ISSN 1957-2968

CENTRAL BANK OF NIGERIA

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Economic and Financial Review
Volume 52, Number 2
June 2014

ISSN 1957-2968

Central Bank of Nigeria

Economic and Financial Review

Volume 52, Number 2, June 2014

Aims and Scope

The *Economic and Financial Review* is published four times a year in March, June, September and December by the Research Department of the Central Bank of Nigeria. The Review contains articles on research undertaken at the Bank, in particular, and Nigeria, in general, mainly on policy issues both at the macroeconomic and sectoral levels in the hope that the research would improve and enhance policy choices. Its main thrust is to promote studies and disseminate research findings, which could facilitate achievement of these objectives. Comments on or objective critiques of published articles are also featured in the review.

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Notes to Contributors

Information on manuscript submission is provided on the last and inside back cover of the Review.

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A Test of the Fisher Effect in Nigeria

Tule, M. K., U. M. Okpanachi, E. T. Adamgbe and S. E. Smith

Abstract

The "Fisher Effect" has stimulated enormous research interest, especially in monetary policy. Expectedly, empirical evidence has varied greatly – from absence of effect to strong effect. This has kept the debate alive, with the benefit of fresh policy-relevant insights and clues especially in developing countries where the literature on the subject is fast growing. This paper contributes to the debate by using the state space model to investigate the dynamic relationship between real interest rate and inflation in Nigeria. The paper reveals varying degrees of effect across interest rate and time horizons.

Keywords: Fisher Effect, State space model, co-integration

JEL Codes: E31, E43, C32

I. Introduction

The conclusion of Fisher (1930) concerning the relationship between changes in short-term interest rates and expected inflation has continued to elicit considerable discussion and research in both academic and policy circles globally. Several empirical studies have been carried out across industrialised and non-industrialised countries on the subject matter. Fisher had posited that nominal interest rate adjusted one-to-one to changes in expected inflation. If this were indeed the case, then, movements in rates should contain vital information about the direction and level of prices in the future. However, empirical evidence on the subject matter has varied from one country to another and across periods.

The relationship between inflation expectation and nominal interest rate is crucial for monetary policy. Continuous examination of this relationship is warranted by the inconclusive nature of available evidence and the likelihood that such a relationship, even if established, may not be permanent. Fisher effect studies have seemingly gained additional impetus and momentum as inflation targeting

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became popular. The reason is simple – it relies on the use of short-term rates, often overnight rate as an intermediate target. The vastness of the literature on industrialised countries in particular, is therefore, not surprising. Interest rate plays a pivotal role in the economy. The viability of Fisher's hypothesis holds overarching implications for monetary policy and, therefore, significant for central banks as well.

In the developing world, the literature on the Fisher's effect is growing. Some studies have pooled developing countries along with advanced countries in multi-country analysis, with most suggesting that the Fisher Effect is either absent or not very strong in these countries (Berument and Jelassi, 2002). Some others have provided contrary indications. Maghyereh and Zoubi (2006), for example, reported a strong Fisher Effect in Turkey, Brazil, Argentina, Mexico and Malaysia. As such, any generalisation about the Fisher Effect in a developing country could easily be misleading. Country-specific studies will continue to be relevant in providing contextual analysis and informed conclusions.

The Central Bank of Nigeria (CBN) like others in developing countries would find studies of this nature useful in enriching evidence needed to support the conduct of monetary policy generally, and particularly in evaluating policy instruments. There are currently only a few studies conducted using Nigerian data to verify this very important proposition.

In Nigeria, the Central Bank of Nigeria (CBN) is the sole monetary authority and its policy stance has continued to evolve. In 2006, the Bank introduced the Monetary Policy Rate (MPR) and a standing deposit/lending facility with a corridor around the MPR as part of its monetary policy implementation framework[1]. Prior to this time, the Bank used the Minimum Rediscount Rate (MRR) to influence interest rates and lending decisions of banks. The MRR was found to be ineffective as it neither

[1]Both the lending and deposit facilities are always available to banks and have helped them to manage their liquidity positions better than previously. They have also reduced the desperation that hitherto characterised activities at the interbank in times of liquidity scarcity thereby helping to reduce volatility in rates at the interbank.

anchored inflation expectations nor short-term interest rates. In fact, for a long time the MRR was unchanged at 14.0 per cent, serving simply as the Bank's rediscount rate.

The introduction of the MPR and the standing deposit/lending facility, following the refinement of the framework, proved to be useful as interbank rates started to show some response to the adjustment decisions of the Bank's Monetary Policy Committee (MPC) with regards to both policy rate and the corridor. Since 2006, the MPR and corridor have been changed on many occasions in response to prevailing macroeconomic and market liquidity conditions[2]. Both the collateralised open buy back (OBB) and uncollateralised interbank call (IBR) have mostly oscillated within the corridor. In addition, by manipulating the MPR the Bank has been able to gain some influence on inflation expectations.

Nigeria's inflation history is mixed with episodes of high and low inflation. The country's worst inflation experience was in the 1990s when inflation rose to above 60.0 per cent. The last ten (10) years have witnessed relatively moderate inflation of less than 20.0 per cent. As monetary policy became more proactive following recent refinements in strategy, inflation outcomes have tended to improve. In fact, year-on-year inflation has not exceeded 15 per cent in the last 5 years. In 2013, inflation was subdued within single digit owing mainly to prolonged tight monetary policy stance. Until the deregulation of the financial system in 1986, interest rates were not market determined and were mostly at a low level applicable to both domestic assets and liabilities of the banking system. The aftermath of the deregulation resulted in an increase in lending rates, which rose in excess of 20.0 per cent on non-prime assets during most of the period up to 2013. Savings and deposit rates have, however, remained relatively low, leaving wide spreads between lending and savings rates.

[2]At inception, the MPR was set at 10.0 per cent with a symmetric corridor of 200 basis points above for the lending facility and below for the deposit facility. There have been occasions since then when the Bank implemented the asymmetric variant of the corridor. Currently, the MPR is 12.0 with 200 basis points symmetric corridor.

The objective of this paper is to investigate the dynamic relationship between inflation and interest rates in Nigeria. The paper tested the Fisher Effect in Nigeria focusing on the basic hypothesis that inflation and nominal interest rates exhibit a proportional relationship.

This paper is unique in its contribution to the literature on Fisher's Effect in Nigeria on the premise that it provides empirical evidence to support policy decisions especially on the impending Inflation Targeting Framework (IT) of the Central Bank by informing the choice of policy instruments. The questions this paper aims to answer are: (i) Does the Fisher Effect Hold in Nigeria?, If yes; how strong is the effect? and (ii) Is there any inter-temporal variations in the Effect or is the Fisher's Effect time-invariant?

This paper is structured into 6 sections. Following this introduction, section 2 reviews the theoretical and empirical literature while section 3 presents the modelling technique and the empirical methodology. The data and modeling of the variables are presented in Section 4. Section 5 is a presentation and analysis of the results while section 6 concludes with some policy recommendations.

II. Literature Review

II.1 Theoretical Review

The idea that gave birth to the Fisher' Effect was initially expressed in Fisher (1896)[3]. His hypothesis about inflation and interest rates which became known as the Fisher's Effect was, however, formally and fully developed much latter in Fisher (1930)[4]. Based on the findings of the study in the U.S and U.K, Fisher came to the conclusion that long-run, nominal interest rate is given by the sum of expected inflation and expected real interest rate. Simply, the Fisher's equation otherwise referred to as the Fisher's parity may be symbolically stated as:

$$R = r^* + \pi^*$$

[3]Irving Fisher's work, "Appreciation and Interest" published in 1896 provided the first clue about what was later called the Fisher's Effect.
[4]"Theory of Interest"

where:

R is nominal rate of interest, r^* is expected real interest rate and π^* is expected inflation[5]. Based on the premise that expected real interest rate (r^*) is constant, nominal interest rate should vary point-for-point with inflation.

$$F'(r^*) = 0, \text{ while } F'(\pi^*) = 1; \text{ therefore, } R \text{ varies with } \pi^* \text{ point-for-point.}$$

If inflation rises by x per cent as a result of monetary expansion, the nominal interest rate also adjusts upwards by the same magnitude. The Fisher's proposition of one-to-one adjustment between inflation and nominal interest rate was inferred from his estimates of the relationship between interest rates and inflation in Britain over the period 1890 to 1924 and in the U.S., 1890 to 1927. Fisher used the distributed lag structure with arithmetically declining lags to model inflation expectation. Some studies have used either the same or a variant of the original Fisher's approach in modeling inflation expectation (Sargent 1969 and Gibson 1972)[6].

Following this exposition by Fisher, very many empirical investigations have been conducted on the same countries studied by Fisher and on several others. Analytical methods, results and conclusions have varied in many respects. If Fisher's Effects holds, then real interest rates must be independent of monetary policy working through expected inflation and long-run nominal interest rates. However, there have been some other propositions that appear to negate the Fishers' consequence. For example, whilst not denying the existence of a positive relationship between inflation and nominal interest rates, some scholars have argued that the proposition of one-to-one could not possibly hold since inflation reduces money balances (Mundel, 1963 and Tobin, 1965).

In a related sense, it is argued that the Fisher's relationship breaks down in the face of prolonged Quantitative Easing (QE) due to what is referred to as 'policy duration effect'.

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[5]This relation is stated in various forms such as $r^* = R - \pi^*$

[4]Following the development of rational expectations by Muth (1961) and efficient markets by Fama (1975), the approach to handling the unobservable inflation expectations shifted a bit. Fama (1975) and Levi and Makin (1979-Not listed (NL) on the reference list) were among the earliest to incorporate the new thinking in the analysis of the Fisher's Effect.

(Okina and Shirasuka, 2004). Policy duration effect arises from expectations of the duration of monetary easing into the future. They further argued that prolonged quantitative easing leads to the formation of stable market expectations about short-term interest rates which cause long-term rate to fall, flattening the yield curve. Inflation expectations could however, remain unchanged because the market is rather concerned with how long the QE would last than the current surplus liquidity. As nominal interest rate falls leaving inflation expectations unchanged, the real economy benefits making monetary policy able to impact on long-run growth.

Soderlind (2001) finds that a very active monetary policy or stricter inflation targeting reduces the strength of the relationship between nominal rates and inflation. Mitchell-Innes (2006) confirms this for South Africa, noting that in the long-run, adjustment of interest rates to inflation is less than unity which he attributed to the success of inflation targeting in meeting inflation expectations within the target range.

II.2 Empirical Literature

II.2.1 Evidence from Advanced Countries

Fisher's hypothesis received tremendous attention in industrialised countries owing to the substantial studies that showed significant relationship between inflation and nominal interest rates. However, evidence on the stability of the one-to-one relationship between the two, remains quite conflicting. The estimated slope coefficients of nominal interest rates on various measures of expected inflation have been shown to be substantially lower than '1', the theorised value (Fama and Gibson, 1984; Huizinga and Mishkin 1986). These studies have nonetheless shown that real interest rates are negatively associated with expected inflation[7].

The observed less than proportional reaction of interest rates to changes in expected inflation as observed in most empirical studies has commonly been

[7]A few other studies, for example Darby (1975), have reported results suggesting that the adjustment of interest rate to expected inflation could be higher than 1.

referred to in the literature as the Fisher Effect Puzzle (Mishkin and Simon, 1995).

Test of the Fisher hypothesis in advanced economies although inconclusive, apparently reveals some time-varying effects and country-specific outcomes. The evidence portrays not very distinctive but an emerging differential along the time periods and tools of analysis. Studies such as Fama (1979), Nelson and Schwert (1977), Mishkin (1984, 1988) and Fama and Gibbsons (1984) have indicated a strong post-war Fisher effect in the U.S, UK and Canada up till 1979, but a reduced effect post-1979. However, a correlation analysis by Mishkin and Simon (1995) indicated a weak nominal interest rates and inflation nexus. Using the Johansen co-integration technique, Hawtrey (1997) failed to find the Fisher effect for Austria over the periods of 1969 to 1994 and 1969 to 1983. This finding corroborated Inder and Silvapulle (1993) that used ECM for the period, 1965 to 1990.

Mishkin and Simon (1995) segmented their study sample into three, 1962 to 1993, 1962 to 1979 and 1979 to 1993 and applied the Engle and Granger approach to show that the Fisher Effect exist in the long-run and it was absent in the short-run. However, Atkins and Sun (2003) used the discrete wavelet transformation technique to investigate Fisher Effect for Canada. The study which covered the period, 1959 to 2002, found support for the long-run Fisher Effect. The robustness of this finding was, however, contested by several studies. In Olekalns (1996), using Austrian data and applying ARCH and Maximum likelihood estimation techniques from 1969 to 1993 there was little evidence of a long-run Fisher Effect. Also, Choudhry (1997) applied the Engle and Granger estimation technique for the period 1955 to 1994 with little evidence of a long-run Fisher Effect in Belgium; Atkins and Serletis (2002) used the Pesaran et. al. (2001), estimation techniques for the period 1880 to 1983 and found little support for a long-run Fisher effect in Norway, Sweden, Italy, Canada, the United Kingdom, and the United States.

In a more recent study Ramadanović (2011) used monthly data of long-term rates to test for the Fisher hypothesis. The evidence did not support the presence of a long-run equilibrium relationship between inflation and nominal interest rates in the

United Kingdom, Switzerland and Germany.

Panopoulou (2005) examined the Fisher effect using both short-term and long-term interest rates in 14 OECD countries. Sufficient evidence was found to support the existence of a long-run Fisher effect. However, application of a discrete wavelet transformation (DWT) to the series as an alternative for the more commonly used differencing approach by Atkins and Sun (2003) found evidence of a Fisher effect for Canada and the United States, using data from 1959 to 2002. Atkins and Coe (2002) used the ARDL Technique to investigate for the Fisher effect in Canada. They used data from 1953 to 2000 and found evidence in support of the Fisher Effect. Other studies that provided evidence in support of the Fisher Effect in Canada include Dutt and Ghosh (1995), Crowder (1997) and Lardic and Mignon (2003); while those that found no support in the same country include Ghazali and Ramlee (2003) and Yuhn (1996).

II.2.2 Evidence from Emerging and Developing Countries

Mitchell-Innes (2006) examined the Fisher Effect under an inflation targeting regime for South Africa using the 3-month bankers' acceptance rate and the 10-year government bond rate as substitutes for short- and long-term interest rates. The data used in the study covered April 2000 to July 2005. The short-run Fisher Effect was not empirically established, while long-term interest rates and expected inflation were found to exhibit a long-run co-integrating relationship. Similarly for South Africa, Wesso (2000) used the Johansen estimation technique to examine whether a relationship exists for the period 1985 to1999 with little evidence of a long-run Fisher Effect. Cooray (2002) examined Sri Lankan data for the presence of Fisher Effect using the Johansen estimation technique. The data covered the period, 1952 to 1998 but finds no evidence of the Fisher Effect. In Turkey, Aksoy and Kutan (2002), using the GARCH estimation technique found no support in the analysis for the long-run Fisher Effect.

From Latin America comes some strong evidence of the Fisher Effect. Carneriro et. al., (2002) examined the Argentine economy for the Fisher Effect using the

Johansen estimation technique using data from 1980 to 1997. The authors confirm a long-run Fisher Effect. Earlier, Garcia (1993) and Phylaktis and Blake (1993) found evidence of a long-run Fisher Effect in Brazil and Argentina. Jorgensen and Terra (2003) also investigated the effect in Latin America using a four variable VAR estimation technique. They found no evidence of a long-run relationship between nominal interest rate and inflation for Brazil, Peru and Chile. Their results, however, supported a long-run Fisher Effect in Mexico and Argentina. Studies by Asemota and Bala (2013) and Obi et. al., (2009) on Nigeria using error correction and Kalman filtration support the existence of a partial Fisher Effect for the period between 1961 and 2009.

III. Methodology

III.1 Data Sources and Research Method

Monthly data for Nigeria between 1970 and 2013 were used to model the relationship between inflation and short-term interest rate. Inflation is the year-on-year change in consumer prices (Inf), while various interest rates were considered such as three-month Nigerian Government Treasury Bills rate (NTB91), three-month deposit rate (dr3m); inter-bank and lending rates. Interest rate series were compiled from various CBN publications while inflation numbers were obtained from the National Bureau of Statistics (NBS) inflation reports.

From the literature, we note a variety of methods for evaluating the relationship between inflation and interest rate or the Fisher Effect. Early attempts at verifying the Fisher Effect relied mostly on OLS regression of interest rate on inflation. The major challenge was how to measure the unobservable inflation expectation. In addition, OLS estimation requires that the variables are stationary in their levels. More often than not interest rate and inflation series lack this highly essential property. With integrated variables, OLS estimates are generally unreliable.

Mishkin (1992) outlined the reasoning and implications of the variables (interest rate and inflation) displaying stochastic trends. Using monthly US data, Mishkin found that interest rate and inflation exhibit common trend which signaled strong

correlation between them. This approach has subsequently dominated Fisher Effect studies in both developed and developing countries[8].

Co-integration between inflation and interest rate imply long-run equilibrium between the two variables, which in a way indicates some Fisher Effect. However, a slightly different argument is emanating, which seems to suggest that co-integration between nominal interest rate and inflation should be more appropriately seen as only a necessary condition for Fisher effect. The sufficient condition is that nominal interest rate should embody an optimal inflation forecast (Miron, 1991)[9]. This dimension calls for the application of other estimation techniques that can more efficiently handle expectations as supplements to the usual co-integration analysis.

Against the foregoing background, this paper employs a state space model following Hamilton (1994) and others as well as a co-integration analysis, to examine Nigerian data for the Fisher's Effect. Unlike the fixed coefficients that co-integration yields, the state space model provides time-varying parameters which provide some insights about the inter-temporal stability or otherwise of parameters (Hamilton, 1994).

III.2. Model Specification

III.2.1 The State Space Model

The state space framework (SSF), given its time-varying properties, provides an informative approach to analysis of the inflation-nominal interest rate relationship. In particular, unlike forecast based methods applied in Million (2004), the SSF is preferred for its ability to estimate unobserved components such as inflation expectations. In addition, when inflation expectation time series generated for such forecast based expectations and other approaches are not available, the SSF becomes a useful tool in the study of the nominal interest rate-inflation

[8]See examples: Mishkin and Simon (1995), Crowder (1997), Dutt and Ghosh (1995), Lee et. al., (1998) Cameiro et. al., (2002), and Granville and Mallick (2004).
[9]For a detailed and more comprehensive presentation of this idea, see Johnson (2005).

relationship. Essentially, it uses the Kalman filter estimation to uncover the time varying effect of inflation dynamics on the nominal interest rate. The general specification of the state space model consists of a state (transition) and measurement or signal (observation) equation. The state equation governs the dynamics of the unobserved or state variables, while the measurement equation relates the observed variable to the unobserved variable. A state space model can be represented as follows:

$$y_t = c_t + \beta_t Z_t + \varepsilon_t \qquad \varepsilon_t \sim N(0, H_t) \qquad \text{(Signal equation)}$$

$$\beta_t = T_t \beta_{t-1} + a_t + R_t \mu_t \qquad \mu_t \sim N(0, Q_t) \qquad \text{(State equation)}$$

In the signal or measurement equation, y_t represents a vector of measured variables of n by 1 dimension; β_t gives the state vector of unobserved variables of m by 1 dimension; Z_t represents a matrix of parameters of n by m dimension and $\varepsilon_t \sim N(0, H_t)$. In the state equation, T_t is an m by m matrix, α_t is an m by 1 vector, R_t is an arbitrary *m* by *g* matrix such that redefining the error term produces an SQS' covariance matrix.

The Fisher relation (Fisher, 1930), postulates that the nominal rate of interest is the sum of the ex-ante real interest rate and expected inflation suggesting that a percentage change in the expected inflation will result in a change in the nominal interest rate. Algebraically, this relation is expressed as:

$$i_t = r_t^e + \pi_t^e \qquad (1)$$

In equation (1), i_t is the nominal interest rate, r_t^e is the ex-ante real rate, while π_t^e denotes the inflation expectation. In order to derive an expression for inflation expectation, we consider the inflation forecast error μ_t, as the difference between actual and expected inflation which we can express in the form:

$$\mu_t = \pi_t^e - \pi_t \qquad (2)$$

From equation 2, we can re-arrange to obtain an expression for inflation expectation as:

$$\pi_t^e = \pi_t + \mu_t \qquad (3)$$

Under the assumption of rational expectation, the forecast error is assumed to be stationary such that substituting for π_t^e in equation (1) produces equation (4).

$$i_t - \pi_t = r_t^e + \mu_t \quad (4)$$

Thus, from equation 4, the ex post real rate, $i_t - \pi_t$, is given as the addition of the ex-ante real rate and the inflation forecast error. In the literature, an examination of the Fisher effect involves fitting the nominal interest rate on the realised or actual inflation. We form this equation by simply rearranging and parameterising equation (4), thus:

$$ir = {}_t^e + \beta_t \pi_t + \mu_t \quad (5)$$

To evaluate the Fisher effect, if the coefficient $\beta_t=1$ there exists a full Fisher effect, but if $\beta_t<1$ it suggests a partial Fisher effect. However, equation (5) which is constant parameterisation can be put in a state space form in order to capture the changing role of monetary policy on the existence or otherwise of the Fisher effect, i.e. to evaluate the time varying dimension of the Fisher effect. Thus, the state space form of equation (5) is given by equation 6.

$$i_t - r_t^e = \alpha_t + \beta_t \pi_t + \mu_t \quad (6a)$$

$$\alpha_t = F_t \alpha_{t-1} + \upsilon_t \quad (6b)$$

$$\beta_t = H_t \beta_{t-1} + \eta_t \quad (6c)$$

Equation (6a) represents the measurement equation, while equation (6b) and (6c) are the state or transition equations for the time-varying intercept term and varying effect of inflation on the real interest rate. The measurement equation relates real interest rate and the unobserved state variable (β_t) with the regression coefficient at the beginning of the series, while the transition equation shows changing path of the state variable and measures the association between the real interest rate and inflation over time. The observation error μ_t and state error η_t are assumed to be white noise.

The first state series is a time-varying intercept (α), that is, the values of the level at the beginning of the series, whereas the second state series is a time-varying measure of inflation persistence, that is, is the slope parameter.

To model inflation expectation, we similarly apply a state space model in equation (7):

$$\pi_t = C_t + \beta_t \pi_{t-1} + \mu_t \quad (7a)$$

$$C_t = F_t C_{t-1} + \varepsilon_t \quad (7b)$$

$$\beta_t = Z_t \beta_{t-1} + \varsigma_t \quad (7c)$$

As in the case of equation (6), the observation error is μ_t and the state errors ε_t *and* ς are assumed to be white noise, while C_t is the drift parameter.

This enables us using the Kalman filter to examine the time varying path of the state (β_t) using observed data. In addition, it can help in establishing whether real interest rate and inflation have common factors. The Kalman filter is a recursive algorithm for carrying out computations in a state space model. Kalman Smoothing produces a more precise estimate of the state vector or slope coefficient. The unknown variance parameters (σ_μ^2 and σ_η^2) are estimated by the maximum likelihood estimation via the Kalman filter prediction error decomposition initialised with the exact initial Kalman filter.

IV. Modeling of Variables

IV.1 Data Patterns and Statistics

Three of the earlier identified series (inflation, NTB rate and 3-month deposit rate) are shown graphically over the period, 1970 to 2013, on figures 1 and 2. Both charts show some co-movement – though insufficient to conclude on the exact nature of the relationship. Between 1970 and around the middle of the 1980s, interest rates appear quite stable, almost flat but started showing minimal movements thereafter. Inflation, on the other hand, rose and fell intermittently across the sample period.

Figure 1: NTB (91-day) rate and inflation (%)

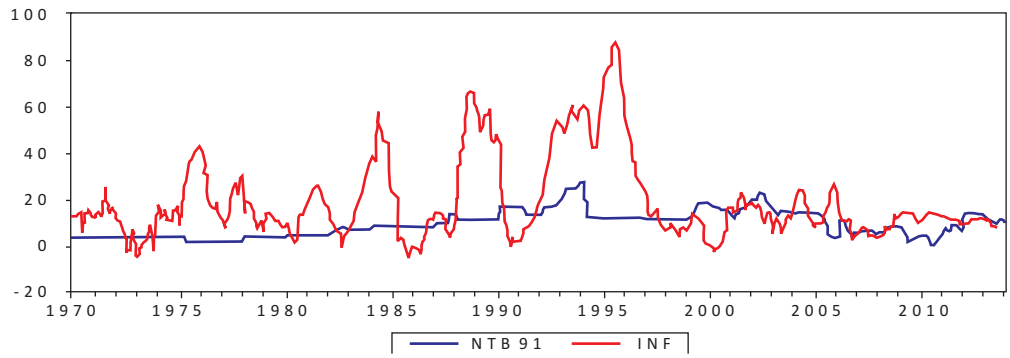


Figure 2: 3-month deposit rate and inflation (%)

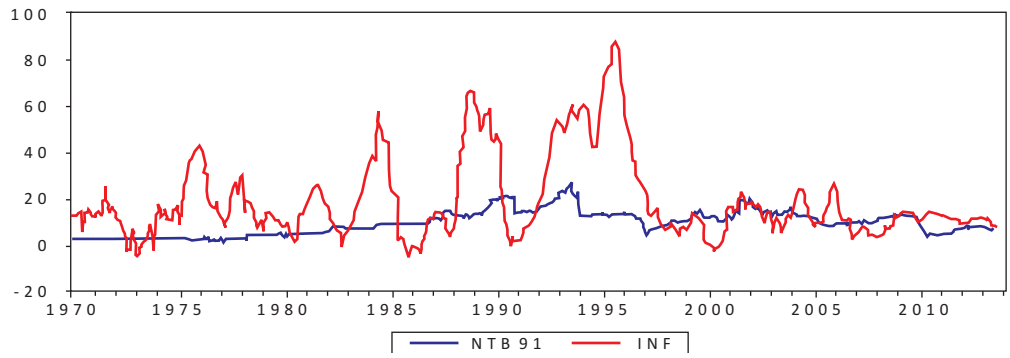
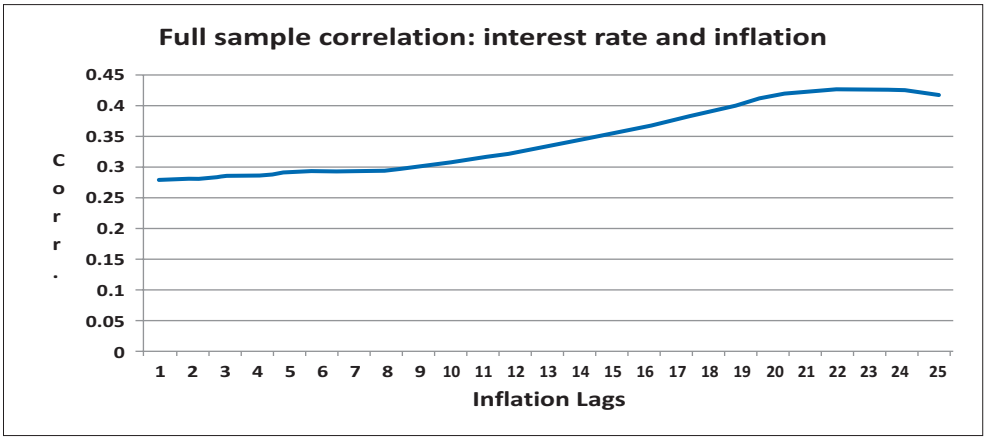


Figure 3 provides further insights about the nature and strength of the relationship between inflation and interest rate. By connecting correlation coefficients between interest rate and inflation at lags (1 – 25) we find a weak positive correlation rising through from about 0.28 to 0.47 around lag 22, after which it starts to diminish. This is not very suggestive of the strong relationship implied by the Fisher hypothesis.

Figure 3: Correlations between NTB (91-day) rate and inflation (%)



Sample statistics vary across periods, but more substantially for inflation (Table 1). For example, while inflation averaged 19.69, 23.43, 17.95 and 10.8 for full, 1974 to 1993, 1994 to 2013 and 2007 to 2013 periods, respectively, NTB rate averaged 9.8, 9.16, 11.62 and 8.02 over the same periods. Expectedly, standard deviations are higher for inflation and over the four sample periods, inflation standard deviations are 17.9, 18.3, 17.98 and 3.02 compared with NBT's 5.65, 6.16, 4.67 and 3.77.

Table 1: Sample Statistics: Full and Sub-Periods

	Full Sample (1970-2013)			1974-1993			1994-2013			2007-2013		
	NTB91	3MDR	Inf	NTB91	3MDR	Inf	NTB91	3MDR	Inf	NTB91	3MDR	Inf
Mean	9.80	9.83	19.69	9.16	9.65	23.43	11.62	11.39	17.95	8.02	9.18	10.80
Maximum	28.00	27.00	89.57	28.00	27.00	67.60	24.50	23.60	89.57	15.00	14.65	15.59
Minimum	1.04	2.00	-4.98	2.50	2.00	-4.98	1.04	4.13	-2.49	1.04	4.13	4.12
Std. Dev.	5.65	5.20	17.90	6.61	6.10	18.31	4.67	3.30	17.98	3.77	2.81	3.02

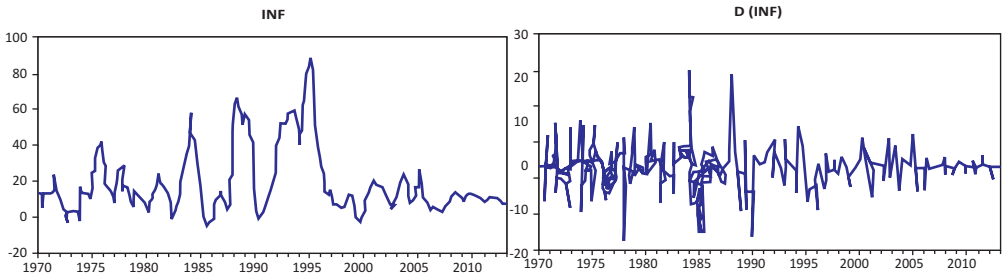
Jarque	39.82	22.84	299.91	57.92	26.03	25.81	1.35	3.15	472.54	2.34	4.10	6.15
Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.21	0.00	0.31	0.13	0.05
Obs.	525	526	525	240	240	240	237	237	237	81	81	81

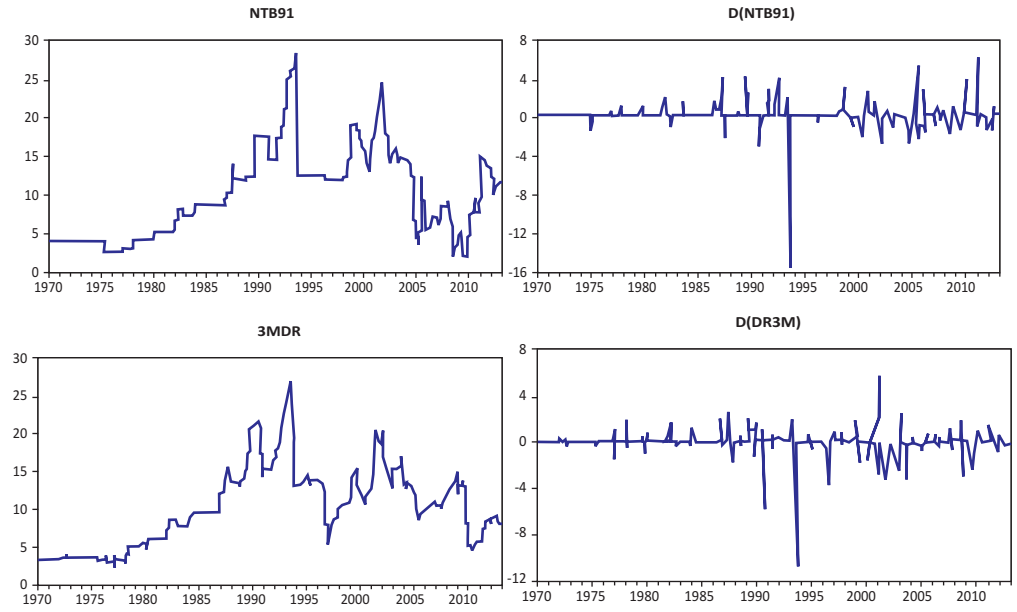
IV.2 Stationarity

Economic analysis using time series has continued to evolve with better understanding of some of covert properties of the series. In one such refinement, Sims (1980) showed that OLS regression of series that are integrated produces spurious results. Following this realisation it is standard practice to check series for stationary. The result of such an evaluation typically determines the choice of modeling technique to be applied. Figure 4 show the series in levels and first differences.

Figure 4 show inflation, NTB rates and deposit rate in levels and first differences side-by-side. The differenced series show better convergence compared to the levels that appear to drift. This is an early indication of the presence of unit root in the series at their levels. After subjecting the series to two standard unit root tests (ADF and Phillips-Peron), we found that they were all integrated of order 1 (Appendix 1). This finding means that OLS modeling of the data will be inappropriate.

Figure 4: Series in levels and first differences





V. Presentation and Analysis of Results

V.1 Co-integration

Following from the stationary results presented in the previous section, the paper proceeded to explore co-integration between inflation and interest rate – which can be a basis for some preliminary inferences about Fisher effect. However, using both the Engle and Granger and Phillips-Ouliaris techniques, the hypothesis of no co-integration between short-term interest rates (proxied by the 91-day NTB rate and 3-month deposit rate) and inflation was not rejected (see Appendices). Absence of co-integration means that there is no long-run equilibrium relationship between the variables and, possibly, no Fisher Effect present[10]. The finding of no co-integration in the full sample (1970-2013) does not rule out the possibility of Fisher effect occurring in sub-periods. To investigate this, the paper employs a suitable technique – The state space model.

[10]Absence of co-integration generally diminishes the possibility of long-run Fisher Effect (Mishkin, 1992; Johnson, 2005). The co-integration approach is limited in this wise. For studies using this approach, it is practically the end the road.

V.2 State Space Model

In order to analyse the existence and extent of the Fishers' Effect, the paper used various interest rates - 90-day Treasury bill rate (TBR), maximum lending rate (MLR), Prime lending rate (PLR), inter-bank call rate (IBCR) and 3-month deposit rate (3MDR). This should help determine which interest rate is subject to the Fisher Effect. Sequel to the estimations, however, the IBCR, PLR and 3MDR showed no evidence of the nominal interest rate-inflation nexus. For robustness and sensitivity evaluation, three measures of inflation were included in the estimation, namely, expected inflation based on its natural trend (generated using equation 7), the actual inflation and a backward-looking inflation, a one-period lag of the actual inflation. The estimates are presented in Tables 2-7.

Figure 5: Estimates of Ex ante TBR and Time-varying Fisher Coefficients

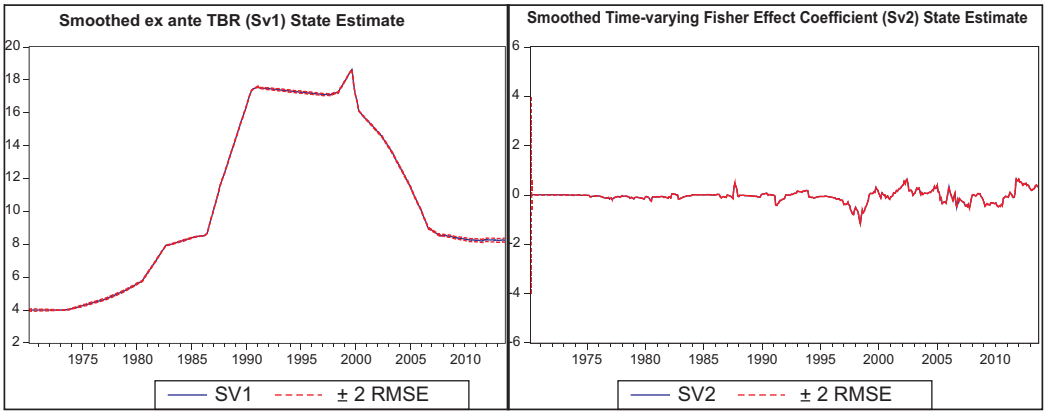


Figure 5 illustrates the ex-ante Treasury bill rate and the time-varying fisher coefficients. The literature review demonstrated that the nominal interest rate is the sum of expected inflation and the ex-ante real interest rate signifying that a percentage change in the expected inflation will result in a change in the nominal interest rate. A fairly obvious inverse co-movement exists between the level of the TBR and inflation rate which is suggestive of the coefficients as common factors. A higher inflation implies a reduced real interest rate, while a higher or lower coefficient on inflation reflected a concomitant change in the real interest rate as shown in Figure 6.

Figure 6: Real Interest-Inflation Relationship

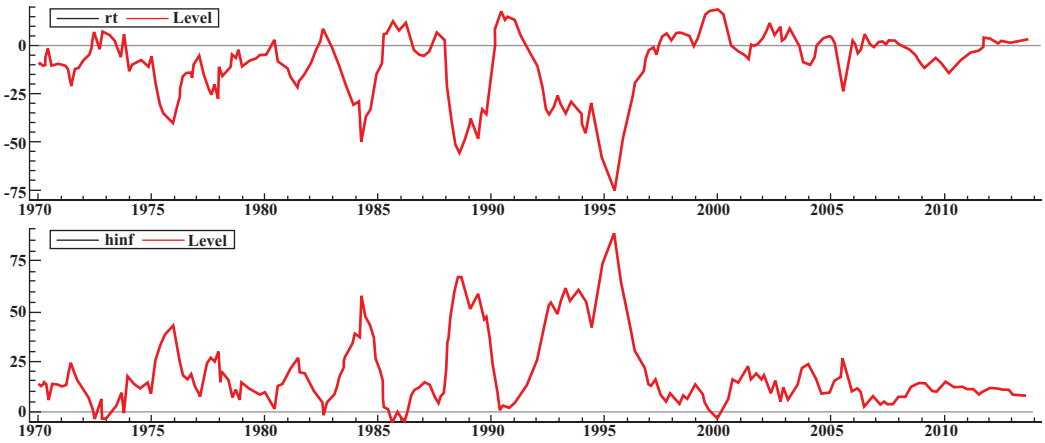


Table 2: Test of Fisher Effect-Treasury Bill Rate with Expected Inflation

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante TB rate (SV1)	8.24814	0.05900	139.80	0.00
Expected inflation (SV2)	0.32282	0.00982	32.88	0.00
Log likelihood	-82423.39	Akaike info criterion		315.206
Parameters	3	Schwarz criterion		315.231
Diffuse priors	2	Hannan-Quinn criter.		315.216

Table 3: Test of Fisher Effect - Treasury Bill Rate with Actual Inflation

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante TBR (SV1)	10.1610	0.0599	169.77	0.00
Actual inflation (SV2)	0.0947	0.0101	9.39	0.00
Log likelihood	-77080.28	Akaike info criterion		294.77
Parameters	3	Schwarz criterion		294.80
Diffuse priors	2	Hannan-Quinn criter.		294.78

Table 4: Test of Fisher Effect-Treasury Bill Rate with Backward-looking Inflation Expectations

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante TBR (SV1)	8.4598	0.0595	142.08	0.00
Backward looking inflation (SV2)	0.2981	0.0099	30.17	0.00
Log likelihood	-77657.65	Akaike info criterion		296.98
Parameters	3	Schwarz criterion		297.01
Diffuse priors	2	Hannan-Quinn criter.		296.99

Table 5: Test of Fisher Effect-MLR with Expected Inflation

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante MLR (SV1)	19.6720	0.0590	333.45	0.00
Expected inflation (SV2)	0.6583	0.0098	67.06	0.00
Log likelihood	-174153.4	Akaike info criterion		665.99
Parameters	3	Schwarz criterion		666.01
Diffuse priors	2	Hannan-Quinn criter.		666.00

Table 6: Test of Fisher Effect-MLR with Actual Inflation

Method: Maximum likelihood (BHHH)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante MLR (SV1)	20.3440	0.0598	339.96	0.00
Actual inflation (SV2)	0.5981	0.0101	59.29	0.00

Log likelihood	-204670	Akaike info criterion		782.69
Parameters	3	Schwarz criterion		782.71
Diffuse priors	2	Hannan-Quinn criter.		782.70

Table 7: Test of Fisher Effect-MLR with Backward-looking Inflation Expectation

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante TBR (SV1)	10.1610	0.0599	169.77	0.00
Actual inflation (SV2)	0.0947	0.0101	9.39	0.00
Log likelihood	-77080.28	Akaike info criterion		294.77
Parameters	3	Schwarz criterion		294.80
Diffuse priors	2	Hannan-Quinn criter.		294.78

The time-varying coefficients of the Fisher Effect are determined on a monthly basis and reveals interesting characteristics as observed in the smoothed state and time-varying plot above. First, for the Treasury bill rate, the Fisher Effect became evident with a coefficient of 0.62 to 0.65 in the last quarter of 2011 suggesting a partial but strong Fisher Effect. The Effect declined steadily to a state position of 0.32, 0.09 and 0.30 as in Table 2-4 in the ninth month of 2013 for each measure of inflation used (expected, actual and backward-looking inflation). Secondly, for the maximum lending rate the effect was observed much earlier in 2008 and within the same period. For the three measures of inflation used on MLR, we found an even and gradual increase in the 'Effect' until it reached its state levels of 0.66, 0.60 and 0.63 as in Table 5-7. Thirdly, Figure 5 showed that the relationship between the nominal interest rate and inflation is generally asymmetric with negative and positive effects across time. Fourthly, in a more repressed financial era, the Fisher Effect was found to be non-existent.

To a large extent, economic agents reallocated their portfolios in order to account

for periods of very high inflation. This is why on the average; periods of high inflation produced lower Fisher Effect based on the two interest rate measures. Finally, the MLR dominates the TBR in its adjustment to changes in inflation. This is obvious since a lower coefficient on the inflation rate in the TBR is implied once the TBR changes. This change triggers a change in other interest rates which also includes the MLR and a possible 'Fisherian debt inflation'.

VI. Conclusion and Policy Recommendations

Using the full sample, the null hypothesis of no co-integration could not be rejected from the estimates (Engle-Granger and Phillips Ouliaris techniques) reported earlier even when other tests were used[11]. The absence of co-integration between inflation and NTB and 3-month deposit rates in the full sample is not surprising. First, during most of the period 1970 to 2013, both interest rates were negative in real terms. Until the deregulation of the economy in the mid-1980s, interest rates were administratively repressed. In fact, as Figures 1 and 2 show, both NTB and 3-month deposit rates were almost flat in the period up to 1986. They started rising only gradually, in an apparently benign response to inflation, from about 1987, but never really met up with the pace of inflation in the late 1980s and mid-1990s. Up to September 2011, the NTB rate was lower than inflation in most cases, implying negative real rates. Figure 3 further buttresses this fact with the very low correlation coefficients at lower lags.

Generally, the relationship between interest rate and inflation is expected to reflect the orientation of monetary policy during any particular period. During 1980s and 1990s, there were economic conditions, some policy-induced, that led to frequent disconnect between inflation and interest rates. First, the CBN regularly financed government debt, ignoring the impact on market dynamics. Low NTB rates facilitated availability of cheap money for government. Secondly, some

[11]To be double sure, alternative evaluation techniques were used: (1) Residual series obtained from an OLS estimate of $(R = \alpha + \beta\pi)$ in level was found to be integrated and (2), upon assumption of co-integration, a co-Integrating regression was performed using the fully modified least squares (FMLS) and tested for co-integration using Hansen stability test, Engle and Granger and Phillips Ouliaris. Non rejected the null of no co-integration.

actions of the Bank were intermittently focused on stabilising the financial markets during the period under review. Moreover, in the 1990s, although inflation soared, the Central Bank's policy orientation did not directly involve raising interest rates. A similar situation played out in the mid-2000s and, in a different form in 2011 when the Central Bank embarked on quantitative easing to smoothen the impact of the global economic and financial crisis. Interest rates during most of the period 1970 to 2013 reflected more of costs imposed by the structural deficiencies in the economy than inflation.

Real returns on NTB rates were consistently positive between 2011 and 2013, unlike in the previous periods. In principle, the Fisher effect is to be expected during such times. But, we could not analyse the period separately for co-integration because of the short span. Fortunately, the state space model was able to achieve this. From the state space model, it was revealed that depending on which measure of inflation is used, varying degrees of the Fisher effect is observed.

Two quick policy issues are apparent from these results: first, the TBR and MLR produce a stronger link with all the different measures of inflation used in the paper, especially backward and forward-looking expectation; and secondly, both backward and forward-looking expectations produced relatively higher partial Fisher Effect. This obviously implies that agents form inflation expectations about their investment decisions which influence the behaviour of interest rates. Therefore, anchoring inflation expectations is important for the interest rate setting behaviour of the Bank.

It can also be inferred that targeting the interbank rate as a basis for the interest rate setting process might not yield positive outcomes in the changing structure of the other interest rates. It means that the TBR and MLR adjust faster, relative to IBCR as inflation changes, reducing its negative influence on the real interest rate. It is apparent for the IBCR that where the Fisher Effect does not exist, its adjustment to inflation changes is sluggish and could be a source of an upward pressure on credit and money growth. This paves the way for agents to react to a long-lasting

propensity of a liquidity surfeit and expenditure, thus, elevating the price level. It is also intuitive to reason that government borrowing plays an important role in the determination of inflation. The fact that TBR and MLR showed a strong link and a partial FE, there is also a strong correlation between these rates.

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Appendices

Appendix 1: Eagle/Granger Co-integration Result

Series: NTB91 INF

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
NTB91	-2.784752	0.2036	-15.19728	0.1745
INF	-3.221783	0.0813	-28.27496	0.0115

*MacKinnon (1996) p-values.

Series: DR3M INF

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
DR3M	-2.808208	0.1949	-15.34575	0.1697
INF	-3.328534	0.0628	-30.52411	0.0070

*MacKinnon (1996) p-values.

Appendix 2: Phillips/Ouliaris Co-integration Results

Series: NTB91 INF

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
NTB91	-2.700799	0.2367	-14.13558	0.2127
INF	-3.399511	0.0525	-23.13259	0.0351

*MacKinnon (1996) p-values.

Series: DR3M INF

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
DR3M	-2.771219	0.2087	-14.30950	0.2061
INF	-3.500592	0.0403	-24.48716	0.0263

*MacKinnon (1996) p-values.

Appendix 3: Test of Fisher Effect-Treasury Bill Rate with Expected Inflation

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante TB rate (SV1)	8.24814	0.05900	139.80	0.00
Expected inflation (SV2)	0.32282	0.00982	32.88	0.00
Log likelihood	-82423.39	Akaike info criterion		315.206
Parameters	3	Schwarz criterion		315.231
Diffuse priors	2	Hannan-Quinn criter.		315.216

Appendix 4: Test of Fisher Effect - Treasury Bill Rate with Actual Inflation

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante TBR (SV1)	10.1610	0.0599	169.77	0.00
Actual inflation (SV2)	0.0947	0.0101	9.39	0.00
Log likelihood	-77080.28	Akaike info criterion		294.77
Parameters	3	Schwarz criterion		294.80
Diffuse priors	2	Hannan-Quinn criter.		294.78

Appendix 5: Test of Fisher Effect-Treasury Bill Rate with Backward-looking Inflation Expectations

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante TBR (SV1)	8.4598	0.0595	142.08	0.00
Backward looking inflation (SV2)	0.2981	0.0099	30.17	0.00
Log likelihood	-77657.65	Akaike info criterion		296.98
Parameters	3	Schwarz criterion		297.01
Diffuse priors	2	Hannan-Quinn criter.		296.99

Appendix 6: Test of Fisher Effect-MLR with Expected Inflation

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante MLR (SV1)	19.6720	0.0590	333.45	0.00
Expected inflation (SV2)	0.6583	0.0098	67.06	0.00
Log likelihood	-174153.4	Akaike info criterion		665.99
Parameters	3	Schwarz criterion		666.01
Diffuse priors	2	Hannan-Quinn criter.		666.00

Appendix 7: Test of Fisher Effect-MLR with Actual Inflation

Method: Maximum likelihood (BHHH)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante MLR (SV1)	20.3440	0.0598	339.96	0.00
Actual inflation (SV2)	0.5981	0.0101	59.29	0.00
Log likelihood	-204670	Akaike info criterion		782.69
Parameters	3	Schwarz criterion		782.71
Diffuse priors	2	Hannan-Quinn criter.		782.70

Appendix 8: Test of Fisher Effect-MLR with Backward-looking Inflation Expectation

Method: Maximum likelihood (Marquardt)				
Sample: 1970M03 2013M09				
Included observations: 523				
Convergence achieved after 1 iteration				
	Final State	Root MSE	z-Statistic	Prob.
Ex-ante TBR (SV1)	10.1610	0.0599	169.77	0.00
Actual inflation (SV2)	0.0947	0.0101	9.39	0.00
Log likelihood	-77080.28	Akaike info criterion		294.77
Parameters	3	Schwarz criterion		294.80
Diffuse priors	2	Hannan-Quinn criter.		294.78

Effect of Monetary Policy on Agricultural Sector in Nigeria

Udeaja, Elias A. and Elijah A. Udoh *

Abstract

The study examined the effect of monetary policy on agricultural sector in Nigeria, utilising time series data for the periods spanning from 1970 to 2010. The study captured both monetary and non-monetary policy variables such as lending rate, commercial banks credit to agriculture, exchange rate, government expenditure in agriculture and inflation rate in examining the effect of monetary policy on agricultural output. The methodology adopted is the Auto- Regressive Distributed Lag (ARDL) Bound Testing Approach. The results obtained showed that exchange rate and government expenditure had positive and significant effect on agricultural output and, hence agricultural sector in Nigeria. It is recommended that a sound exchange rate policy should be implemented aimed at boosting agricultural exports in Nigeria. Also, government investment to provide the basic infrastructure and institutions should be sustained because without the appropriate institutions, monetary policy cannot impact positively on real sector.

Keywords: Monetary Policy, Agriculture

JEL Classification: E5, O15

I. Introduction

Mainstream macroeconomic theory has identified two major policies used for the management of an economy. These two most widely used policies are the fiscal and monetary policies. The existence of these policies over the years has created some sort of debate as to the relative effectiveness of one policy over the other. The debate notwithstanding, it is generally held that both monetary and fiscal policies if properly executed, are capable of correcting distortions as well as streamlining economic activities in an economy.

Departing from the above debate and beaming the searchlight on monetary policy, one question usually asked is how potent is monetary policy in regulating economic activities?

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The answer to this question hangs on the transmission channels through which money supply passes through to influence economic activities. Three transmission channels can be identified through which monetary policy works to affect real output. These include: interest rate channel; credit channel; and exchange rate channel. Nwosa and Saibu (2012) had noted that while issues on monetary transmission channels and aggregate output abound in the literature, a sectoral analysis of the transmission channels through which monetary policy impulse had suffered neglect.

The effect of macroeconomic policy on agriculture is well documented in studies such as Schuh (1974), Tweeten (1980), Chambers (1984), Orden (1986), Barbhart (1989), Orden and Fackler (1989) and Oden (2003). The general consensus from these studies is that any change in macroeconomic policy should have a significant impact on agricultural prices, agricultural incomes and agricultural exports. On the other hand, there is an assertion that monetary policy has real and nominal effect on the overall economic activities and hence agricultural sector only in the short-run and medium-run but has no significant effect in the long-run (Ardeni and Freebrain, 2002). This assertion is further buttressed by the fact that the fundamental forces that shape outcome and, hence forces that determine the behaviour of prices and output in the agricultural sector are believed to be consequences of non-monetary conditions (Kliesen and Poole, 2000). Forces such as high productivity growth, natural hazards, low price and income elasticities of demand for agricultural products, and fluctuations in the export market for agricultural commodities, among others, are well beyond the control of the central banks. However, the monetary authority can influence outcomes in the agricultural sector by maintaining low/steady inflation rate, low interest rate and operating easy money supply. In this reasoning and following the Keynesian view on monetary policy, an increase in money supply should lead to a fall in interest rate, which in turn, leads to increased investment in agriculture and consequently increase in output.

In Nigeria, the role of agriculture in economic development cannot be

underestimated. Apart from being the major employer of labour, particularly in the rural areas, and providing food for the teeming population, the sector is a veritable source of industrial linkages and development. However, the dismal performance of the sector has been attributed to several factors, including macroeconomic environment. Here, macroeconomic environment comprises, among other things, the monetary policy, which is used to regulate activities in the agricultural sector. In essence, the degree to which monetary policy affects agriculture depends solely on what policy variable(s) and target the monetary authority decides to vary. Previous studies have identified the credit channel as the major source through which monetary policy can impact on the agricultural sector (Omojimite, 2012). However, in recent times, monetary policy appears to have failed in directing credit to the agricultural sector. Credit to the agricultural sector declined from 19.8 per cent in 1960 to 2.2, 1.3 and 1.7 per cent in 2007, 2009 and 2010, respectively. The spread between lending and deposit rates have widened despite the drop in the policy rate to 6.00 per cent in 2010. It is against this backdrop that we need to examine the role of monetary policy in agricultural sector performance in Nigeria for the period 1970 to 2010.

This paper is organised in five sections. Following the introduction is section 2, the literature review and theoretical framework. Section 3 provides trends on monetary policy variables. Analysis of monetary policy and performance of agricultural sector in Nigeria is the focus of section 4. Method of analysis and empirical results are presented in section 5, while section 6 offers recommendations for policy and conclusion.

II. Literature Review

II.1 Theoretical Framework

The basic macroeconomic texts have documented a long standing dispute about the role of monetary policy in the determination of income and prices. Three contending schools of thought each with different view about the role of money have evolved over time. They include: the classical school; the Keynesian school; and the monetary school.

To the classical, the link between money, income and prices is explained under the framework of the quantity theory. According to classical theory, an increase in the supply of money leads to an increase in the general price level, while real variables such as real income, the rate of interest and the level of real economic activity remain constant. Thus, the classical transmission mechanism proceeds as follows: an increase in the money supply (given the constancy of both velocity of money and real output) will increase the level of liquidity in the system. The increase in the level of liquidity leads to the demand for goods and services, which in turn, results in rising prices. This rising prices reduce the real wage and provides incentives for employers to expand employment and pushes output towards equilibrium.

Unlike the classical view, the Keynesian model recognises the crucial role monetary policy can play in an economy. According to Keynes, variations in money supply have an inherent impact on real variables such as the aggregate demand, the level of employment, output and income (Jhingan, 2004). Thus, in the Keynesian transmission mechanism, the impact of monetary policy is indirect, through the interest rate. As observed by Keynes, when the quantity of money increases, its first impact is on the interest rate, which tends to fall. Given the marginal efficiency of capital, the fall in interest rate will increase the level of investment through the multiplier effect, thereby increasing income, output and employment.

To the monetarists, changes in money supply have a direct impact on the level of economic activity. The monetarists are of the view that interest rate plays no part in influencing the workings of the monetary policy. Thus, according to the monetarist transmission mechanism, variations in the money supply, which causes variations in the real variables, are strictly a portfolio adjustment process (Jhingan, 2004). This was based on their belief that money is a veritable substitute for all types of assets. Thus, if money supply increases, say government buying securities in an open market, sellers will probably rid themselves of excess cash by depositing them in their bank account thereby increasing banks reserves and ability to create money. When this happens, economic agents will bid for assets, forcing prices of these

securities to rise relative to the prices of real assets, thereby creating further desire by wealth holders to acquire more real assets. All these combine to raise the demand for current productive services both for producing new and for purchasing production services (Ajayi and Ojo, 2006). In this way, monetary impulse spreads from the financial market to the goods markets, thereby increasing aggregate output (Friedman, 1969).

The theoretical leaning of this paper is Keynesian, which emphasise the role of interest rate and credit channel. The Monetarists stressed the role of financial market, which in Nigeria context is underdeveloped. Furthermore, the agricultural sector is still peasantry and not fully commercial and mechanised, hence an insignificant participant in the financial market.

II.2 Empirical Studies

Macroeconomic literature has established a theoretical link between monetary policy variables and real economic activity. For instance, the Keynesian monetary theory has recognised the crucial role played by money supply in causing inherent variations in the level of economic activity. According to the Keynesians, changes in money supply have the potency of causing permanent influence on real output via a fall in interest rate, working through the marginal efficiency of capital to stimulate investment and raise output (Athukorala, 1998). Such a theoretical postulate has raised empirical question as to what real effect does monetary policy have on the level of output. This theoretical puzzle has generated a lot of curiosity in the minds of researchers and policy analysts alike in investigating this relationship. Large amount of studies have been conducted both in the advanced economies as well as in developing ones in establishing the effect of monetary policy on output in general and sector specific in particular. Modern studies in this respect have improved upon the earlier ones by adopting recent methods of estimation.

Eyo (2008) examined the extent to which macroeconomic policies adopted have affected agricultural output growth in Nigeria. The study employed time series

data for the periods 1970-2005 on selected macroeconomic variables in the framework of Multiple Ordinary Least Squares (MOLS) regression technique. The empirical results from this study showed that macroeconomic policies had not affected agricultural output growth in Nigeria, as macroeconomic environment has not been able to support operators of agricultural sector to acquire high-pay-off-input that are very important in improving the capital base of the agricultural sector in Nigeria.

Using Three Stage Least Squares (3SLS) estimation technique and Simulation experiment, Udah (2009) investigated how monetary policy variables interact with aggregate supply, demand and prices to aid stabilisation policies in Nigeria, using time series data for the periods between 1970 and 2004. The simulation result showed that an increase in money supply will lead to a higher output, employment and higher price level in Nigeria. On the other hand, the result showed that a reduction in money supply by 10 per cent will lead to a reduction in inflation rate by 2.17 percentage points, while output and labour demand would reduce by 0.41 and 0.35 percentage points, respectively. As the paper further noted, this monetary squeeze may as well impose a huge burden on the Nigerian economy.
Onoja and Agumagu (2009) examined the impact of economic policy variables on agricultural output (food production) in Nigeria during the two-term tenure of Obasanjo administration in Nigeria. The data set used for this study spanned from 1999 to 2006. Three functional forms of the model (Linear, Double log and Semi-log forms) were estimated, using Multiple OLS regression technique after transformation using Prais-Winsten method. The results of the study showed that the Federal Government's macroeconomic policy had very little impact in boosting agricultural output (food production) in Nigeria during the period. Specifically, the study showed that commercial banks' credit to agriculture, Agricultural Credit Guarantee Scheme Fund and interest rate had insignificant impact on food production in Nigeria for the period reviewed.

Using a structural vector autoregresion (SVAR) approach, Chuku (2009) conducted a controlled experiment to assess the effects of monetary policy

shocks on output and prices in Nigeria, utilising quarterly data from 1986:1 to 2008:4. The result found evidence that monetary policy innovations had both real and nominal effects on economic parameter depending on the policy variables selected. Specifically, the result of the paper indicated that price-based nominal anchors (MRR and REER) do not have a significant influence on real economic activity, whereas innovations in the quantity-based nominal anchor (m_2) affected economic activities modestly. The conclusion from the study is that the manipulation of the quantity of money (m2) in the economy is the most influential instrument for monetary policy implementation.

Udoh (2011) tested the relationship between government expenditure, private investment and agricultural sector growth in Nigeria during 1970 to 2008 within the framework of autoregressive distributed lag (ARDL) modelling and bound testing approach. Result of the error correction model showed that increase in public expenditure had a positive and significant influence on the growth of the agricultural output in Nigeria. On the contrary, foreign direct investment was insignificant on agricultural output in Nigeria. Similar results were also obtained in subsequent work by Udoh et. al., (2012).

Saibu and Nwosa (2011) examined the effect of monetary policy on sectoral output growth in Nigeria, using time series quarterly data for the periods from 1986:1 to 2008:4 within the framework of an Autoregressive Distributive Lag (ARDL) model. The result of the co-integration test showed that there is a long-run relationship between the sectors' output and monetary policy variables. However, the overall results from the study showed that to a considerable extent, different monetary policy variables had different influence on the sectors' output. Thus, unlike manufacturing, which was non-responsive to all policy variables, agricultural sector was responsive to changes in interest rate and bank credit. Meanwhile, further examination of the results revealed that exchange rate was the most important monetary policy variable as it had significant effect on four sectors (Building/Construction, Mining, Service and Wholesale/Retail), while asset price was not significant in any of the sectors. The paper, therefore, advocated for the

adoption of sector specific policy based on relative strength and importance of each sector to the economy.

Large amount of literature also abound linking changes in agricultural prices to monetary changes. Studies in this regard attempted to establish whether monetary changes have any real effect on agricultural product prices both in the short-run (overshooting hypothesis) and in the long-run (money neutrality hypothesis). Empirical studies such as Frankel (1986), Chambers and Just (1980), Orden (1986), Bessler (1984), Devadoss and Meyers (1987), Lai, Hu and Wang (1996) among others have established that monetary policy changes have real short-run effect on agricultural prices. In other words, these studies provided empirical support for the overshooting hypothesis. For instance, Lai, Hu and Wang (1996), using an extended Frankel's framework, investigated the robustness of overshooting hypothesis under the conditions of anticipated and unanticipated monetary changes and found that agricultural prices could overshoot their long-run equilibrium state if monetary policy is unanticipated.

On the other hand, the results from studies on long-run analysis have remained inconclusive. This, according to Bakucs and Ferto (2005), could be attributed to choice of variables, mistreatment of the time series nature of the data and the misspecification of the model. However, there exists other studies providing evidences for both short-run (overshooting hypothesis) and long-run (money neutrality hypothesis) effects of monetary changes on agricultural prices (Orden and Fackler, 1989; Roberton and Orden, 1990; Saghaian, Reed and Merchant, 2002; Cho et al., 2004; Bakucs and Ferto, 2005 and Asfaha and Jooste, 2006). For example, Asfaha and Jooste (2006) investigate the short and long-run impacts of monetary policy on relative agricultural prices in South Africa using monthly time series data for the periods spanning January 1995 to June 2005. The study employed the Johansen Co-integration analysis and Vector Error Correction Model (VECM). The result of the co-integration test showed that monetary changes had a long-run real effect on agricultural prices. The result, according to the study, rejected the long-run money neutrality hypothesis. The result of the short-

run dynamics provided evidence that agricultural prices overshoot their long-run values in the short-run, indicating that when a monetary shock occurs, the agricultural sector will have to bear the burden of adjustment and increased vulnerability of farmers.

Omojimite (2012) examined the relationship between public institutions and the productivity of the agricultural sector in Nigeria using time series data for the period 1970 to 2008. Employing the fully modified ordinary least squares technique, the result indicated that there was a positive and significant relationship between the volume of credit to the agricultural sector and growth. The result also showed that the dummy for institutional framework (DUM) was positively related to agricultural productivity and was significant at the conventional level of significance. This indicated that the institutional support programmes and policies in the agricultural sector raised the volume of institutional credit to that sector and impacted significantly on the sector's output and growth.

From the review of the literature above, one observation can be made. This is the fact that most studies on the impact of monetary policy on the economy concentrated more on the aggregate level of output, neglecting sector specific analysis. Such neglect has produced inference gap and may undermine empirical strength of these studies. The study differs from previous studies by concentrating its findings in the agricultural sector through examining how monetary policy influences outcomes in the sector in Nigeria. This is the gap the study attempts to fill.

II.3 Agricultural Sector Performance in Nigeria

The role of agriculture in any economy cannot be underestimated. This is because agriculture has been and will continue to be the bedrock of economic growth and development. Indeed, agriculture is one of the leading sectors of the Nigerian economy. Apart from providing food for the growing population, the sector provides the needed raw materials and other allied products for the productive sector. The sector is also a major employer of labour, particularly in the rural areas. According to Abayomi (2006), over 70 per cent of the labour force mostly from rural

areas was employed in agriculture in the 1950s and 1960s in Nigeria. The sector was also the major foreign exchange earner during the years preceding oil revolution in Nigeria. As observed by Uniamikogbo and Enoma (2001), increments in the export of agricultural products are major ways of increasing income and foreign exchange earning in most developing countries. In the 1960s, agriculture was the dominant economic activity, employing over 60 per cent of the population, providing about 70 per cent of the Federal Government revenue, accounting for over 65 per cent of the total gross domestic product and constituting almost 80 per cent of Nigeria's total exports.

Table 1: Contribution to Real Gross Domestic Product by Sector (1960-2010)

Economic Activity	Agriculture	Industry	Building/ Construction	Wholesale & Retail Trade	Services
1960	64.27	5.85	4.45	12.43	12.99
1965	55.36	11.83	5.15	13.30	14.40
1970	44.74	19.41	5.24	12.16	18.45
1975	28.11	27.47	7.11	21.05	16.26
1980	20.61	34.62	9.69	20.03	15.05
1985	32.70	42.33	1.65	13.87	9.45
1990	31.52	43.20	1.63	13.39	10.25
1995	34.19	38.44	1.86	13.97	11.55
2000	35.83	36.99	1.95	13.11	12.12
2005	41.19	28.32	1.52	13.75	15.21
2006	41.72	26.04	1.62	14.95	15.66
2007	42.01	23.92	1.72	16.18	16.17
2008	42.13	21.80	1.84	17.41	16.84
2009	41.84	20.56	1.93	18.16	17.50
2010	40.84	20.36	1.20	18.70	18.10

Source: Central Bank of Nigeria Statistical Bulletin, 2010 and Author's compilation.

The above impressive track record has, however, diminished, following the emergence of oil in the late 1960s and the subsequent boom of the early 1970s. As shown in Table 1 below, agriculture was the dominant economic sector from 1960 to 1970, contributing 64.3 per cent to real GDP in 1960, 55.4 per cent in 1965 and 44.7 per cent in 1970. This was the biggest economic activity when compared with productivity shares of other sectors during the periods.

Beginning from 1970, the role of agriculture in economy started diminishing and by 1975, agriculture share of the total real GDP had fallen to 28.1 per cent and further to 20.6 per cent in 1980. This was in sharp contrast to the industrial, trade and services sectors whose share rose during the period (see Table 1). However, following the implementation of the Structural Adjustment Programme (SAP) in 1986, productivity in the agricultural sector showed significant revival, rising from 31.5 per cent in 1990 to 35.8 per cent in 2000 and further to 41.2 per cent in 2005 and stood at 40.8 per cent in 2010. On the contrary, the hitherto buoyant industrial sector's share in the total real GDP had began to fall starting from 2005, when compared with that of agriculture. From 42.3 per cent in 1990, industrial share of the total real GDP fell to 28.3 per cent in 2005, and further fell to 20.4 per cent of real GDP in 2010. As also shown in table 1, productivity shares of both the domestic trade and services subsectors had fluctuated between 1980 and 1990, while stagnation in productivity was recorded in the domestic trade sector from 1985 to 2005. However, beginning from 2006, the trade and services sub-sectors had recorded increasing productivity shares in the total real output. It is rather sad that the building and construction barely contributed up to 2 per cent of the total real GDP since 1985 till date.

From the analysis above, it is clearly seen that agriculture is the largest economic activity in Nigeria, thereby stressing the almost indispensable role it performs in the country. It is, however, worthy of note that the impressive performance of the agricultural sector would not have been possible without the crop sub-sector's brilliant performance (see table 2 below).

Table 2: Agriculture Production by Activity (per cent of Total) in Nigeria

Year	Crop Production	Livestock	Forestry	Fishing
1960	79.6	8.5	9.4	2.5
1965	77.3	9.2	8.9	4.6
1970	76.6	6.9	5.7	10.8
1975	63.2	13.4	5.5	17.9
1980	66.0	18.7	3.1	12.2
1985	74.1	18.2	5.0	2.7
1990	81.1	11.3	2.5	5.0
1995	85.1	10.6	1.2	3.1
2000	83.9	9.7	1.7	4.7
2005	88.6	6.6	1.3	3.6
2006	89.1	6.4	1.2	3.3
2007	89.1	6.4	1.2	3.3
2008	89.1	6.4	1.2	3.3
2009	89.3	6.4	1.2	3.1

Source: Central Bank of Nigeria Statistical Bulletin, 2009 and Author's compilation.

From table 2 above, crop production had contributed over 80 per cent of the sector's total output, followed by the livestock production and fishing and forestry making the rear. It must be stressed here that the high performance of crop production sub-sector is the manifestation of the dominant agricultural activity in the country over the years.

III. Trend Analysis of Key Policy Variables

This section analyses trends in key variables used by the monetary authorities in influencing the economy.

III.1 Commercial Bank Sectoral Credit Allocation in Nigeria

One of the Central Bank's monetary policy instruments in Nigeria is the sectoral credit allocation. The Central Bank in its monetary policy formulation issues

guidelines on domestic credit allocation which also set credit limits for each sector of the economy from the aggregate commercial banks' loans and advances to the private sector. The main purpose of the guidelines on sectoral credit allocation is to stimulate the productive sectors of the economy so as to stem the inflationary tide in the country and to encourage investment by fixing interest rate relatively low.

In the CBN credit allocation guidelines, the economy is divided into three, namely: the priority sector; the less-preferred sector and the unclassified sector. The priority sector comprises Agriculture, Solid Minerals, Exports and Manufacturing. The less-preferred sector, on the other hand, consist of Real Estate, Public Utilities, Transport and communications, Finance and Insurance, Government, Import and Domestic trade, while the unclassified sector includes all other activities not mentioned above. However, for the purpose of this study, we will center our analysis on the priority sector in which the agricultural sector is the main focus.

Table 3: Commercial Banks Credit to the Priority Sector in Nigeria (as Percentage of Total Credit)

Year	Agriculture	Solid Minerals	Exports	Manufacturing	Total
1960	19.8	9.7	-	4.2	33.7
1965	25.3	0.5	-	10.7	36.5
1970	2.0	1.9	19.8	21.7	45.4
1975	2.6	1.1	7.0	28.6	39.3
1980	7.3	8.0	1.6	30.8	47.7
1985	10.8	1.9	1.0	26.6	40.3
1990	16.2	1.4	2.9	30.3	50.8
1995	22.0	10.5	16.9	50.6	100.0
2000	8.2	7.4	5.5	28.9	50.0
2001	7.2	7.9	4.1	25.7	44.9
2002	6.3	8.2	3.1	24.6	42.2
2003	5.6	7.6	3.2	23.0	39.4
2004	4.6	9.1	2.2	23.0	38.9
2005	3.5	8.3	1.7	18.8	32.3

2006	2.5	8.6	1.4	16.4	28.9
2007	2.2	9.0	1.3	9.4	21.9
2008	1.9	10.1	1.1	10.7	23.8
2009	1.3	11.3	0.7	11.3	24.6
2010	1.7	15.3	5.8	12.8	35.6

Source: Central Bank of Nigeria Statistical Bulletin, 2010 and Author's Compilation

As evidenced from table 3, manufacturing sector has been the biggest beneficiary of commercial banks credit allocation to the priority sector of the Nigerian economy during the period under review. Apart from the 1960s, mid-1980s and the 1990s, where credits to the agricultural sector recorded appreciable results, credit to agricultural sector for the rest of the period under review had been relatively low. As shown in the table, commercial banks credit to the priority sector in 1960 was 33.7 per cent of total credit, of which 19.8 per cent went to Agriculture, 9.7 per cent mining and solid minerals and 4.2 per cent manufacturing. This increased to 36.5 per cent of total credit in 1965 with the share of Agriculture 25.3 per cent, mining and solid minerals sector 10.5 per cent, while 10.7 per cent accrued to manufacturing. By 1970, commercial banks credit to the priority sector had reached 45.4 per cent of the total credit of which 2.0 per cent went to Agriculture, 1.9 per cent to mining and solid minerals, 19.8 per cent to export, and 21.7 per cent to manufacturing. After falling to 39.3 per cent in 1975, credit to priority sector rose to 47.7 per cent in 1980, but fell again to 40.3 per cent before rising to 50.8 per cent in 1990.

The sub-sectoral analysis showed that the manufacturing sector continued to amass greater percentage of credit to priority sector during the review period. In 1995, credit to the priority sector reached 100 per cent with Manufacturing taking 50.6 per cent, 16.9 per cent went to export, and 10.5 per cent to mining and solid minerals, while 22.0 per cent went to Agriculture.

The sectoral credit allocation was, however, discontinued in 1996. Notwithstanding, the flow of credit to the agricultural sector did not remarkably

change. Beginning from 2000, the percentage of credit to agriculture from total credit allocated to the priority sector had continued to fall. From 22.0 per cent in 1995, credit to agriculture fell to 8.2 per cent in 2000, 3.5 per cent in 2005, 2.5 per cent in 2006, 2.2 per cent in 2007, 1.9 per cent in 2008, and down to 1.3 per cent in 2009 before rising marginally to 1.7 per cent in 2010. The reasons for the poor performance of credit to the agricultural sector are not farfetched. The neglect of the sector following the emergence of oil; the reluctance on the part of commercial bank to loan to small scale farmers; high interest rate charged by banks; and unfavourable macroeconomic environment among others are some of the reasons for the poor credit allocated to agriculture in Nigeria.

From the analysis above, it can be shown that manufacturing sector continued to dominate credit allocation to priority sector during the review period, with credit to mining and solid minerals sector showing some improvement, while the shares of credit to agriculture and export in total credit continued to plunge.

III.2 Minimum Rediscount Rate (MRR), Deposit and Lending Rates in Nigeria (1970-2010)

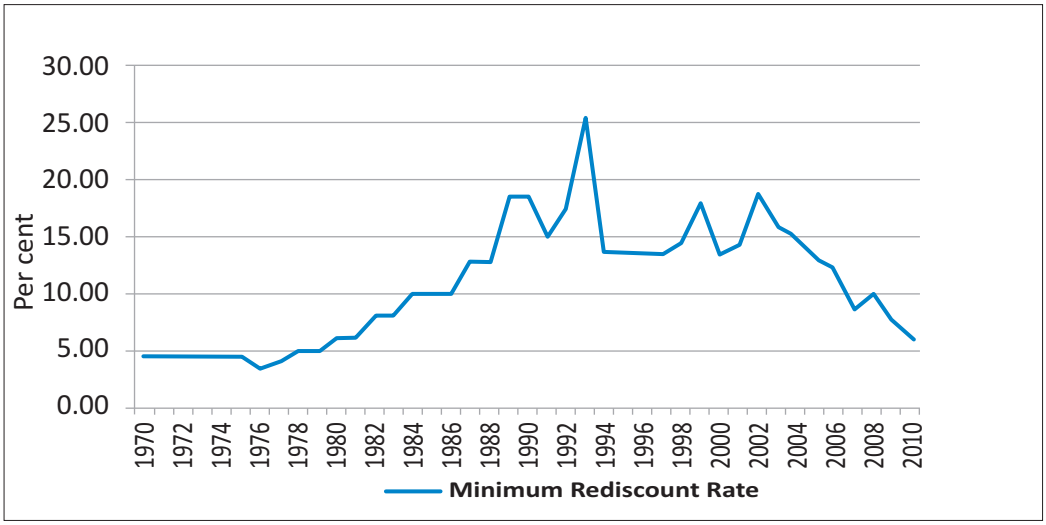
The implementation of monetary policy in Nigeria over time was anchored on the Minimum Rediscount Rate (MRR). By definition, the MRR is the minimum rate at which the Central Bank discounts first class bill with the commercial banks. This rate represents a benchmark upon which other interest rates are determined in the economy. The rate also acts as a signal for other rates in the financial system. That means that movements in other interest rates are strongly tied to movements in MRR.

Prior to the deregulation and liberalisation of the Nigerian economy, monetary policy implementation was highly controlled. Interest rates (deposit and lending) were directly controlled by the government via the Central Bank. Interest rate was fixed at relatively low levels. The aim was to promote investment and growth. As revealed in figures 1 and 2, the MRR was fixed between 1970 and 1975 at an average rate of 4.5 per cent. This also led to the fixing of both Savings and Lending

rates at 3.0 and 7.0 per cent, respectively ,between 1970 and 1974 with a spread of 4.0 per cent. The MRR ,however ,fluctuated between 3.5 and 8.0 per cent from 1976 to 1983, which also caused fluctuation in savings rate between 4.0 and 7.5 per cent from 1975 to 1983 and lending rate between 6.0 and 7.5 per cent from 1975 to 1983.

Between 1984 and 2006, the MRR was double digit reaching a peak of 26.0 per cent in 1993. The high rates of MRR during these periods were meant to stem inflationary pressures experienced in the country. The double digit MRR also led to double digit lending rate between 1982 and 2010. The savings rate ,on the other hand, was double digit between 1987 and 1996, after which the rates were single digits from 1997 to 2010.

Figure 1: Minimum Rediscount Rate in Nigeria (1970-2010)

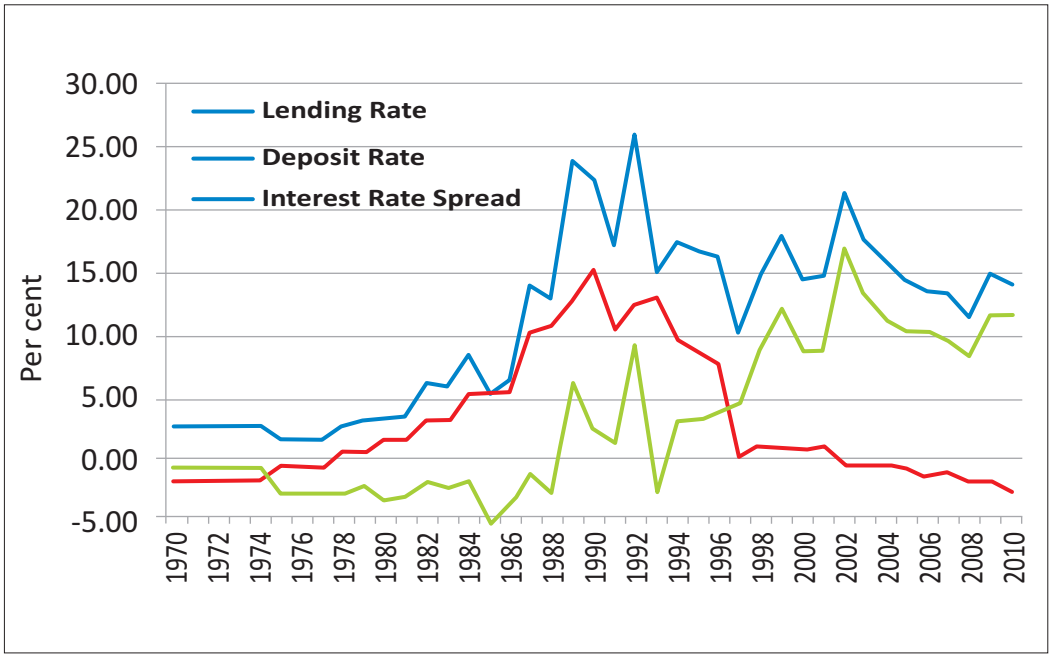


Source: CBN 2010.

It is also worthy of note that the spread between lending and savings rates was relatively low between 1970 and 1988. The spread was 4.0 per cent from 1970 to 1974 but declined to 1.5 per cent in 1980, before assuming a negative value in 1985 (see figure 2). The spread, however, reached the highest peak of 20.7 per cent in 2002 and remained double digit till 2010. As revealed by figure 2, while lending rate

was double digit between 1997 and 2010, savings rate was in single digit and continuously declined. The low savings rate reflected disincentive to saving, which also affected availability of credit to the economy in general and agricultural sector, in particular.

Figure 2: Lending Rate, Savings Rate and Spread In Nigeria (1970-2010)

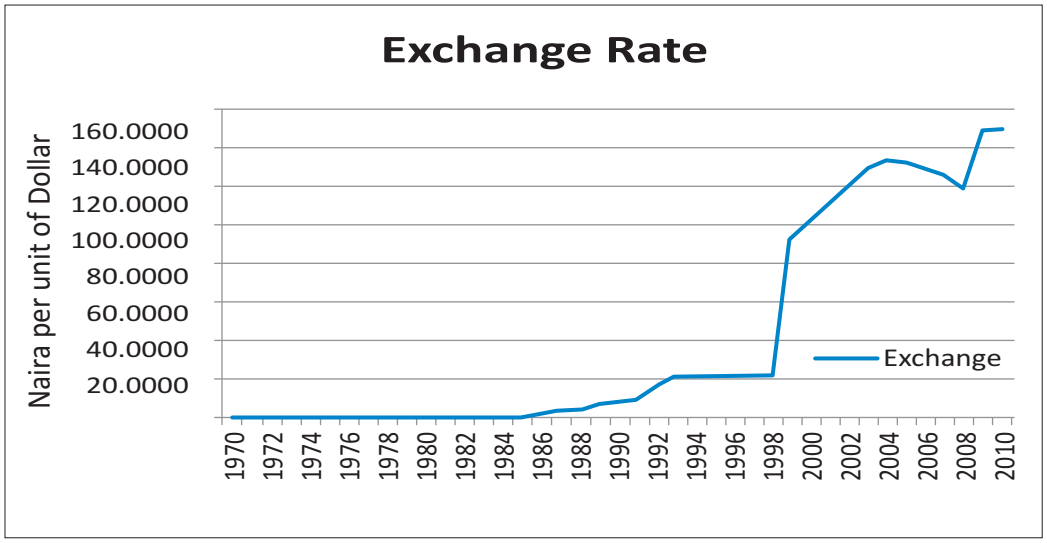


Source: CBN 2010.

III.3 Exchange Rate Movements in Nigeria (1970-2010)

In line with monetary policy trend in Nigeria, exchange rate was controlled by the government. Nigeria operated a fixed exchange rate system between 1970 and the middle of 1980s. This is depicted in figure 3 as exchange rate was fixed at less than one naira to US dollar.

Figure 3: Exchange Rate in Nigeria (1970-2010)



Source: CBN 2010.

The fixed exchange rate system led to the overvaluation of the Naira relative to the major global currencies, resulting in distortions in the domestic economy as imports become relatively cheaper. The development resulted in balance of payments disequilibrium and subsequent capital flight and a drain on the external reserves. In 1980, following the oil glut, and the global depression and the mounting external debts that followed, it became imperative for the country to move away from the pegged exchange rate system to a flexible one. In 1986, under the Structural Adjustment Programme (SAP), Nigeria adopted the flexible exchange rate system, which allowed the exchange rate to be determined by the market forces. The adoption of the flexible exchange rate system however, led to the depreciation of the currency from ₦0.8938/US$1 in 1985 to ₦2.0206/U$1 in 1986.

Various reforms were carried out in an attempt to achieve the objectives of exchange rate policy including the Second-Tier Foreign Exchange Market (SFEM) which metamorphosed from the Foreign Exchange Market (FEM), the Autonomous Foreign Exchange Market (AFEM), Inter-Bank Foreign Exchange Market (IFEM), the Retail Dutch Auction System (rDAS) and the Wholesale Dutch

Auction System (WDAS). The application of each arrangement also produced a significant effect on the exchange rate as the naira exchange rate continued to depreciate gradually. By 1991, the exchange rate had depreciated to ₦9.9095/US$1 and sharply to ₦17.2984/US$1 in 1992. The rate further depreciated to ₦92.6934/US$1 in 1999, ₦102.1052/US$1 in 2000, ₦132.1470/US$1 in 2005 before reaching a height of ₦150.66/US$1 in 2010.

IV. Monetary Policy Objectives and Agricultural Sector in Nigeria

Generally, the objective of monetary policy is the same both in the developed and developing economies. The objectives of monetary policy include ,among others , the achievement of price stability; attainment of full employment; attainment of balance of payments equilibrium; achievement of rapid economic growth and maintenance of exchange rate stability. However, as observed by Ajayi and Ojo (2006), there seems to be very scanty empirical studies on the objectives of monetary policy in Nigeria. This study therefore deviates in its analysis and concentrates more in reviewing monetary policy objectives over the years and its effect on the agricultural sector in Nigeria.

While earlier analysis in this respect has discussed monetary policy performance , using two broad epochs, this study splits the two epochs into short intervals and proceeds with the analysis. Following from Ajayi and Ojo (2006) analysis, the current study splits the periods as follows.

Phase 1: 1960 - 1969

The early part of this period was characterised by maintaining sound currency. The Central Bank of Nigeria was still at its infancy with limited power to fully administer a sound monetary policy. The then newly issued Nigerian currency suffered acceptability and convertibility as it was still tied to the British pounds and sterling. The objective of monetary policy was that of accumulation of external reserves. But after 1962, emphasis was put on development as policy objective strived to ensure adequate supply of credit to the economy without creating inflationary pressures (Ajayi and Ojo, 2006). The increase in credit greatly benefited the agricultural sector as credit to agriculture increased ,leading to an increase in

agricultural output. Consequently, the contribution of agriculture to real total GDP stood at 55.4 per cent in 1965 (see table 1). The later part of 1965 witnessed the policy of credit rationing in the form of guidelines that placed ceilings on the ability of commercial banks to create credits. This led to a sharp fall in credit allocated to agriculture from 25.3 per cent in 1965 to 2.0 per cent in 1970 (see table 3). However, the later part of the period witnessed the outbreak of civil war, which redirected the objective of monetary policy. In effect, monetary policy was redirected at financing the war as government pursued the policy of cheap borrowing to execute the war.

Phase 2: 1970- 1974

This period is usually referred to as the inflationary era. This is because the period was characterised by rising inflationary pressures from the disruption of the economic activities by the civil war. Monetary policy stance was expansionary in line with the Federal Government's 3Rs- Reconstruction, Resettlement and Reconciliation programme. By 1975 inflation had become a serious national issue as inflation rate reached about 34 per cent from about 3 per cent in 1972 (Ajayi and Ojo, 2006). To stem such tide in inflation, the CBN introduced the sectoral distribution of credit policy, in which cheap credits were allowed to the more productive sectors of the economy ,in particular the agricultural sector. Interest rate was also kept at relatively low levels at about 7.0 per cent. Other direct monetary measures to control the indiscriminate credit creation by commercial banks included: credit ceilings; selective credit controls; cash requirements; and special deposits. Following this monetary tightening policy, credit to agriculture fell from 25.3 per cent in 1965 to 2.6 per cent in 1975. The share of agriculture in total real GDP also fell from 44.7 per cent in 1970 to 28.1 per cent in 1975.

Phase 3: 1975-1985

The period was also characterised by direct control of monetary policy instruments by the Government through the monetary authorities. The main objective of monetary policy in this period was the promotion of rapid and sustainable

economic growth. To achieve this objective, the CBN continued with its direct control and rationing of credit policy as loans and advances were directed to the preferred sectors of the economy. The ceiling on individual banks' credit to the preferred sectors was fixed at 30-40 per cent of banks aggregate loans and advances in the early 1980s, but was reduced to 7 per cent in 1985 (Ajayi and Ojo, 2006). Agriculture being the core component of the preferred sector benefited from this policy as share of credit to the sector increased from 2.6 per cent in 1975 to 10.8 per cent in 1985. Its share of the total real GDP also rose from 20.6 per cent in 1980 to 32.7 per cent in 1985. However, beginning from early 1980s, there was shortfall in oil receipts which made it increasingly difficult for the Government to perform its fiscal responsibilities. The government therefore resorted to borrowing from the Central Bank to finance the existing huge deficits. The development had adverse implications for monetary management. The monetary control framework, which relied heavily on credit ceilings and selective credit controls, increasingly failed to achieve the set targets as their implementation became less effective (CBN,2007).

Phase 4: 1986-2010

Beginning from 1986, the monetary policy formulation and objectives assumed a different dimension. The deregulation of the economy following the implementation of SAP in 1986 brought with it monetary policy changes. SAP was introduced as a result of the crash in the international oil market prices and the resultant deteriorating economic conditions in the country. SAP was designed to achieve the following objectives, namely:

i. To achieve fiscal balance and balance of payments viability by altering and restructuring the production and consumption patterns in the economy;
ii. To rationalise the role of the public sector and accelerate the growth potentials of the private sector;
iii. To restructure and diversify the productive base of the economy so as to reduce dependency on the oil sector; and
iv. To embark on privatization and commercialisation of the economy aimed

at promoting industrial efficiency, among others.

The main strategies of the programme were the deregulation of external trade and payments arrangements, the adoption of a market-determined exchange rate for the naira, substantial reduction in complex price and administrative controls and more reliance on market forces as a major determinant of economic activity.

Under the SAP framework, the objective of monetary policy was directed at inducing the emergence of a market-oriented financial system for effective mobilisation of financial savings and efficient resource allocation. To achieve this, monetary policy variables such as interest rate and exchange rate were liberalised thereby allowing banks to determine deposit and lending rates based on market conditions. The main instrument of the market-based framework was the open market operations (OMO). OMO was complemented by reserve requirements and discount window operations. Meanwhile, the deregulation of the interest rate had positive effects on the agricultural sector in Nigeria. First, following the deregulation of interest rate, credit allocation to agricultural sector rose from 10.8 per cent in 1985 to 16.2 per cent in 1990 and further to 22.0 per cent in 1995. Second, agricultural share of the total real GDP also experienced some sort of revival as it rose from 20.6 per cent in 1980 to 31.5 per cent in 1990 and further to 34.2 per cent in 1995 (see table 1).

Another major development was that the sector-specific credit allocation targets were compressed into four sectors in 1986, and subsequently to two in 1987 and by 1996, all mandatory credit allocation mechanisms were abolished. Both commercial and merchant banks were subjected to equal treatment since their operations were found to produce similar effects on the monetary process. In 2002, the CBN commenced a medium-term monetary policy framework with the primary aim of achieving price and exchange rate stability by minimising the problem of time inconsistency and over-reaction due to temporary shocks. The Dutch Auction System (DAS) of foreign exchange management was reintroduced. This action engendered relative stability, and stemmed further

depletion of reserves. However, the financial system was characterised by rapid expansion in monetary aggregates, particularly during the second half of 2000, influenced by the monetisation of enhanced oil receipts. Consequently, monetary growth accelerated significantly, exceeding policy targets by substantial margins. Savings rate and the inter-bank call rates fell generally due to the liquidity surfeit in the banking system and the spread between deposit and lending rates widened (see figure 2 for trend). The high lending rates constricted credit to agriculture as commercial banks loans to the sector fell from 22.0 per cent of total commercial banks credit in 1995 to 8.5 per cent of total credit in 2000 and fell further to 3.5 per cent of total credit in 2005.

In 2003, another monetary policy measure was designed aimed at promoting a stable macroeconomic environment and achieve a non-inflationary output growth rate of 5 per cent. In pursuit of its developmental effort, the Central Bank, in collaboration with the Bankers' Committee, established the Small and Medium Industries Equity Investment Scheme (SMIEIS). Credit delivery to real sector was encouraged through the SMIEIS and an incentive of lower Cash Reserve Requirement (CRR) regime was prescribed for those banks that increased their credit allocation to the real sector by 20 per cent or more. Moreover, the Bank provided guarantees for agricultural loans under the Agricultural Credit Guarantee Scheme (ACGS). In spite of these schemes, commercial banks credit to agriculture continued to plunge as shown in table 3.

Following the global financial crisis of 2008/2009, the Central Bank of Nigeria recognised the need to accompany the objective of maintaining price stability with financial system stability. The thrust of monetary policy during the period centered on providing adequate liquidity in the banking system. The Monetary Policy Rate (MPR) was upheld as an anchor to all other short-term market rates. The major instrument of the monetary policy was the Open Market Operations (OMO) conducted through Treasury Bills auction in the primary market. This policy continued into 2010 as monetary policy objective aimed at ensuring price and

financial stability.

V. The Government's Interventions in Agricultural Sector through the Central Bank of Nigeria

The role of government through the Central Bank of Nigeria (CBN) in the agricultural sector has always been in term of financing. Over the years, the Nigerian government through the central bank has instituted various schemes aimed at enhancing the development of agriculture in Nigeria. Among these schemes are:

i. **Sectoral Credit Allocation:** Prior to 1996, direct measures such as selective credit control, credit ceilings, administered interest rate and exchange rate, cash requirements and special deposits were frequently used to regulate the flow of credit in the economy by the CBN. Cheap credits were allowed to the more productive (priority) sectors of the economy and in particular the agricultural sector. Interest rate was also kept at relatively low levels at about 7.0 per cent .

ii. **Nigeria Agricultural Co-operative and Rural Development Bank (NACRDB):** The bank was established in 1972, but renamed Nigerian Agricultural and Cooperative Bank (NACB) in 1978. In 2000, it was merged with the People's Bank of Nigeria (PBN) to become Nigerian Agricultural Cooperative and Rural Development Bank Limited (NACRDB). The bank is jointly owned by the Central Bank of Nigeria (40 per cent) and the Federal Ministry of Finance (60 per cent). The bank was purposefully set up to promote growth in the quantity and quality of credit to agriculture, including lending to individuals and state governments. It was also aimed at directly making loans available and strengthening local micro finance banks, which deliver credit at the local community level. It was also to improve storage facilities and promote marketing of farm produce.

iii. **Agricultural Credit Guarantee Scheme Fund (ACGSF):** Agricultural Credit Guarantee Scheme Fund (ACGSF) was established in 1977 under the

management of the Central Bank of Nigeria (CBN), which handles the day-to-day operations of the Scheme. The Federal Government holds 60 per cent of the total shares, while, Central Bank of Nigeria holds the remaining 40 per cent of the shares. The main objective of the Fund was to guarantee credit facilities extended to farmers by banks up to 75 per cent of the amount in default net of any security realized. Agricultural activities for which loans can be guaranteed by the Fund include: establishment or management of plantation for the production of rubber, oil palm, cocoa, coffee, tea and similar crops; production of cereal crops, tubers, fruits of all kinds, cotton, beans, groundnuts, sheanuts, benniseed, vegetables, pine-apples, bananas and plantains; animal husbandry, including poultry, piggery, cattle rearing and the like, fish farming and fish capture; processing activities such as cassava to gari, oil palm fruit to palm oil and kernel, groundnut to groundnut oil, etc and farm machinery and hire services.

iv. **The Self-Help Group Linkage Programme:** The Self-Help Group Linkage programme was launched in 1991 by the government via the Central Bank of Nigeria. It became operational in 1992. This Scheme was a product under the Agricultural Credit Guarantee Scheme Fund (ACGSF). The aim of the Self-Help Group Linkage Banking is to inculcate the culture of savings and banking habit in group members as well enable them to build up resources for financing their farm projects without recourse to bank borrowing on the long-run. Under this Scheme, farmers are encouraged to form themselves into groups of between 5 and 15 on the basis of common purpose and undertake regular savings with a partner bank of their choice. After 6 months of regular savings, the group can apply for loan, which is given to them in multiples of the balance in their savings account at the time of the application for the loan.

v. **The Trust Fund Model (TFM):** The Trust Fund Model was established to enhance credit supply to the agricultural and rural sectors of the economy.

Under the Model, oil companies, State and Local Governments and Non-Governmental Organisations (NGOs) are required to place funds in trust with lending banks to augment the small group-savings of the farmers as security for agricultural loans. The Trust Fund secures 25 per cent or more of the intended loans of the prospective borrowers, the farmers' savings secure another 25 per cent while the ACGSF guarantees 75.0 per cent of the remaining 50.0 per cent, thereby leaving the lending bank with a risk exposure of only 12.5 per cent.

vi. **The Interest Drawback Programme (IDP):** The Interest Drawback Programme was developed as an interest rate management framework under the ACGSF to reduce effective borrowing rates without the complication of introducing dual interest rate regime or contradicting the existing deregulation policy of the government. Under the IDP, farmers will borrow from lending banks at market-determined rates, but the Programme will provide interest rebate of a determined percentage to them where the loans are repaid as and when due. The IDP is funded jointly by the Federal Government and the Central Bank of Nigeria in the ratio of 60:40. The IDP is regarded as a dedicated fund for interest drawback on agricultural loans or IDP Fund and separated from the ACGSF capital.

vii. **Small and Medium Industries Equity Investment Scheme (SMIEIS):** The Government through the Central Bank of Nigeria established the Small and Medium Industries Equity Scheme (SMIEIS) in 2001. The Scheme requires banks to set aside 10 per cent of their before-tax profit annually to be invested in equity in small and medium industries. The specific objectives of the scheme include: to facilitate the flow of funds for the establishment of new Small and Medium Investment (SMI) projects; stimulate economic growth, develop local technology and generate employment; develop and package viable industries with Nigerian entrepreneurs; provide venture capital and management that would spearhead the restructuring and financing of the small and medium scale industries (SMI). The range of

activities of which funds shall be applied are those in the real sector, which include: Agro-Allied; Information Technology and Communication; Manufacturing; Educational Establishments; Services; Tourism and Leisure; Solid Minerals; and Construction.

viii. **Refinancing and Rediscounting Scheme (RRF):** In 2002, the Refinancing and Rediscounting Scheme (RRF) was launched by the Central Bank of Nigeria. The RRF was developed to serve as an incentive for attracting loans to medium to long-gestation real sector projects such as agriculture, semi-manufacturing and manufacturing, exploration and exploitation of solid minerals, and Information Technology (IT). It is a window and an incentive meant to provide temporary relief to deposit money banks, which may face liquidity problems as a result of committing their resources to medium to long-term funding of real sector activities. To farmers, it offer concessionary interest rate on term loans for agricultural investments and afford them to conveniently repay the loans as well as to make profits.

ix. **Agricultural Credit Support Scheme (ACSS):** In 2006, the Federal Government through the Central Bank of Nigeria (CBN) with the active support and participation of the Bankers' Committee established the Agricultural Credit Support Scheme (ACSS) with the total fund portfolio of N50 billion. The main aim of the Scheme was to develop the agricultural sector of Nigeria by providing credit facilities to farmers at single digit interest rates to enable them make use of the untapped potentials in the sector, thereby reducing the cost of food products and inflation rate. This will consequently increase the production of agricultural exports and diversify the revenue base as well as increase the foreign exchange earnings of the country. The Scheme at its inception was billed to grant loans to deserving farmers at 14 per cent interest, but farmers who are able to pay back the loan within the stipulated period enjoy a rebate of 6 per cent, resulting to 8 per cent effective interest rate paid by farmers.

x. **Commercial Agriculture Credit Scheme (CACS) Fund:** As part of its developmental role, the Central Bank of Nigeria (CBN), in conjunction with the Federal Ministry of Agriculture and Water Resources (FMA&WR), established the ₦200 billion Commercial Agriculture Credit Scheme (CACS) fund in April 2009. The Funds are being channeled through the deposit money banks to farmers with interest rate not exceeding 9 per cent and maturity period not more than 7 years. The overall objective of the Scheme is to provide finance for the country's agricultural value chain comprising production, processing, storage and marketing. The specific objectives of the Scheme include:

- To speed up the development of the agricultural sector in Nigeria by providing credit facilities to large-scale commercial farmers at a single digit interest rate (precisely at 9 per cent);
- To enhance food security in the country by increasing food supply and effecting lower agricultural products prices, thereby ensuring low food inflation;
- To reduce the cost of credit in agricultural production to enable farmers exploit the untapped potentials of the sector; and
- To increase total output, generate employment, diversify Nigeria's revenue base, raise the level of foreign exchange earnings and provide input for manufacturing and processing on a sustainable basis.

VI. Methodology

The study adopted the Auto- Regressive Distributed Lag (ARDL) model for its analysis. One advantage of the Bound Testing approach is that it can be applied irrespective of whether variables in the model are purely I(0), purely I(1) and mutually co-integrated. This avoids the pre-testing problems associated with standard co-integration test such as the classification of variables into I(0) and I(1). Moreover, the test is relatively efficient in small and finite sample data size. However, before estimating the ARDL model, the study tested for unit root and co-

integration among variables in the model. The unit root test is conducted using the Augmented Dickey Fuller (ADF) test proposed by Dickey and Fuller (1979) and Phillips-Perron (PP) test proposed by Phillips and Perron (1988) with intercept only.

VI.1 Empirical Model

Theoretical literature established three major transmission channels through which monetary policy affects agricultural output. These include interest rate channel, credit channel and exchange rate channel. The study considered these endogenous variables in addition to two non-policy variables, which also affect the agricultural sector.

Based on this theoretical exposition, the empirical model was formulated and expressed as:

AGOUT= f (LEN, CBLA, EXCH, INF, GXPA) (1)

Where:

AGOUT = Agricultural GDP

LEN = Lending Rate

CBLA = Commercial Banks Loans and Advances to Agriculture in Nigeria

EXCH = Exchange Rate

INF = Inflation Rate

GXPA = Government Expenditure in Agriculture in Nigeria

Given the time series nature of the data used, the unit root procedure requires estimating the following ADF and PP equations:

ADF Estimation:

$$\Delta Y_t = a_0 + \gamma Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + U_t \quad (2)$$

Where:

$\Delta Y_t = Y_t - Y_{t-1}$ is the first difference of series Y_t;

$\Delta Y_{t-1} = Y_{t-1} - Y_{t-2}$ is the first difference of Y_{t-1}

$$Y_t = \lambda_0 + \rho Y_{t-1} + \varepsilon_t. \quad (3)$$

Where:

a_0, λ_0, γ, β_i, and ρ are parameters to be estimated; U_t, and ε_t are stochastic error terms.

In both ADF and PP tests, the null hypothesis of non-stationarity (presence of unit root) is accepted if $\gamma = 0$ and $\rho = 1$, respectively, while the null hypothesis of non-stationarity is rejected if $\gamma < 0$ and $\rho < 1$, respectively.

Following from Pesaran, Shin and Smith (2001), the Error Correction Model (ECM) of the unrestricted Auto Regressive Distributed Lag (ARDL) equation based on equation (1) is specified as follows:

$$\Delta AGOUT_t = \alpha_0 + \alpha_1 LEN_{t-1} + \alpha_2 CBLA_{t-1} + \alpha_3 EXCH_{t-1} + \alpha_4 INF_{t-1} + \alpha_5 GXPA_{t-1} + \sum_{i=1}^{k} \beta_i \Delta AGOUT_{t-i} + \sum_{i=0}^{k} \varphi_i \Delta LEN_{t-i} + \sum_{i=0}^{k} \delta_i \Delta CBLA_{t-i} + \sum_{i=0}^{k} \omega_i \Delta EXCH_{t-i} + \sum_{i=0}^{k} \gamma_i \Delta INF_{t-i} + \sum_{i=0}^{k} \pi_i \Delta GXPA_{t-i} + U_t \quad (4)$$

Where:

U_t is the white noise error term.

The first part of the right hand side of equation (4) with parameters a_1 to a_5 represents the long-run dynamics of the model and the second part with parameters β_i to π_i represents the short-run dynamics of the model.

The ARDL approach involves testing first for the co-integration relationship among the variables in the model. In specific term, the bounds test involves estimating equation (4) and then testing the null hypothesis (H_0) of no long-run relationship against the alternative hypothesis (H_a) that there is a long-run relationship. That is: H_0: $a_1=a_2=a_3=a_4=a_5=0$, against the alternative hypothesis: H_a: $a_1 \neq a_2 \neq a_3 \neq a_4 \neq a_5 \neq 0$. The calculated F-statistic is then compared with the critical values given in Pesaran et. al.,(2001). If the computed F-statistics exceeds the upper critical value, the null hypothesis of no long-run relationship can be rejected. On the other hand, if the F-statistics falls below a lower critical value, then the null hypothesis cannot be rejected. Lastly, if the F-statistics lies between the upper and lower critical values, it

renders the result inconclusive.

On the event that the existence of long-run relationship among the variables is established, the second stage involves the estimation of the error correction model of equation (4) for short-run and long-run dynamics.

VI.2 Data Sources

The study employed time series data collected on annual basis from 1970-2010. The relevant data for the study was obtained from the Central Bank of Nigeria Statistical Bulletin, the Central Bank of Nigeria (CBN) Annual Reports and Statement of Accounts and the National Bureau of Statistics.

VI.3 Analysis of Results

The result of the unit root tests using Augmented Dickey-Fuller test and Phillip-Perron test in Tables 4 and 5. As shown in table 4, the result of the unit root test using Augmented Dickey-Fuller test of stationarity revealed that only two variables (CBLA and GXPA) were stationary at levels. Hence, the null hypothesis of non-stationarity could not be rejected at levels. However, at first difference, all variables were stationary. That is, at first difference, the variables were integrated of order 1(1).

Table 4: Test for unit root using ADF Test

Variables	Levels	First Difference	Critical Values at 5per cent	Order of Integration
AGOUT	-0.4048	-6.1463*	-3.5297	1(1)
CBLA	3.3503*	-2.1374	-3.5683	1(0)
EXCH	-1.4815	-6.0650*	-3.5297	1(1)
GXPA	-5.5219*	-5.9211*	-3.5577	1(0)
LEN	-1.5707	-9.8502*	-3.5297	1(1)
INF	-3.3266	-6.2933*	-3.5330	1(1)

*denotes significance at 5per cent.

Table 5 also showed the test of unit root using Phllip-Perron test. As the result showed, only one variable (GXPA) was stationary at levels. Just as in the ADF test above, the null hypothesis of non-stationary of the series could not be rejected. All variables were, however, stationary when the series was differenced once.

From the unit root tests conducted above, it was revealed that the variables were integrated of order 1(1), which suggested the presence of co-integration relationship among them. To establish this long-run relationship, the bounds test co-integration analysis was carried out. The result of the bounds test was reported in table 6. From the result obtained, the calculated F-Statistics value of 1251.49 was greater than the upper- bound critical value of 4.90 at 1 per cent level. Since the F-Statistics value was greater than the upper-bound critical value, the null hypothesis of no co-integration was rejected; hence there was co-integration (long-run relationship) among the variables in the model.

Table 5: Test for unit root using PP test

Variables	Levels	First-diff	Critical Value at 5per cent	Order of Integration
AGOUT	-0.3609	-6.1503*	-3.5297	I(1)
CBLA	-2.0655	-28.7995*	-3.5297	I(1)
EXCH	-1.4815	-6.0650*	-3.5297	I(1)
GXPA	-5.5334*	-31.5919*	-3.5297	I(0)
LEN	-2.8068	-10.0030*	-3.5297	I(1)
INF	-3.1857	-11.5234*	-3.5297	I(1)

*denotes significance at 5 per cent.

Since it was established that there was a long-run relationship among the variables in the model, we proceeded to estimate the error correction model for short-run estimates. The results of the short-run dynamics from the error correction model presented in Table 7 showed that exchange rate and government expenditure on agriculture had significant short-run effect on agricultural output in Nigeria. The

coefficient of exchange rate was positive, showing that a shock to exchange rate (i.e. depreciation) will generate positive reaction to increased agricultural production for export. Precisely, the high elasticity of exchange rate is indicative of the strong sensitivity of agricultural output to exchange rate shock. An appreciation of the exchange rate will increase competitiveness of agricultural export and attract investment in the agricultural sector. Similarly, the positive sign of the coefficient of Government expenditure on agriculture showed that there was a short-run positive effect of Government spending on agricultural output in Nigeria. This implied that a 1 per cent increase in Government expenditure in agriculture leads to 1.08 per cent increase in agriculture productivity in Nigeria, other things being equal. The result was in line with those obtained by Udoh (2011) and Udoh et. al.,(2012).

The adjusted R-Squared showed that the explanatory variables have explained 52 per cent of the total variations in agricultural output in Nigeria. The F-statistics (13.81) also showed that the explanatory variables collectively were significant in explaining short-run changes in agricultural output in Nigeria. The Durbin-Watson value of 1.91 showed there was no autocorrelation in the model. Meanwhile, the coefficient of the error correction term is negative in line with a priori expectation but however, not statistically significant. Thus, there is a slow rate of adjustment to equilibrium.

Table 6: Results from Bounds test

Bounds Test:	
F-statistic (p-value)	1251.49 (0.02)
Critical bounds (1per cent)#:	
lower and upper	3.60 and 4.90
Decision:	Co-integration

#Unrestricted Intercept and Unrestricted trend (k=6) from Pesaran et. al.,(2001).
The full regression result is presented in Table A1 in the appendix.

Table 7: Error Correction Model

Dependent Variable: ?AGOUT			
Explanatory variables	**Coefficient**	**t-statistic**	**Probability**
Constant	4854.75	2.67	0.01
?EXCH(-4)	905.33	4.58	0.0001
?GXPA(-3)	1.08	5.94	0.0000
ECM(-1)	-0.009	-0.14	0.88
Adjusted R-squared	0.52	F-statistic	13.81

Diagnostic Tests: Serial Correlation [0.16 (0.85)], ARCH [0.039 (0.84)], Heteroscedasticity [0.18 (0.99)] Functional Form (RAMSEY RESET) [0.12 (0.88)

VII. Policy Recommendations and Conclusion

The study examined the effect of monetary policy on agricultural output in Nigeria for the period 1970 to 2010, utilising monetary policy variables such as commercial banks credit to agricultural sector, exchange rate, lending rate and two non-policy variables, which were Government expenditure and inflation rate. As earlier stated, it is believed that monetary policy has real and nominal effect on the overall economic activities and, hence agricultural sector only in the short-run and medium–run, but has no significant effect in the long-run. The argument in this regard is that the fundamental forces that shape outcome and, hence forces that determine the behaviour of output in the agricultural sector are believed to be consequences of non-monetary conditions. Following from the above debate, the study was undertaken to examine whether monetary policy has effect on the outcomes of agricultural output in Nigeria.

The result obtained showed that monetary policy through exchange rate channel had significant positive effect on agricultural output in Nigeria. The results also showed that Government expenditure on agricultural sector had a positive and significant impact on output of agriculture in Nigeria.

To boost agricultural productivity in Nigeria, the following policy recommendations are relevant:

i There is need for the Government to continue to invest in the agricultural sector in Nigeria through its direct spending in the sector. Spending may take the form of infrastructural development, establishment of research centres, provision of farm inputs at subsidised rates, and direct provision of credits to farmers through specialised agencies.

ii There is need to maintain a sound exchange rate policy that will lead to increased agricultural output in the economy. The current exchange rate appears overvalued. The study has demonstrated that some level of depreciation should be permitted to help boost agricultural exports. However, excessive depreciation should be avoided as it can affect importation of essential farm inputs such as equipments and machineries needed by farmers.

iii Farmers should be given easy access to credit so as to boost their productivity. Commercial banks should be mandated to lend to farmers at a very low interest rate. The existing small and medium scale investment scheme fund and the microfinance arrangements should be properly managed and made functional as they can prove to be veritable sources of finance to farmers.

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Appendix

Table A1: Results from Bounds test

Dependent Variable: ΔAGOUT			
Variable	**Coefficient**	**t-Statistic**	**Probability**
CONSTANT	537508.50	61.68	0.01
CBLA(-1)	152.54	57.11	0.01
EXCH(-1)	-13519.31	-42.60	0.01
INF(-1)	-3643.73	-29.06	0.02
GXPA(-1)	-433.77	-60.16	0.01
LEN(-1)	-70092.01	-63.53	0.01
ΔAGOUT(-1)	-0.31	-14.62	0.04
ΔAGOUT(-2)	0.40	21.98	0.02
ΔAGOUT(-3)	-0.29	-12.59	0.05
ΔAGOUT(-4)	0.17	4.04	0.15
ΔCBLA	12.60	57.20	0.01
ΔCBLA(-1)	-91.78	-58.25	0.01
ΔCBLA(-2)	-94.69	-49.33	0.01
ΔCBLA(-3)	-55.25	-48.38	0.01
ΔCBLA(-4)	-223.87	-59.79	0.01
ΔEXCH	30231.68	39.35	0.01
ΔEXCH(-1)	83151.46	62.73	0.01
ΔEXCH(-2)	58118.30	51.85	0.01
ΔEXCH(-3)	38478.03	42.19	0.01
ΔEXCH(-4)	-12009.18	-12.70	0.05
ΔGXPA	-42.53	-38.14	0.01
ΔGXPA(-1)	290.12	63.74	0.01
ΔGXPA(-2)	152.65	64.98	0.01
ΔGXPA(-3)	48.29	65.12	0.01
ΔGXPA(-4)	24.59	53.78	0.01
ΔLEN	-8935.57	-38.63	0.02

ΔLEN(-1)	48776.17	62.00	0.01
ΔLEN(-2)	64992.42	63.05	0.01
ΔLEN(-3)	59336.52	69.92	0.01
ΔLEN(-4)	37615.63	63.66	0.01
ΔINF	80.01	1.69	0.33
ΔINF(-1)	3685.46	36.80	0.02
ΔINF(-2)	2737.44	40.14	0.02
Δ INF(-3)	2377.59	37.50	0.02
ΔINF(-4)	2543.94	49.93	0.01

R-squared	0.99
Adjusted R-squared	0.99
Durbin-Watson stat	2.49
F-statistic	626.52
Prob(F-statistic)	0.03

Bounds Test:	
F-statistic	1251.49
(p-value)	(0.02)
Critical bounds (1per cent)#:	
lower and upper	3.60 and 4.90
Decision:	Co-integration

#Unrestricted Intercept and Unrestricted trend (k=6) from Pesaran et al (2001).

Table A2: Error Correction Model

Dependent Variable: ΔAGOUT

Variable	**Coefficient**	**t-Statistic**	**Probability**
CONSTANT	4854.75	2.67	0.01
ΔEXCH(-4)	905.33	4.58	0.0001
ΔGXPA(-3)	1.08	5.94	0.0000
ECM(-1)	-0.009	-0.14	0.88

R-squared	0.56
Adjusted R-squared	0.52
Durbin-Watson stat	1.91
F-statistic	13.81

Diagnostic Tests: Serial Correlation [0.16 (0.85)], ARCH [0.039 (0.84)], Heteroscedasticity [0.18 (0.99)] Functional Form (RAMSEY RESET) [0.12 (0.88).

An Autoregressive Distributed Lag (ARDL) Approach to the Oil Consumption and Growth Nexus: Nigerian Evidence

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Abstract

This study attempted to examine the relationship between oil consumption, carbon emission and economic growth in Nigeria covering the period 1980-2011. The study applied Dickey-Fuller Generalised Least Square (DF-GLS) unit root test and autoregressive distributed lag (ARDL) bound test approach to co-integration. The bond test results revealed a long-run equilibrium relationship among oil consumption, carbon emission and economic growth. The result also showed a positive and statistically significant impact of oil consumption on economic growth. The coefficient of error correction term in the ARDL model was statistically significant, indicating that the adjustment process by which long-run equilibrium is restored after a shock is very fast. In conclusion, oil consumption played an important role in the economic growth of Nigeria, thus efforts to conserve oil will have a negative repercussions on economic growth. Therefore, Nigeria should endeavour to overcome the

Keywords: Oil consumption, Economic growth, ARDL, Nigeria

I. Introduction

Oil serves as one of the critical factor in promoting and sustaining economic growth. Despite Nigeria's proven reserve of crude oil of 37.2 billion barrels as at the end of 2010, the tenth largest in the world and the second largest in Africa behind Libya, the largest amount of that consumed is imported (Sambo, 2010). It is worth noting that the share of oil in total export value rose from less than 1 per cent in 1958 to a peak of 97 per cent in 1984 and has not been less than 90 per cent since then. In the first half of 1990, it accounted for over 95 per cent of total exports and its share of GDP had ranged between 25 and 30 per cent in recent years.

However, the linkage of carbon emission and growth is also closely related to the

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relationship between oil consumption and carbon emission as combating oil use will, on one hand, reduce the level of emission and on the other might affect economic growth in a negative manner (Ozturk and Uddin, 2012). With the recent rapid industrialisation, increased population and significant change in life style, the threat of global warming, climate change and environmental degradation particularly the unprecedented increase in CO_2 emissions (Nwosa, 2013) became visible. It is, therefore, important to examine the relationship among oil consumption, CO_2 emissions and economic growth by bringing out the policy implications on the economy.

Unlike the previous studies conducted on the relationship between energy consumption and economic growth in Nigeria (e.g., Ebohon, 1996: Odularo, 2008; Olusegun, 2008; Omotor, 2008; Odularo and Okonkwo, 2009; Dantama, Zakari, and Inuwa, 2012; Dantama and Inuwa, 2012; Olumuyiwa, 2012; Nwosa, 2013; and Olufemi and Olalekan, 2013), the relationship between oil consumption and economic growth has not been deeply examined.

To the best of the authors' knowledge, no study that focuses on the relationship between oil consumption and economic growth with respect to Nigeria has been carried out. Thus, the purpose of this paper is to examine the effect of oil consumption and CO_2 emissions on economic growth and to also suggest appropriate policy recommendation. The rest of the paper is organised as follows. Section 2 presents the brief literature review whereas, Section 3 discusses the nature of the data and the proposed econometric methods adopted. Section 4 presents the empirical results, while the last Section concludes the paper.

II. Literature Review and Theoretical Framework

It is worth-noting that mainstream economic theories do not explicitly specified a relationship among energy consumption, CO_2 emissions, and economic growth. A number of studies have examined the relationship between energy consumption and economic growth, between environmental pollution and economic growth and their policy implications (Tiwari, 2011). This line of research focuses on the

Environmental Kuznets Curve (EKC) or what is also termed the Carbon Kuznets Curve (CKC) hypothesis. The higher economic growth rates pursued by developing countries, the greater the consumption of an increasing quantity of commercial energy, which comes at the cost of ignoring technologies that are more efficient. Thus, there is controversy as to whether energy consumption is a stimulating factor, or is itself a result of economic growth. The increased share of CO_2 emissions in the atmosphere that is a product of the unbridled use of fossil fuels has negative impacts on natural systems (Tiwari, 2011).

However, empirical studies were conducted to examine the relationship between oil consumption, carbon emissions and economic growth. Zou and Chau (2006),Yoo (2006), Aktas and Yilmaz (2008), Bhusal (2010); and Farooq and Ullah (2011) applied Johansen maximum likelihood co-integration technique and error correction model to study the short- and long-run relationships between oil consumption and economic growth for China, Korea, Turkey, Nepal and Pakistan, respectively. The estimation results revealed a bi-directional causal short and long-run equilibrium relationship between oil consumption and economic growth. Other studies by Park and Yoo (2013), Yazdan and Hossein (2013) and Lim, Lim, and Yoo (2014) also applied the Johansen maximum likelihood co-integration test technique and Granger causality test based vector error correction model (VECM) to study causal relationship between oil consumption and economic growth for Malaysia, Iran and Philippines, respectively. The studies concluded that a long-run equilibrium relationship existed between oil consumption and economic growth. The short-run causality revealed bidirectional causality between oil consumption and economic growth. The long-run causality results further revealed bidirectional causality between oil consumption and economic growth. A similar study by Stambuli (2014) for Tanzania during the period 1972-2010 revealed a long-run equilibrium relationship between oil consumption, oil prices, and economic growth. The Granger causality test revealed a unidirectional causality running from oil consumption to oil prices, and from economic growth to oil consumption. The results therefore justified conservation hypothesis.

Using autoregressive distributed lag (ARDL) bounds test, Fuinhas and Marques (2012) examined the relationship between oil consumption and economic growth in Portugal during the period 1965-2009. The results established a long-run equilibrium relationship between oil consumption and economic growth. It further revealed bidirectional causality between oil consumption and economic growth in both the short-run and long-run.

However, on the basis of panel data, Narayan and Wong (2009) applied panel co-integration developed by Pedroni and Panel Granger causality test to identify the determinants of oil consumption for 6 Australian states and Territory over the period 1985-2006. The results showed the existence of long-run relationship among oil consumption, oil prices, and income. Further, oil prices had positive but statistically insignificant impact on oil consumption, while income had a positive and significant effect on oil consumption; meaning that 1 per cent increase in per capita income would lead to an increase in per capita oil consumption by 0.2 per cent. The causality test results suggested unidirectional causality running from income to both oil prices and oil consumption in both the short-and long-run. Similarly, Pourhosseingholi (2013) applied Pedroni panel co-integration technique, full modified ordinary least square (FMOLS) and Granger causality test based on vector error correction model (VECM) to examine the causal relationship between oil consumption and economic growth for the OPEC member countries during the period 1980-2011. The study concluded that a long-run equilibrium relationship existed between oil consumption and economic growth while the Granger causality test results presented a bi-directional causality between oil consumption and economic growth.

Al-mulali (2011) applied Engle and Granger, Kao co-integration techniques and panel Granger causality test to investigate the impact of oil consumption on economic growth for MENA countries over the period 1980-2011. The results showed that CO_2 emission and oil consumption had long-run equilibrium relationship with economic growth. Furthermore, Granger causality test results reveal bidirectional causality between oil consumption, CO_2 emission and

economic growth in both short and long-run.

Behmiri and Manso (2012) applied Engle-Granger two-stage co-integration technique and panel Granger causality tests to investigate the long-run and causal relationships between crude oil consumption and economic growth, covering the period 1976-2009 for 27 OECD countries. The results suggested the existence of long-run relationships among crude oil consumption, crude oil price and GDP proxied for economic growth. The panel Granger causality results showed two-way relationships for both short- and long-run, thereby disputing crude oil conservation hypothesis as any increase or decrease in crude oil consumption would adversely affect the economic growth of the OECD countries.

Another recent study by Chu (2012) employed Bootstrap panel Granger Causality test to study the direction of causality between oil consumption and economic growth for 49 countries over the period 1970-2010. The results were classified into growth, conservation, neutrality and feedback hypotheses. The direction of causality between oil consumption and output justified neutrality hypothesis for 24 countries, growth hypothesis for 5 countries, conservation hypothesis for 13 countries as well as feedback hypothesis for 7 countries.

However, using a cross-country study of 42 countries to compare oil consumption and economic efficiency of advanced, developing and emerging economies, Halkos and Tzeremes (2011) applied Data Envelopment Analysis (DEA) and generalised method of moments (GMM) over the period 1986-2006. The findings showed that advanced economies had much higher turning points compared to developing and emerging economies. Moreover, oil consumption increased economic efficiency for all the countries. Finally, the GMM estimates revealed the presence of an inverted U-shaped relationship between countries economic efficiency and oil consumption, with statistically significant estimates.

Ozturk and Uddin (2012) applied Johansen maximum likelihood test approach to co-integration and Granger causality based on vector error correction model

(VECM) to investigate the causal relationship between energy consumption, carbon emissions and economic growth for India during the period 1971-2007. The results showed bidirectional causality between energy consumption and economic growth. Also, there was unidirectional causality running from energy consumption to carbon emission.

III. Methodology

III.1 Data

The data used consisted of annual time series of Real Gross Domestic Product (RGDP), oil consumption and CO_2 emissions for Nigeria 1980 to 2011. The data on RGDP was obtained from the Central Bank of Nigeria Statistical Bulletin, while data on oil consumption were obtained from the International Energy Statistics and data on CO_2 emissions were obtained from World Development Indicators (2013). RGDP was used as proxy for economic growth, following the work of Zou and Chau (2006), Oil consumption was used as petroleum consumption. It was expressed as thousands of barrels per day as done by Yoo (2013) and Fuinhas and Marques (2013). A carbon dioxide emission was employed as those emissions stemming from the burning of fossil fuels and the manufacture of cement. The choice of this variable was justified as done by Lim, Lim and Yoo (2014) and Ozturk and Uddin (2012).

III.2 Unit Root Test

The ARDL bounds testing approach to co-integration can be applied irrespective of whether the variables are I(0), I(1) or fractionally co-integrated. However, in the presence of I(2) variables the computed F-statistics provided by Pesaran, Shin, and Smith (2001) become invalid. This is because the bounds test is based on the assumption that the variables should be I(0) or I(1). Therefore, the implementation of unit root tests in the ARDL procedure is necessary to ensure that none of the variables is integrated of order two i.e. I(2) or beyond. For this purpose, the study uses the conventional DF-GLS unit root tests.

III.3 Co-integration Test

Autoregressive Distributed Lag (ARDL) bounds testing approach to co-integration has been applied to examine long-run equilibrium relationship between the variables. An ARDL model is a general dynamic speci?cation, which uses the lags of the dependent variable and the lagged and contemporaneous values of the independent variables, through which the short-run and the long-run equilibrium relationship can be estimated. ARDL technique involves estimating the following unrestricted error correction model:

$$\Delta \ln RGDP_t = \alpha_0 + \alpha_1 \ln RGDP_{t-1} + \alpha_2 \ln OILC_{t-1} + \alpha_3 1nCOEM_{t-1} + \sum_{i=1}^{q} \alpha_{4i} \Delta \ln RGDP_{t-i} + \sum_{i=0}^{p} \alpha_{5i} \Delta \ln OILC_{t-i} + \sum_{i=0}^{r} \alpha_{6i} \Delta 1nCOEM_{t-i} + \mu_{t1} \quad (1)$$

$$\Delta \ln OILC_t = \beta_0 + \beta_1 \ln OILC_{t-1} + \beta_2 \ln RGDP_{t-1} + \beta_3 1nCOEM_{t-1} + \sum_{i=1}^{q} \beta_{4i} \Delta \ln OILC_{t-i} + \sum_{i=0}^{p} \beta_{5i} \Delta \ln RGDP_{t-i} + \sum_{i=0}^{r} \beta_{6i} \Delta 1nCOEM_{t-i} + \mu_{t2} \quad (2)$$

$$\Delta \ln COEM_t = \delta_0 + \delta_1 1nCOEM_{t-1} + \delta_2 \ln RGDP_{t-1} + \delta_3 \ln OILC_{t-1} + \sum_{i=0}^{q} \delta_{4i} \Delta 1nCOEM_{t-i} + \sum_{i=0}^{p} \delta_{5i} \Delta \ln RGDP_{t-i} + \sum_{i=1}^{r} \delta_{6i} \Delta \ln OILC_{t-i} + \mu_{t3} \quad (3)$$

From equation (1) through (3), ? represents the difference notation, while lnRGDP, lnOILC and lnCOEM are the natural logarithm of RGDP, oil consumption and CO_2 emissions, respectively. The null hypothesis for each of the equation is:

H_0: $a_1 = a_2 = a_3 = 0$, H_1: $a_1 \neq a_2 \neq a_3 \neq 0$

H_0: $\beta_1 = \beta_2 = \beta_3 = 0$ H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq 0$

H_0: $\delta_1 = \delta_2 = \delta_3 = 0$ $H_1 \neq \delta_1 \neq \delta_2 \neq \delta_3 \neq 0$

From Eqs. (1)–(3), the F-test can be used to examine whether a long-run equilibrium relationship exists between the variables or not, by testing the signi?cance of the

lagged level variable. The computed F-statistics for co-integration are denoted as F_{RGDP}(RGDP/OILC,COEM), F_{OILC}(OILC/RGDP,CEOM), and F_{CEOM}(COEM/RGDP OILC)for each equation, respectively. Pesaran, Shin and Smith (2001) tabulated two sets of critical values. The ?rst set of critical values is called lower-bounds critical values, and the second set of critical values is known as upper bounds critical values. According to Pesaran, Shin, and Smith (2001), the null hypothesis of no co-integration is rejected if the calculated F-statistic is more than the upper-bound critical values. On the other hand, if the calculated F-statistic is less than the lower-bound critical values, we cannot reject the null hypothesis, and hence the variables are not co-integrated. Finally, the decision about co-integration is inconclusive if the calculated F-statistic falls between the lower and upper-bound critical values.

IV. Empirical Results

This section consists preliminary analyses (where results of the of unit root tests and co-integration tests are presented and discussed); estimation results (where the regression results are presented and discussed); and post-estimation analysis (where the model diagnostics are presented and discussed).

IV.1 Preliminary Analyses

The results of the unit root test are presented in Table 1. The DF-GLS test results indicate that all the variables; i.e. RGDP, oil consumption, and CO_2 emissions, are stationary after first differencing. Thus, the necessary condition for the application of the bounds test is justified.

Table 1 Unit Root Tests

Variable	DF-GLS test at Level	DF-GLS at first Difference
RGDP	-0.225930	-2.246696**
OILC	-1.362379	-4.487645***
COEM	-1.276135	-4.933902***

***Source*:** authors' computations ***and** indicates level of significance at 1per cent and 5per cent

IV.2 Estimation Results

The results of the bounds test approach to co-integration are reported in Table 2. The bounds test indicated that co-integration was only present when RGDP was the dependent variable. This was because F_{RGDP} (RGDP/OILC, COEM) was 6.1294 higher than the upper bound critical value at the 5per cent critical value. However, the bounds test indicated that the test was inclusive when OILC was taken as dependent variable because F_{OILC} (OILC/RGDP, COEM) fell within the lower and upper bound critical value. As for COEM as dependent variable, the F_{COEM}(COEM/RGDP, OILC,) was lower than the lower bound critical value at the 5 per cent level. Therefore, there was co-integration when Real GDP was treated as the dependent variable.

Table 2: Bounds Test Results

F-Statistic	Critical Values at 5per cent	Lower bound	Upper bound
F_{RGDP} (RGDP/OILC,COEM)	=6.1294	2.9666	4.2347
F_{OILC} (OILC/RGDP,COEM)	=4.0594		
F_{COEM} (COEM/RGDP,OILC)	=1.0528		

Source: authors' computations.

The results of the estimated long-run coefficients were presented in Table 3. The estimated coefficients of the long-run relationship showed that oil consumption has a positive and significant impact on real GDP; a proxy for economic growth. Therefore, a unit increase in oil consumption led to approximately 1.98 unit increase in real GDP in Nigeria. However, the coefficient of CO_2 emissions was not significant.

Table 3: Results of Estimated Long-run Coefficients

Regressor	Coefficient	Standard error	T-ratio [p-value]
Dependent variable; RGDP			
OILC	1.9784	.011481	172.3301[.000]
COEM	-.22164	.21095	-1.0507[.303]

Source: authors' computations.

The results of the short-run dynamic coefficients associated with the long-run relationship obtained from the ECM equation were reported in Table 4. The sign of the short-run dynamic impact was maintained to the long-run. The error correction coefficient estimated at -0.12832 (0.002) was highly significant; it had the correct sign and implied a high speed of adjustment to equilibrium after a shock. Approximately 12.8 per cent of disequilibria from the previous year's shock was restored in the current year.

Table 4: Error Correction Representation for the Selected ARDL Model

Regressor	Coefficient	Standard error	T-ratio [p-value]
Dependent variable:			
?RGDP			
?OILC	.25388	.073960	3.4326 [.002]
?CEOM	-.028441	.024283	-1.1713[.252]
ECM (-1)	-.12832	.037532	-3.4190[.002]

Source: authors' computations.

IV.3 Post-estimation Analysis

Table 5 presented diagnostics test of the estimated ARDL model. The model passed all diagnostic tests. There was no evidence of serial correlation and the model was well specified, based on their probability values. Similarly, the battery of diagnostic tests for heteroscedasticity and normality of the residuals, did not find any signi?cant evidence of departures from standard assumptions.

Table 5: Diagnostics Test

Test Statistics	LM test
Serial Correlation	CHSQ(1) =1.8068[.179]
Functional Form	CHSQ(1) =0.021169[.884]
Normality	CHSQ(2) =0 .80823[.668]
Heteroscedasticity	CHSQ(1) =0 .89441[.344]

Source: authors' computation.

V. Conclusion

This study examined the relationship among oil consumption, CO_2 emissions, and economic growth in Nigeria during the period 1980–2011 using autoregressive distributed lag (ARDL) bounds testing approach to co-integration. Empirical results showed that there was long-run equilibrium relationship among oil consumption, CO_2 emissions, and economic growth. Also, oil consumption had positive and statistically significant impact on economic growth. Furthermore, the coefficient of error correction term in the ARDL model was statistically significant and was correctly signed.

Thus, oil consumption could be considered as one of the leading determinants of economic growth in the short-run as well as in the long-run. The basic premise for this may be that the enormous use of oil, mostly in the industry sector, had directly pushed the economy. Therefore, policy makers in Nigeria should take into account that implementing oil conservation policies will affect economic growth negatively since it has been found to have positive impact on economic growth.

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