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Muse, Bernard and Alimi, R. Santos

Rufus Giwa Polytechnics, Owo, Ondo State, Ondo State, Nigeria, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria

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Bernard O. Muse
Department of Mathematics and Statistics, Rufus Giwa Polytechnics, Owo, Ondo State

R. Santos Alimi
Economics Department, AdekunleAjasin University, Akungba-Akoko, Ondo State.
E-mail:swtdunn.santos@gmail.com

ABSTRACT

This paper investigates the relationship between expected inflation and nominal interest rates in Nigeria and the extent to which the Fisher effect hypothesis holds, for the period 1970-2009. We made attempt to advance the field by testing the traditional closed-economy Fisher hypothesis and an augmented Fisher hypothesis by incorporating the foreign interest rate and nominal effective exchange rate variable in the context of a small open developing economy, such as, Nigeria. The stability of the functions was also tested by CUSUM and CUSUMSQ. Our findings tend to suggest: (i) that the nominal interest rates and expected inflation move together in the long run but not on one-to-one basis. This indicates that full Fisher hypothesis does not hold but there is a strong Fisher effect in the case of Nigeria over the period under study (ii) consistency with the international Fisher hypothesis, these domestic variables have a long run relationship with the international variables (iii) in the closed-economy context,the causality run strictly from expected inflation to nominal interest rates as suggested by the Fisher hypothesis and there is no "reverse causation." But in the open economy context, the expected inflation and international variables contain the information that predict the nominal interest rate(iv) that only about 29 percent of the disequilibrium between long term and short term interest rate is corrected within the year. (v) finally, CUSUM test stability of the coefficients.

Keywords: Fisher Effect, Co-integration, Error Correction Model, Nigeria

Introduction

Krugman and Obstfeld (2003) define the Fisher effect by saying that "all else equal, a rise in a country's expected inflation rate will eventually cause an equal rise in the interest rate that deposits of its currency offer: Similarly, a fall in the expected inflation rate will eventually cause a fall in the interest rate".

The hypothesis, proposed by Fisher (1930), that the nominal rate of interest should reflect movements in the expected rate of inflation has been the subject of much empirical research in many developed countries. This wealth of literature can be attributed to various factors including the pivotal role that the nominal rate of interest and, perhaps more importantly, the real rate of interest plays in the economy. Real interest rate is an important determinant of saving and investment behaviour of households and businesses, and therefore crucial in the growth and development of an economy (DuetscheBundesbank, 2001). The validity of the Fisher effect also has important implications for monetary policy and needs to be considered by central banks.

A significant amount of research has been conducted in developed countries and emerging economies to prove and establish this hypothesis: among the most recent papers are those by Choudhry(1997), Yuhn (1996), Crowder and Hoffman (1996), Lardic& Mignon(2003), Dutt and Ghosh (1995), Muscatelli & Spinelli(2000) Hawtrey (1997), Koustas and Serletis (1999) and Mishkin and Simon (1995), Garcia (1993), Miyagawa & Moritai(2003), Carneiro, Divino and Rocha (2002), Lee, Clark &Ahn(1998), Phylaktis and Blake (1993), Jorgensen and Terra(2003), Atkins & Serletis (2002), Ghazali & Ramlee(2003), Wesso(2000), Esteve, Bajo-Rubio and Diaz-Roldan(2003), Laatsch & Klien(2002), Fahmy & Kandil(2003). But few studies have been conducted in Nigeria to validate this important hypothesis, among which are; Obi, Nurudeen and Wafure (2009) and Akinlo (2011).

Evidence on the long-run Fisher effect is mixed (for an excellent and comprehensive survey of recent evidence on long-run monetary neutrality and other long-run neutrality propositions, see Bullard (1999). Moreso, there has been renewed academic interest in the empirical testing of Fisher effect due to inflation-targeting monetary policy in many countries of the world and the advances in the time series techniques for studying non-stationary data with the help of various cointegration techniques and recently developed Auto-regressive Distributed Lag (ARDL).

This study is important because empirical studies on the existence of fisher effect in developing countries are sparse, especially study on Nigeria. Furthermore, the high rates of inflation and interest have continued to be of intense concern to government and policy-makers. Thus, we investigate the relationship between expected inflation and nominal interest rates in Nigeria and the extent to which the Fisher effect hypothesis holds, for the period 1970-2009 and make use of annual data.

The remainder of this paper is structured as follows: The next section describes the data and methodology employed in this study. This is followed by results and interpretation. The final section concludes this study.

Model specification

Fisher (1930) asserted that a percentage increase in the expected rate of inflation would lead to a percentage increase in the nominal interest rates. This is described by the following Fisher identity:

$$i_t = r_t + \pi^e_t \qquad (1)$$

where$i_t$is the nominal interest rate, $r_t$is the ex antereal interest rate, and π^e_tisthe expected inflation rate. Using the rational expectations model to estimate inflation expectations wouldmean that the difference between actual inflation (π_t) and expected inflation (π^e_t)is captured by an error term (εt):

$$\pi_t - \pi^e_t = \varepsilon t \qquad (2)$$

This rational expectations model for inflation expectations can beincorporated into the Fisher equation as follows.

$$i_t = r_t + \pi_t \qquad (3)$$

Rearranging equation 2:

$$\pi_t = \pi^e_t + \varepsilon_t \qquad (4)$$

where ε_t is a white noise error term. If we assume that the real interest rate is alsogenerated under a stationary process, where r_t^e is the ex antereal interest rateand υ_t is the stationary component, we obtain:

$$r_t = r_t^e + \upsilon_t \qquad (5)$$

Now by substituting equation (4)and (5) into equation (3):

$$i_t = r_t^e + \pi_t^e + \mu_t \qquad (6)$$

Equation (6) is the traditional closed-economy Fisher hypothesis. Incorporating the foreign interest rate and nominal effective exchange rate variable in the context of a small open developing economy, we thus modify equation (6) as

$$i_t = r_t^e + \pi_t^e + fi_t + exch_t + \mu_t \qquad (7)$$

Therefore we estimate the following model:

$$NOMINT_t = \delta + \varphi_1 EXPINF_t + \varphi_2 FORINT_t + \varphi_3 NEER_t + \mu_t \qquad (8)$$

where μ_t is the sum of the two stationary error terms (i.e $\varepsilon_t+\upsilon_t$), r_t^e (δ) is the long run real interest rate, π_t^e is the expected rate of inflation, fi_t is the foreign interest rate and $exch_t$ is the nominal effective exchange rate. The strong form Fisher hypothesis is validated if a long-run unit proportional relationship exists between expected inflation ($EXPINF_t$) and nominal interest rates ($NOMINT_t$) and $\varphi_1=1$, if $\varphi_1<1$ this would be consistent with a weak form Fisher hypothesis.

The first challenge facing any empirical Fisherian study is to derive an inflation expectations proxy. Wooldridge (2003) suggested that the expected inflation this year should take the value of last year's inflation: $\pi_t^e = \pi_{t-1}$.

Type and Sources of Data

The empirical analysis was carried out using time series model. The study uses long and up-to-date annual time-series data (1970-2009), with a total of 40 observations for each variable. The data on nominal interest and expected inflation are obtained from Central Bank of Nigeria Statistical Bulletin, Annual Report and Statements of Account for different years. We use money market interest rate as nominal interest variable and last year inflation as proxy for expected inflation. We use US six month London Interbank Rate obtained from the World Economic Outlook Publication Report as proxy for foreign interest rate. All the variables are in percentage and linear form.

Data Processing Technique

In this study, our empirical investigation consists of three main steps. First, we examine the stationarity of our variables; nominal interest rate, expected inflation rate, foreign interest rate and nominal effective exchange rate. A non-stationary time series has a different mean at different points in time, and its variance increases with the sample size (Harris and Sollis (2003). A characteristic of non- stationary time series is very crucial in the sense that the linear combinations of these time series make spurious regression. In the case of spurious regression, t-values of the coefficients are highly significant, coefficient of determination (R2) is very close to one and the Durbin Watson (DW) statistic value is very low, which often lead investigators to commit a high frequency of Type 1 errors (Granger and Newbold, 1974). In that case, the results of the estimation of the coefficient became biased. Therefore it is necessary to detect the existence of stationarity or non-stationarity in the series to avoid spurious regression. For this, the unit root tests are conducted using the Augmented Dickey-

Fuller (ADF) test and Philips-Perron (PP). If a unit root is detected for more than one variable, we further conduct the test for cointegration to determine whether we should use Error Correction Mechanism (ECM).

Cointegration can be defined simply as the long-term, or equilibrium, relationship between two series. This makes cointegration an ideal analysis technique to validate the Fisher hypothesis: by ascertaining the existence of a long-term unit proportionate relationship between nominal interest rates and expected inflation. Cointegration analysis can thereby establish if nominal interest rates are cointergrated with expected inflation. The cointegration method by Johansen (1991; 1995) has become the most cited cointegration technique used in Fisherian literature, and is thus used in this study. We therefore estimate Equation (8) using the ordinary least square (OLS) method. The software application utilized was E-views 7.0.

RESULTS AND INTERPRETATION

Unit root test

Appropriate tests have been developed by Dickey and Fuller (1981) and Phillips and Perron (1988) to test whether a time series has a unit root. Tables 1 and 2 therefore provide the results of the unit root tests. Table 1 shows the Augment Dickey and Fuller (ADF) and the Phillips and Perron (PP) tests with constant only while Table 2 shows the ADF and PP tests with constant and linear trend.

Table 1: Results of (ADF) and (PP) unit root test, constant only

Variable level	ADF Test	PP
$NOMINT_t$	-1.518178	-1.774944
$EXPINF_t$	-3.750433***	-3.287390**
$FORINT_t$	-0.810983	-0.832659
$NEER_t$	-1.269346	-1.29400
$\Delta NOMINT_t$	-3.384367**	-6.904677***
$\Delta EXPINF_t$	-6.230838***	-11.28416***
$\Delta FORINT_t$	-4.412583***	-6.888661***
$\Delta NEER_t$	-4.401836***	-4.390374***

1% (***), 5% (**)and 10% (*)

Table 2: Results of (ADF) and (PP) unit root test, constant and linear trend

Variable level	ADF Test	PP
$NOMINT_t$	-1.476210	-1.965189
$EXPINF_t$	-3.686009**	-3.219410*
$FORINT_t$	-5.467356***	-2.919212
$NEER_t$	-0.487103	-0.787551
$\Delta NOMINT_t$	-3.349146*	-6.861831***
$\Delta EXPINF_t$	-6.202885***	-12.02996***
$\Delta FORINT_t$	-4.359624***	-7.061584***
$\Delta NEER_t$	-4.609329***	-4.609329***

1% (***), 5% (**)and 10% (*)

The first differences of all the variables are stationary at both the 1 and 5% levels with or without deterministic trend under the two tests. However, expected inflation is stationary at level both at 1% (constant only) and 5% (constant and linear trend) levels using ADF test while it is stationary at both the 5% (constant only) and 10% (constant and linear trend) levels using PP test. Moreso, foreign interest rate is stationary at 1% level I(0) only with deterministic trend using Augment Dickey and Fuller (ADF). Hence, we conclude that these variables are integrated of order one I(1), it therefore necessary to determine whether there is at least one linear combination of the variables that is l(0).

Table 3: Lag Length Selection

Lag	LR	FPE	AIC	SC	HQ
0	NA	1.73E+08	30.32098	30.49693	30.38239
1	152.7777	3070274*	26.28156*	27.16129*	26.58861*
2	15.27803	4396799	26.60459	28.18811	27.15728
3	27.60198*	3535281	26.29340	28.58070	27.09173

*indicates lag order selected by the criterion

Table 3 reports the optimal lag length of one (1) out of a maximum of 3 lag lengths as selected by four different criteria: Final Prediction Error (FPE), Schwarz and Akaike information criteria (SC, AIC) as well as Hannan-Quinn Information Criterion (HQ).

Table 4 provides the results from the application of Johansen cointegration test among the data set. Empirical findings show that both the maximum eigenvalue and the trace tests reject the null hypothesis of no cointegration at the 5 percent significance level according to critical value estimates. The result show a cointegration rank of one in both trace test and max-eigen value test at 5% significance level.

Therefore, the empirical findings lead to the conclusion that a long run relationship between nominal interest rate, expected inflation rate, foreign interest rate and nominal effective exchange rate exists.

Table 4: COINTEGRATION RANK TEST ASSUMING LINEAR DETERMINISTIC TREND

	Null Hypothesis	Test Statistics	0.05 Critical Value	Probability Value
Lags		1		
Trace Statistics	r=0	72.98280*	63.87610	0.0071
	r=1	35.00690	42.91525	0.2448
	r=2	11.38594	25.87211	0.8523
Max-Eigen Statistics	r=0	37.97590*	32.11832	0.0086
	r≤1	23.62097	25.82321	0.0951
	r≤2	8.705032	19.38704	0.9151
Trace	No of Vectors	1		
Max-Eigen	No of Vectors	1		

[a]Denotes rejection of the null hypothesis at 0.05 level

Since the existence of a long-run relationship has been established between long-term interest rates and expected inflation and other variables, the short-run dynamics of the model can be established within an error correction model.

In order to estimate the Fisher effect we will use a simple formulation of an error correction model. We specify the error correction term as follows;

$$NOMINT_t = \delta + \varphi_1 EXPINF_t + \varphi_2 FORINT_t + \varphi_3 NEER_t + \mu_t \quad \text{(from equation 8)}$$

$$\mu_t = NOMINT_t - \delta - \varphi_1 EXPINF_t - \varphi_2 FORINT_t - \varphi_3 NEER_t \qquad (9)$$

where$\mu_t$is the residual term and φ is a cointegratingcoefficient. From equation (9), we can formulate a simple ECM as:

$$\Delta NOMINT_t = \lambda_1 + \lambda_2 \Delta EXPINF_t + \lambda_3 \Delta FORINT_t + \lambda_4 \Delta NEER_t + \Omega\mu_{t-1} + \nu_t \quad (10)$$

Specifically from the ECM expressed in equation (10), λ captures any immediate, short term or contemporaneous effect that the explanatory variables have on NOMINT. The coefficient φ_i reflects the long-run equilibrium effect of EXPINF, FORINT and NEER on NOMINT and the absolute value of Ω decides how quickly the equilibrium is restored. We can therefore say that $\lambda_i$andΩ are the short-run parameters while φ_i is the long-run parameter.

Table 5: ESTIMATED LONG RUN COEFFICIENTS

Variables	Co-efficient	Std. Error	t-statistics	P-value
C	15.03544	2.813039	5.344911	0.0000
$EXPINF_t$	0.059493	0.031301	1.900645	0.0661
$FORINT_t$	-0.446747	0.241464	-1.850161	0.0733
$NEER_t$	-0.026364	0.024131	-1.092538	0.2825
AR(1)	0.744216	0.133338	5.581435	0.0000
$\mathbf{R^2}$= 0.793799 F-Statistics= 31.75941(0.0000) AIC=5.010481 SIC=5.225953 Durbin-Watson=1.954834				

We estimate the equation (8) and report the estimation results, including the estimated first-order autoregressive coefficient of the error term in Table 5, using OLS. All the estimated long-run coefficients are significant at 10% except for nominal effective exchange rate. The result of long run estimated coefficient shows that a ten percentage increasein expected inflation rate will lead to about 0.6percentage rises in nominal interest rate while a ten percentage rise in foreign interest rate will bring about a fall in nominal interest rate by 4.45 percent. Furthermore, a ten percentage increase in nominal effective exchange rate will lead to about 0.3 percentage fall in nominal interest rate.The coefficient of determination (R2) is 0.793799. The result shows that about 80% of variation in nominal interest rate is caused by variations in the explanatory variables. The Durbin-Watson statistics is 1.954834 which shows the absence of serial correlation.

Table 6: ECM Short Run Coefficient Estimates

Dependent Variable=D(NOMINT)		
Regressors	Co-efficient	Prob-value
C	0.126036	0.7738
D(EXPINFL)	0.05825	NA
D(EXPINFL(-1))	-0.061745	0.0439
D(FORINT)	-0.321990	0.0444
D(FORINT(-1))	-0.042191	0.8142
D(NEER)	-0.020565	0.0248
D(NEER(-1))	0.031454	0.3792
ECM(-1)	0.288785	0.0215

Since the existence of a long-run relationship has been established among the series, the short-run dynamics of the model can be established within an error correction model, which gives us the proportion of disequilibrium error that is accumulated in the previous period, corrected in the current period. The P-value of the error correction term coefficient in Table 6 shows that it is statistically significant at a 5% level, thus suggesting that nominal interest rate adjust to the explanatory variables. The coefficient of ecm(-1)is equal to 0.288785 for short run model implying that the deviation from the long-term inequality is corrected by about 29% each year. The lag length of short run model is selected on the basis on AIC and SIC.

We conducted next the Wald coefficient tests to investigate whether full Fisher Hypothesis holds for Nigeria or not, and if not, to verify if there is Fisher effect at all. The results of these tests are reported in tables 7 and 8. The Wald test results shown in table 7 reveal that full (standard) Fisher's hypothesis does not hold in the Nigerian economy. The Wald tests in table 8show that Fisher effect is strong in the economy and that the other variables are significantly different from zero.

Table 7: Wald coefficient test for strong Fisher Hypothesis

Estimated equation; $NOMINT_t = \delta + \varphi_1 EXPINF_t + \varphi_2 FORINT_t + \varphi_3 NEER_t$			
Null Hypothesis; $\varphi_1=1$			
Test Statistics	Value	Df	Probability
t-statistics	-31.94501	33	0.0000
F- statistics	1020.484	(1,33)	0.0000
x^2 – statistics	1020.484	1	0.0000

Table 8: Wald coefficient test for the significance of constant and other dependent variable

Estimated equation; $NOMINT_t = \delta + \varphi_1 EXPINF_t + \varphi_2 FORINT_t + \varphi_3 NEER_t$			
Null Hypothesis; $\delta=0$, $\varphi_1=0$, $\varphi_2=0$, $\varphi_3=0$,			
Test Statistics	Value	Df	Probability
F- statistics	12.64479	(4,33)	0.0000
x^2 – statistics	50.57914	4	0.0000

Causality Test

Having ascertained that a cointegrating relationship exist between both nominal interest rates, expected inflation rate, foreign interest rate and nominal effective exchange rate, the final step in this study is to verify if inflation Granger Cause nominal interest as posed by Fisher Hypothesis. If so then we can say that it is nominal interest rates that respond to movements in inflation expectations. The results of the Pair-wise Granger Causality Test are reported in Table 9.

Table 9: Pair-wise Granger Causality Test

Direction of Causality	F Value	Prob.	Granger Causality
FORINTRATE does not Granger Cause EXPINF	0.13989	0.7106	No Causality
EXPINF does not Granger Cause FORINTRATE	0.45972	0.5022	
NOMINT does not Granger Cause EXPINF	3.64639	0.0644	Unidirectional Causality
EXPINF does not Granger Cause NOMINT	5.18318	0.0290	EXPINF → NOMINT
NEER does not Granger Cause EXPINF	1.77598	0.1913	Unidirectional Causality
EXPINF does not Granger Cause NEER	3.58101	0.0667	EXPINF → NEER
NOMINT does not Granger Cause FORINTRATE	1.12037	0.2969	No Causality
FORINTRATE does not Granger Cause NOMINT	0.30280	0.5855	
NEER does not Granger Cause FORINTRATE	0.29078	0.5930	No Causality
FORINTRATE does not Granger Cause NEER	0.72788	0.3992	
NEER does not Granger Cause NOMINT	1.04730	0.3130	No Causality

NOMINT does not Granger Cause NEER	0.47095	0.4969	

With 1 lags at 5% level of significance, the test suggests that there is uni-directional causality between expected inflation and nominal interest rate. It also reveals that causality run strictly from expected inflation to nominal effective exchange rates at 10% level of significance. However, the rests show no causality results.

Stability Tests

Finally, we have examined the stability of the long-run parameters together with the short-run movements for the equations. For test, we relied on cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) tests proposed by Borensztein, *et al.* (1998). The same procedure has been utilized by Pesaran and Pesaran (1997), Suleiman (2005) and Mohsen *et al.* (2002) to test the stability of the long-run coefficients. The tests applied to the residuals of the ECM model.

Figure 1

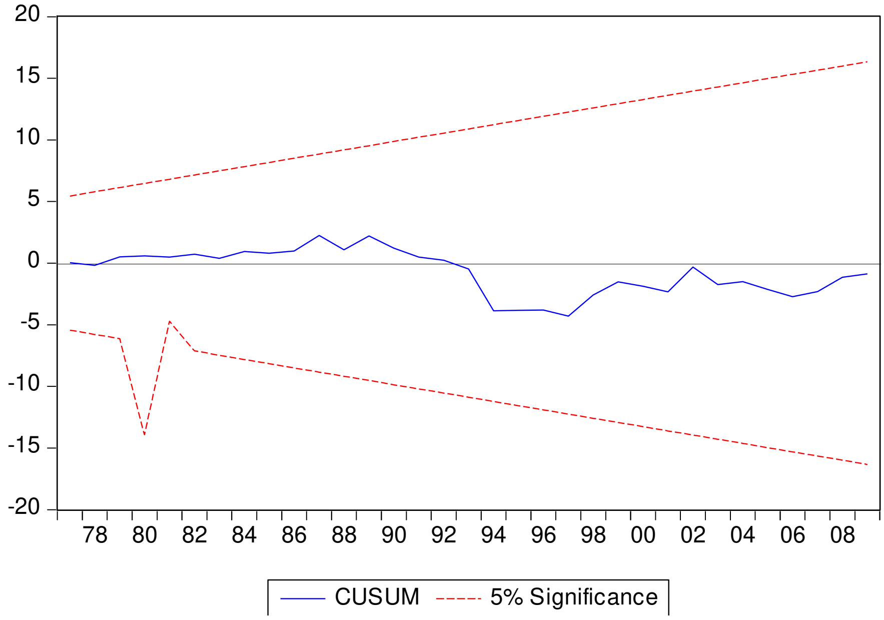
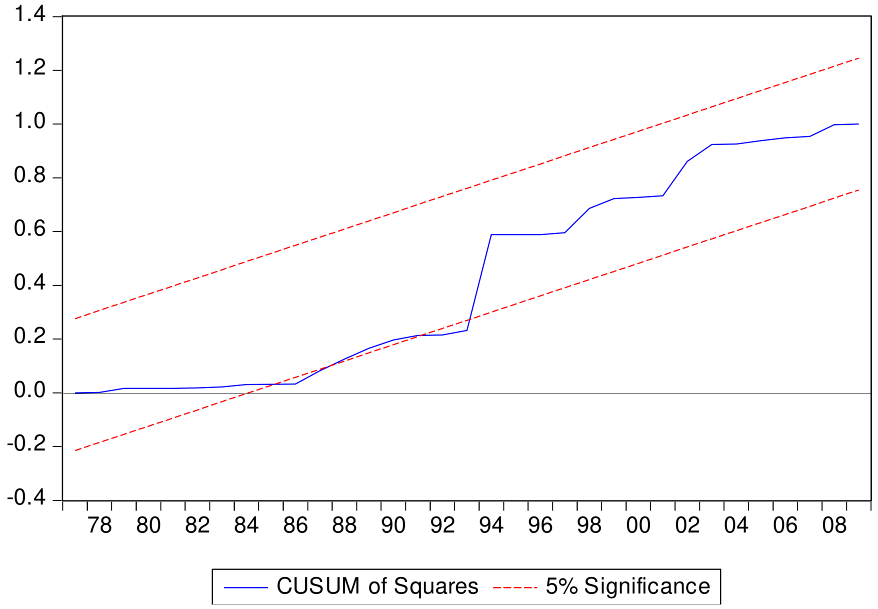


Figure 2



Figures 1 and 2 plot the CUSUM and CUSUM of squares statistics for Equation (10). It can be seen from Figure 1 that the plot of CUSUM stays within the critical 5% bounds that confirms the long-run relationships between variables and also shows the stability of coefficient. However, CUSUMSQ statistics exceed the 5% critical bounds of parameter stability, thus indicates instability of the coefficient.

SUMMARY AND CONCLUSION

This paper investigates the relationship between expected inflation and nominal interest rates in Nigeria and the extent to which the Fisher effect hypothesis holds, for the period 1970-2009. We attempted to advance the field by testing the traditional closed-economy Fisher hypothesis and an augmented Fisher hypothesis by incorporating the foreign interest rate and nominal effective exchange rate variable in the context of a small open developing economy, such as, Nigeria. The stability of the functions was also tested by CUSUM and CUSUMSQ. The results of the unit root tests indicated the variables under study were I(1) processes. Consequently, the Error Correction Model was employed. The cointegration results show that there is long run relationship between nominal interest rates, expected inflation and the international variables, which implies that all the variables move together in the long run.

With the use of Wald coefficient test, this study tends to suggest that the nominal interest rates and expected inflation move together in the long run but not on one-to-one basis. This indicates that full Fisher hypothesis does not hold but there is a strong Fisher effect in the case of Nigeria over the period under study. Moreso, the paper revealed that in the closed-economy context, the causality run strictly from expected inflation to nominal interest rates as suggested by the Fisher hypothesis and there is no "reverse causation."However, in the open economy context, causality does not run only from expected inflation rate to nominal interest rate but also run from expected inflation to nominal effective exchange rate. The result further showed that aside expected inflation, the international variables- foreign interest and nominal effective exchange rates- contain information that predict the nominal interest rate. Next we estimated short run dynamics of the model which suggested that about 29percent of the disequilibrium between long term and short term interest rate is corrected within the year. Finally, we conducted CUSUM and CUSUMSQ testsof which only CUSUM test confirms the long-run relationships between variables and also shows the stability of the coefficients. The policy implication based on the partial Fisher effect in Nigeria is that more credible policy should anchor a stable inflation expectation over the long-run and the level of actual inflation should become the central target variable of the monetary policy.

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