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Long-Run Relationship between Interest Rate and Inflation: Evidence from Nigeria.

Amaefula C. G
Department of Mathematics and Statistics, Federal University Otuoke, P.M.B. 126 Yenegua, Bayelsa State

Abstract: *This paper examines whether long-run equilibrium relationship exist between interest rate and inflation in Nigeria. The data sets on interest rate and inflation covered the period of January, 1995 to December, 2014. Johansen cointegration test was adopted to ascertain whether there is the existence of long-run relationship between the two variables and vector error correction model (VECM) of granger causality was also employed to accommodate the long run and short run relationship and to find out whether the flow of relationship is bi-directional or unidirectional. The results show evidence of long-run equilibrium relationship between the two variables with strong evidence of unidirectional granger causality flow from interest rate to inflation rate at the long-run. The finding has empirical implication to monetary policy makers in areas of microeconomic planning in Nigeria.*
Keywords: *Co-integration, VECM, Granger Causality, Interest rate and Inflation*

I. Introduction

Interest rate and inflation are macroeconomic indicators crucial in any monetary policy framework of the Central bank of any nation. Understanding the relation between these two macroeconomic indicators is basic in keeping a balance economy. Inflation is the rate of increase in the general price level. This could be attributed to low interest rate resulting to propensity to borrowing more or may be, the government is spending excessively on defense or fight against insurgency. Price level could also rise if there is not enough supply to service the rising demand for home goods and services (this may be as a result of acute short fall in supply or over growing population). These causes of inflation are generally categorized under demand pull. Also, price levels could increase when the price of doing business begins to rise up independent of demand, when local currency loses value and the cost of importing raw material goes up or when government negotiates new wages due to labor unions' agitation and strikes-cost push inflation.

Interest rate is the cost of borrowing or simply the price of money. Low interest rate put more borrowing power in the hands of consumers. Literary, when consumers spend more, the economy tends to grow naturally inducing inflation. When inflation goes up interest rate tends to rise and it comes down when interest rate tends to fall. This indicates a co-movement between the two variables.

Some previous studies have examined the effect of inflation on interest rates or the impact of interest rate variation on inflation. However, this study examines whether the relationship between interest rate and inflation exist in the long-run or short-run. Does bi-directional causal relation exist? Which causal flow is stronger or is there uni-directional causality? The outcome will help to give appropriate information and advice to the government for a better monetary policy, especially at this period of rising inflationary trend. The rest of the paper is arranged as follows; section 2 deals with the literature review, section 3 deals with the materials and econometric methodology, section 4 shows the data analysis and results and section 5 gives the conclusion and policy implication.

II. Literature Review

Various studies on the relationship between interest rate and inflation have evolved over time in literature. Some of these studies are theoretically based while some are empirical. Fisher hypothesis suggests that inflation is the main determinant of interest rates, and as the inflation rate increases by one per cent, the rate of interest increases by the same amount. And a relationship between inflation and interest rate is found to exist using Fisher effect as a frame work ([8]; [9]; [19]). [10] test whether the Fisher effect holds in the US, and they find evidence in favor of approximately constant real interest rates, as implied by the Fisher hypothesis. [22] used error correction model (ECM) and provided evidence in favor of the Fisher hypothesis for 20 OECD economies for the period 1980-2004. [18] test the Fisher hypothesis for East Asian economies using panel unit root tests and find empirical evidence to support the validity of the Fisher hypothesis in this context.

[20] examined the relation between real interest rates and inflation employing a model that is estimated as a state-space system that includes observations on Treasury bills with different maturities and NBER-ASA survey forecasts of inflation for the period between 1968 and 1988. The result showed that real interest rates and expected inflation are significantly negatively correlated. [3] used quarterly data (the three-month T-bill rate and

the implicit price deflator for total consumption expenditure) for the US to test the long-run relationship between nominal interest rates and inflation through cointegration analysis. Their showed that a 1 percent increase in inflation yields a 1.34 percent increase in the nominal interest rate. After adjusting for tax effects, this effect is found to be 0.97, which is almost equal to unity. [15] assessed the impact of inflation uncertainty on interest rate within the Fisher hypothesis framework in the UK with a quarterly data from 1958:4 to 1994:4, applying heteroscedastic models, his results showed that both the expected inflation and conditional variability of inflation affect the UK three month Treasury- bill rate

[11] have confirmed a relationship between interest rate and inflation rate in the long-run. [21] examined the relationship between inflationary expectations and the variations in interest rate in Nigeria using the Generalized Method of Moment (GMM) estimator. Their results indicate that the effect of interest rate variation on expected inflation in Nigeria is negative and significant. [14] investigated the interaction between nominal interest rates and inflation for Turkey over the period of 1984-2003.. Their result supports the idea that there is a long-run relationship between interest rates and inflation for Turkish markets. They also find that causality exists in only one direction from nominal interest rates to inflation.

III. Materials And Econometric Methodology

3.1 Data Source and Variable Definition

The two sets of time series data consist of monthly deposit rate and consumer price index (CPI) obtained from the published ([1] and [2]) statistical bulletin. And the data sets cover the period of 1985M1 to 2014M12. The two variables are defined as follows; Interest rate is represented as ITR and inflation is represented as IFR (consumer price index is used as proxy for inflation).

3.2 Unit Root Test

Many macroeconomic time series have time varying mean, covariance and exhibit non-stationary behavior. Unit root tests are important in examining the order of integration of a time series data. Several unit root test have evolve over time in literature. But the study will use the Augmented Dickey-Fuller (ADF) test since there is no level shift in the variables and the sample size is large. Investigating whether a sequence contains a unit root, consider the [4] and [5] tests as follows;

$$\Delta y_t = \alpha_0 + \alpha_1 t + \phi y_{t-1} + \sum_{j=1}^{p-1} \beta_j \Delta y_{t-j} + u_t \tag{1}$$

$$\Delta y_t = \alpha_0 + \phi y_{t-1} + \sum_{j=1}^{p-1} \beta_j \Delta y_{t-j} + u_t \tag{2}$$

$$\Delta y_t = \phi y_{t-1} + \sum_{j=1}^{p-1} \beta_j \Delta y_{t-j} + u_t \tag{3}$$

In (1) there is both the drift term and the deterministic trend. The drift term is excluded in (2) and (3) excludes both the intercept term and the deterministic trend. The null hypothesis H_0: ϕ =0 versus the alternative H_1: ϕ <0. If the ADF test statistic is greater than 1%,5% and 10% critical values, the ADF test null hypothesis of a unit root is accepted.

3.3 Co-Integration

The concept of co-integration provides a strong framework that allows us to describe the existence of an equilibrium, or stationary relationship among two or more non-stationary time series. In other words, if two or more time series have the same order of integration, having moments such as means, variances and co-variances varying with time, and there exist some linear combination of these series that defines the equilibrium relationship with time invariant linear properties, such variables are said to be co-integrated. According to [12] and [7], variables are called co-integrated if they have a common stochastic trend. When two or more time series are co-integrated the variables are said to have a long equilibrium relationship. A test for co-integration offers a useful method of distinguishing meaningful regression from the one [23] called 'nonsense' and [13] referred as 'spurious'.

Engle and Granger (1987) proposed a regression of y_t on x_t such that

$$y_t = \alpha_0 + \alpha_1 x_t + u_t \tag{4}$$

In (4), y_t and x_t are co-integrated if they have the same order of integration and residual u_t is stationary. [4] argued that the Engle and Granger co-integration is sensitive to the choice of response variables; hence, the test result may not be consistent. However, co-integration in this study is based on ([16], [17]) method which is represented as follows;

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_i + \varepsilon_t \tag{5}$$

Where, $\Pi = \sum_{i=1}^{p} \Lambda_i - \mathrm{I}$, $\Gamma_i = -\sum_{j-i+1}^{p} \Lambda_j$, x_t is a d-vector of deterministic variables, y_t is a k-vector of integrated I(1) variables, ε_t is a vector of white noise with zero mean and finite variance. The number of cointegrating vector is represented by the rank of coefficient matrix Π.

This method estimates the Π matrix in an unrestricted form and then test if one can reject the restriction imposed by the reduced rank of Π. The likelihood ratio (LR) test for the hypothesis that there are at most r cointegration vectors is known as the trace test statistic.

3.4 Granger Causality Test-VECM

If two time series are co-integrated the vector error correction model is a suitable modeling framework. The VECM for the case of ITR and IFR can be written as follows;

$$\Delta IFR_t = \alpha_c + \beta_c ECT_{t-1} + \sum_{i=1}^{n} \tau_{ci} \Delta ITR_{t-1} + \sum_{i=1}^{m} \lambda_{ci} \Delta IFR_{t-1} + \varepsilon_{ct} \tag{6}$$

$$\Delta ITR_t = \alpha_s + \beta_s ECT_{t-1} + \sum_{i=1}^{n} \tau_{si} \Delta ITR_{t-1} + \sum_{i=1}^{m} \lambda_{si} \Delta IFR_{t-1} + \varepsilon_{st} \tag{7}$$

Where, ECT is the lagged error correction term derived from the long-run co-integrating relationship. $\beta_i (i = c, s)$ are adjustment parameter coefficients, Δ is a difference operator and ε_{it}'s are random error terms assumed to be uncorrelated with mean zero. λ_i and $\tau_i (i = c, s)$ are the short-run or long term parameter.

Testing for the significant of parameter coefficients i.e is testing H_0: λ_{ci} =0 for all i and H_0: λ_{si} for all i in (6) and (7) respectively will help in identifying the source of causation. Note that the significant of the β_c and β_s can be tested in (6) and (7). The significant of the β_i's $(i = c, s)$ indicate how fast deviations from the long run equilibrium are eliminated by changes in each variable. The test can be accomplished via the F-test. If β_c =0 or β_s =0, it indicate granger non-causality in the long run equilibrium or weak exogeneity. For the IFR and ITR, this means the both variables do not respond to a deviation from long-run relationship in the previous time period.

IV. Data Analysis And Results

The results in Table 1-3 show the analysis of the unit root test using ADF unit root test, cointegration and error correction model.

Table1. Unit Root Test using ADF

Variable	Test	Deterministic Terms	Lags	Test value	critical values			Result
					1%	5%	10%	
IFR	ADF	C	0	3.4033	-3.4576	-2.8734	-2.5732	Not Stationary
		C, t	0	-0.2662	-3.9969	-3.4287	-3.1378	
ΔIFR		C	0	-15.9265	-3.4577	-2.8735	-2.5732	Stationary
		C,t	0	-16.8287	-3.9971	-3.4288	-3.1379	
ITR	ADF	C	0	-2.3306	-3.4576	-2.8734	-2.5732	Not Stationary
		C,t	0	-2.4841	-3.9969	-3.4287	-3.1378	
ΔITR		C	0	-15.9044	-3.4577	-2..8735	-2.5732	Stationary
		C,t	0	-15.8742	-3.9971	-3.4288	-3.1379	

The result of Table 1 shows that inflation and interest rate are nonstationary in their level series and stationary after first difference. This indicates that the variables have the same order of integration, that is I(1). The lag order used in the ADF unit root test were suggested by the model selection criteria.

Table 2. The Result of Johansen Cointegration Test

Null Hypothesis H_0	Alternative Hypothesis H_1	Trace statistic	Critical value (5%)	Prob.
$r=0$	$r=1$	30.14379	25.87211	0.0138
$r\leq 1$	$r=2$	10.38339	12.51798	0.1108

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

The result of Table 2 above shows that we reject the null hypothesis that $r=0$ at 5% level as both the trace statistic value are greater than the 5% critical value. Hence, there is one cointegration relationship between interest rate and inflation.

Table 3. The result of VEC Model of equation (6) and (7)

Variable	Coefficients	Standard error	t-statistic
ΔIFR_t **is the dependent variable**			
α_c	0.645797	0.09810	6.58312*
ECT_{t-1}	0.013581	0.00407	3.33677*
ΔITR_{t-1}	-0.058078	0.09460	-0.61392
ΔITR_{t-2}	-0.053962	0.09443	-0.57144
ΔIFR_{t-1}	-0.091078	0.06613	-1.37720
ΔIFR_{t-2}	0.059688	0.06628	0.90058
ΔITR_t **is the dependent variable**			
α_c	-0.022807	0.06779	-0.33646
ECT_{t-1}	-0.000403	0.00281	-0.14316
ΔITR_{t-1}	-0.023424	0.06537	-0.35833
ΔITR_{t-2}	0.095603	0.06525	1.46515
ΔIFR_{t-1}	0.056636	0.04570	1.23938
ΔIFR_{t-2}	-0.046047	0.04580	-1.00547

Source: computed by the author. The symbol (*) indicates significant at 5%

Table 3 shows the result of VEC model. The result seems not to indicate any short-run relationship between interest rate and inflation in Nigeria as t –values are not significant at 5% level. This result implies weak relationship between interest rate and inflation in the short-run. However, the coefficient of ECT in Equation (6) has a t-statistic of 3.33677 and it is significant at 5% level indicating long-run Granger causality exist from interest rate to inflation, while the reverse does not. The results also indicate that last 1 month and 2 months changes in interest rate exhibit negative effect on changes in inflation, but none is significant. Also, last 1 month and 2 months changes in inflation rate exhibit negative and positive effect on changes in interest rate respectively, but none is significant. These results imply non existence of short term relationship between interest rate and inflation.

V. Conclusion And Policy Implication

The paper examined whether there exist long run between Interest Rate and Inflation in Nigeria. The ADF unit root test was employed to check the order of integration of the two time series variables. Johanson cointegration test was used to establish the cointegration rank via trace statistic. And the VECM was adopted to model the short-run and long-run equilibrium relationship and the causality analysis.

The result showed that both variables have the same order of integration and long-run equilibrium relationships exist between them. The result strongly indicates that interest rate does Granger cause inflation rate at the long-run and however, there exist weak evidence of Granger causal relation between the two variables in the short-run. The result implies that when the cost of borrowing money is low, it tends to spur inflation at the long run.

It thus becomes necessary for the monetary policy makers to use the knowledge of long-run equilibrium relationship that exist between interest rate and inflation to manage inflation for better economic stability.

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