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Exchange Rate Volatility and Foreign Capital Inflows in Nigeria: A Vector Error Correction Model Approach

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Abstract: The aim of this study is to examine the relationship between exchange rate volatility and foreign capital inflows in Nigeria. The results of the past studies were inconclusive and the uniqueness of this work also lies in the consideration of other important variables such as external debt and remittances as parts of strategic variables to capture foreign capital inflows which the bulk of the past studies have failed to recognize. Data were collected from CBN Statistical Bulletin and UNCTAD investment report from 1990 to 2016. Relevant pre-estimation tests such as unit roots and Johansen conitegration were carried out. Because all the study variables were integrated of order one i.e I(1) and have two cointegrating equations vector error correction model was estimated. Consequently, the error correction model reveals that about 32 percent of total disequilibrium due to external shock in the previous year is corrected in the current year. Therefore, it will take about three (3) years for the system to adjust back to its long run equilibrium path. Results further showed that FDI inflows increase the level of volatility in exchange rate in the short run but the volatility dies away over time. Conversely, remittance reduces exchange rate volatility while increases in external debt increase exchange rate volatility. It is recommended that the Central Bank of Nigeria should make more efforts to stabilize the exchange rate. In addition, policies and practices which may ease receipt of remittances from citizens in diaspora should be put in place while external debt should be discouraged as much as possible in the country.

Keywords: Exchange Rate Volatility; Foreign Capital; VECM and Nigeria

JEL Classification: F02; F21; F24; F31

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Introduction

The current wave of globalization orchestrated by various economic integration projects, financial market liberalization and the advent of digital technology has been an engine room for the flows of capital among the countries of the world. Meanwhile, it has been established in the literature that capital moves from developed economies to developing economies due to investment opportunities and better returns on these investments (Lucas, 1990). The stability of macroeconomic indicators such as exchange rate, inflation rate are crucial factors that determine the inflows of foreign capital from the global community into the domestic economy. Since the introduction of the Structural Adjustment Programme in Nigeria in 1986, the country has relied heavily on the foreign capital in the forms of external debt, foreign direct investment and official development assistance to augment the deficient saving-investment gap in the economy. Exchange rate volatility has been conceptualized as a haphazard fluctuation in exchange rate which could manifest in the form of appreciation or depreciation of domestic currency. It is worth of note that a cursory look at the exchange rate data shows that exchange rate volatility has been in the form of depreciation since the implementation of the Structural Adjustment Programme. This statement is further reinforced by Aliyu, (2011) who submitted that Nigeria`s currency has been depreciating on a continuous basis from 1980`s to 2010. This trend has since continued till present. In the recent time, the aftermath effect of volatility in exchange rate on other economic variables has been the major concern of scholars and policy makers. This has generated several arguments in the literature regarding what actually causes volatility in exchange rate of domestic currency. However, massive capital inflows has been identified as one of the variables that could cause adverse effect to the exchange rate of the domestic economy (De Paula, 2012, Ghosh, 2010).

Consequently, an attempt to verify this claim in Nigeria has sparked off researches in different quarters with different propositions. See (Amasoma, Nwosa and Fasoranti**,** 2015; Caruana, 2011; Osinubi and Amaghionyeodiwe 2009; Udoh and Egwaikhide, 2008; Ogunleye, 2008). Considering the fact that the results of the past studies were inconclusive the need for further studies on this subject matter becomes imperative. The uniqueness of this work also lies in the consideration of other important variables such as external debt and remittances as parts of strategic variables to capture foreign capital inflows which the bulk of the past studies have failed to recognize. Therefore, this study will contribute to the existing literature by establishing the nature of relationship which exists between foreign capital inflows and exchange rate volatility in the country.

The later parts of this paper are organized as follows: section two consists of the review of related literature meanwhile section three presents the research

methodology, discusses the estimated results, summarized and concluded accordingly.

Literature Review

Empirical literature

In this section of the paper, an attempt has been made to briefly review the relevant existing studies that focus on the subject matter of this study.

Author(s)	Year	Study & Countries	Methodology	Results & Conclusion
Aliyu et al	2009	Examination of exchange rate pass-through in Nigeria between 1986 and 2007.	Vector Error Correction Model	The exchange rate pass-through was low and decreasing in Nigeria, which partly contradicts the conventional submission in the literature which states exchange rate pass-through in developing countries is always significantly higher than those of developed ones. However, the authors opined that if the appropriate policy measure is put in place Nigeria, exchange rate pass through has the possibility to increase in the long run in the country.
Due and Sen	2006	Investigation into a relationship between capital flows, real exchange rate, fiscal and monetary policy indicators and the current account surplus in India from 1993 to 2004.	Cointegration and granger causality approach	There was a long run relationship between all the variables of interest in the study. Similarly, there was an existence of a unidirectional feedback running from all of the studied variables to the real exchange rate in the country.
Caporale *et*.	2013	Analysis of the relationship between exchange rate uncertainty and different components of portfolio flows, such as equity and bond flows, alongside with the dynamic linkages between exchange rate volatility and the variability of these two types of flows in Australia, the UK, Japan, Canada, Sweden and the Euro area between 1988 and 2011.	Bivariate GARCH-BEKK-in-mean model	The impact of exchange rate uncertainty on equity flows was negative in the UK, Sweden and Euro area. Meanwhile, it was positive in Australia. However, the impact on bond flows was negative in all countries apart from Canada where it is positive.

Teddy	2015	Estimation of the relationship between exchange rate volatility and private capital inflows in Zambia.	GARCH model, Johansen cointegration test and error correction model	The nominal exchange rate volatility and foreign portfolio investment had a significant negative relationship with each other in Zambia.
Ogun, Egwaikkhide and Ogunleye	2012	Analysis of real exchange rate and foreign direct investment in Sub-Saharan Africa.	Granger causality and simultaneous techniques	FDI flows in Sub Saharan Africa were sensitive to real exchange rate movements. In the same vein, there was an existence of statistically significant linkage between the two variables in the continent.
Nwosa and Amassona.	2014	Evaluation of a relationship between capital inflows and exchange rate in Nigeria between 1986 and 2011.	Granger causality and error correction model	Foreign portfolio inflows had an insignificant relationship with exchange rate in the country.
Chonnikara	2010	Investigation into the relationship between exchange rate volatility, foreign direct investment and portfolio flows in Thailand between 2005 and 2009.	Panel data analysis.	Negative relationship existed between exchange rate risk and foreign portfolio investment. The implication of this is high exchange rate risk lowered each firm –specific foreign portfolio flow to Thailand.
Osinubi and Amaghionyeodiwe	2009	Estimation of effect of exchange rate volatility on foreign direct investment (FDI) in Nigeria between 1970 and 2004.	Ordinary Least Square (OLS) and the error correction model (ECM) estimation approach	There was a significant positive relationship between real inward FDI and exchange rate. It was submitted in the study also that exchange rate volatility should not be a source of worry for foreign investors in Nigeria.
Udoh and Egwaikhide	2008	Assessment of the link between exchange rate volatility, inflation uncertainty and foreign direct investment in Nigeria between 1970 and 2005.	GARCH model	Exchange rate volatility and inflation uncertainty had significantly negative effect on foreign direct investment. Meanwhile, the study posited that the principal determinants of FDI inflow in Nigeria were appropriate size of the government sector, infrastructural development and international competitiveness.
Abdul	2009	Analysis of real effective exchange rate volatilities	Granger causality	There was a causal relationship between foreign capital inflows

		and capital inflows in Pakistan between 1991 and 2007.	test	and exchange rate volatility in the country.
Odusola and Akinlo	2001	Estimation of the link between Nigeria's Naira Depreciation, Output and Inflation.	Structural VAR model	The parallel exchange rate had a negative impact on output in the short run alone. Consequently, the strategic sources of perturbations in the official exchange rate prices were parallel exchange rate and lending rate. It was discovered in the study that, the notable causes of inflation dynamics in Nigeria were output and parallel exchange rate.
Harris	2002	Assessment of the relationship between new economy and the exchange rate regime	Generalized Least Square model	If the real exchange rate is adequately managed it would spur productivity and economic growth in both short and long run simultaneously. This conclusion was supported by the competitiveness hypothesis, which stipulates that productivity and growth could come from exchange rate depreciation in the short run.

Source: Authors` Compilation (2018)

In a nutshell, the compiled literature above shows that the studies on exchange rate volatility and foreign capital are inconclusive in Nigeria and beyond. This attests to the relevance of this study.

Methodology

Secondary data from 1990 to 2016 is used for this study. Exchange rate, external debt and remittances data were extracted from the CBN Statistical Bulletin. In the same vein, data on FDI inflows in Nigeria was adopted from UNCTAD database published by World Bank.

Model Specification

The model for this study can be specified in the general form as follows:

$$EXr = F (FDI, RMT, ExtD,) \quad \text{……..…. (1)}$$

Model (I) could be expatiated in a linear form as thus;

$$LnEXrt = \alpha_1 + \alpha_2 LnFDIt + \alpha_3 LnRMTt + Ln\alpha_4 ExtDt + e_i \text{ …….. (2)}$$

Where

FDI represents Foreign Direct Investment which is measured by the annual FDI inflow into the country.

EXr is used to proxy exchange rate. It is measured by the annual Naira/Dollars official exchange rate. However, Exchange Rate Volatility is estimated by using the Standard Deviation of the first difference of logarithms of the exchange rate. The standard deviation is computed over a one year period as an indicator of short run volatility as well as over 26 years period to capture long run variability. ExtD connotes external debt. RMT stands for remittances from overseas. ei captures error term which is assumed to be stochastic and t represent years.

$\alpha 1$ *is an intercept and* $\alpha 2$, $\alpha 3$ *and* $\alpha 4$ *are slope parameters* to be estimated. It is expected that coefficient of the variables to have the following signs: $\alpha_{2<0}$, $\alpha 3_{<0}$, $\alpha_{4>0}$

Pre-estimation analysis:

(a) Unit root test:
(b) Cointegration test.

Model Estimation

It is pertinent for this study to examine various diagnostic tests such as unit roots and cointegration before the estimation error correction model. The standard augmented Dickey Fuller test, Philips Perron test and Johansen cointegration technique would be employed to determine the order of integration and the existence or otherwise of long run equilibrium among the variables systematically. Furthermore, the existence of a cointegrating relationship among the set of the adopted variables in the model symbolizes the existence of a long-run relationship among the variables. Hence, a simple VAR model with i lags could be illustrated as follows to mark the beginning of ECM estimation in this work.

$$y_t = \alpha_1 + \alpha_2 y_{t-1} + \alpha_3 y_{t-2} + ... + \alpha_k y_{t-i} + U_t \quad \text{(III)}$$

In order to estimate the long run relationship alongside with the short run relationship between the variables, the short run error correction model is specified explicitly as follows.

$$\Delta EXr_t = \beta_0 + \sum_{i=1}^{p} \beta_1 \Delta EXr_{t-1} + \sum_{i=0}^{p} \beta_2 \Delta RMT_{t-1} + \sum_{i=0}^{p} \beta_3 \Delta ExtD_{t-1} + \emptyset ECM_{t-1} + U_t \text{-- (iv)}$$

The ECM_{t-1} is the error correction term of the short run equation.

Results and Discussion

Table 1. Descriptive Statistics of Annual Data Series (1990-2016)

Descriptive Statistics	EXr	LFDI	LExtD	LRMT
Mean	201.2311	2.186300	24.48834	2.396482
Median	220.7902	2.114852	34.90157	2.048133
Maximum	353.9423	32.12595	34.04959	34.72861
Minimum	9.307808	-1.440286	31.15545	-4.246120
Std. Deviation	76.23267	5.212966	1.957753	5.566975
Skewness	1.202722	5.276509	-3.045381	5.321533
Kurtosis	3.123479	33.49586	10.361635	31.52543
Jargue-Bera	1.968266	694.9094	85.15226	555.9447
Probability	0.802599	0.001000	0.000010	0.000001
Sum	3753.669	59.40011	743.0950	62.82500
Sum. Sq. Deviation	215451.7	541.7901	10.920012	663.7829
Observation	27	27	27	27

Source: Authors` Computation (2018)

In table 1, various descriptive statistics of the data utilized in this study are shown. The mean and median values of the selected variables are very close. This shows that the distribution of the data series is near symmetry. This is reinforced by the argument of Karmel and Polasek (1980) who concluded that a distribution becomes perfectly symmetrical the moment the mean, mode and median converge.

Table 2. Unit Root Test

Variables	ADF Test			PP Test		
	Level	1st Difference	Remarks	Level	1st Difference	Remarks
LEXr	-2.98104***	-2.98623***	I (1)	-2.98104***	-2.98623***	I (1)
LFDI	2.988620***	2.99183***	I (1)	2.97620***	2.99192***	I (1)
LExtD	-2.98104***	-2.98623***	I (1)	-2.98104***	2.99182***	I (1)
LREMT	2.98622***	2.99180***	I(1)	2.98621***	2.99180***	I(1)

*Source: Authors` Computation (2018) *** %5 level of significance*

In the table 2 above, an attempt has been made to verify the stationarity of the data used in this work in order to eliminate the problem of spurious result that is always linked to time series data. In view of the above, the dataset was subjected to a unit

root test. Consequently, the estimated standard Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests confirmed the presence of unit root in all the variables of interest. The series subsequently became stationary after first differencing.

Table 3. Johansen Cointegration Test (Trace Statistics) and (Maximum Eigenvalue)

Null Hypothesis	Eigenvalue	Trace Statistics	P-value	Eigenvalue	Maximum Eigenvalue	P-value
r=0*	0.441390	38.05584	0.2996	0.441390	14.55759	0.2996
r≤1*	0.389042	23.49825	0.2224	0.389042	23.49825	0.2224
r≤2*	0.252723	11.18008	0.2007	0.252723	7.282984	0.4562
r≤3	0.144342	3.897100	0.0484	0.144342	3.897100	0.0484

Source: Authors` computation (2018)

The non-stationarity nature of the variables of interest necessitated the examination of the long run equilibrium among these variables because these variables might wander away in the short run, yet the probability of their convergence in the long run is high. As a result of the above, this paper applied Johansen and Juselius (1990) cointegration test to verify if these variables are cointegrated. However, as shown in the above, the estimated results from Trace statistics and Maximum eigenvalue statistics model at a lag interval of 1 to 1 indicated the existence of at most three cointegrating vectors in the systems. This implies that the variables do have a long run equilibrium relationship with one another, though they might likely show some adjustment to short run disequilibrium. Hence, vector error correction model was estimated to capture the long run relationship alongside with the short run disequilibrium in the model.

Table 4. Vector Error Correction Estimates for Exchange Rate Volatility and Foreign Capital Inflows in Nigeria

Parsimonious Short Run Regression Estimate				
Endogenous Variable: LEXr, LFDI, LExtD, LRMT				
Econometric Method: VECM Estimate				
Sample: 1990-2016				
Equation	**D(LEXT)**	**D(LFDI)**	**D(LEXTDEBT)**	**D(LRMT)**
ECM	-0.321395**	-10.51834**	-2.471561*	-2.767213
	(2.520440)	(-2.394239)	(-1.799198)	(-0.984129)
D(LEXT(-1)	0.011237	1.115463	0.002718	-0.794059
	(0.052082)	(0.350566)	(0.007021)	(0.488386)
D(LFDI(-1)	0.202904*	2.604044	2.097455**	3.200167
	(1.912023)	(0.793684)	(2.387791)	(0.957861)
D(LEXTDEBT(-1)	0.065231	-0.577217	0.324293	3.571089
	(0.233589)	(0.140159)	(0.647117)	(0.977319)
D(LRMT(-1)	-0.057896***	-4.035478**	-1.642844*	-0.794059

	(4.740272)	(2.000382)	(1.941677)	(0.488386)
R-Squared	0.634705	0.654262	0.685712	0.542285
Adj. R-Squared	0.502058	0.531393	0.578567	0.413428
Long Run Regression Estimate				
Endogenous Variable: LEXr, LFDI, LExtD, LRMT				
Econometric Method: VECM Estimate				
Sample: 1990-2016				
Equation	**LEXT**	**LFDI**	**LEXTDEBT**	**LRMT**
LEXT(-1)	-0.233226	8.927332	2.581622	1.165207
	(0.552950)	(2.713131)	(1.876395)	(0.548947)
LFDI(-1)	-0.160377*	0.033909	2.097455	-4.532046
	(1.235566)	(2.187059)	(2.387791)	(2.098333)
LEXTDEBT(-1)	0.119527	5.603851	0.209310	3.571089
	(0.545966)	(1.581550)	(1.827755)	(0.977319)
LRMT(-1)	-0.057896**	-4.035478	-1.642844	-0.049499
	(2.740272)	(2.000382)	(1.941677)	(3.497761)
Durbin-Watson stat	1.963654	1.503397	1.615378	1.480960

*Source: Authors` computation (2019) *Significant at 10%, **Significant at 5%, ***Significant at 1%*

The table above presents the results of the estimated vector error correction model. The error correction term, ECM(-1) has an expected sign and significant. It reveals that about 32 percent of total disequilibrium due to external shock in the previous year is corrected in the current year. This shows that all the variables of interest in the model converged in the long run as earlier validated by the cointegration test. Similarly, the first differenced lagged value of the dependent variable- DL(EXr(-1) is positive. This implies that the volatility in exchange rate in the previous year increases the level of volatility in the exchange rate in the current year, though not significant. However, the coefficient of FDI shows that FDI inflows has a positive relationship with exchange rate volatility in the short run. In another words, FDI inflows increase the level of volatility in exchange rate in the country. A unit change in the stock of FDI increases exchange rate volatility by 20% on annual basis in the country, though not significant at 5 % level of significance. This result contradicts the a priori expectation. It is worth of note that exchange rate volatility increases the level of uncertainty and risk factors in the economy. This could discourage the foreign investors and thereby leads to declining of FDI inflows in the future. This argument aligns with the propositions of Osinubi and Amaghionyeodiwe (2009), Ogunleye (2008), Udoh and Egwaikhide (2008) who corroborated that exchange rate volatility had a negative impact on FDI inflows in Nigeria. However, in the long run FDI reduces exchange rate volatility in the country. As a unit change in the stock of FDI reduces exchange rate volatility by 16%. This finding is supported by Chege (2009) and Barrell et al. (2004) while examining emerging economies. Meanwhile Ellahi (2011) reported contrary result while carrying out similar study in Pakistan. In the same vein, remittance and

exchange rate volatility have a negative and significant relationship in both short run and long run. However, external debt and exchange rate volatility have a non-significant positive relationship with each other in the short run and long the long run concurrently. As external debt changes by a unit, volatility in exchange rate increases by 7% in the country. This finding is consistent with the similar work of Masuku (2012) in Kenya. Meanwhile Cavallo et al (2005) and Siregar and Pontines (2005) reported contrary argument in East Asian economies. The model has R-squared value of 63% which indicates that the fitness of the model is good. Meanwhile, after the degree of freedom was adjusted, the explanatory power of the model declined to 50%.

Diagnostic and Stability Tests

Table 5. Diagnostic Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.055395	Prob. F(2,18)	0.9463
Obs*R-squared	1.152933	Prob. Chi-Square(2)	0.9264

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.892271	Prob. F(8,16)	0.1321
Obs*R-squared	12.15403	Prob. Chi-Square(8)	0.1445
Scaled explained SS	21.64852	Prob. Chi-Square(8)	0.0056

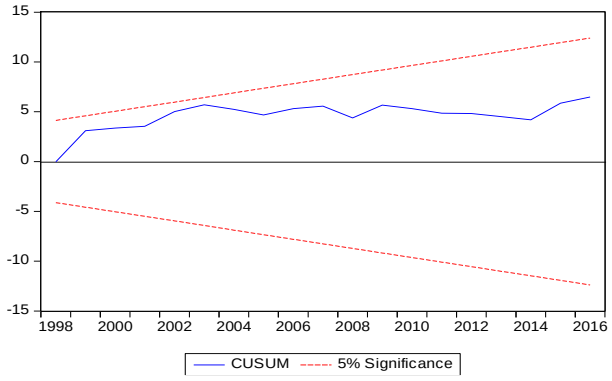

Figure 1. Stability Tests

CUSUM Stability Test

Source: Authors` Computation (2019)

It is important to establish the appropriateness of the short run (parsimonious) model adopted for this work. In view of the above, further attempt was made to subject the data to diagnostic test (the Serial Correlation LM test) and stability tests (Cumulative Sum (CUSUM) on the residual of the short run model. The results presented in the above table shows that the F-statistics of the Serial Correlation LM test of the model is not significant, this proved that there is no serial correlation in the residuals of the ECM regression estimate. The Breusch-Pagan-Godfrey test confirmed the absence of heteroskedacity since the observed Chi-Square is greater critical value. In the same vein, the results of cumulative sum (CUSUM) test shows that the residuals of the error-correction model lies within the critical bounds of five percent significant level. This confirms the stability of the estimated parameters over the period 1990-2016. Hence, the model has been reasonably specified.

Conclusion and Recommendations

This paper has examined the relationship between exchange rate volatility and foreign capital inflows between 1990 and 2016 in Nigeria. The test for cointegration proved that there is a long-run equilibrium relationship between exchange rate volatility and foreign capital inflows in Nigeria, while the error correction term indicated that about 32% of the total disequilibrium in the previous year would be corrected in the current year. However, FDI inflows increase the level of volatility in exchange rate in the short run but the volatility dies away in the long run. Meanwhile, remittance reduces exchange rate volatility in the both short run and the long run. However, external debt contributes to exchange rate volatility in the short run and the long run. Therefore, due to the findings that emerged in this paper it is expedient we make the following recommendations for the policy makers, investors and future researcher. The negative impact of foreign direct investment inflows on the country`s exchange rate in the short run calls for the urgent attention of the appropriate authorities in the Central Bank of Nigeria to come up with a policy measure that has the capacity to insulate the country`s exchange rate from the short run FDI inflows shocks. In addition, mechanism to facilitate ease of receipt of remittances from the citizens in the diaspora should be put in place, while external debt should be discouraged in the country. Furthermore, it is instructive that the policy measures that would stabilize the exchange rate in the country should be initiated and implemented.

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