competitive real exchange rate.

Omojomite and Akpokodje (2010) investigated the effect of exchange rate reforms on Nigeria's trade performance during the period 1986-2007. The study was carried out given that exchange rate reform (combined with trade policy reforms) under Nigeria's economic reform programme which was anticipated to diversify the export base of the economy from oil to non-oil exports through competitiveness in the relative price of non-oil exports in addition to reducing imports, especially of consumer goods. It finds a small positive effect of exchange rate reforms on non-oil exports when the value of the country's currency is reduced via depreciation. However, the structure of imports which is pro-consumer goods remained unchanged even after the adoption of exchange rate reforms. Contrary to expectation, exchange rate reforms were found to stimulate imports rather than constrain it, even though in an insignificant manner.

Oyinlola *et al.*, (2010) [32] examined the long-run and short-run impacts of exchange rate and price changes on trade flow in Nigeria using exports and imports functions. The bounds testing (Autoregressive distributive lag model) approach to co-integration was applied on a quarterly data from 1980Q1 to 2007Q4. The results indicate that in the short-run and long-run, Nigeria's trade flows are majorly influenced by relative prices, domestic and foreign income, nominal effective exchange rates and the stock of external reserves. It was also revealed by the result that in the long-run, devaluation is more effective than relative prices in altering imports demand at both the baseline and augmented models. In exports demand, however, the reverse is the case.

Shehu and Youtang (2012) [35] examined the causal relationship between exchange rate volatility (ERV), trade flows and economic growth of Nigeria which is considered as small open economy. The empirical study is based on time series data over the period of 1970-2009 applying time series econometrics methodology. The results indicate significant effects of ERV on trade flows in Nigeria. Their research finding supports a preference for a flexible exchange rate regime over the fixed regime as it facilitates more trade flows to Nigeria. They recommended effective diversification of the Nigerian economy by encouraging more manufacturing firms' production output sufficient enough to meet the demand of both domestic and regional markets of West Africa followed by full implementation of floating exchange rate system.

Omojimite and Akpokodje (2010) [29] empirically compared the effect of exchange rate volatility on the exports of a panel of seven Communaute Financiere Africaine (CFA) countries with that of nine non-CFA counterparts during the period 1986-2006. The GARCH model was utilized in generating exchange rate volatility series for this period. These series were then incorporated into an export equation and estimated using techniques such as OLS, fixed effect, first difference GMM and the systems GMM equation. The system GMM technique, as shown in the result, performed better than the other estimation techniques. It was found that exchange rate volatility negatively impacts on the exports of both panels of countries with a larger effect on the panel of the non-CFA than on the CFA countries. They concluded on the need to take appropriate monetary and fiscal policy actions to stem the rising exchange rate volatility.

Adeyemi, Paul and Oluwatomisin (2013) [3] investigated the impact of currency devaluation on Nigeria trade balance using the Johansen co-integration and variance decomposition analyses from 1970-2010 with the following variables; domestic income, domestic and foreign money supply, domestic interest rate and nominal exchange rate. The absence of trade balance variable in the model casts doubt on the usefulness of this analysis.

Yasmina, (2012) estimated the effects of Real Effective Exchange Rate (REER) on Algeria's trade balance (TB) with variables: Real effective exchange rate (REER), foreign income (Y*) and real domestic income (Y). This study used unit root tests, co-integration techniques, Error Correction Model (ECM) and impulse response function with time series data covering the periods of 1981Q1-2009Q4. The omission of export and import variables in a trade balance analysis is bound to produce an unrealistic estimation.

Adeniyi, Omisakin, & Oyinlola, (2011) [2] attempted to query the existence or otherwise of a J-Curve in four West African Monetary Zone (WAMZ) countries: namely The Gambia, Ghana, Nigeria and Sierra Leone. They used data from first quarter in 1980 to fourth quarter of 2007 and bounds testing approach, with an autoregressive distributed lag (ARDL) methodology to co-integration in capturing the impact of devaluation on the trade balance. The results indicate that there is co-integration among foreign income, trade balance, domestic income and the real effective exchange rate in all countries. More importantly, the results seem to support the J-Curve hypothesis only in the case of Nigeria with no exhibition of J-curve pattern for Sierra Leone. Real devaluation policy with its attendant differential impact across countries implies that such policies should engender incentives that are compatible with the growth and developmental objectives of member states.

Ogbonna, (2010) focused on the relationship between the exchange rate and trade balance in Benin Republic for the period 1950 to 2008. The author employed cointegration, vector error correction modeling (VECM) and causality tests to determine the long run, as well as short-run dynamics, between the exchange rate and the trade balance for Benin.

A study by Dada (2017) examined the causal nexus between exchange rate volatility and trade balance in 13 sub-Saharan African countries from 2000-2015 using the GARCH model. Pairwise Granger causality indicated that there is unidirectional causality between exchange rate volatility and trade balance. Furthermore, the result shows that there is bidirectional causality between real exchange rate and exchange rate volatility; and trade balance and economic growth. The study concluded that exchange rate volatility is important in determining trade balance in sub-Saharan African countries.

Using GARCH approach, Oghenebrume (2018) [27] empirically investigated the effect of exchange rate volatility on balance of payments in Nigeria from 1980 to 2016. The finding confirmed that exchange rate is positively related to balance of payments; while real gross domestic, inflation rate and volatility of exchange rate are negatively related to balance of payments. The study concluded by recommending the need for government to encourage export promotion strategies.

3. Empirical Methodology

We begin our empirical isometrics using a Vector Auto-regression (VAR) Model, which has proven to be particularly useful for describing the dynamic behavior of economic and financial time series and for forecasting. It often provides superior forecasts to those from univariate time series models [39]. This study makes use of the VAR model and, upon the confirmation of a co-integrating relationship, deploys the vector error correction (VECM) [40]. Since the estimation of the VECM is contingent upon the existence of a co-integrating relationship between our model variable (trade balance, exchange rate and inflation), we also pre-test for the existence of unit root and con-integration. A comprehensive discussion of the stationarity and co-integration testing procedure is rife in the literature (see e.g Gujarati and Porter, 2009; Johansen 1988; Johansen and Juselius 1990; Ansari and Ahmed, 2007) [15]. We set out with the specification of the estimable unrestricted VAR model thus,

$$T_t = \beta_0 + \beta_1 T_{t-1} + ... + \beta_2 T_{t-p} + \beta_3 E_{t-1} + ... + \beta_4 E_{t-p} + \beta_5 \Pi_{t-1} + ... + \beta_6 \Pi_{t-p} + \mu_t \quad 1$$

$$E_t = \alpha_0 + \alpha_1 E_{t-1} + ... + \alpha_2 E_{t-p} + \alpha_3 T_{t-1} + ... + \alpha_4 T_{t-p} + \alpha_5 \Pi_{t-1} + ... + \alpha_6 \Pi_{t-p} + \mu_t \quad 2$$

$$\Pi_t = \phi_0 + \phi_1 \Pi_{t-1} + ... + \phi_2 \Pi_{t-p} + \phi_3 T_{t-1} + ... + \phi_4 T_{t-p} + \phi_5 E_{t-1} + ... + \phi_6 E_{t-p} + \mu_t \quad 3$$

Where;
T= trade balance;
E= nominal effective exchange rate;
Π=CPI-based inflation rate; and
ϕ, α and β are the coefficients.

The VAR model presented as equation 1, 2 and 3 describes the evolution of a set of k variables (here, trade balance, exchange rate, CPI-based inflation rate) as a linear function of their past values and past values of other variables in the VAR system. In particular, the model depicts a system of p-ordered VAR model. For instance, E_{t-p} denote the (t-p) the lag of the variable (E). A common feature of all the equations in the VAR system is that none of them includes the contemporaneous value of the variables in the right-hand side. This makes it plausible, though not always certain, that the regressors are: (i) weakly exogenous; and therefore (ii) that, if all of the variables are stationary and ergodic, OLS can produce asymptotically desirable estimators. The appropriate lag length is determined by minimum AIC or SIC criteria.
In terms of a priori expectation, the variables in the model bear theoretically expected relationship with trade balance with the prediction concerning the sign depending on the approach (Elasticity, Monetary or Absorption Approach) being considered (see section 2). Going by the elasticity approach which emphasizes the role of exchange rate, devaluation of the nominal effective exchange rate (NEER) will lead to increase in export and decline in import because domestic goods will become cheaper for foreign buyers when the nominal exchange rate is devalued or depreciates. And so, we expect the coefficient of the nominal effective exchange rate in the model to be positively related to trade balance. Theory also predicts that an increase in inflation will decrease trade balance. This is because increase in the inflation rate makes export dearer and import cheaper. So, we expect a negative relationship between inflation and trade balance.
If the existence of co-integrating relationship is established between trade balance and other endogenous regressors (exchange rate and inflation rate) in the VAR system, then the Vector Error Correction Model (VECM) first used by Sargan (1964) and popularized in the ensuing literature by Engle and Granger (1987) [13] is constructed to account for equilibrium adjustment. The VECM implemented in this study is of the form:

$$\Delta x_t = \sum_{j}^{k} \beta_j \Delta x_{t-j} + \sum_{i}^{m} \alpha_i EC_{t-i} + v_t \qquad 4$$

Where Δx_t is a (3×1) column vector of the first difference of trade balance (△T), first difference of nominal effective exchange rate (△E) and first difference of CPI-based inflation rate (△Π). The β_j are the parameters to be estimated, v_t is a (3×1) column vector of white noise error term and Δx_{t-j} is the j^th lagged term of Δx_t. Importantly, EC_{t-i} contains individual error-correction terms obtained by lagging (one period) the residuals retrieved from each of the 'm' co-integrating equations. The coefficients of the error correction terms (α_i) measure the speed of adjustment – capturing the speed at which short-run disequilibrium (associated with short-run dynamics) is adjusted to return to equilibrium in the long run.
As can be easily seen from equation 4, the VECM is essentially a VAR model except that it incorporates innovations, the so-called error-correction terms, from the co-integrating equations. Importantly, the reason for the choice of the VECM is that it retains most desirable properties of VAR. For instance, like the VAR it: (i) is a generalized reduced form which helps to detect the statistical relationship among the variables in the system; (ii) does not impose any theoretical structure on the estimates but allows each variables in the system to interact with itself and with other variables; and (iii) provides a convenient way of analyzing the impact of variables using variance decomposition and impulse responses.
Finally, in order to ascertain the direction of causality between trade balance and exchange rate in Nigeria, we specify the following Granger causality equations:

$$T_t = \sum_{i=1}^{n} \alpha T_{t-1} + \sum_{i=1}^{n} \beta E_{t-1} \qquad 5$$

$$E_t = \sum_{i=1}^{n} \phi E_{t-1} + \sum_{i=1}^{n} \delta T_{t-1} \qquad 6$$

Where: T and E, as has been noted, represent trade balance and nominal effective exchange rate, respectively. α, β, ϕ, δ are the coefficients of the trade balance and nominal effective exchange rate in the Granger Causality equations.
Time series data on trade balance, exchange rate and inflation is obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin and World Development Indicator (WDI) database. Trade balance is normally computed by subtracting the annual values of imports from exports.

4. Results
Beginning the analysis of result with a trend characterization of the relationship between nominal exchange rate, real effective exchange rate, inflation rate and total trade (Figure 1), the picture that the clearly emerges from Figure 1 is that both the nominal and real effectiveness naira exchange rate have historically trailed the country's trade balance. Can exchange rate volatility tell us something about the Nigeria's trade balance position? We endeavor to answer this using the more robust VECM framework employed in this study.
We begin the analysis of the regression result with the stationary test scorecard presented in Table 1. Going by the ADF test result presented, we are unable to reject the null hypothesis of a unit root at the level values of the variables. In other words, the entire variables are found to be non-stationary at their level form. However, the variables became stationary after taking the first difference (Table 2).

Table 1: Augmented Dickey-Fuller Unit Root Tests at levels.

Variable	ADF	Critical values (5%)	Order of Integration	Remark
TB	-2.77	-2.93	I(0)	Non-stationary
EXR	-1.53	-3.51	I(0)	Non-stationary
INF	-3.51	-3.57	I(0)	Non-stationary

***Source*:** Author's Computation from E-views. Note: Decision rule-if ADF test statistics is greater than Mackinnon critical values at 5 %, then reject the null hypothesis of a unit root.

Table 2: Augmented Dickey-Fuller Unit Root Test result after the first difference

Variable	ADF	Critical Values (5%)	Order of Integration	Remark
TB	-6.58	-3.52	I(1)	Stationary
EXR	-6.15	-3.51	I(1)	Stationary
INF	-7.04	-3.51	I(1)	Stationary

***Source*:** Author's Computation from E-views

Having found that trade balance, nominal effective exchange rate index and inflation rate are stationary at first difference, the next thing is to implement the text for a long-run relationship between the variables, the so-called co-integration test (Table 3). In order words, we test whether or not a linear combination of the series is stationary (or whether they are co-integrated) or not. This verification is needed to test whether there is an inherent tendency for the variables to move together in the long-run.

Table 3: Result of Johansen and Juselius (1990) Test of co-integration

Hypothesized No of CE(S)	Trace Statistic	5% Critical Value	Max. Eigen Value	0.05 Critical Value
$\rho = 0$	52.2506*	47.8561	26.0161*	27.5843
$\rho \leq 1$	26.2345	29.7971	17.1489	21.1316
$\rho \leq 2$	9.0855	15.4947	6.6269	14.2646
$\rho \leq 3$	2.4586	3.8415	2.4586	3.8415

As can be easily seen from Table 3, both the Trace statistics and Maximum Eigen value indicates that there is only one co-integration equation, i.e., the variables are cointegrated with a maximum of one cointegrating vector. It is important to note that the 'target equation' in our VECM is the co-integrating equation. The number of target equations would usually depend on the number of co-integrating equations (Ekong and Onye, 2015). Since the Johansen and Juselius (1990) [19] test for co-integration indicates that there is only one co-integrating equation, we have just one target equation from our VECM system. This is the equation in which Trade balance is the response variable. Our finding of, at least one co-integrating vector, also suggests that the error correction model (ECM) of trade balance can be used and that it potentially combines information of both the short-run dynamics and the long run equilibrium conditions.

We proceed by first reporting the result of the unrestricted VAR regression before presenting the Vector Error Correction Estimates. The unrestricted VAR result is as shown below:

Table 4: Result of the Unrestricted VAR Estimate

Expel. Vars.	Dep Vars.		
	Trade Bal	NEER	INF
Trade(-1)	0.567274	0.026836	-0.153513
	[3.23870]	[0.11453]	[-0.76896]
Trade(-2)	0.376556	0.175779	0.453482
	[1.98997]	[0.69439]	[2.10259]
Neer (-1)	0.073442	1.223197	-0.404437
	[3.49209]	[6.12661]	[-2.37755]
Neer (-2)	0.046210	-0.328234	0.316070
	[2.33476]	[-1.77746]	[2.00889]
INF (-1)	-0.016543	0.143982	0.715068
	[-0.11185]	[0.72766]	[4.24156]
INF(-2)	0.188137	-0.272831	-0.248847
	[1.27664]	[-1.38392]	[-1.48151]

Note: t-statistics in [ ]; R^2 =0.611444 0.885822, 0.528650 AIC=24.51, SIC=25.32

As can be easily seen from the VAR estimate, nominal effective exchange rate index positively and significantly impacted trade balance with a lag. The next issue we look at is the vector error correction result that account for short-run dynamics.

Table 5: Over-parameterized VECM Result

Regressors	Dep. Var			
Error Correction:	D(Trade)	D(Neer)	D(INF)	D(EC1)
CointEq1	0.023405	0.057992	-0.02	0.056170
	[0.42384]	[0.94295]	[-0.35128]	[9171663]
D(Trade(-1))	-0.40	-0.04	-0.33	0.943830
	[-1.71767]	[-0.14626]	[-1.25193]	[3.7e+07]
D(Trade(-2))	0.431610	1.682151	-0.49	0.376556
	[0.36927]	[1.29222]	[-0.37253]	[2905538]
D(Neer (-1))	0.05	0.224245	-0.20	-0.03
	[2.27268]	[1.10977]	[-0.95117]	[-1353637]
D(Neer (-2))	0.01	0.085125	-0.25	0.046210
	[3.06521]	[0.41969]	[-1.22359]	[2288423]
D(INF(-1))	-0.07	0.241093	-0.05	0.171594
	[-0.33421]	[1.08733]	[-0.21517]	[7773279]
D(INF(-2))	0.160127	0.177905	-0.59	0.188137
	[0.60562]	[0.60415]	[-1.95611]	[6417362]
D(EC1(-1))	-0.47	-0.74	-0.01	0.00
	[-2.42652]	[-1.46737]	[-0.01902]	[-0.93780]
D(EC1(-2))	- 0.451481	0.027075	-0.19	7.85E-10
	[1.62809]	[0.07974]	[-0.56445]	[0.02321]
C	-0.21	2.339597	0.067674	-0.14
	[-0.08225]	[0.81103]	[0.02310]	[-495200.]

Note: t-statistics in [ ]; AIC=1.8, SIC=3.8

With the Vector Error Correction Mechanism (VECM), both the long-run equilibrium and short-run dynamic relationships associated with variables can be established. Having obtained the VAR estimated, we retrieve the residual from the target equation (trade balance equation) and incorporate this into the vector error correction model (equation 4). In estimating the VECM, we are carefully guided in the selection of lag length of the right hand-side variable by the Akaike and Schwarz information criteria – selecting the model with minimum value of the two information criteria. In doing this, we follow the Hendry's general to specific (GS) approach

(Hendry 1995) where the maximum lag length considered is four.. However, given that we have a total of three (n=3) variables in the VECM model, be began by estimating a general function in which the right-hand side variable has a maximum lag length of two (n-1) and proceed by eliminating the insignificant variables to arrive at the parsimonious VECM result. The VECM result with maximum lag length of two is, therefore, the over parameterized result (Table 5). The variables with more than one lag length are found to be statistically insignificant and are eliminated

Table 6 reports that results corresponding to the regression that is based on GS approach. We implemented the Ramsey RESET test for functional misspecification and the Breusch-Godfrey's Serial Correlation LM test (not reported) and found our result to be robust.

Table 6: Parsimonious VECM Result

Regressors	Dep. Var: Trade Balance		
	Co-efficient	**Standard error**	**t-statistic**
D(TRADE(-1))	0.1099	0.9444	2.1640
D(NEER(-1))	0.4691	112.0	4.7830
D(INF(-1))	0.0594	8.103	0.1279
D(EC1(-1))	-0.3917	0.1522	-4.4115
C	-4.2281	15.810	-0.3747

***Source*:** Author's Computation from E-views

R^2: 0.832539 Adj R^2: 0.799047 F-Statistics: 24.85774

From the parsimonious error correction result, the signs of the coefficients are all as expected. The short-run coefficient of exchange rate, inflation and the error correction term are 0.46, 0.05 and -0.39 are statistically significant except the coefficient of inflation. The negative and insignificant effect of inflation on trade balance is reaffirmed in both the short-term parsimonious model and the overall parameterized money. A possible explanatory for the insignificant effect of inflationary spree on trade balance is that due to windfall from crude oil export (a major export commodity for Nigeria) the population could still be able to import more that the export amid rising domestic prices. This would translate to negative trade balance for Nigeria. The error correction term has the expected sign. In addition, it is significant at the conventional level – substantiating the evidence for co-integration of the variables in the system earlier established. The estimated coefficient of the EC term suggests that last period disequilibrium is corrected by about 39% or more in the next year.

Finally Table 7 report the result of the Granger causality equation earlier specified (as equations 5 and 6). As seen from can be easily seen from Table 7, we are able to reject the null hypothesis that exchange rate does not granger cause trade balance and therefore conclude that exchange rate granger causes trade balance. This implies that exchange rate movement has important implication for Nigeria trade balance.

Table 7: Granger Causality Result

Null Hypothesis:	F-Statistic	P-value	Decision
EXR does not Granger cause TB	49.49	2.E-11	Reject
TB does not Granger cause EXR	0.005	0.99	Accept
INF does not Granger cause TB	0.30	0.74	Accept
TB does not Granger cause INF	0.26	0.77	Accept
INF does not Granger cause EXR	0.63	0.53	Accept
EXR does not Granger cause INF	0.99	0.37	Accept

***Source*:** Author's Computation from E-views

The implication of these movements in the exchange rate is that it can either strengthen or weaken the country's external balance position. An appreciation in the exchange rate would weaken the external balance, while exchange rate depreciation would increase the external balance of the country. This accentuates the need for a stabilized exchange rate in the economy.

5. Conclusions

The paper examined the effect of exchange rate volatility on Nigeria's trade balance over the period of 1981 to 2016 by relying on the vector error correction mechanisms. The studied showed with clear analysis that a conscientious and carefully monetary policy in general and exchange rate management policy in particularly is required for improvement trade balance for Nigeria under the current managed-float system. In this is regard, the attempt in 2016 by the monetary authority in Nigeria to completely float the Naira can at best support mis-development particularly in the terms of Nigeria trade relationship with the rest on the world. To ensure exchange rate stability that will support development in the tradable goods sector, therefore, proper management of the naira exchange rate is needed.

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38. A distinction between exchange rate risk and uncertainty is in order. While in the case of a risky event an explicit probability can be assigned (Moradi, 2006), uncertainty refers to situations in which the probability of the future events cannot be determined. In measuring the welfare costs of exchange rate volatility the greater part of the costs is related to exchange rate risk. this is in contrast with the case of inflation in which a greater part of the welfare cost is related to inflation uncertainty (see e.g., Bulkley, 1984; Wilson, 2006 for an exposition).
39. VAR was introduced by Sims (1980) as a technique that could be used by macroeconomists to characterize the joint dynamic behavior of a collection of variables without requiring strong restrictions of the kind needed to identify underlying structural parameters. It has become a prevalent method of time-series modeling.
40. An unrestricted VAR includes all variables in each equation while a restricted VAR might include some variables in one equation, other variables in another equation. A VAR with different lag lengths for each equation could be viewed as a restricted VAR. For a VAR to be unrestricted, it is required that the same number of lags of all of the variables is used in all equations. Therefore, in order to determine the appropriate lag lengths, the multivariate generalization of Akaike's information criterion (*AIC*) is used.