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HOW VALID IS THE INTERNATIONAL FISHER EFFECT IN NIGERIA? EVIDENCE ON NAIRA EXCHANGE RATE AGAINST USA-DOLLAR AND EURO-19 CURRENCIES

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ABSTRACT

This paper investigates the validity of international Fishers Effect for Nigerian Naira against the USA-dollar and Euro-19 currencies. We applied Gregory-Hansen cointegration technique to account for single unknown structural break and ARDL techniques to estimate long-run and short-run parameters. Monthly data covering the period 2000:M1 to 2019:M12 is put to empirical testing. The results suggest the existence of a structural break in either 2016M04 or 2016M10 together with a cointergration or long-run relationship. However, only 10 percent and 21 percent volatility (depreciation) of Naira against the USA Dollar is accounted for by Nigeria-USA interest rate differentials in both the long-run and short-run respectively. Furthermore, about 21 percent and 20 percent in Naira-Euro-19 volatility (depreciation) is explained by Nigeria-Euro-19 interest rate differentials in both the long-run and short-run respectively. The implication of the results is that IFE is weakly valid in Nigeria and that movement in Naira exchange rate against the USA-dollar and Euro-19 currencies is rather determine by other fundamental factors such as economy-wide productivity, oil price volatility and import demand intensity. On the basis of these findings, the paper recommends that other tools besides interest rate should be used in management of exchange rate in Nigeria.

Keywords: International Fisher's Effect, Structural Breaks, Exchange rate Volatility. JEL Classification: C22, F31, F41

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1. INTRODUCTION

Exchange rate is an important relative price which connects domestic and world markets for goods and assets and exerts significant influences on internal and external balance of an economy over the medium- to-long term (Aliyu, 2010). Economic agents' take active interest in exchange rate movement in a highly interconnected and interdependent world because internally its affect production, employment, prices, cost of living, government revenue, wellbeing etc. and externally it determines export demand, import demand and capital flow (Obadan, 1993b,2006,)

Theoretically, International Fisher's Effect (IFE hereafter) is one of the theoretical explanations of the forces behind movement in the spot exchange rate. The theory posits that, under flexible exchange rate regime and free capital mobility, appreciation or depreciation of a country currency is approximately equal to the nominal interest rate differentials between any two countries. The currency of the country with higher nominal interest rate is expected to depreciate against the currency of the country with the lower nominal interest rate, as the higher nominal interest rate reflect an expectation of inflation (Madura 2007). In other words IFE suggest that arbitrage between financial market through free capital mobility ensure that nominal interest rate differential between two countries is an unbiased predictor of the future movement of exchange rate (Giddy & Dufey 1975).

In reality, evidences in support of IFE hypothesis across different bilateral countries combination are mixed. For instances, (Kulkarni, 1991; Ersan, 2008; Ortiz & Monge, 2015; Puci & Mansaku 2016) have tested the validity of IFE and found that it's did explain the movement in the exchange rate. While, (Sundqvist, 2002; Alam, Alam, & Shuvo, 2011; Shalishali, 2012; Mogaji 2019) studies have failed to convincingly validate the IFE hypothesis.

In January, 2000 Naira was exchange to United State Dollar at the rate of ₦ 98.97; by the end of December, 2019 the rate increase to ₦306.9 representing about 210 percent depreciation in Naira value. On the one hand, as at December 2001 the exchange rate of Naira to Euro-19 stands at ₦100.45; by December, 2019 its goes for about ₦341.19 representing about 239.66 percent depreciation. These two currencies are the official currency of United State of America, Belgium, the Netherlands and Spain who were four out of the top five international trade partners of Nigeria (NBS 2019; CBN 2020).

Despite numerous studies that test the validity of IFE, there are still no clear cut evidences on the validity of IFE in the case of Nigeria. To this end, this paper carried out an empirical test of IFE for Naira-US Dollar, and Naira-Euro19 currencies using

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monthly data series over the periods 2000:M1 to 2019:M12. The paper contributes to the literature in three key areas: one, provide additional evidences on the validity of IFE in general and particularly in Nigeria. Two, calculate and used the volatility of exchange rate instead of the traditional appreciation or depreciation rate used by previous studies and, finally, employed Gregory and Hansen Co-integration test that take care of structural breaks in the data.

The paper is structured in to five sections: section one is the introduction as outline above; section two contains reviewed empirical literature; section three is the theoretical framework and econometrics techniques; section four details the results and its discussion and finally section five concludes and highlights the policy implication of the findings.

2. LITERATURE REVIEW

Past empirical attempts to test the validity of IFE have produced mixed evidences. Ordinary least square (OLS) was the main technique used by pioneer authors to estimate the link between movements in exchange rate and interest rate differentials between two countries. Recently, many authors have employed various co-integration techniques in their analyses. A summary of key studies reviewed is presented in to two broad groups below:

The first group of studies has found evidences that support the validity of IFE. Kulkarni (1991) tested the evidences for Purchasing Power Parity and IFE for US dollar and Japanese Yen exchange rate by estimating a dynamic equation with OLS technique for both quarterly and monthly data frequency over the period 1990-1988. The results show that both of these theories provide a satisfactory explanation of the behavior of exchange rate movement; he further observed that the quarterly data are more relevant for these theories than the monthly data. Puci and Mansaku (2016) tested IFE hypothesis for United State Dollar (USD) and Chinese Yuan (CNY) using monthly data covering the period 2002 to 2014; Engle - Granger and Johansen co - integration techniques. They discovered evidence in favor of the theory at 1% confidence level. *He* (2018) investigated whether Fisher effect and the IFE exist between China and South Korea, he estimates a fully modified ordinary least squares (FMOLS) model for both annual and monthly data sets. His finding confirmed the existences of Fisher effect and IFE for China and South Korea for the period studied in both short run and long-run. Also, Wu (1999); Asari, et al., (2011); Hatemi-J, (2009); Ortiz and Monge, (2015) corroborated the above findings.

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The second sets of studies have reported evidences of partial existences of IFE and or complete non-existences. Mogaji (2019) assess the validity of IFE alongside other parity conditions in fifteen-members Economic Community of West African States (ECOWAS) that are planning to adopt the "eco" currency. He applied a combination of Engle-Granger, Philip-Ouliaris, Park's, and Johansen cointergration tests for monthly, quarterly and annual data sets over the period 1990 to 2017. The findings revealed that international parity theoretical propositions of absolute and relative Purchasing Power Parity, IFE and the uncovered interest parity are hugely not valid across the proposed '*Ecozone*'. In addition, El Khawaga, Esam, and Hammam (2013) examine the validity of IFE hypothesis for the Egyptian economy against USA and Germany. He applied Autoregressive Distributed Lag (ARDL) bounds test approach to co-integration, error correction model, impulse response function, variance decomposition and Granger causality test to quarterly data sets over 2003Q1 to 2012Q4 period. Evidences suggest partial existences of IFE in the case of Egyptian Pound to US dollars, while no sign of IFE was detected in the case of Egyptian Pound to Euro currency.

Adam and Ofori (2017) test the validity of International Fisher Effect in West African Monetary Zone (WAMZ) countries. He applied conventional Engle-Granger and fractional cointergration tests on nominal interest rate differentials and exchange rates. The findings confirmed cointegrating relationship in fifteen out of the twenty country pairs. However, the assumptions necessary for the validity of IFE were only met for Ghana to Cape Verde and Ghana to Sierra Leone at five percent significance level. Sundqvist (2002); Shalishali (2012); Alam, Alam, and Shuvo (2011) have all reported partial existence of International Fisher Effect. Clearly, there are inadequate studies on International Fisher Effects validity with references to Nigeria.

3. METHODOLOGY AND DATA

The theoretical foundation of IFE hypothesis can be deduced from Fisher effect and the relative version of Purchasing Power Parity. The Fisher effect states that a change in a country's expected inflation rate will result in a proportionate change in the country's interest rate (Eun & Resnick 2011)[1]. Formally stated as:

$$(1 + i) = (1 + r) \times (1 + E[\pi]) \qquad (1)$$

[1] **The theoretical expositions in this section were guided by Eun, Cheol S.; Resnick, Bruce G. (2011). International Financial Management, 6th Edition. McGraw-Hill/Irwin. ISBN 978-0-07-803465-7.**

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Where: i denotes nominal interest rate

r denotes the real interest rate

$E[\pi]$ denotes expected inflation rate

After re-arranging, equation (1) is transformed in to:

$$i + 1 = 1 + E[\pi] + r + rE[\pi] \qquad (2)$$

The term $rE[\pi]$ is assumed to be insignificant under a low inflation rate regime and consequently the expected inflation rate can be an unbiased predictor of the differences between the nominal and the real interest rate in any given country.

$$E[\pi] \approx i - r \qquad (3)$$

Let further, assume that unrestricted capital mobility between any two countries will ensure that the real interest rate in the two counties will always be equal such that:

$$r_d = r_f \qquad (4)$$

Then we substitute the approximate relationship in equation (4) into the relative purchasing power parity formula, we end up with a formal equation for the IFE hypothesis as follows:

$$\frac{\Delta S(d/f)}{S(d/f)} = \frac{i_d - i_f}{1 + i_f} \approx i_d - i_f \qquad (5)$$

Where: r_d = represents domestic interest rate

r_f = represent foreign interest rate

S= Represent the spot exchange between any two countries

Equation (5) above represents a deterministic relationship between the rate of change in the exchange rate and the differences in nominal interest rate between any two countries under flexible exchange rate regime with free mobility of capital. It represents an exact or deterministic relationship between the two variables. However, to arrive at an econometric model estimated for the study equation (5) is transformed to a semi logarithm form and an error term is added to it as follows:

$$ln\frac{\Delta S_t(dt/ft)}{S_t(dt/ft)} = \alpha + \beta\left(\frac{i_{dt} - i_{ft}}{1 + i_{ft}}\right) \approx i_{dt} - i_{ft} + e_t \qquad (6)$$

Where: Δ = is the changes in the exchange rate (volatility)

α = is the value of the exchange rate when the interest rate differential is zero

β= 0< β <1, the closer β is to one the stronger the validity of IFE

e_t = is the error term that is assumed to be a white noise process

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3.1 Data Sources and Measurement

Monthly frequency data on 3-Months Treasury Bill for Nigerian economy, Naira exchange rate against USA dollar and Euro-19 is sourced from Central Bank of Nigeria website https://www.cbn.gov.ng; 3-Month Treasury bill for USA and Euro-19 are sourced from the Federal Reserve Bank of St. Louis website https://fred.stlouisfed.org and Organisation for Economic Co-operation and Development (OECD) website https://stats.oecd.org/ respectively. The sample covered the period 2000:M1-2019:M12 (240) observations with the exception of Naira exchange rate against Euro-19 that covered only 2001:M12-2019:M12 period (217) observation due to data paucity.

To suite the theoretical foundation of the IFE hypothesis volatility of average monthly exchange rate of naira against USA dollar and Euro-19 is used to represent rate of change in the respective nominal exchange rate. in line with (Zubair & Jega, 2008 and Aliyu, 2010) the paper measured exchange rate volatility as the standard deviation of each series of monthly observation from the average nominal exchange rate of the naira vis-à-vis the US dollar and the Euro-19 currencies using equation (7) below and the natural logarithm of the derived series is used in the estimation to allow interpretation of the estimates in percentage term.

$$Voln = \sqrt{\sum(NERij - \overline{NER}j)^2} \qquad (7)$$

Also, the 3-Month Treasury bill interest rate differential between Nigeria, USA and Euro-19 is calculated using the following formula:

$$\text{ird} = \frac{i_{dt} - i_{ft}}{1 + i_{ft}} \qquad (8)$$

Table 3.1 Variable Measurements and Data Sources

Variables	Description	Sources
lnVOLN_USD	Log of Naira-USA Dollar exchange rate standard deviation	CBN
lnVOLN_EU	Log of Naira-Euro19 exchange rate standard deviation	CBN
USAIRD	Differences between Nigerian Treasury bill rate and USA treasury bill rate	CBN, Fed Reserve of stlouis

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EUIRD	Differences between Nigerian Treasury bill rate and Euro19 treasury bill rate	CBN, OECD
Dummy1	0 from January 2000 to April 2016, 1from May 2016 to December 2019	Author(s) construction
Dummy2	0 from December 2001 to October 2016, 1from November 2016 to December 2019	Author(s) construction

Sources: Author(s) Summary from Various Sources

3.2 Techniques of Data Analysis

The stochastic properties of the data are checked using Phillip-Perron's (1988) and Zivot-Andrews (1992) unit root tests techniques. The PP test used a nonparametric statistical methods to account for the serial correlation in the error term and test the hypothesis $\delta = 0$ or $\rho = 1$ of non-stationarity against the alternative which states that the series is stationary if $-1 < \rho < 1$. However, Phillip-Perron's test tends to be biased towards non-rejection of the null hypothesis in the presence of structural breaks. The Zivot-Andrews (1992) unit root test allows for a single endogenously determined break in the intercept and the trend (slope) of the series, all the results are summerised in Table 1.

Gregory and Hansen (1996) test for cointergration with structural breaks is also used to verify the existences of cointegration relationship among the variables. The test is an extension of the Engle and Granger (1987) approach to cointegration and it involves testing the null hypothesis of no cointegration against alternative of cointegration with a single regime shift in an unknown date based on extensions of the traditional ADF-, Z and Zt – test types. The structural change can occur at intercept and/ or changes in slope as indicated in Equation (9)

$$Y_t = \beta_0 + \beta_1 \emptyset_t + \delta_1 T + \delta_2 \emptyset_t T + \sum_{i=1}^{n} \alpha_{1i} X_{it} + \sum_{i=1}^{n} \alpha_{2i} Q_t X_{it} + e_t \qquad (9)$$

Where Y_t is the dependent variable, X_{it} are the independent variables, e_t is assumed to be I(0) error term, and $\emptyset_t$ is the dummy variable to consider a structural break in the constant, slope and trend. Gregory and Hansen (1996) further outline the indicator for the change as:

$$\Phi = \begin{cases} 0, if\ t \leq [n\tau] \\ 0, if\ t\ \leq [n\tau] \end{cases} \qquad (10)$$

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Where the unknown parameter $\tau \in (0, 1)$ denotes the relative timing of the change point and [ ] denotes integer part. Results of the test are reported in table 2 below. The evidence suggests the rejection of the null hypothesis of no cointegration in favor of the alternative hypothesis of cointegration at 5% level of significance because the estimated statistics are greater than the 5% critical values. After confirming the existences of cointegration and long-run relationship among the variables through the Gregory-Hansen (1996) cointegration approach; the long-run and short-run parameters are estimated within the framework of ARDL bounds testing approach to cointegration as specified in equation 10 and 11 (Pesaran et al. 2001)[2]

$$\Delta lnVOLN\_USD_t = \alpha_0 + \sum_{i=1}^{n} \alpha 1i\ \Delta lnVOLN\_USD_{t-i} + \sum_{i=0}^{n} \alpha 2i \Delta lnUSAIRD_{t-i} + \emptyset 1 lnVOLN\_USD_{t-1} + \emptyset 2 lnUSAIRD_{t-1} + \emptyset 3 dummy1 + \varepsilon 1_t \quad (10)$$

$$\Delta lnVOLN\_USD_t = \alpha_0 + \sum_{i=1}^{n} \alpha 1i\ \Delta lnVOLN\_USD_{t-i} + \sum_{i=0}^{n} \alpha 2i \Delta ln\mathrm{USAIRD}_{t-i} + \gamma 1 ECT_{t-1} + \epsilon 1_t \quad (11)$$

4.0 RESULTS AND DISCUSSION

This section summerised results from the empirical analysis of the data under: variables trend analysis, test of Stationarity and cointergration among the variables and ARDL estimate of long-run and short-run parameters.

[2] The long-run and short-run ARDL equations were only specified and reported for Naira-USA Dollar exchange rate model. While, that of Naira-Euro19 exchange rate model were not reported for brevity purpose, but are available on request.

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4.1 Variables Trend Analysis

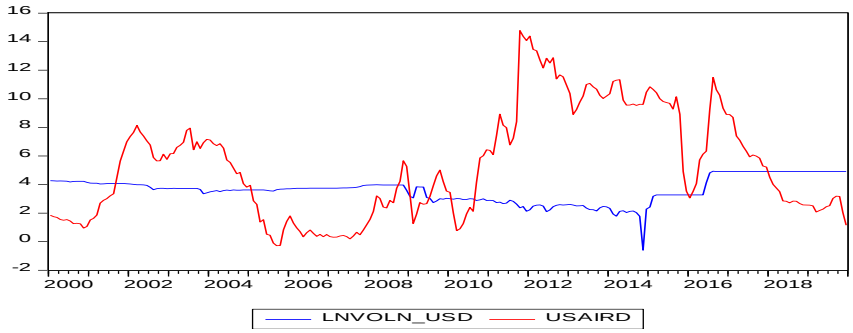

Figure 4.1: Trend of Naira/US dollar Volatility and Nigeria/USA Interest Rate Differential

Figure 4.1 shows that on average the log of Naira-USA dollar volatility persistently even out despite the fact that Nigeria–USA interest rate differential tends to grossly fluctuates over time. On the other hand, figure 4.2 indicates that both the log of volatility of Naira-Euro-19 have somewhat even out between 2000-2008; moves in opposite direction around 2009-2016 and log of volatility of Naira-Euro-19 even out further despite a spike in the Nigeria- Euro-19 interest rate differentials.

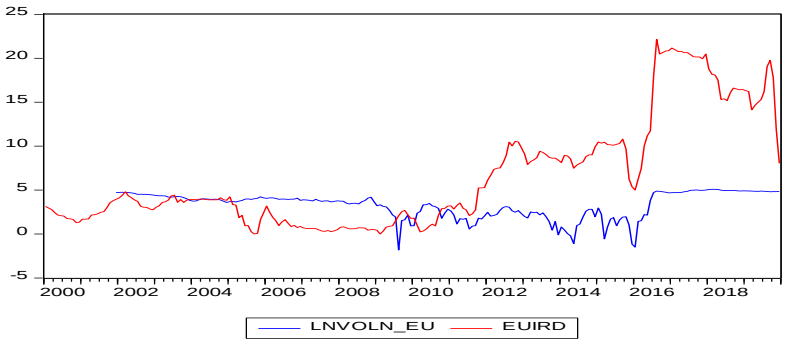

Figure 4.2: Trend of Naira/Euro Volatility and Nigeria/Euro Interest Rate Differentials

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4.2 Results of Unit Root and Cointergration Tests

Table 4.1: Unit Root Tests Results Summary

	Phillips-Perron unit root test		Zivot-Andrews unit root test			
	Level	1st differences	Level		1st differences	
	t-statistics	t-statistics	t-statistics	BD	t-statistics	BD
lnVOLN_USD	-1.90	-21.18**	-6.12**	2014M12	-	-
lnVOLN_EU	-2.82	-17.81**	-3.52	2015M04	-6.44**	2014M06
USAIRD	-1.84	-11.24**	-4.59	2010M09	-11.65**	2010M04
EUIRD	-1.52	-8.96**	-4.41	2016M07	-9.39**	2016M02

Appropriate lag lengths are selected based on the Akaike Information Criteria

**Stands for the statistical significance at 5% level. BD is break date

Sources: Author(s) summary from Eviews10 output

Phillips-Perron unit root test shows that all the variables have a unit root *I*(1), meaning that they are non-stationary, but can be made stationary after first differencing. This is further confirm by Zivot-Andrews (1992) unit root test with the exception of LnVOLN_USD that is *I*(0). Overall, test of cointergration can be carried out amongst the series.

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Table 4.2: Gregory-Hansen Test for Cointergration with Regime Shifts

	Naira against USA-Dollar			*Naira Against Euro-19*		
Model	*ADF-statistic [BD]*	*Z_t-Statistic [BD]*	*Z_a-Statistic [BD]*	*ADF-statistic [BD]*	*Z_t-Statistic [BD]*	*Z_a-Statistic [BD]*
Model 1: Level	-5.53** [2016m4]	-4.99** [2016m4]	-45.58** [2016m4]	-5.22** [2016m10]	-4.92 [2016m4]	-48.34** [2016m4]
Model 2: Level & Trend	-7.19** [2016m3]	-6.88** [2016m4]	-79.84** [2016m4]	-7.29** [2016m8]	-7.18** [2016m4]	-84.62** [2016m4]
Model 3: Regime	-5.83** [2016m7]	-5.37** [2016m7]	-51.35** [2016m7]	-5.24** [2016m10]	-4.87 [2016m8]	-47.88** [2016m8]

Sources: Author(s) summary from Eviews10 output

Note: [BD] is break date; the 5% critical values in models 1, 2, and 3 for both ADF and Z_t are -4.61, -4.99 and -4.95 respectively. While for Z_a are -40.48, -47.96 and -47.04

**represents the existence of cointegration at 5% level of significance

The results from Gregory-Hansen (1996) cointergration test in table 4.2 indicate the rejection of null hypothesis at 5% level of significance in all the three models for naira against the USA-dollar and naira against euro-19 respectively. Since; the test statistics are greater than the critical values in absolute terms. Overall, the evidences indicate that allowing for one structural shift; long run or cointegrating relationship exists between the variables. Following this, long-run and short-run parameters are estimated within the framework of ARDL and are presented in table 4.3

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4.3 Long-Run and Short-run Parameters Estimates

Table 4.3: long-run and short-run ARDL Parameters Estimates

PANEL A: Naira against USA-Dollar		*PANEL B: Naira Against Euro-19*	
Long-run estimates from ARDL models			
Variables	Coefficients [T-statistics]	Coefficients[T-statistics]	
Costants	0.66* [3.67]	0.40* [2.29]	
lnVOLN_USD			
lnVOLN_EU			
USAIRD	-0.10*[-3.59]		
EUIRD		-0.21**[1.82]	
Dummy1	1.02** [1.92]		
Dummy2		9.64 [1.64]	
USAIRD_Dummy1	0.13[1.44]		
EUIRD_Dummy2		-0.22 [-0.67]	
Short-run estimates from ARDL models			
ΔUSAIRD	-0.21*[-3.12]		
ΔEUIRD		-0.20*[-2.89]	
ECTt-1	-0.17* [-3.82]	-0.12*[-2.77]	
R^2	0.20		0.22
Adj. R^2	0.17		0.17
D.W-Stat	2.00		
Diagnostic Tests			
Serial Correlation: F(2,216)	1.41[0.2472]	0.352[0.70]	
Normality: Jarque-Bera	22625[0.000]	2759[0.000]	
Heteroscedasticity: F[7;227]	2.76[0.06]	1.637[0.06]	

Sources: Author(s) Summary from Eviews10 Output

Table 4.3 (panel A) shows the reaction of Naira-USA dollar exchange rate to Nigeria-USA interest rate differentials. The intercept as a measure of the level of risk premium is positively and statistically significant at five percent level. A 1 percent increase in the interest rate differentials between Nigeria and USA will lead to about -0.10 percent and -0.21 percent decrease in Naira-USA dollar exchange rate volatility (depreciation) in both the long-run and short-run respectively. The dummy1 variable

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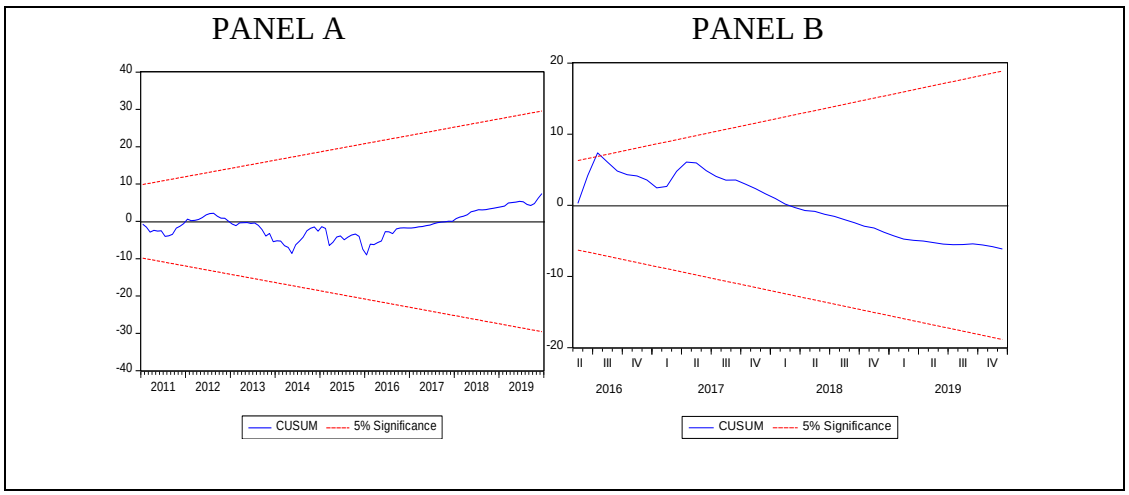
is statistically significant at 10 percent level, implying the significant effect of the structural break in the model. The error correction term which measures the speed of adjustment is low at about 17 percent, but statistically significant at 5 percent level.

In addition, the risk premium in Naira-Euro-19 model is also positive and statistically significant; a 1 percent increase in Nigeria- Euro-19 interest rate differentials will on average lead to about -0.21 percent and -0.20 percent decrease in Naira-Euro19 volatility (depreciation) in both the long-run and short-run respectively. The error correction is negative and statistically significant but with very low speed of adjustment of about 12 percent. The dummy2 variable shows that the structural break does not matter in naira-euro-19 models.

Overall, IFE is weakly valid on Nigerian naira against USA and Euro-19 currencies. Since, the estimated values of the slopes in the two models are quite less than unity; implying that the sample period does not support the one for one relationship between interest rate differentials and exchange rate movement. Thus, other fundamental factors such as economy-wide productivity, oil price volatility and import demand intensity were more responsible for observed volatility in Naira-USA dollar and Euro-19 exchange rates. The findings in the presents paper is consistent with that of (Sundqvist, 2002; Alam, Alam, & Shuvo, 2011; Shalishali, 2012; He, 2018; Mogaji 2019) who reported weak validity status of IFE in their respective studies.

4.4 Models Stability Tests

Base on the plot of Cumulative Sum of Recursive Residuals in figure 4.3 the two estimated exchange rate volatility model are stable at 5 percent level.



Source: Author Plot Using Eviews 10

Figure4.3: Plots of Cumulative Sum of Recursive Residuals

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5.0 CONCLUSION AND POLICY IMPLICATION

The paper carried out empirical test of IFE validity in Nigeria. We applied Gregory-Hansen and ARDL cointegration techniques. Estimates of the long-run and short-run parameters suggest partial validity of International Fisher Effect in Nigeria. The implications of these results are that interest rate differentials between Nigeria and USA and Nigeria- Euro-19 cannot be used to predict the movement of naira exchange rates against the two currencies. On the basis of these findings, the paper recommends that other tools besides interest rate should be used in management of exchange rate in Nigeria.

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