Journal of Economics and International Finance Vol. 2(12), pp. 261-271, November 2010
Available online at http://www.academicjournals.org/JEIF ISSN 2006-9812

Full length research

Determinants of interest rates in Nigeria: An error correction model

Abayomi Toyin Onanuga[1] and Adebayo M. Shittu[2]*

[1]Department of Accounting, Banking and Finance Olabisi Onabanjo University, P.M.B. 2002, Ago-Iwoye, Ogun State, Nigeria.
[2]Department of Agricultural Economics and Farm Management, University of Agriculture, Abeokuta, Ogun State, Nigeria.

Accepted 28 September, 2010

This paper analyzes the determinants of interest rate in Nigeria within the framework of a Vector Error Correction Model (VECM), using quarterly data between first quarter of 2000 and last quarter of 2008. The study found that the Treasury Bill Rates (TBR) in Nigeria and its hypothesized determinants are generally I (1) series, with two cointegrating equations existing among their linear combinations. Results based on normalisation of the restricted VAR system in respect of the TBR and real GDP revealed that Real money supply (RMS) and Expected Foreign Returns (EFR) exerts significant ($p<0.01$) long-run influence on both the TBR and domestic outputs. The equilibrium relationship was found to be stable, with exogenous shocks due to TBR being corrected within 92 days, while those due to real output are corrected within 4-days. In general, rising domestic outputs and past quarters' TBR leads to significant increases in current TBR in Nigeria, while increase in past quarters' RMS cause current TBR in Nigeria to decline. Overall, real GDP accounts for as much as 37.4% of the variation in TBR after 5 quarters (15 months), while RMS and EFR accounted for 8.41 and 4.48% of variation in TBR in the same period.

Key words: Interest rate determination, vector error correction model, Nigeria.

INTRODUCTION

Prior to 1993, a regime of direct control of interest rates was adopted in Nigeria, most especially between 1974 and 1992. In this period, interest rate policy was driven by considerations of promoting overall investment and channelling credit to identified priority sectors (Nnana, 2001). However, many policy analysts contended that this practice promotes inefficiency and corruption in the system, as credit funds accessed for use in the priority sectors are often diverted to other sectors rendering the policy objective ineffective. Moreover, fixing interest rates in a regime where inflation rates are high and volatile, is more or less providing dis-incentives for investments. It was against this background, that a new policy framework focused at the deregulation of interest rates, the year 1993, interest rate was very volatile and unduly high, to the extent that Monetary Policy Rate (MPR) was was adopted towards the tail end of 1992. However, in 26%, Treasury Bill Rate (TBR) stood at 26.80%, while other savings rates float between 28.2 - 23.6%: the highest rates in the period 1970 to 2008. In 1994, due to the high volatility of interest rates, government decided to fix the MPR at 13.5%, TBR 12.5% and other savings rates reacted to this shock as they declined to a range of between 13 and 14.27% from their 1993 position (CBN 1994). The cap on interest rate adopted in 1994 was lifted in October 1996 and a flexible interest rate regime largely determined by the forces of supply and demand for funds was put in place and this has remained so, since late 1990s to date (CBN 2007). However, the problem has been that the market-based approach to interest rate management in Nigeria, has always been associated with substantial interest rate volatility (CBN 2006), calling to question the overall desirability of the

*Corresponding author. E-mail: amshittu@yahoo.com. Tel: +2348058871650.

JEL, E43, C52.

strategy. A considerable number of studies (Omole and Falokun, 1999; Ojo, 2000; Nnanna, 2002; Adebiyi and Babatope-Obasa, 2004; Olakah and Oyaromade, 2007) have examined the problem and have identified domestic factors such as inflation, growth in equity and exchange rates as key factors explaining interest rate variability in Nigeria. However, most of these studies were largely descriptive, while those that employed econometric techniques did not take into consideration statistical properties of the series, as they relate to stationarity of the individual series and cointegration among linear combinations of the series, before applying the least square techniques in estimating their models. However, the problem has been that Nelson and Plosser (1982) and many other recent studies, have shown that most economic series are not stationary, while Granger and Newbold (1974) had earlier reported that application of least square regression to equations containing non-stationary series results in spurious regression. They emphasised further that while coefficient estimates from such model may appear to be of correct signs and magnitudes, deeper investigations often reveal flaws; meaning that standard inference procedures do not apply to regression models that contain non-stationary series.

Evidence from studies of interest rate determination in other climes, also suggests the need to examine the influence of external factors such as interest rates in other countries and the degree of openness of an increasingly deregulated economy like Nigeria. For example, Edwards and Khan (1995) in a study of the behaviour of nominal interest rates in a small semi-open economy (Columbia), found evidence that the differentials between domestic nominal interest rates and world interest rates plus expected devaluation would lead to higher domestic rate of interest. They also reported that excess supply of real money exerted significant negative pressure on nominal interest rates. On his own, Gochoco (1991) reported that the relative importance of domestic versus external factors in determining domestic nominal interest rate depends on the degree of openness of the capital account. He noted that when capital flows are totally unrestricted, the domestic interest rate would be determined by the external factors via the uncovered interest parity relationship. If however, the capital account were completely closed, the domestic interest rate would be determined predominantly by domestic conditions via the Fisher effect. It is against the above background that this study, in a departure from other studies in Nigeria, is examining the influence of both domestic and external factors on interest rates movement in Nigeria within the framework of Vector Error Correction Modelling (VECM). The starting point of the analyses is the examination of the statistical properties of the quarterly time series of the nominal interest rate in Nigeria and its hypothesized determinant. This revealed the series are generally I(1) series and are cointegrated. VECM was then used to analyze both the short-run and long-run relations among the series, while the associated variance decomposition were respectively used to analyze the adjustment mechanisms of the series to exogenous shocks to the long-run relations and the relative importance of the hypothesized determinants in influencing interest rate movements in Nigeria. The rest of the paper is organized as follows, the theoretical foundation, the vector error correction model, the data and their sources and model estimation, as well as diagnostic techniques. Subsequently, the results and discussion is followed by the summary and conclusions.

Theoretical framework

The theoretical framework for this study is adapted from (Patnaik and Vasudevan, 1998), which tries to factor the degree of openness of an economy in the analysis of the influence of both internal and external factors on interest rate movements in a semi-open economy like Nigeria. Suppose we have a closed economy, in which there is no inflow or outflow of capital and the demand for money is the demand for real money. In such an economy, money is held by the economic units purely to finance transactions and increase the demand for money with real output. However, it is worthy of note, that holding money has an opportunity cost that is measured by the nominal rate of interest, with higher interest rates discouraging the holding of wealth in the form of money.

If M is assumed to be the nominal stock of money and P is the price level, real money demand is defined as M/P, which is a function of the interest rate, i and the output, Y. Short run equilibrium in the money market exists, when the demand for money is equal to the supply of money. Assuming the elasticity of money demand with respect to domestic outputs is constant; we may specify a log-linear form of the money demand function in any period t in a closed economy as:

$$\ln M_t^d = \ln\left[\frac{M_t}{P_t}\right] = \alpha_0 + \alpha_1 \ln Y_t - \alpha_2 i_t \qquad 1$$

At equilibrium, the demand for real money is equal to the supply of money ($M_t^s = M_t / P_t$), which is assumed to be policy determined and therefore exogenous. In the closed economy case therefore, equilibrium in the money market exists when:

$$\ln\left[\frac{M_t}{P_t}\right] = \alpha_0 + \alpha_1 \ln Y_t - \alpha_2 i_t \ldots \qquad 2$$

Or

$$i_t = \frac{\alpha_0}{\alpha_2} + \frac{\alpha_1}{\alpha_2} \ln Y_t - \frac{1}{\alpha_2} \ln \frac{M_t}{P_t} \qquad 3$$

For an open economy that is completely open to the rest of the world, the domestic and foreign interest rates will be closely linked and the following uncovered interest rate arbitrage condition will hold as postulated by Gupta and Gupta (1997):

$$i_t = i_t^* + e_t^e \quad 4$$

where i_t^* is the world interest rate for a financial asset with the same characteristics as the domestic instrument and e_t^e is the expected rate of change of the domestic exchange rate. Equation 4 will capture both the short and long run, when there are no impediments on capital movements.

If we assume that the degree of openness can be measured by ψ as we combine the closed and open economy extremes and that the nominal interest rate, is a weighted average of the two cases, the case in a mixed economy can be represented as follows:

$$i_t = (1-\psi)\left[\frac{\alpha_0}{\alpha_2} + \frac{\alpha_1}{\alpha_2}\ln Y_t - \frac{1}{\alpha_2}\ln\frac{M_t}{P_t}\right] + \psi\left(i_t^* + e_t^{.e}\right). \quad 5$$

This leads us to a reduced form equation for nominal interest rate in a semi-open economy, which can be presented as follows:

$$i_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln\frac{M_t}{P_t} + \beta_3\left(i_t^* + e_t^{.e}\right) \quad 6$$

Where:

$$\beta_0 = (1-\psi)\frac{\alpha_0}{\alpha_2}$$

$$\beta_1 = (1-\psi)\frac{\alpha_1}{\alpha_2}$$

$$\beta_2 = (1-\psi)\frac{1}{\alpha_2}$$

$$\beta_3 = \psi$$

Equation (6) defines the long run relationship between interest rate, output, real money supply and the domestic equivalent of foreign returns and is the theoretical model that underlies analyses undertaken in this study.

$$TBR_t = \beta_0 + \beta_1 \ln RGDP_t + \beta_2 \ln RMS_t + \beta_3 EFR_t + \varepsilon_t \quad \ldots 7$$

where: TBR_t is the average market interest rates in Nigeria in quarter t, measured by the Treasury Bill Rate; lnRGDP is the natural logarithm of the real GDP in Nigeria, as measure of the domestic outputs; lnRMSis the natural logarithm of the Real Money Supply (RMS) in Nigeria, measured as the broad money supply (M2) deflated by the composite CPI; EFR is the expected foreign return estimated by adding the US 3-month TBR and rate of depreciation of the Naira exchange rate (N/US$) in the corresponding quarters; β_i i=0, 1, 2 and 3, are the parameters of the longrun model, while ε_t is the stochastic residual term.

METHODOLOGY

Study data and sources

This study is based on secondary data obtained principally from two sources: the 2009 edition of the International Monetary Fund (IMF) - International Financial Statistics CD-ROM (IMF, 2009) and 2008 edition of Central Bank of Nigeria (CBN) - Statistical Bulletin (CBN, 2008). The data consists of the quarterly time series of Nigeria's Treasury Bill Rates (TBR), composite Consumer Price Index (CPI), principal exchange rates (N/US$) and the United State (US) 3-month Treasury bill rates, all of which were extracted from IMF (2009) for the period: 2000:Q1 – 2008:Q4. Other data include the quarterly time series of Nigeria's real Gross Domestic Product (GDP) obtained also for the period 2000:Q1 – 2008:Q4 from CBN (2008), because these were not available on IMF (2009), which only supplied annual GDP figures for Nigeria. The data set was also restricted to the period: 2000:Q1 – 2008:Q4, because this was the period for which complete data set for the analysis could be obtained.

Model specification

Following the theoretical framework presented earlier, the economic model for this study is specified as follows:

$$TBR_t = \beta_0 + \beta_1 \ln RGDP_t + \beta_2 \ln RMS_t + \beta_3 EFR_t + \varepsilon_t \quad 7$$

Where:

TBR_t is the average market interest rates in Nigeria in quarter t, measured by the Treasury Bill Rate; lnRGDP is the natural logarithm of the real GDP in Nigeria, as a measure of the domestic outputs; lnRMS is the natural logarithm of the Real Money Supply (RMS) in Nigeria, measured as the broad money supply (M2) deflated by the composite CPI; EFR is the expected foreign return estimated by adding the US 3-month TBR and rate of depreciation of the Naira exchange rate (N/US$) in the corresponding quarters; β_i i=0, 1, 2 and 3, are the parameters of the long-run model, while ε_t is the stochastic residual term.

Considering evidence in literature, which suggests that most economic series tend to be non-stationary (Nelson and Plosser, 1982), a violation of a major presumption in the application of the classical least square regression analysis, that often results in spurious results (Granger and Newbold, 1974; Arize et al., 2000), estimation of the economic model in equation 7, was preceded by examination of the statistical properties of the series, including tests

of stationarity of the individual series and test of cointegration among the series in the economic model.

Tests for stationarity

The test for stationarity of the individual series in the economic model was undertaken using the augmented Dickey-Fuller (ADF) and Phillips-Perron unit root tests procedure in E-Views version 6. In the ADF tests, suppose Y_t is the test series (which could be the level or first difference of the economic series whose stationarity is being examined), the form of ADF test procedure adopted was a test for significance of the coefficient associated with the lagged value of the test series (Y_{t-1}) in the following ADF regression:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \quad (8)$$

where ε_t for t = 1, …., N is assumed to be Gaussian white noise.

The number of lagged term p, was set to be chosen automatically by E-View software to ensure the errors are uncorrelated. The test series is said to be non-stationary, if the ADF test revealed the Null Hypothesis that $\alpha_1 = 0$ could not be rejected against an alternative that $\alpha_1 < 0$, and stationary if otherwise. Economic series are said to be integrated of order d, denoted as I(d), where the order of integration is the number of unit roots contained in the series or the number of differencing operations it takes to make the series stationary.

Following evidence in this study, which revealed that the series in the economic model are general I(1) series, it became obvious that least square technique would not be appropriate for the estimation of the economic model. Thus, bearing in mind the need to accommodate the interdependence of relationships between most economic variables, the economic model was re-conceptualized as a vector auto-regressive system (9), allowing for the possibility of cointegration among the endogenous variables.

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + Bx_t + e_t \quad (9)$$

where: x is vector of deterministic variables, constant (C) and/or trend; y is vector of I(1) endogenous variables including TBR, lnRGDP, lnRMS and EFR; B, Γ and Π are matrices of coefficients to be estimated, while
e is vector of stochastic residuals.

Terms in B give the influence of the associated deterministic variables, while Γ, represent short-term elasticities of response. By Granger's representation theorem, if the coefficient matrix Π in (9) has reduced rank r<k (k=4 in this case), which implies that r distinct linearly dependent associations of endogenous variables in y_t exists, then there exist k x r matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is stationary (E-Views, 2007). In this case, r is the number of cointegrating relations (the rank), while each column of β is the cointegrating vector. The element of α are the adjustment parameters in the vector error correction model.

Co-integration test

The next stage in the examination of statistical properties of the series was a test for cointegration among the endogenous variables in the VAR system in equation 9. This was implemented in E-Views using procedures from Johansen (1992, 1995) system based techniques. In testing for the number of cointegrating vectors among economic time series, Johansen's (1992, 1995) system approach is to estimate the Π matrix in an unrestricted form, and then test whether we can reject the restrictions implied by the reduced rank of Π (E-Views, 2007). The software provides procedures for conducting both a maximum Eigen value and trace statistic based co integration tests, which were used in this study.

However, in implementing the Johansen technique, two main issues had to be addressed. The first is the choice of the optimal lag length in the VAR system, while the second relates to how deterministic variables such as constant and trend should enter into the VAR system. Noting that the lag length ought to be set long enough to ensure that the residuals are white noise (E-Views, 2007) and considering that the study was based on quarterly data, the first issue was resolved by first estimating a VAR with four lags.

The lag structure of the estimated VAR was then examined using a combination of VAR lag order selection criteria and checking that the inverse roots of the characteristic polynomial lie within a unit circle, which is a condition for having a stable VAR system. This process led to the choice of four lags, which was used in the cointegration test and subsequent analyses.

The second issue was resolved by the application of the so called Pantula principle (Johansen, 1992; Pantula, et al., 1994… which requires trial of various possible ways of incorporating deterministic terms I n the model, s tarting from t he least restrictive which allows no deterministic component) to the most restrictive (which allows intercept and trend in the cointegrating equation and linear trend in the VAR) and selecting the least restrictive option among those characterized with the smallest number of cointegrating equations, if more than one. This was undertaken by examining the implied number of cointegrating equations for t he five candidate specifications in the results generated by running the E-Views Johansen cointegration test summary option.

The final VEC model and variance decomposition

On the basis of evidence from various diagnostic and specification tests, the final specification of the statistical model in Equation 9 was finally estimated as a Vector Error Correction (VEC) model, with one CE imposed, up to three lags allowed for each of the endogenous variables in the VAR and with constant (no trend) allowed in the CE and no constant in the VAR. This final specification, served as the basis for assessing the influence of domestic outputs and money supply as well as expected foreign returns on both the short and long run variation of interest rates (represented by the TBR) in Nigeria. The relative importance of the variables in impacting interest rate movements in Nigeria was also assessed by variance decomposition analysis.

RESULTS AND DISCUSSION

Trends in interest rates

As a background to this study, the trends in domestic interest rate and the expected returns to foreign investments in Nigeria were analyzed. The results are summarized in Figure 1, while descriptive statistics of the various indicators are presented in Table 1. The study finds that the Treasury Bill Rates (TBR) in Nigeria, were generally higher and much volatile (in absolute terms)

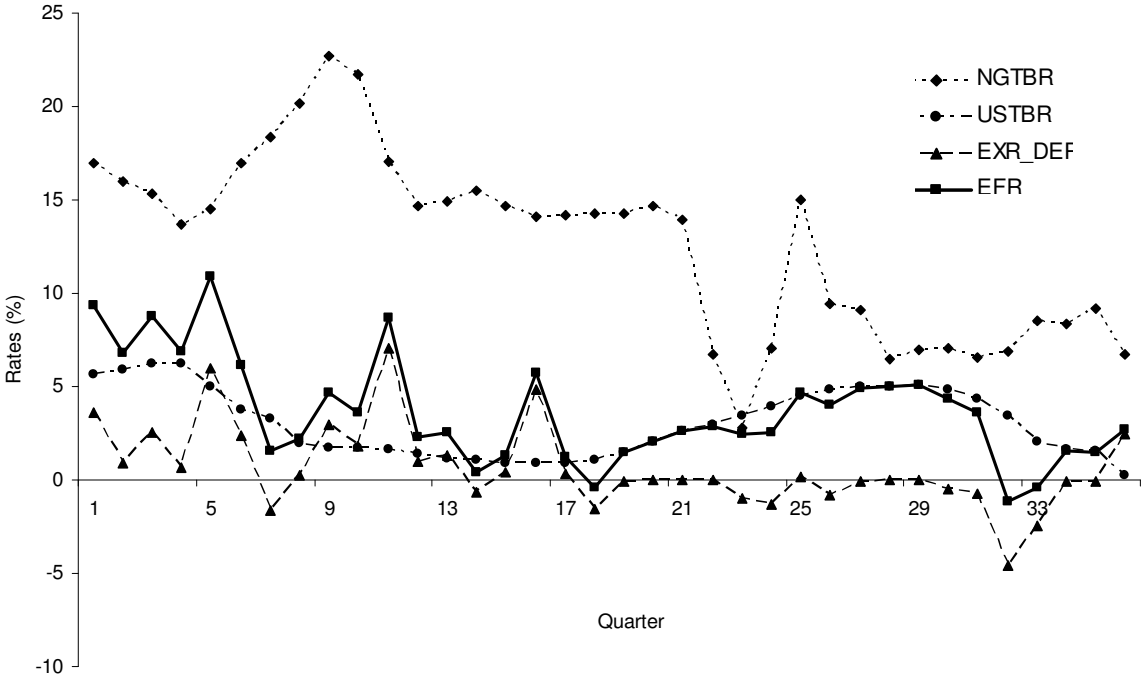

Figure 1. Trends in treasury bill rates and expected foreign returns in2000:Q1 – 2008:Q4.

Table 1. Descriptive statistics of interest rates and EFR in Nigeria.

Period	Statistic	NIG-TBR	US-TBR	EXR-DEP	EFR
	Minimum	13.67	0.93	-1.67	-0.44
	Maximum	22.70	6.22	7.01	10.94
2000 - 2004	Mean	16.23	2.70	1.61	4.31
	Std. Error of Mean	0.59	0.44	0.52	0.75
	Std. Deviation	2.62	1.98	2.33	3.36
	Minimum	2.78	0.24	-4.62	-1.16
	Maximum	14.99	5.11	2.44	5.07
2005 - 2008	Mean	8.17	3.47	-0.58	2.89
	Std. Error of Mean	0.73	0.38	0.37	0.46
	Std. Deviation	2.92	1.51	1.47	1.86
	Minimum	2.78	0.24	-4.62	-1.16
	Maximum	22.70	6.22	7.01	10.94
2000 - 2008	Mean	12.65	3.04	0.63	3.68
	Std. Error of Mean	0.81	0.30	0.38	0.48
	Std. Deviation	4.89	1.80	2.26	2.85

As shown in Figure 1, the gaps between the two interest rates were, until much recent times, generally being closed over time with the Nigeria TBR falling from as high as 22.71% in the second quarter 2002 to as low as 2.78% in the second quarter of 2005, while the US 3-month TBR rose steadily from 0.93% in the last quarter of 2003 to 5.11% in the first quarter of 2007. The average TBR in Nigeria, which was 16.23% in 2000-2004, fell to 8.17% in 2005 to 2008, while the US 3-month TBR rose from 2.70 to 3.47% in the corresponding periods.

than the US 3-month TBR and therefore the Expected Foreign Returns (EFR), which was measured as the sum of the US 3-month TBR and expected percentage depreciation of Nigeria's exchange rates (N/US$) in the

Table 2. Results of ADF unit root test.

Variable	ADF statistics		Phillips-Perron statistics		Remark
	Test at Level	Test at first difference	Test at Level	Test at first difference	
TBR	-1.54	-4.93**	-1.39	-7.07**	1(1)
LNRGDP	-2.53	-8.23**	-2.76	-9.54**	1(1)
LNRMS	-1.47	-5.01**	1.35	-4.67**	1(1)
EFR	-3.46*	-7.78**	-3.38*	-16.46**	1(0)
Critical values					
1%	-3.63	-3.64	-3.63	-3.64	
5%	-2.95	-2.95	-2.95	-2.95	

** and * imply significance at 1 and 5% levels respectively.

corresponding quarters. The mean TBR (±Standard Error of Mean) in Nigeria over the 2000:Q1 to 2008:Q4 period was 12.65 ± 0.81% as against the US 3-month TBR and the EFR, which were respectively 3.04 ± 0.3 and 3.68 ± 0.48%.

As shown in Figure 1, the gaps between the two interest rates were until much recent times, generally being closed over time with the Nigeria TBR, falling from as high as 22.71% in the second quarter of 2002, to as low as 2.78% in the second quarter of 2005, while the US 3-month TBR rose steadily from 0.93% in the last quarter of 2003 to 5.11% in the first quarter of 2007. The average TBR in Nigeria, which was 16.23% in 2000 to 2004, fell to 8.17% in 2005 to 2008, while the US 3-month TBR rose from 2.70 to 3.47% in the corresponding periods.

Statistical properties of the economic series

Results of unit root tests

As a pre-condition for estimation of the model describing the relationship between domestic interest rates (TBR) in Nigeria and its determinants, Augmented Dickey Fuller (ADF) and Phillips-Perron tests were conducted to verify stationarity (or presence of Unit roots) in the individual series of the model. The results are summarised in Table 2.

As shown in Table 2, the series in the economic model are generally I(1) series, given that they are all non-stationary in their levels, but stationary in their first difference for ADF tests at 1% level of significance. It thus implies that their inclusion in classical least square regressions is most likely going to produce spurious results (Granger and Newbold, 1974). Thus, the economic model that describes the relationship between TBR in Nigeria and its determinants was re-specified as a VAR, as earlier defined in Equation 9.

Optimal lag length in the VAR

A major requirement in conducting Johansen (1992, 1995) co integration tests and estimation of a VAR system, either in its unrestricted or restricted Vector Error Correction (VEC) forms, is the choice of an optimal lag length. In this study, this choice was made by examining the lag structure in an unrestricted VAR originally specified with four lags, using a combination of VAR lag order selection criteria and examination of the roots of the characteristic polynomial to verify if the VAR is stable.
Table 3 presents the evidence based on the VAR Lag Order Selection Criteria, while Figure 2 presents the inverse roots of the AR characteristic polynomial associated with the different lag orders specified by the selection criteria.

As shown in Table 3, while the LR, SC and HQ criteria suggests the use of one lag, the FPE criterion suggests the use of 3 lags while the AIC criterion suggests that four lags should be accommodated in the VAR. Examination of the inverse roots of the AR characteristic within the unit circle for the VAR specification involving four lags. This shows that the VAR in Equation 9 will be unstable if only one or three lags is/are accommodated. Thus, subsequent analyses were based on VAR with four lags.

Deterministic specification and co integration test

Having selected the optimal lag length for the VAR system, the choice of how deterministic terms, constant and trend, should be accommodated in the candidate Vector Error Correction (VEC) model, which had to be made before the Johansen (1992, 1995) system based co-integration test could be performed, was made by application of the Pantula principle (Johansen, 1992). This entailed selection of the least restrictive specification among those specifications having the lowest number of co-integrating equations (CE), if more than one. The summary statistics of the number of CE in all the five possible specifications are presented in Table 4.

As shown in Table 4, application of the Pantula principle would suggest that the co-integration test should be conducted under the assumption of having linear data trend in the series and thus allowing constant (non trend) in the CE and test VAR if the choice is based on Trace test, while the maximum eigenvalue test suggests the

Table 3. Results of VAR lag order selection criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-146.2440	NA	0.140692	9.390248	9.573465	9.450979
1	-70.80121	127.3096*	0.003461	5.675076	6.591161*	5.978732*
2	-52.58852	26.18074	0.003175	5.536783	7.185736	6.083364
3	-33.67409	22.46089	0.003034*	5.354630	7.736451	6.144137
4	-13.74105	18.68722	0.003159	5.108816*	8.223504	6.141247

* indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.

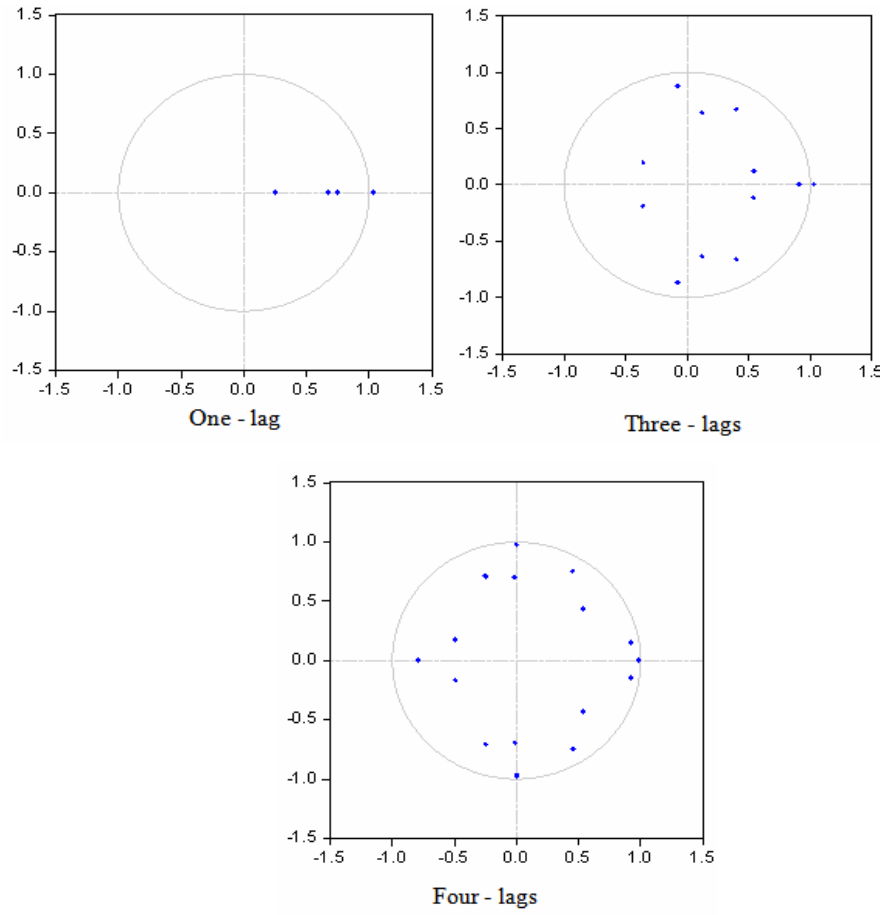

Figure 2. Inverse roots of AR characteristic polynomials associated with VAR systems with different lag structures.

choice of a model having neither constant nor trend in both the CE and VAR. Considering however, that it is very much uncommon for economic series not to be characterised by some deterministic trend (Arise et al., 2000) and the evidence in Figure 1, which suggests a linear trend exists in the study data, the former specification, as implied by Trace test was adopted in the study. The detailed cointegration result is presented in Table 5. As shown in Table 5, the null hypothesis of no co-integration is rejected by both the Trace test and maximum Eigen value test. However, while Trace test revealed that, two CE exists among linear combinations of the TBR in Nigeria and its hypothesized determinants for tests at 5% level of significance, the maximum Eigen value test suggests only one CE exists at that level, even though it would also provide a weak evidence of two CE (p=0.0889), if the test was conducted at 10% level of significance.

Table 4. Summary of co-integration results by deterministic specifications.

Data Trend	None	None	Linear	Linear	Quadratic
Test type	No intercept No trend	Intercept No trend	Intercept No trend	Intercept Trend	Intercept Trend
Trace	3	3	2	2	2
Max-Eig	1	1	1	2	2

Table 5. Results of co-integration tests.

Hypothesized no. of co-integrating equations (CE)	Trace test		Max-Eigen value test	
	Trace statistic	Critical value (p<0.05)	Max-Eigen statistic	Critical value (p<0.05)
None	96.79317*	47.85613	65.53415*	27.58434
At most 1	31.25902*	29.79707	19.28516	21.13162
At most 2	11.97386	15.49471	10.53143	14.26460
At most 3	1.442426	3.841466	1.442426	3.841466

* implies statistic is significant at p<0.05.

The main implication of the foregoing is that even though the TBR in Nigeria and its hypothesised determi-nants are generally I(1) series, some stable long-run equilibrium relationship exists among the series, which could be given some error correction representations (Engle and Granger, 1987). It also shows that the finding of no causality in the relationship between them (in the Granger[1], 1969 sense) is ruled out (Granger, 1986 and 1989); just as the possibility of the estimated relationship being spurious is also ruled out (Masih and Masih, 1998).

The estimated long-run relationship (t-ratio in parentheses), based on normalisation in respect of TBR and domestic output, may be written as:

$$TBR_t = 161.73 - \underset{(-2.75)}{10.28}\ln RMS_{t-1} - \underset{(-2.97)}{1.10}\, EFR_{t-1}$$
$$\ln RGDP_t = 1.01 + \underset{(7.21)}{0.75}\ln RMS_{t-1} + \underset{(3.50)}{0.04}\, EFR_{t-1} \quad (10)$$

The estimated co-integrating Equations in (10), reveals that real money supply and expected foreign returns exert significant (p<0.01) but opposite influence on both the TBR and domestic outputs. One percent increase in RMS and EFR was revealed as causing TBR to decline by 10.28 and 1.10% respectively in the long-run, while causing domestic output to increase by 0.75 and 0.04% respectively. There are at least two major policy implica-tions of the above findings. The first relates to the evidence that RMS and EFR exert significant and negative long-run influence on TBR. This shows that, measures that seek to stimulate private investment in domestic treasury bills, by promoting higher interest rates, would have to be accompanied by measures aimed at lowering RMS and EFR in the country. In other words, there would be a need to keep the rate of increase in domestic money supply within the rate of increase in the real sector output, if government seeks to stimulate investment in its treasury bills. Considering also that most of the variations in EFR in Nigeria were due to the depreciation of Naira relative to the US Dollar. Thus, it implies that measures that weaken the Naira exchange rate relative to the US$, tends to cause domestic interest rate in Nigeria to fall, while enhancing domestic outputs in the long-run.

The second policy implication of the evidence in the study is that, government policies that seek to increase the TBR (through manipulation of the RMS and EFR), in a bid to stimulate investments in government's treasury bills is at conflict with the larger economic development goal of raising domestic outputs and income. It thus implies that governments in Nigeria need to exercise some caution in the use of treasury bills to mobilize short-term funds for their fiscal activities. The overall policy implication of these results is that, the performance of the domestic economy is better enhanced in the long-run, when government's monetary and exchange rate policies are targeted at enhancing RMS, promoting reasonable depreciation of Naira relative to other foreign currencies and in the process, lowering the TBR in Nigeria.

RESULTS

VECM results

Table 6 presents the short-run components of the

Granger approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. Thus y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently, if the coefficients of the lagged x's are statistically significant (Eviews, 2007).

Table 6. Estimated vector error correction model.

Error correction	D(TBR)	D(LNRGDP)	D(LNRMS)	D(EFR)
ecm1(-1)	-0.977025 (-3.12074)	0.008865 (1.04934)	-0.016959(-0.89591)	0.240690 (0.60110)
ecm2(-1)	-21.30276 (-3.03673)	0.037969 (0.20059)	-0.082241(-0.19390)	16.62504 (1.85297)
D(TBR(-1))	0.633566 (2.37033)	-0.007506 (-1.04075)	0.027965 (1.73039)	0.044918 (0.13139)
D(TBR(-2))	0.045135(0.15529)	0.000297 (0.03790)	0.014476 (0.82374)	0.109690 (0.29507)
D(TBR(-3))	0.115893 (0.54680)	-0.001724 (-0.30148)	0.004078 (0.31824)	0.084289 (0.31094)
D(TBR(-4))	0.048865 (0.23331)	0.002781 (0.49206)	0.011916 (0.94104)	0.085166 (0.31794)
D(LNRGDP(-1))	46.93288 (3.75553)	-0.869202 (-2.57760)	0.974169 (1.28927)	-11.35606 (-0.71049)
D(LNRGDP(-2))	27.86402 (1.81590)	-0.857226 (-2.07035)	0.679654 (0.73257)	-6.572768 (-0.33491)
D(LNRGDP(-3))	30.04508 (2.45903)	-0.771916 (-2.34133)	0.817469 (1.10656)	-4.484751 (-0.28699)
D(LNRGDP(-4))	12.25327 (0.94416)	0.016057 (0.04585)	0.606751 (0.77325)	0.419310 (0.02526)
D(LNRMS(-1))	-11.77648 (-2.36355)	-0.079366 (-0.59032)	0.429864 (1.42690)	0.963836 (0.15125)
D(LNRMS(-2))	-4.376622 (-0.69786)	-0.134448 (-0.79449)	-0.263002 (-0.69359)	17.39061 (2.16811)
D(LNRMS(-3))	-13.60059 (-2.52634)	0.015290 (0.10526)	0.228807 (0.70294)	1.044862 (0.15175)
D(LNRMS(-4))	-0.485682 (-0.07325)	-0.216229 (-1.20859)	0.027334 (0.06818)	15.97899 (1.88430)
D(EFR(-1))	0.014079 (0.07532)	-0.002260 (-0.44811)	0.001706 (0.15099)	-0.328819 (-1.37540)
D(EFR(-2))	-0.215072 (-1.24475)	-0.006598 (-1.41522)	0.014031 (1.34312)	-0.445213 (-2.01466)
D(EFR(-3))	-0.035245 (-0.16343)	-0.003975 (-0.68305)	0.008193 (0.62832)	-0.147616 (-0.53517)
D(EFR(-4))	-0.013122 (-0.07652)	0.004829 (1.04362)	0.007120 (0.68671)	-0.425694 (-1.94100)
C	-1.576327 (-1.61107)	0.089854 (3.40336)	-0.028377 (-0.47967)	-1.314198 (-1.05018)
Adj. R-squared	0.559522	0.661669	-0.239419	0.141189
F-statistic	3.117100	4.259481	0.678050	1.274000
Log likelihood	-48.97727	63.01115	38.00049	-56.60530

Figures in parentheses are t-values associated with the respective parameters.

estimated Vector Error Correction Model (VECM), with the restrictions implied by the two CEs imposed. Examination of the F-statistics and the adjusted R^2, suggests that the variables in the VECM significantly explained short-run changes in only the TBR and the real GDP at $p<0.05$, accounting for 55.9 and 66.1% of the short-run variation in the two series respectively; but not those of RMS and EFR. But while the error correction coefficients in the TBR equation were significant at 1% level and associated with the desirable negative signs, those in the real GDP equation were not statistically significant even at $p<0.10$% level. This shows that TBR in Nigeria, adjusts significantly to shocks to its equilibrium relationship with its hypothesized determinants, that are caused by exogenous changes in past values of TBR and real GDP, while real GDP do not. Effects on TBR of shocks that destabilizes the equilibrium relationship between TBR and its determinants are corrected within 1.04 quarters (92 days), while those affecting real output are corrected within 4-days.

Focusing on the short-term coefficient (elasticities) results on Table 6, when compared with Equation 10 shows that while RMS and EFR significantly influence real output on the long-run, their short-run impacts on real output are not significant, with only past values of real output (up to the past three quarters) being the main determinants of the current values of real output.

However, the evidence in respect of TBR, revealed that virtually all the hypothesized determinants (except EFR in the short-run) exercise significant influence on TBR both in the long-run and short-run. In general, rising domestic outputs and past value of TBR, leads to significant increases in current values of the TBR in Nigeria, while increase in RMS (up to the past three quarters) cause TBR in Nigeria to decline. We could however, not find any evidence that short-run changes in EFR have significant influence on current values of TBR (even at 10% level).

Variance decomposition results

In order to determine the relative importance of each random innovation in affecting the variables in the estimated VEC model, the variations in TBR and real outputs in Nigeria were separated into the component shocks at forecast horizons of 1 to 12 quarters (three to 36 months) by variance decomposition methods. The results are summarised in Table 7. The columns give the percentage of variance in TBR and lnRGDP that are due to innovations associated with specified variables, with each row adding up to 100.

Table 7. Variance decomposition results.

Quarter	S.E.	TBR	LNRGDP	LNRMS	EFR
Variance decomposition of TBR					
1	1.887992	100.0000	0.000000	0.000000	0.000000
2	2.289999	81.28968	10.48178	5.531284	2.697251
3	2.456759	72.38491	18.12695	4.978459	4.509681
4	2.774770	57.38492	31.61802	7.057161	3.939899
5	2.989193	49.49061	37.61904	8.414830	4.475522
6	3.226355	42.55778	32.37554	20.36307	4.703609
7	3.848283	30.23138	23.65467	42.38120	3.732746
8	4.644877	20.77100	19.81921	55.06357	4.346215
9	5.425456	15.29534	20.25786	60.13533	4.311467
10	5.707941	14.91183	19.08727	62.01086	3.990040
11	5.807251	16.39739	18.59449	61.07394	3.934184
12	5.923437	16.48574	20.01380	59.71762	3.782848
Variance decomposition of LNRGDP					
1	0.050945	13.90019	86.09981	0.000000	0.000000
2	0.055655	11.93603	85.43421	0.625026	2.004728
3	0.060672	18.78339	72.35040	7.089431	1.776783
4	0.061743	18.44188	72.78290	7.055353	1.719867
5	0.087022	11.03453	76.97578	10.09404	1.895639
6	0.091880	9.901833	73.70146	14.30585	2.090853
7	0.092634	11.29916	72.52465	14.07936	2.096827
8	0.095490	11.75413	71.69608	14.45876	2.091028
9	0.108428	9.419637	77.35975	11.21406	2.006550
10	0.111658	9.086280	78.15842	10.60698	2.148321
11	0.112859	9.663697	76.52828	11.69239	2.115633
12	0.116129	9.353905	75.09532	13.43195	2.118826

Apart from its own innovation that accounts for over 50% of the variation in TBR within the first year, real GDP accounts for as much as 37.4% of the variation in TBR after 5 quarters (15 months), while RMS and EFR accounted for 8.41 and 4.48% of variation in TBR in the same period. It is however worthy of note, that most (over 50%) variation in TBR from the second year upward were due to variations in RMS; while variations in real GDP are largely due to its own innovations.

SUMMARY AND CONCLUSION

The goal of this paper has been to examine the influence and relative importance of various domestic and foreign factors in the determination of interest rates, particularly the Treasury Bill Rate (TBR) in Nigeria. Using a sample of quarterly observations from January 2000 to April 2008, analyzed by descriptive and econometric techniques. Evidence from this study shows that the series of TBR in Nigeria and its hypothesized determinants are generally I(1) series. Johansen (1992, 1995) system based co-integration tests revealed that two (2) co-integrating equations (CE) exist between linear combinations of the series. Results based on normalization of the restricted Vector Autoregressive (VAR) system in respect of TBR and real outputs, with two CE imposed, revealed that increase in real money supply (RMS) and expected foreign returns (EFR) exert significant ($p<0.01$) and negative influence on TBR, while simultaneously exerting significant ($p<0.01$) and positive influence on domestic outputs in the long-run. This shows that the performance of the domestic economy is better enhanced in the long-run, when government's monetary and exchange rate policies are targeted at enhancing RMS, promoting reasonable depreciation of Naira relative to other foreign currencies and in the process, lowering the TBR in Nigeria.

Evidence based on the short-run component of the estimated Vector Error Correction Model (VECM) and the associated variance decomposition, revealed that the equilibrium relationship between TBR and its determinants is stable, exogenous shocks due to TBR being corrected within 1.04 quarters (92 days), while those due

to real output are corrected within 4-days. The study also found, in general, that rising domestic outputs and past value of TBR leads to significant increases in current values of the TBR in Nigeria, while increase in RMS (up to the past three quarters) cause TBR in Nigeria to decline. Overall, real GDP accounts for as much as 37.4% of the variation in TBR after 5 quarters (15 months), while RMS and EFR accounted for 8.41 and 4.48% of variation in TBR in the same period.

REFERENCES

Adebiyi MA, Babatope-Obasa B (2004). Institutional Framework, Interest Rate Policy and the Financing of the Nigerian Manufacturing Sub-Sector'. A paper presented at the African Development and Poverty Reduction (The macro-macro linkage) Conference at Lord Charles Hotel Somerset West, South Africa. 13th -15th Oct.

Arize AC, Chooekawong P, Prasanpanic V (2000). Foreign Trade Behaviour in Thailand: Stable or Unstable? Ame. Econ. Rev., 44(2): 36-45.

Central Bank of Nigeria (CBN), (2008). Statistical Bulletin, Special Anniversary Edition, December, 2008. CBN, Abuja, Nigeria.

Edwards S, Khan MS (1995). Interest Rate Determination in Developing Countries: A Conceptual Framework. IMF Staff Paper, p. 377-403.

Eviews (2007). Eviews 6 Users Guide. Quantitative Micro Software (QMS) Inc, USA.

Gochoco MS (1991). Financial Liberalisation and Interest Rate Determination: The Case of Philippines, 1981-1985. J. Macroecon., 13(2): 335-350.

Granger CWJ (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. Econometrica. 37: 424-438.

Granger CWJ, Newbold P (1974). Spurious regressions in econometrics. J. Econometrics, 2: 110-120.

Granger CWJ, Newbold P (1986). Forecasting Economic Time Series, 2/e. Academic Press.

Gupta DD, Gupta BD (1997). Interest Rates in Open Economies. Policy Research Working Paper, World Bank.

Johansen S (1992). Determination of Cointegration Rank in the Presence of a Linear Trend. Oxford Bull. Econ. Stat., 54: 383-397.

Johansen S (1995). Likelihood-based Inference in Cointegrated Vector Autoregressive Models. Oxford University Press, UK.

Nelson CR, Plosser C (1982). Trends and random walks in macroeconomic time series. J. Monetary Econ., 10: 129-62.

Nnanna JO (2002). Monetary Policy and Exchange rate Stability in Nigeria. The Nigerian Banker, July-Dec: 43-53.

Ojo MO (2000). Monetary and Financial Sector Policies in the year 2000. CBN Bullion, 24(2): 17-26.

Olakah JKA, Oyaromade R (2007). Estimating a DSGE Model on Nigerian Economy, A Paper Presented at the 12th African Econometric Society (AES) Conference in Cape Town, South Africa July 4-6th

Omole DA, Falokun GO (1999). The Impact of Interest Rate Liberalization on the Corporate Financing Strategies of Quoted Companies in Nigeria. AERC Research paper 88, AERC, Nigeria.

Pantula SG, Gonzales-Farias G, Fuller WA (1994). A comparison of unit root criteria. J. Bus. Econ. Stat. 12: 449-459.

Patnaik I, Vasudevan D (1998). Interest Rate Determination: An Error Correction Model, National Council Appl. Econ. Res. New Delhi. 110 002.