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Cointegration, Causality and Fisher Effect in Nigeria: An Empirical Analysis (1970-2011)

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Abstract
This paper empirically investigates the existence of fisher effect in Nigeria. Specifically, it seeks to: examine the relationship between expected inflation and nominal interest rate in Nigeria; and also determine the nature and direction of causality between expected inflation and nominal interest rate in Nigeria. Employing Cointegration, Granger causality and error correction techniques and using data spanning the period of 1970-2011, the results indicate the existence of long run partial fisher effect in Nigeria. Specifically, there exists a long run positive and significant relationship between inflation and interest rate in Nigeria. Furthermore, there exists a unidirectional causality running from inflation to interest rate in Nigeria. The paper recommends amongst others that, given the crucial role of interest rate in determining savings and investment which are necessary for economic growth and development, policy makers and relevant monetary authorities should employ measures that will prevent inflation rate from rising to alarming heights in order to ensure that interest rates are maintained at reasonably low levels in Nigeria.
Keywords: Cointegration, Causality, Inflation, nominal interest rate Fisher Effect

1. Introduction

Interest rate and inflation are two important issues that usually occupy dominant and priority positions in the agenda of policy makers and governments in the global economy. They are two macroeconomic variables whose behaviour cannot be ignored but monitored, planned and properly guided if the macroeconomic stability of any society is to be attained. Besides, the economic growth and development of countries all over the world hinges greatly on the efficient and effective management of certain macroeconomic variables including interest rates and the general price level. Furthermore, the relationship between the interest rates and inflation is equally of crucial importance to policy makers and governments.

The Fisher hypothesis (a theory that expresses a relationship between interest rates and inflation), was first introduced by Irving Fisher, an American economist in 1930. He postulated that the nominal interest rate in any given period is equal to the sum of the real interest rate and the expected rate of inflation. The Fisher relation suggests that when expected inflation rises, nominal interest rate will rise with an equal amount leaving the real rate unaltered (Asemota and Bala, 2011). However, the existence of fisher hypothesis has continued to generate series of debate among economists (Obi, Nurudeen and Wafure, 2009).

By definition, inflation refers to a sustained rise in the general level of prices (Blanchard, 2009). Inflation is commonly understood as a situation of substantial and rapid general increase in the level of prices and consequent deterioration in the value of money over a period of time (Mitthani, 2010). On the other hands, interest rate is a reward for capital (Ahuja, 2010). There are two concepts of interest rate. Nominal interest rate is the interest rate that ignores the effects of inflation on the cost of borrowing, while the real interest rate is the interest rate that is adjusted by subtracting expected changes in the price level (inflation) so that it more accurately reflects the true cost of borrowing (Mishkin, 2010). In a nutshell, the real interest rate equals the nominal interest rate minus the expected inflation rate.

Available data on the Nigerian economy reveal that throughout the period 1970 to 2011, interest rate equally fluctuated actively as inflation rate. For instance interest rate increased from 8 percent in 1970 to peak at 29.80% in 1992 when inflation rate is 44.81% but however, falls to 20.18% in 1995 when inflation rate is at its peak point of 72.81%.

It is pertinent to note that 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 (Duetsche Bundesbank, 2001). For instance, if interest rate (specifically, lending rate) is high, this will discourage borrowing which will inadvertently affect businesses thus leading to low output levels. Conversely, high interest rates (specifically, saving deposit rates), will encourage savings since the holders of surplus funds expect high returns on their savings.

It is also important to note that inflation rate has enormous implications for macroeconomic stability for instance, high rates of inflation will reduce aggregate demand, production, employment, trade deficits, and balance of payments. On the other hand, a low and moderate inflation will encourage economic activity, particularly production. This in turn will raise gross domestic product (GDP), reduce unemployment, and ease the balance of payments problems (Obi, Nurudeen and Wafure, 2009).

Is there any relationship between inflation and interest rate in Nigeria? Does an increase in expected inflation lead to a rise in nominal interest rate in Nigeria? Is there any evidence of the existence of the fisher effect in Nigeria? Is there any causality between expected inflation and nominal interest rate in Nigeria? If yes, what is the nature and direction of such causality? These and more are the crucial and underlying questions that this paper seeks to answer. Thus, the major objective of this paper is to investigate the fisher hypothesis in Nigeria using Cointegration, Granger causality and the Error Correction Mechanisms and using data spanning the period of 1970-201. Specifically, it seeks to: examine the relationship between expected inflation and nominal interest rates in Nigeria: and also determine the nature and direction of causality between expected inflation and nominal nterest rates in Nigeria.

This study is important because, although there exists a vast reservoir of studies on Fishers effect in other countries, there is a paucity of such studies in Nigeria. Thus, apart, from filling the existing gap in literature, this study will also serve as a veritable tool in the hands of the Central Bank and other relevant monetary authorities for efficient, effective and result-oriented policy actions. The paper is divided into five sections, section 1 is the introduction, and section 2 contains the literature review while section 3 contains the methodology and the model specification. In section 4, the results are presented and discussed in detail. Section 5 embodies the policy recommendations and conclusion of the paper.

2. **Literature Review**

2.1 **Theoretical Literature Review**

The Fisher hypothesis is the theoretical backbone of the relationship between inflation and interest rate. The Theory states that expected inflation is the main determinant of nominal interest rates (Obi, Nurudeen and Wafure, 2009). According to Irving Fisher, nominal interest rates consists of two components – the real rate of interest, to which real saving and investment respond, and a premium based on expected change in the price level (William & Denis (1969) in Ogbonna (2013)). The real interest rate can be obtained from nominal interest rate by adjusting for inflation rate that takes place in a year. Thus, the relationship among the real rate of interest, nominal rate of interest and inflation rate can be stated as below:

$$r = i - \pi \quad (1)$$

Where:

r= interest rate
i = nominal interest rate
π = inflation rate

Rearranging equation (1) we have:

$$i = r + \pi \quad (2)$$

Equation (2) shows that change in nominal interest rate (i) can occur due to the following reasons: (1) changes in real interest rate and (2) changes in rate of inflation. The relationship between nominal interest rate, real interest rate and inflation rate is called Fisher Equation after the economist. Irving Fisher (1867-1947) who first of all stated this relation (Ahuja, 2010). Since nominal interest rate (i) is the sum of real interest rate (r) and rate of inflation (π), it therefore follows that a rise in inflation rate will raise the nominal interest rate, while the real interest rate will remain unchanged. In fact, there is one for one adjustment of nominal interest rate to changes in inflation rate. The adjustment of nominal interest rate to changes in inflation rate is called Fisher effect (Ahuja 2010).

2.2 **Empirical Literature Review**

There is a preponderance of empirical studies on Fisher Effect in many countries all over the world. For instance, Ray (2012) did an empirical testing of international Fisher effect in the United States (US) and selected Asian counties including India, Korea and Japan by regressing interest rate differential on inflation rate differential using quarterly data from 2001: Q1 to 2012: Q2. The finding showed the existence of partial fisher effect in the United States because, although nominal interest rate and inflation where positively related, they do not move one-to one- as proposed by the Fisher effect hypothesis. Japan, India and Korea however showed no evidence of Fisher effect.

Ito (2009) examined the fisher hypothesis with Japanese long term interest rates using data set spanning from 1970-2007. Employing cointegration technique, the results revealed that all interest rates move together with expected inflation in the long run equilibrium. This implied that, nominal interest rates in Japan were sensitive to inflationary expectations.Crowder (2003) investigated Fishers relation for eight industrialized counties including Germany, Netherlands and Italy using data spanning the period 1960 to 1993. The study made use of nominal lending rate, nominal interest rate and call money and Treasury bond rate. The results showed evidence of Fisher effect for Germany, Netherlands and Italy.

Kasman and Turguflu (2005) tested the Fisher hypothesis using a fractional cointegration analysis for 33 countries including Chile. Their results showed that there is a cointegrating relationship between the two variables for most countries including Chile implying the validity of the fisher hypothesis. Westerlund (2008) used panel cointegration to test for the existence of fisher effect in 20 OECD (Organization of Economic Cooperation and Development Countries between 1980 to 2004. The empirical results showed a long-run relationship between nominal interest rate and inflation. The study concludes that fisher's effect cannot be rejected once the panel evidence on cointegration has been taken into account.

Similarly, Toyeshim (2011) did a panel cointegration analysis of the fisher effect for Japan, Britain and U.S from 1990 to 2010. The study confirmed the validity of fishers effect when short run and long-run nominal interest rate were used although the relationship between nominal interest rate and inflation was seen not to be one-to-one. Gul and Ekinci (2006) empirically analyzed the relationship between nominal interest rate and inflation using high frequency data of nominal interest rate and inflation of Turkey. With time series of techniques, the study provides evidence that long run relationship exist between nominal interest rate and inflation. The causality test result however, indicates that there is only one directional causality that runs from interest rate to inflation.

Nkegbe and Mumin (2012) studied inflation an interest rate movements in Ghana with the view to finding out the trend and possible causal links between them monthly data from 1995 to 2011. Granger causality and cointegration test were used. The result showed a two-way causality between inflation and nominal interest rate while the cointegration test also showed that a long run relationship exist between inflation and nominal interest. On the contrary, empirical studies such as Choudhry (1997), Wesso (2000), Shalishali, (2012) and Sheefeni (2013) found no evidence of fisher effect existing in diverse countries of interest.

There is a paucity of empirical studies that investigate the Fishers effect in Nigeria. However, the few that exist have divergent conclusions about the existence of fisher effect in Nigeria. For instance, Alimi and Awomuse (2012) employed cointegration and error correction techniques to investigate the relationship between expected inflation and nominal interest rate in Nigeria from 1970 to 2009. The empirical result showed that expected inflation and nominal interest rate move together but not on a one-to-one basis. The error correction result showed that about 16% of the disequilibrium between long term and short term interest rate were corrected.

Similarly, Obi, Nurudeen and Wafure(2009) examined the existence of fisher effect in Nigeria usind data spanning the period 1970-2007. Employing cointegration and error correction techniques, the results revealed the existence of long run partial fisher effect in Nigeria.

Adegboyega, Odusanya and Popoola (2013) used a Bounds test approach to cointegration to investigate Fishers effect in Nigeria between the period of 1986-2011. the findings revealed the existence of cointegration amongst interest rate, inflation and money supply. Furthermore, the results revealed a negative relationship between interest rate and inflation and a positive relationship between money supply and inflation. With these results, they inferred a partial fisher effect within the period of study.

Muse and Alimi (2012) tested an augmented Fisher hypothesis for a small open economy using Nigeria as a case study with a data set that covered 1970 t0 2009 by incorporating foreign interest rate and nominal effective exchange rate into their model. Employing Granger causality and cointegration tests, the results showed that expected inflation and nominal interest rate move together but not on a one-to-one basis. The causality test also shows that causality runs from expected inflation to nominal interest rate as suggested by fisher's hypothesis.

Nwosa and Oseni (2012) studied the nexus among monetary policy, exchange rate and inflation in Nigeria for the period spanning from 1986 to 2010. The study employed cointegration and Granger causality test with a multi-variate vector error correction model (VECM). The study showed that there is a unidirectional causality

that runs from inflation and exchange rate to interest rate which was used as a measure of monetary policy. The study, thus suggest a possible operation of fishers effect since inflation granger causes interest rate.
On the contrary, there are some studies that found no evidence of fisher effect in Nigeria. These include: Amadusu (2012), Asemota and Bala (2011), Chichi and Ogomegbuman (2013), Udoka, Anyingang and Tapang (2012), and Ogbonna (2013)..

3.0 **Methodology**

3.1 Model Specification

This study employs a multi-variate cointegration regression analysis in order to find out if there is any long-run relationship between Interest rate (IR) and Inflation (IFN). This is done in order to avoid spurious correlation and regression results often encountered in non-stationary time series data. Specifically, this study proposes a framework based on the Fisher hypothesis which postulates that, when expected inflation rises, nominal interest rates will also rise on a one-to-one basis. Thus, the researcher specifies a model in which Interest Rate (IR) is expressed as a function of Inflation (INF) as in equation 3.1.1

$IR = F(INF)$ - - - - - - - - 3.1.1

However, it is absolutely imperative to take cognizance of the fact that there are other factors other than inflation which exert much influence on Interest rate. Thus, in order that the interest rate model specified for purposes of this research is not under-specified, other variables such as: Broad Money Supply (MS) and Fiscal Deficits (FD), are included in the model. Thus, the Interest rate model is specified as:

$IR = f(INF, MS_t\ Fd_t)$ - - - - - - - - 3.1.2

More technically written, we have:

$IR=bo+b_1INF+b2MS_t+b3FD_t+b4_t+\mu_t$ - - - - - - 3.1.3

Where:

IR= Nominal Interest rate (%) (prime lending rate)
INF= Inflation rate (%)
MS_t= Growth rate of Money Supply (%)
FD_t = Growth rate of Fiscal Deficits (%)
μ_t = stochastic error term
t = time period
b0 – b3 are parameters of the model representing the coefficients of the explanatory variables.

A Priori Expectations

b_1, b_2 and b_3 >0

3.2. Data

The series employed are annual observations of Interest rate (IR), Inflation rate (INF), Broad Money Supply (MS) and Fiscal Deficit (FD) for the period 1970-2011. They were sourced from various issues of the Central Bank of Nigeria (CBN) statistical Bulletin

3.3. **Estimation Techniques**

The Unit Root test involves testing for the order of integration of each time series (variable) A series is said to be integrated of order I(1) if it needs to be differenced once to become stationary. The same holds for an I(2) series which will need to be differenced twice to become stationary. Thus a stationary series is integrated of order zero I(0) (i.e, no differencing is necessary). Both the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979,1981), and the Philips-Perron (Philip and Perron, 1988) “unit root” tests, are employed to determine the order of integration of each series.

3.3.2 **The Cointegration**

This involves testing for the existence or otherwise of co integration between series that have the same order of integration. The existence of cointegration between series implies the existence of a long- term relationship between such variables and vice versa. This study employs the maximum likelihood test procedure established by Johansen and Juselius (1990) and Johansen (1991).

3.3.3 **The Error Correction Model**

If the existence of Cointegration is established amongst the series, then an Error Correction Mechanism (ECM) first used by Sargan (1964) and later popularized by Engel and Granger (1969) is constructed to correct for any

disequilibrium in the short run. In an ECM, the dynamics of both short-run (changes) and long –runs (levels) adjustment processes are modeled simultaneously, thereby offering the possibility of revealing information about both the short-run and long-run relationship.

3.3.**4 Granger Causality Test**

The Granger causality test is used to detect the nature and direction of influence or causality between two variables. If two variables are co-integrated then the causality of the co-integrated variables are captured in a vector error correction model (VECM).

4.0 Analysis and Discussion of Results

4.1 Unit Root Tests

Table 4.1a Result of Unit Root Test Based on Augmented Dickey-Fuller (Constant, time and trend included)

Variables	**ADF statistic**	**1% critical level**	**5% critical level**	**10% critical level**	**Order of integration**
IR	-9.993997	-3.605593	-2.936942	-2.606857	I(1)
INF	-6.414470	-3.610453	-2.938987	-2.607932	I(1)
MSt	-4.466297	-3.600987	-2.935001	-2.935001	I(0)
FDt	-3.863527	-3.600987	--2.935001	-2.605836	I(0)

Source: Computed Result (E-view 5.0)

Table 4.1b Result of Unit Root Test Based on Philip Perron Test (Constant, time and trend included)

Variables	**ADF statistic**	**1% critical level**	**5% critical level**	**10% critical level**	**Order of integration**
IR	-10.07826	-3.605593	-2.936942	-2.606857	I(1)
INF	-10.62075	-3.605593	-2.936942	-2.606857	I(1)
MSt	-4.350954	-3.600987	-2.935001	-2.605836	I(0)
FDt	-3.973325	-3.600987	-2.935001	-2.605836	I(0)

Source: Computed Result (E-view 5.0)

Notes:

(1) The acronyms for variables are as earlier defined in section 3.1 under model specification

(2) The test was performed with trend and intercept and the critical values of the test are at 1%, 5%, and 10% levels of significance respectively

(3) Order (0) and order (1) indicate stationarity of the various variables at level and at first difference respectively.

(4) The Ho is that series is non-stationary against alternative hypothesis H_1 of a series being stationary. The rejection of the Ho for the ADF and PP tests are based on the Mckinnon critical values. The lag lengths were determined in accordance with the Sic.

After comparing the test statistic value against the Mackinnon critical value at 5% level of significance, it was noticed that two out of the four variables in the two tests employed, that is ADF and PP, were stationary at levels. The results of both the ADF and PP test show that MS_t and FDt were stationary at levels while IR and INF were stationary at first difference.

4.2 Cointegration Rank Tests

Table 4.2a Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.519723	59.33665	47.85613	0.0029
At most 1 *	0.407326	30.00097	29.79707	0.0474
At most 2	0.161184	9.076536	15.49471	0.3583
At most 3	0.049863	2.045957	3.841466	0.1526

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

Table 4.2b Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.519723	29.33568	27.58434	0.0295
At most 1	0.407326	20.92444	21.13162	0.0534
At most 2	0.161184	7.030580	14.26460	0.4855
At most 3	0.049863	2.045957	3.841466	0.1526

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

From the table, the trace statistic indicated 2 cointegrating equations at the 5% level of significance while the maximum Eigen value statistic indicates 1 cointegrating equation at the 5% level of significance. This result suggests that there is co-integration or long–run relationship between the variables tested.

4.2 Error Correction Model Results

The error correction mechanism for the variables that influence nominal interest rate(IR) was estimated to capture the dynamics in the Interest rate equation in the short run and to identify the speed of adjustment as a response to departures from the long run equilibrium. To obtain a parsimonious dynamic ECM for the Interest rate equation, an initial over-parametised model was estimated which was too difficult to interprete. Thus, it was reduced and simplified into an interpretable parsimonious model of Interest rate in Nigeria. The result is presented below.

Table 4.3 Parsimonious Error Correction Result of Factors Influencing Nominal Interest rate.
Dependent Variable: IR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.24477	1.920164	8.460094	0.0000
INF(-1)	0.103617	0.038027	2.724864	0.0099
MST	-0.026849	0.038872	-0.690716	0.4942
FDT	-0.247078	0.127566	-1.936869	0.0606
ECM(-1)	0.746719	0.116848	6.390500	0.0000

R-squared	0.627331	Mean dependent var	15.06463
Adjusted R-squared	0.585923	S.D. dependent var	6.508518
S.E. of regression	4.188155	Akaike info criterion	5.816247
Sum squared resid	631.4630	Schwarz criterion	6.025219
Log likelihood	-114.2331	F-statistic	15.15009
Durbin-Watson stat	2.547503	Prob(F-statistic)	0.000000

The result of the parsimonious model presented in table 4.3 shows a well defined error correction term ECM(-1) which which is negative and statistically significant at 1% probabaility level. The significance of the coefficient of the error term supports our earlier positions that the variables under study are indeed cointegrated. The absolute value of the coefficient of the error term indicates that the disequilibriums in the long run trend of the

dependent variable (that is interest rate) takes approximately 1/0.75 years (that is 1.3 years) to be corrected back to the equilibrium level. This coefficient represents the speed of adjustment and it is also consistent with the hypothesis of convergence towards the long-run equilibrium once the inflation equation fluctuates from its equilibrium in the short-run. The effect of this ECM is not only large but also has a negative sign as expected and is significant at 1% probability level. Thus, this validates our earlier position that the variables under study are indeed cointegrated.

The diagnostic test for the ECM revealed R^2 of 0.627331 implying that the specified explanatory time series explained about 63% of the adjusted total variations in nominal interest rate (IR). The F-statistic of 15.15 is significant at 1% probability level thus indicating that the R^2 is significant and the model has goodness of fit. The Durbin Watson value of 2.55 however reveals the existence of minor serial correlation.

It is also pertinent to note that, of all the explanatory variables, it is only inflation rate(INF) and Fiscal Deficit(FDt) that are significant in the parsimonious results presented in table 4.3. The lagged INF is significant at 1% probability level and is also positive. This indicates that inflation rate has a positive or direct and significant influence on nominal interest rate in the short run. This implies that an increase in inflation rate will also lead to an increase in interest rate. This relationship is such that a 1% increase in inflation rate will on the average lead to a 0.10% increase in interest rate. This reveals that there exists a partial fisher effect in Nigeria as interest rate and inflation do not move one-to-one. This finding is in conformity with earlier findings by Obi, Nurudeen and Wafure(2009) and Alimi and Awomuse(2012). FDt is significant at 10% probability level but it is negative. This indicates that fiscal deficit has a negative or an inverse but significant influence on nominal interest rate in the short run.

4.4 **Granger Causality Results**

Table 4.4 Pairwise Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Probability
INF does not Granger Cause IR	40	2.78966	0.07514*****
IR does not Granger Cause INF		0.61559	0.54607
MST does not Granger Cause IR	40	1.22402	0.30633
IR does not Granger Cause MST		1.38033	0.26485
FDT does not Granger Cause IR	40	2.88034	0.06950*****
IR does not Granger Cause FDT		0.05068	0.95065

From the Granger results, the null hypothesis that inflation rate(INF) does not Granger cause interest rate(IR) is rejected. This is because computed F- statistic value is significant at 10% probability level. Thus the results show that inflation granger causes interest rate in Nigeria. This finding conforms to the works of Muse and Alimi (2012) and Nwosa and Oseni (2012). On the contrary, we accept the null hypothesis that IR does not Granger cause INF. Thus, unidirectional causality exists between INF and IR with the direction running from INF to IR.

We accept the null hypothesis that the growth rate of real broad money supply (MSt) does not granger cause interest rate (IR). Similarly, we accept the null hypothesis that IR does not granger cause MSt. Thus, there is no causality between MSt and IR.

Furthermore, we reject the null hypothesis that FDt does not granger cause IR because computed F- statistic value is significant at 10% probability level. On the contrary, we accept the null hypothesis that IR does not granger cause FDt. Thus, unidirectional causality exists between FDt and IR with the causality running from FDt to IR.

5. Policy Recommendations and Conclusion

The major focus of this study is to empirically investigate the existence of fisher effect in Nigeria. Specifically we sought to: examine the relationship between expected inflation and nominal interest rate in Nigeria; and also determine the nature and direction of causality between expected inflation and nominal interest rate in Nigeria. Employing Cointegration, Granger causality and error correction techniques and using data spanning the period of 1970-2011, the results indicate the existence of long run partial fisher effect in Nigeria. Specifically, there exists a long run positive and significant relationship between inflation and interest rate in Nigeria. Furthermore, there exists a unidirectional causality running from inflation to interest rate in Nigeria.

From the findings of this study, the policy options can be easily discerned. While there exists a long run relationship among the variables employed for purposes of this research, policy option requires that, in the short run, efforts should be aimed at encouraging inflation targeting strategies that will stabilize the general price level in Nigeria given its significant relationship with interest rate. Specifically policy makers and relevant monetary authorities should employ measures that will prevent inflation rate from rising to alarming heights in order to ensure that interest rates are maintained at reasonably low levels. Furthermore, government should ensure that fiscal deficits are not allowed to be unreasonably high in order to curtail its adverse effects on interest rate.

Finally, given that interest rate plays a crucial role in determining savings and investment which are necessary for economic growth and development of the nation, it therefore follows that any effort geared towards maintaining it at economy-friendly levels is a worthwhile attempt and should be treated as a matter of urgent national importance if the economic growth and development of Nigeria is to be fast-tracked.

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