Fisher's Effect in Nigeria: Empirical Analysis using ARDL (Bound Test) Approach

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Abstract: ***There has been controversy over the submission on the fisher hypothesis; that there must be a one-to-one relationship between interest rate and inflation. Perhaps, several methods have been used to establish the theoretical framework of the fisher effect, but full fishers effect results was not actualized in Nigeria. On this basis, the study re-examine the fisher effects in Nigeria considering the scope between 1986 – 2011(post-SAP era).The newly developed Autoregressive Distributed Lags (ARDL) model to cointegration was employed to investigate the existence of a long run relation among the series, and also the existence of fisher effect. The study reveals a partial fisher effect for the post-SAP era in Nigeria; a negative relation between interest rate and consumer price index while there exist a positive relation with broad money supply. There exist a long run cointegration among interest rate, money supply and consumer price index a proxied as inflation.***

Keywords: Fisher effect, Money supply, Interest rate, Consumer price Index, ARDL, Nigeria

1. Introduction

The existence of the Fisher effect has been subject to debate. Its importance, however, is unarguable. From a macroeconomic perspective, the Fisher effect is the cornerstone of neutrality monetary models (that is money supply) and it is critical in explaining the movement of other economic fundamentals (that is exchange rate). More importantly, because inflation is the fact of life in economies, and because of the difference between nominal and real interest rate, which affects all inter temporal savings and investment decisions in the economy, the understanding of the Fisher link- the inflation, nominal and real interest rate- is the key to gaining knowledge about how each economy runs as a whole and how different economies interact.

The general acceptance for the theory of the Fisher Effect, empirical support for its existence in the real world has been rather mixed. Many studies including Fama and Gibbon [11], Huizinga and Mishkin [16] and Kandel et al. [18] have found the estimated slope coefficients in regressions of nominal interest rates on various measures of expected inflation to be substantially less than the hypothesized value of one, implying that real interest rates are negatively associated with expected inflation.

In recent years, the development of new and more powerful econometric methods has rekindled empirical work into the validity of Fisher effect. Mishkin [20] employed the Engle-Granger error-correction mechanism to test for the effect in US, while Hawtrey [15] and Daniels et al [6] have separately applied Johansen's method to Australian data. Both latter works have yielded support for the existence of the Fisher effect. Perhaps, Payne and Ewing [26] applied a similar approach to the data of nine less developed countries (LDCs) and their results showed that five of the countries display no sign of a long run Fisher effect, while three of them provided convincing evidence of it

Indeed, different scholars have tested the fisher effect across countries using various forms of data, methodology etc. Most often than not, most research work have used various econometric techniques to test the validity of fisher effect such as Johansen's co-integration tests, error correction models. In short, Engsted [9], Koustas and Serletis [17], Atkins and Serletis [2], and Rapach [28], among others, formally tested for cointegration and found no support for cointegration between inflation and nominal interest rates. On the other hand, Mishkin [20], Evans and Lewis [10], and Crowder and Hoffman [6], among others, found evidence in favour of cointegration with post-war United States data. Lee [19] and Westerlund [29] in their study of interest rate and inflation confirmed the existence of fisher effect.

Domestically (Nigeria), Asemota and Bala [1] using the cointegration and Kalman filter approaches could not find evidence of a full Fisher effect for the nominal interest and inflation rates in Nigeria. Also, in a similar study on fisher effects includes the work of Obi et.al [24], Akinlo [3] and Awomuse et al [4]. Though their works are similar, their results show that the nominal interest rates and inflation move together in the long run but not on one-to-one basis. This indicates that full Fisher hypothesis does not hold, but thus confirming the existence of a long run partial fisher effect in Nigeria.

This study tries to re-examine the fisher effect in the context of Nigeria for the post-SAP era, the reason for the scope is due to the fact that it was during this period that the economy of the country have undergone series of reform such as privatization, de-regularizations, macroeconomic stability (which often translates into the control of inflation), as well as adoption of various forms of monetary policy target in order to stimulate savings and investment; thus subsequently translate into economic growth etc. Also, cointegration technique, the so-called autoregressive distributed lag (ARDL) of Pesaran *et al*. [25] is employed to test the existence of long-run equilibrium among the variables. Indeed, the study extends the Pesaran *et al*. procedure into multivariate analysis. Moreso, the choice for ARDL bound tests is that it often relatively more efficient in the case of small and

finite sample data sizes, and gives unbiased estimates of the long-run model [14].

The rest of the paper is structured as follows. Section two describes the data and methodology employed in this study. This is followed by section three that relates the results and interpretation. Section four concludes this study.

2. Data and Methodology

2.1 Specification of the Model

Fisher [12] asserted that a change in inflation is expected to influence interest rate on one-to-one basis. Therefore, the relationship between interest rate and inflation is expressed as:

$It = f(\pi t, Ut)$ ..... (1)

where It is the real interest rate, πt represent the inflation rate/consumer price index and Ut is the error term

Fisher further claims that real interest rate was unrelated to the expected inflation rate and was determined entirely by the real factors in an economy, such as the productivity of capital and investor time preference". Thus by including money supply into equation (1) above we have the functions as:

$it=f(\pi t, Ms, Ut)$ ..... (2)

Therefore we estimate the following model:

$INTt = \delta + \varphi INFLt + \alpha Ms + \mu t$ ..... (3)

The strong form Fisher hypothesis is validated if a long-run unit proportional relationship exists between inflation (INFLt) and real interest rates (INTt) and $\varphi=1$, if $\varphi<1$ this would be consistent with a weak form Fisher hypothesis. Perhaps, the empirical analysis was carried out using time series model. The study uses long and up-to-date annual time-series data (1986-2011), with a total of 26 observations for each variable. The data on real interest (INT), inflation (INFL) and money supply (MS) are obtained from the Central Bank of Nigeria Statistical Bulletin, Annual Report and Statements of Account for different years. All the variables are in percentage and linear form.

2.2 Frame work of Analysis

Nelson and Plosser [22] argue that most of the macroeconomic series are non stationary at level, but stationary after first differencing. If the estimated variables are non-stationary, the regression results with these non-stationary variables will be spurious (see Granger and Newbold, [13]. Mishkin [20] argues that both inflation and interest rates contain unit roots, hence, the equation suffers from the spurious regression problem, except, if the variables are cointegrated. However, it is essential to determine the stationarity and order of integration, I(d) of each series to avoid the spurious regression phenomenon. It becomes imperative to subject them to stationarity test.

In view of the foregoing, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Unit Root tests are employed to test the integration level and the possible co-integration among the variables (Dickey and Fuller [7]; Phillips and Perron [27]). The PP procedures, which compute a residual variance that is robust to auto-correlation, are applied to test for unit roots as an alternative to ADF unit root test.

To investigate the long-run relationship between each pair of variables under consideration, the bounds test for co-integration within ARDL (the autoregressive distributed lag) modelling approach was adopted in this study. This model was developed by Pesaran et al. [25] and can be applied irrespective of the order of integration of the variables (irrespective of whether regressors are purely I(0), purely I(1) or mutually co-integrated). The ARDL modelling approach involves estimating the following error correction models:

$\Delta InY_t=a_{oy} + \sum b_{iy}\Delta InY_{t-1} + \sum c_{iy}\Delta InX_{t-1} + \sum d_{iy}\Delta InM2_{t-1} + \beta_{1y}InY_{t-1} + \beta_{2y}InX_{t-1} + \beta_{3y}InM2_{t-1} + \mathcal{E}_{1t}$ ... (4)

$\Delta InX_t=a_{ox} + \sum b_{ix}\Delta InX_{t-1} + \sum c_{ix}\Delta InY_{t-1} + \sum d_{ix}\Delta InM2_{t-1} + \Omega_{1x}InX_{t-1} + \Omega_{2x}InY_{t-1} + \Omega_{3x}InM2_{t-1} + \mathcal{E}_{2t}$..... (5)

$\Delta InM2_t=a_{om} + \sum b_{im}\Delta InM2_{t-1} + \sum c_{im}\Delta InY_{t-1} + \sum d_{im}\Delta InX_{t-1} + \omega_{1m}InM2_{t-1} + \omega_{2m}InY_{t-1} + \omega_{3m}InX_{t-1} + \mathcal{E}_{3t}$ (6)

From equations (4),(5) and (6) above, Δ is the difference operator, Yt is the dependent variable, Xt is the independent variable, M2 is the log of the independent variable and $\mathcal{E}_{1t}$, $\mathcal{E}_{2t}$ and $\mathcal{E}_{3t}$ are serially independent random errors with mean zero and finite covariance matrix. In addition, from equations (4), (5) and (6), the F-test is used for investigating one or more long-run relationships. In the case of one or more long-run relationships, the F-test indicates which variable should be normalized. In Equation (4), when Y is the dependent variable, the null hypothesis of no co-integration is H_0: $\beta_1Y = \beta_2Y = \beta_3Y= 0$ and the alternative hypothesis of co-integration is H_1: $\beta_1Y \neq\beta_2Y\neq \beta_3Y\neq 0$. Likewise, from Equation (5), when X is the dependent variable, the null hypothesis of no co-integration is H_0: $\Omega_1Y = \Omega_2Y = \Omega_3Y= 0$ and the alternative hypothesis of co-integration is H_1: $\Omega_1Y \neq \Omega_2Y\neq \Omega_3Y\neq 0$. Also, from Equation (6), when X is the dependent variable, the null hypothesis of no co-integration is H_0:$\omega_{1m} = \omega_{2m} =\omega_{3m}=0$ and the alternative hypothesis of co-integration is H_1:$\omega_{1m} \neq\omega_{1m} \neq\omega_{1m} \neq 0$.

Hence, in the case of co-integration based on the bounds test, the Granger causality tests should be done under vector error correction model (VECM) when the variables under consideration are co-integrated, or simply says that the bound test is basically computed based on an estimated of unrestricted error-correction models (UECM) or error correction version of autoregressive distributed lag (ARDL) model, by Ordinary Least Square (OLS) estimator (Pesaran et al., [25]).

By doing so, the short-run deviations of series from their long-run equilibrium path are also captured by including an error correction term (See also Narayan and Smyth,

[21]). The long-run relationship between the variables indicates that there is Granger-causality in at least one direction which is determined by the F-statistic and the lagged error-correction term. The short-run causal effect and is represented by the F-statistic on the explanatory variables while the t-statistic on the coefficient of the lagged error-correction term represents the long-run causal relationship (Odhiambo, [23]; Narayan and Smyth, [21]). Therefore, error correction models of co-integration can be specified as follows:

$$\Delta InY_t=\alpha_o + \pi^p_{11}(L)\Delta InY_t + \pi^q_{12}(L)\Delta InX_t + \pi^r_{13}(L)\Delta InM2_t + \partial ECT_{t-1} + \mu_{1t} \quad \text{.....(7)}$$

$$\Delta InX_t=\alpha_1 + \pi^p_{21}(L)\Delta InX_t + \pi^q_{22}(L)\Delta InM2_t + \pi^r_{23}(L)\Delta InY_t + \partial ECT_{t-1} + \mu_{2t} \quad \text{.....(8)}$$

$$\Delta InM2_t=\alpha_2 + \pi^p_{31}(L)\Delta InM2_t + \pi^q_{32}(L)\Delta InY_t + \pi^r_{33}(L)\Delta InX_t + \partial ECT_{t-1} + \mu_{3t} \quad \text{.....(9)}$$

From equations (7), (8) and (9), Δ denotes the difference operator and L denotes the lag operator where (L)ΔlnYt = ΔlnYt-1. ECTt-1 is the lagged error correction term derived from the long-run co-integration model. Hence, μ_{1t}, μ_{2t} and μ_{3t} are serially independent random errors with mean zero and finite covariance matrix. Finally, according to the VECM for causality tests, having statistically significant F and t ratios for ECTt-1 in equations (7),(8) and (9) would be enough condition to have causation among X,Y and M2.

3. Empirical Results and Interpretation

Obviously, the selection of the lag length are important in estimating the ARDL regression, the test run over 3 lag length of 1, 2, and 3 to determine the optimal lag length. However, lag length is determine by SBC and AIC which both indicated the optimal lag level as 3.

Table 1: Test Statistics and Choice Criteria for selecting the order of The VAR model

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-201.0691	NA	10215.58	17.74514	17.89324	17.78238
1	-98.70594	169.1217	3.076176	9.626603	10.21903	9.775598
2	-88.89196	13.65423	3.009971	9.555823	10.59258	9.816564
3	-69.67583	21.72259*	1.404682*	8.667463*	10.14854*	9.039951*

Table 2: Results from bound test and F-Statistics for testing the Existence of Long run Relationship

Dependent Variable	*F-Statistics*	*Decision*
F_{int}(int/cpi,Log(M2))	6.4299* (0.006)	Cointegration
F_{cpi}(cpi/int, log(M2))	162.0440* (0.0000)	Cointegration
F_{M2} (log(M2)/ cpi,int)	143.1513* (0.0000)	Cointegration
Bound Testing Critical Values @ 5%	3.79	Lower Bound Testing Value
	4.85	Upper Bound Testing
Bound Testing Critical Values @ 10%	3.18	Lower Bound Testing Value
	4.12	Upper Bound Testing

Note: The critical values are taken from Pesaran et al. (2001), with two explanatory variables and * denote rejecting the null at 10 percent level, ( ) represent the probability value

The calculated F-statistics are reported in Table 2 above when each variable is considered as a dependent variable (normalized) in the ARDL-OLS regressions. Their values for equation (4), (5) and (6) are 6.4299, 162.044 and 143.1513 respectively with their probability standing at 10 per cent and 5 per cent as well. From these results, it is clear that there is a long run relationship amongst the variables. This implies that the null hypothesis of no cointegration among the variables in equation (4), (5) and (6) is rejected. Thus the reason is that the calculated F-statistics is greater than the bound test critical value both at 5 per cent and 10 per cent respectively. Thus, these results reveal a long-run relationship between interest rate, consumer price index and broad money supply in Nigeria.

Table 3: Estimated long run coefficients using the ARDL approach

Variable	*Coefficient*	*t-statistics*	*Prob*
C	-18.5916	-1.15547	0.2598
CPI	-0.1701	-3.2739	0.0033
Log(M2)	3.7756	-2.6548	0.0142

The results obtained by normalizing on equation (3), in the long run are reported in Table 3 above. The estimated coefficients of the long-run relationship are significant for both consumer price index and broad money supply. Consumer price index has a negative significant impact on the interest rate at the 5 per cent level. The broad money supply (M2) has a positive significant impact on the interest rate at the 10 per cent. Besides, this estimate has shown that despite all sort of macroeconomic reform embarked upon by the Nigeria government the relationship between interest rate and inflation (CPI) has reveal that full Fisher hypothesis does not hold, but thus confirming the existence of a long run partial fisher effect in Nigeria i.e.a partial fisher effect under the scope of the study. Perhaps, this study was in line with the study of Obi et.al [24], Akinlo [3] and Awomuse et al [4].

Table 4: Results of Error Correction Models

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	1.851846	5.390275	0.343553	0.7377
D(INTR(-1))	0.989577	0.526722	1.878747	0.0870
D(INTR(-2))	0.372951	0.344882	1.081387	0.3027
D(INTR(-3))	0.248441	0.259978	0.955624	0.3598
D(LOG(M2(-1)))	14.21570	11.35069	1.252409	0.2364
D(LOG(M2(-2)))	-6.433105	11.04921	-0.582223	0.5722
D(LOG(M2(-3)))	-15.23213	13.98799	-1.088944	0.2995
D(CPI(-1))	0.411153	0.366787	1.120958	0.2862
D(CPI(-2))	-0.206622	0.463839	-0.445460	0.6646
D(CPI(-3))	-0.241685	0.315939	-0.764975	0.4604
ECT(-1)	-1.943162	0.642146	-3.026043	0.0115
R-squared	0.737511	Mean dependent var		-0.390000
Adjusted R-squared	0.498884	S.D. dependent var		5.556099
S.E. of regression	3.933138	Akaike info criterion		5.883605
Sum squared resid	170.1653	Schwarz criterion		6.429126
Log likelihood	-53.71966	F-statistic		3.090645
Durbin-Watson stat	1.962617	Prob(F-statistic)		0.038816

The equation (7) – (9) are estimated by OLS regression separately. The results of the short-run dynamic coefficients associated with the long run relationships obtained from the equation (7) are presented in table 4 above. Thus the long run coefficient result, the coefficient on the lagged error correction term is significant at 5 percent level with the expected sign. Its value is estimated to -1.94 which implies that the speed of adjustment to equilibrium after a shock is high.
Also, with the ECT to be statistically significant with 3.02604, hence, the long run consumer price index (CPI) and broad money supply Granger cause interest rate in Nigeria.

Table 5: Results of diagnostic tests

	F- statistics	*Probability*
White Heteroskedasticity test	2.742553	0.055
Jarque-Bera test	3.103257	0.211
Ramsey RESET Test (log likelihood ratio)	3.384045	0.336
Breusch-Godfrey Serial Correlation test	0.29288	0.830
ARCH LM Test	0.63690	0.600

Table 5 above reveal the diagnostic tests results from the empirical analysis for the study, it aid to examine the statistical properties of the estimated model. The model was tested for normality, serial correlation, autoregressive conditional heteroskedasticity, heteroskedasticity and specification error. The results reported that the model is well specified. The diagnostics indicate that the residuals are normally distributed, homoskedastic and serially uncorrelated and that the parameter appear to be stable.

4. Conclusions

The paper examines the dynamic of fisher effect in Nigeria for the post-SAP era (1986 – 2011). We implements ARDL model to cointegration to investigate the existence of a long run relation among the series and to establish whether the theoretical submission about the fisher's effect hold. Apparently, the use of ARDL is of the submission that it can be applied irrespective of the order of integration of the variables (irrespective of whether regressors are purely I(0), purely I(1) or mutually co-integrated). The results of the study show that there exist a partial fisher effect in the country, thereby giving a negative relationship between interest rate and consumer price index while a positive relationship exist in relation to broad money supply; and also that there is a cointegration among the variables specified in the model. Thus, consumer price index and broad money supply promote interest rate in Nigeria in the long run. Indeed, this present study also supported recent research work of Obi et.al [24], Akinlo [3] and Awomuse et al [4]. It was estimated that the short run dynamics of the model which suggested that about 1.94 percent of the disequilibrium between the long run and short run variables received a correction approximately two years. From all indication, it shows that despite various form of macroeconomic reforms embarked upon by the monetary authority in Nigeria lesser result is yet to come. Hence, it is imperative for the government to ensure sound macroeconomic policy that will not only be directed at monetary but also fiscal policy which will try to reduce the imbalances within the economy system.

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