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Rate of Interest, Money Supply, Prices and Output Interdependences in Nigeria: A Vec Approach

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Abstract

Recent developments, in the financial system in Nigeria have generated a renewed attention on the nexus between real and nominal economic variables. This study examined the relationship between nominal rate of interest, nominal money supply, prices and real output using quarterly data on these variables from 1980:1 to 2012:4. The study adopted a Vector Error-Correction Mechanism to test for the short - and long – run relationships and found out that nominal money supply has no contemporaneous effect on real output in Nigeria but does have significant impact on the latter in the long-run thereby refuting the money neutrality hypothesis. Consequent upon its bid to further examine these interdependences, Granger Causality tests, Impulse Response Functions and Variance Decompositions were carried out. The major findings are that nominal money supply and inflation rate are the most important endogenous variables in explaining variations and shocks to other variables like real output and inflation in Nigeria. The study recommends, inter alia, that money supply, not interest rate, should be used appropriately as an intermediate policy variable with real output being the final target and that appropriate inflation-targeting policies be put in place because of its significant role in explaining variations in long – run real output.

Keywords: Nominal variables; Real variables; Interdependences; Vector error correction; Impulse response; Variance decomposition

Introduction

In recent time, the interdependences between rate of interest, money supply, inflation and output have been generating a lot of interest among the academics and policy makers globally. A theory that readily comes to mind in this respect is that which was put forward by Friedman and Meiselman which related money supply to prices [1]. This theory remains popular among economists; its postulation that inflation is always and everywhere a monetary phenomenon remains noteworthy. This theory also relates money supply to output like Sim who empirically tested the money-output nexus in the United States [2]. There are other economic hypotheses like the money neutrality and Fishers which related nominal money supply to real output in the long – run and rate of interest to expected inflation rate respectively. There is also the money demand function in which money balance is a function of income and interest rate.

However, the Keynesian and Monetarists have had serious debates in the past based on the role of money and the behaviour of prices. Empirical estimates on these dynamics have also yielded varying results stemming chiefly from the use of different methodologies, data and scopes of study.

This work differs from previous works in a number of ways: unlike Vladimir and Dana who examined the relationship between money and output in the Czech Republic using a VAR analysis–this work (i) uses a VECM analysis in estimating the long and short run dynamics amongst the stated variables (ii) differs in terms of sample chosen-based on Nigeria [3]. Furthermore, Patrick and James examined the long-run monetary neutrality and long-horizon regressions, their main objective was to test the plausibility of the long-run money neutrality [4]. This work extended the scope by also testing for other dynamics amongst real variables and nominal money supply central to monetary economics. In Nigeria, Busari evaluated the money demand function and focused mainly on the long and short run money demand function while making use of real variables like real money supply, real output, inflation and other variables [5]. His scope of study was between 1979 and 2003. The scope of this study is more encompassing as it used quarterly data from 1980:1 to 2012:4 and used various techniques in assessing the dynamics amongst the four endogenous variables.

This study aims at examining these interdependences using quarterly data on these variables from the 1st quarter of 1980 to the 4th quarter of 2012, in Nigeria. In specific terms, it aims at testing the plausibility of the money neutrality hypothesis using the long and short run estimates of a Vector Error-Correction Model; assessing, based on economic theories, as stated earlier, concerning the money-output nexus, money-prices nexus and interest-inflation rates relationship. The methodologies adopted to accomplish these objectives are the Granger Causality test, Impulse Response Functions and the Variance Decomposition, both of which are based on the VECM estimates.

The remaining part of this work is divided thus: Section 2 deals with the Literature Review; section 3 presents the Research Methodology and empirical findings and section 4 gives the conclusion and areas of further studies.

Review of Literature

Employing various techniques, both for developed and developing countries, Sims [2] observed that a unidirectional causality runs from money supply to nominal income in the post war period in United States. Brillembourg and Khan [6] observed that money Granger caused prices and income. Studies like Geweke [7]; Hall and Taylor [8]; Lucas and Walsh confirmed, empirically, the strong relationship between inflation and the growth of money supply [9,10]. Strands of literature including Bernanke and Blinder, Cristiano et al. and Cushman and Zha opined that an unforeseen tightening of monetary policy in the first phase lowers monetary aggregates and various economic activities and consequently leads to a reduction in the inflation rate in the next stage

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[11-13]. Hodrick stated that tests of long-horizon asset predictability based on a VAR methodology perform better than those based on OLS [14]. In India, Rangarajan and Arif discovered that changes in real output do not respond to money supply but that inflation responds to money supply [15]. According to Dutta and Gangadhar, structural factors, plus monetary factors, are very pivotal to generating and sustaining the inflation process and volatilities in economic activity [16]. In Nigeria, Busari found out that the one period past value of short-run money demand and changes in GDP have positive relationship and are positively related to movements in money demand in the short-run while the three- month deposit rate and inflation rate are both negatively linked to the movement in money demand in the short-run [5]. Saadet et al. adopted a fractional cointegration technique in examining the Fisher Hypothesis using data from thirty-three developed and developing countries [17]. They observed a long-run relationship between nominal interest rate and expected inflation rate thereby validating this hypothesis. Rudebusch and Svensson concluded that the behaviour of money, whether real or nominal, does not have any marginal significant impact on deviations of real output from its potential level [18,19]. The government of Pakistan used M_2 as an intermediate target to control inflation following from the assumptions that the demand for M_2 function is stable and has strong link with inflation rate [20].

Research Methodology and Empirical Findings

Measurement and sources of data

In this study, as stated earlier, we use quarterly data from 1980:1 to 2012:4. Quarterly values on Real Output (RGDP), Nominal Money Supply (M_2), Nominal Interest Rate (INT) and Inflation Rate (proxied by the Consumer Price Index – CPI) from 1980 to 2009 are obtained from the Central Bank of Nigeria Statistical Bulletin (2010 Golden Jubilee edition). Values for 2010 to 2012 are obtained from the World Development Indicators 2013. All variables are expressed in their logarithmic forms except for the interest rate which is in a percentage form.

This work employs the following analytical procedure sequentially: Presentation of the empirical model which consists of a four-variable (endogenous) Vector Error-Correction Model; Stationarity and Integration tests; Cointegration test; Granger Causality test; Impulse Response Functions (IRFs) and Variance Decompositions (VDCs).

The model specification

The system to be estimated is made of four endogenous variables: the nominal rate of interest(INT), nominal money supply(MS), inflation (CPI) and the real output(RGDP). The VECM is adopted for these reasons: (i) it allows for the test of the long and short run relationship among the endogenous variables (ii) it retains the advantages of a standard Vector Autoregression (VAR) and includes the fact that the statistical relationship among the variables could be detected (iii) the variables are allowed to interact with themselves without having to impose theoretical structure on the estimates (iv) the IRFs and VDCs help to trace the impact of shocks to a given variable on another and the contribution of each variable to forecast error of itself and others.

VECM is a special case of the VAR for cointegrated variables. The model for this study can be expressed thus:

$X_t = (lnRGDP_t, ln\ CPI_t, lnMS_t, INT_t)'$; that is, X_t is a vector of 4 endogenous variables.

The 1st objective is to test mainly for the plausibility of the long-run money neutrality hypothesis in Nigeria. Thus we aim at checking whether or not there exist contemporaneous and long run impact of nominal supply on real output.

Starting with a simple VAR model with k lags, the equation could be expressed as follows:

$$X_t=\beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \beta_k X_{t-k} + U_t$$

where $X'_t=(lnRGDP_t, lnCPI_t, lnMS_t, INT_t)$; $\beta_i=4\ X\ 4$ matrix of parameters, $i=1, 2, \ldots, k$; $U_t=4\ X\ 1$ vector of multivariate normal random variables with mean of 0 and variance-covariance matrix Σ.

A typical VECM in its simplest form could be written as:

$$\Delta X_t = \Pi X_{t-k} + \Omega_1 \Delta X_{t-1} + \Omega_2 \Delta X_{t-2} + \ldots + \Omega_{k-1} \Delta X_{t-(k-1)} + U_t$$

where $\Pi = (\Sigma_{i=1}^{k} \beta_i) - I_g$ and $\Omega_i = (\Sigma_{j=1}^{k} \beta_i) - I_g$; $k= 4$ (for a 4-variable VECM)

Stationarity and integration tests

Past studies revealed that time series data for variables like interest rate, inflation rate and money supply, be it monthly, quarterly or annual, are likely to be non-stationary [19,21]. This study adopts the Augmented Dickey Fuller (ADF) (with constant only and with both constant and trend) and the ADF GLS tests (with constant and trend) to test for the stationarity of each variable. As a necessary but not sufficient condition for cointegration, each of the variables should have the same order of integration. The results of the ADF and ADF GLS are shown in Table 1 below. The ADF GLS is a variant of the ADF test and possesses more power in handling trend components. The ADF test shows that all variables but lnRGDP are integrated of order one, I(1) while lnRGDP is integrated of order zero, I(0). The ADF GLS test however shows that all the variables have the same order of integration and are all I(1). Based on this, we proceed to test for cointegration. Since the ADF GLS test is sensitive to lag length, we use the Bayesian (Schwartz) Information Criterion in selecting the lag length. The SBC (BIC) is asymptotically consistent and has superior large sample properties. The AIC is biased towards selecting an over parametized model. Monte Carlo studies however have shown that in small samples, the AIC can work better than the SBC [22]. However, our sample is large enough and so the BIC criterion is used. The BIC suggested a lag length of 4, 1, 1 and 6 for the endogenous variables respectively.

The stationarity test and lag specification are presented in Tables 1 and 2 below:

Variables	ADF (at level)		ADF (first difference)		Order of Integration
	With Constant	With Constant and Trend	With Constant	With Constant and Trend	
Ln(RGDP)	0.1014	-3.6138	-11.8731	-11.3367	I(0)
Ln(MS)	0.6332	-2.6167	-12.6036	-12.612	I(1)
Ln(CPI)	-1.9846	-0.1919	-9.3814	-9.7041	I(1)
INT	-2.4325	-2.3720	-5.2016	-5.4549	I(1)

Table 1a: ADF test.

	LnRGDP With constant and Trend		LnMS With constant and Trend		LnCPI With constant and Trend		INT With constant and Trend	
Critical Value	**Level**	**1st Difference**	**Level**	**1st Difference**	**Level**	**1st Difference**	**Level**	**1st Difference**
1%	-3.46	-3.46	-3.46	**-3.46**	-3.46	-3.46	-3.46	-3.46
5%	-2.93	-2.93	-2.93	-2.93	-2.93	-2.93	-2.93	-2.93
10%	-2.64	-2.64	-2.64	-2.64	-2.64	-2.64	-2.64	-2.64
T Stat	**-2.33**	**-12.08**	**-1.43**	**-11.25**	**-0.46**	**-9.49**	**-1.71**	**-5.14**
Order of Integration		**I(1)**		**I(1)**		**I(1)**		**I(1)**

Table 1b: ADF GLS test.

Variables	Lags
LnRGDP	4
LnMS	1
LnCPI	1
INT	6

Table 2: SBC lag length selection.

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.25649	61.913	0.0011	37.604	0.0010
1	0.10444	24.274	0.1952	14.009	0.3783
2	0.077306	10.265	0.2656	10.218	0.2017
3	0.00036792	0.046734	0.8288	0.046734	0.8289

Table 3: Johansen Cointegration test.
Johansen test:
Number of equations=4
Lag order=5
Estimation period: 1981:2-2012:4 (T=127)
Case 3: Unrestricted constant
Log-likelihood=1338.87 (including constant term: 978.462)

Cointegration test (Johansen)

This is the test for long run relationship amongst the variables. Existence of at least one cointegrating equation shows that the variables have a common long run trend, that is, they are cointegrated. The VECM lag length was first selected. The model was initially over specified by selecting an optimal lag order of 12 after which the BIC suggested lag order of 5.

We then tested for the number of cointegrating vector (r) present in the data by the use of the trace statistics and the Johansen full maximum likelihood test (Lmax) test. The two tests both indicate that there is 1 cointegrating vector at the 5 percent level of significance as shown in Table 3. The existence of a cointegrating vector implies that there is a long-run relationship between LnRGDP and other endogenous variables including LnMS.

Long run estimates: We imposed the rank of the cointegrating vector which in this case is 1, the normalized cointegrating vector is presented in Table 4

LnRGDP	LnMS	LnCPI	INT
1.0000	-4.060	0.2566	-1.5348
(0.0000)	(0.0323)	(0.0415)	(0.6512)

Table 4: Results for Normalized Cointegrating Vector.

This long-run relationship can be expressed as:

LnRGDP – 0.4060LnMS + 0.2566 LnCPI - 1. 5348INT

The result shows that *Ln(MS) and Ln(CPI)* are not in conformity with the a priori expectation but they are both significant in explaining variations in *Ln(RGDP)* in the long-run. *INT* conforms to a priori expectation but it is not significant. However, since the cointegrating coefficient for all the variables at 5 percent significance level (other than *INT*) are non-zero, this suggests that we can retain the variables in the cointegrating space. We also chose to retain interest rate in the cointegrating space.

Const	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*	
d_l_RGDP_	2.41946	0.493124	4.9064	<0.00001	***
d_l_RGDP_2	0.0245956	0.0412456	0.5963	0.5522	
d_l_RGDP_3	-0.108987	0.0402303	-2.7091	0.00784	***
d_l_RGDP_4	-0.0118557	0.0387448	-0.306	0.76019	
d_l_RGDP_5	0.145375	0.0398158	3.6512	0.0004	***
d_l_MS_1	-0.151695	0.111109	-1.3653	0.17498	
d_l_MS_2	-0.0958487	0.110432	-0.8679	0.38733	
d_l_MS_3	-0.0012126	0.111632	-0.0109	0.99135	
d_l_MS_4	-0.054599	0.109917	-0.4967	0.62038	
d_l_CPI_1	-0.0028486	0.0791398	-0.036	0.97135	
d_l_CPI_2	-0.0700849	0.0792747	-0.8841	0.3786	
d_l_CPI_3	-0.0403569	0.0788322	-0.5119	0.60973	
d_l_CPI_4	0.196421	0.0762675	2.5754	0.01135	**
d_INT_1	0.123947	1.07354	0.1155	0.9083	
d_INT_2	-0.209319	1.32092	-0.1585	0.87438	
d_INT_3	-0.351854	1.31736	-0.2671	0.7899	
d_INT_4	-0.814304	1.07647	-0.7565	0.45101	
EC1	-0.355353	0.0728732	-4.8763	<0.00001	***
Mean dependent var		0.01263	S.D. dependent var		0.093207
Sum squared resid		0.600242	S.E. of regression		0.074208
R-squared		0.45165	Adjusted R-squared		0.366128
rho		0.04493	Durbin-Watson		1.89553

Table 5: Equation 1: d_l_RGDP.

Thus, since *LnMS* (nominal money supply) is found to be significant in explaining variations in *LnRGDP* (real output) in the long – run, the money neutrality hypothesis is thereby rejected. This result is in conformity with that of Saghaian [19].

The VECM estimates: short-run dynamics: From the long-run estimates, variables could be said to have (or not have) a common trend in the long run. According to Engle and Granger [23], existences of cointegration between non-stationary variables indicate that an error-correction representation can be specified.

The coefficient of the cointegrating equation in the VECM refers to the speed of adjustment and shows how quickly any disequilibrium in the short-run is restored after a temporary disequilibrium. Table 5 depicts this.

The VECM short run estimates show that only the 1st, 2nd and 4th lags of *LnRGDP* and the 4th lag of *LnCPI* are significant in explaining variations in *LnRGDP* in the short run at 1% level of significance. The error correction is however correctly signed and also highly significant and it shows that about 36% of the disequilibrium in *LnRGDP* is corrected in the next period. It is also observed that nominal variables such as money supply and interest rate do not have contemporaneous impact on a real variable such as real output contrary to the position of the money neutrality proponents that nominal variables do have contemporaneous impact on real variables but neutral in the long run.

Granger causality tests

Granger causality implies the presence of feedback from one variable to the other. Engle and Granger, Hendry and Granger opined that the existence of cointegration is the basis for causality [23-25]. Following from the tenets of this theory, if two variables have long-run (cointegrating) relationship, then causality must exist in at least one direction [26,27].

The relationships of particular interest in this work relate to the nexus between (i) real output (*LnRGDP)* and nominal money supply (*LnMS)* (ii) inflation rate (*CPI*) and nominal money supply and (iii) interest rate (*INT)* and inflation rate (*LnCPI).*

Since Granger causality is sensitive to lag order, the BIC & HQ criteria suggested a lag of 5. The full results of these tests are presented in Appendix A.

For (i), Granger causality between *LnRGDP* and *LnMS* show that a unidirectional causality runs from *LnMS* to *LnRGDP*. Hence, *LnMS* Granger causes *LnRGDP* at the 5% level of significance.

For (ii), a unidirectional causality also runs from *LnMS* to *LnCPI* at 5% level of significance. Thus the former Granger causes the latter.

For (iii), independence is observed between *INT* and *LnCPI*, that is, no one Granger causes the other.

The Impulse Response Functions (IRFs) based on VECM results

The IRFs obtain from the Moving Average (MA) representation of the original VAR model. They (IRFs) depict the dynamic response of a particular endogenous variable to a one-period standard deviation shock to the system. As it were, impulse responses trace out the responsiveness of dependent variables in a VAR to shocks to each of the variables. Hence, the effects upon the system consequent upon a unit shock to each variable from each separate equation are noted [28,29].

The IRFs are sensitive to lag lengths and ordering of variables. The BIC and Hannan – Quinn statistics could be used to choose the lag length [30]. Since we are basically interested in the dynamics amongst these variables, we allow shock to each variable affect others. The variables are I(1) following from the results of the unit root tests and we estimate the system as an unrestricted VAR in levels despite the fact that each variable is likely to be generated by a unit root stochastic process. This follows from Sims [31] advice. The implication of this is that we do not consider the significance of the individual coefficients in the estimated equations but the dynamics of the system can be examined by examining the IRFs [32].

With respect to the ordering, we do not have a particular theoretical basis for the ordering but we bear in mind the relevant economic theory and hypotheses as stated earlier which are the quantity theory of money, money neutrality hypothesis and Fishers hypothesis. Thus, we allow any two variables relating to the theory or any of these hypotheses to be ordered after each other.

The unrestricted VAR approach begins with a reduced form equation. The structural model that underpins this reduced form allows for a contemporaneous and lagged interaction between the variables of the system. Hence the structural model can be written as:

$$0 = B_0 + B_1X_t + B_2(L)\, X(L) + \varepsilon$$

Where $B_0 = [b_{LnRGDP}\ b_{LnMS}\ b_{LnCPI}\ b_{INT}]'$; is a vector of constants

$$B_1 = \begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} \\ b_{21} & 1 & b_{23} & b_{24} \\ b_{31} & b_{32} & 1 & b_{34} \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix};$$ is a matrix of coefficients that relate to the contemporaneous interaction between the variables in the system

$X_t = [lnRGDP\ lnMS\ lnCPI\ INT]'$ is a vector of the system variables

$$B_2(L) = \begin{bmatrix} b_{11}(L) & b_{12}(L) & b_{13}(L) & b_{14}(L) \\ b_{21}(L) & b_{22}(L) & b_{23}(L) & b_{24}(L) \\ b_{31}(L) & b_{32}(L) & b_{33}(L) & b_{34}(L) \\ b_{41}(L) & b_{42}(L) & b_{43}(L) & b_{44}(L) \end{bmatrix};$$ is a vector of coefficients that relate to the influence of variables on their current value.

$X_t(L) = [lnRGDP_{t-L}\ lnMS_{t-L}\ lnCPI_{t-L}\ INT_{t-L}]'$; is a vector of lagged variables in the system with L representing the lag length which in this case, following the BIC and HQ specifications, is 5.

$\varepsilon = [\varepsilon_{RGDP}\ \varepsilon_{lnMS}\ \varepsilon_{lnCPI}\ \varepsilon_{INT}]'$; is a vector of structural errors

The reduced form version of our structural model can be written as:

$$X_t = A_0 + A_1(L)X_{t-L} + e_t$$

where $A_0 = B_1^{-1}B_0$; $A_1(L) = B_1^{-1}B_2(L)$ and $e_t = B_1^{-1}\varepsilon$

However, the Ordinary Least Square technique can be used for the estimation since we have the same variables on the right hand side of the system. The Choleski decomposition which converts the B_1 matrix to be lower triangular is used by setting all the coefficients above the diagonal to zero.

With respect to the orderings, there are six (6) ways (2! + 2! + 2!) in which they can be arranged going by the money-output, money-price and interest-inflation relationships. Importantly, any variable that appears before others is allowed to have contemporaneous effect on them and is affected by only its own shock; and the reverse is impossible. For example, ordering 1 below shows that (LnRGDP) is allowed to have contemporaneous impact on LnMS and others, but LnMS cannot have contemporaneous effect on LnRGDP. A ten year horizon is used for the IRFs.

$X_t = [lnRGDP\ lnMS\ lnCPI\ INT]'$ …………………. *ordering 1*

$X_t = lnMS\ lnRGDP\ lnCPI\ INT]'$……………………*ordering 2*

$X_t = [lnCPI\ lnMS\ lnRGDP\ INT]'$…………………..*ordering 3*

$X_t = [lnMS\ lnCPI\ lnRGDP\ INT]'$…………………..*ordering 4*

$X_t = [INT\ lnCPI\ lnRGDP\ lnMS]'$…………………..*ordering 5*

$X_t = [lnCPI\ INT\ lnRGDP\ lnMS]'$…………………..*ordering 6*

The full IRFs are presented in Appendix B

IRF interpretations for orderings 1 and 2: LnRGDP and LnMS dynamics

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For ordering 1, the response of *LnMS* to one standard deviation shock to *LnRGDP* has a positive and increasing impact over the years up to the 10th forecast year.

For the 2nd ordering, the response of LnRGDP to one standard deviation innovation to LnMS reduces and becomes negative up to the 3rd forecast year after which the response starts increasing and becomes positive from the 4.5th forecast year.

IRF interpretations for orderings 3 and 4: Lncpi And Lnms Dynamics

For ordering 3, the response of LnMS to a standard deviation innovation to LnCPI is positive but declines up to the 4th forecast year after which the response increases sharply up to the 5th year and then steadily up to the 10th forecast year.

For the 4th ordering, the response of LnCPI to a standard deviation innovation to LnMS is positive and sharp from the 1st to the 4th year, positive but declining between the 4th and 5th years, after which the response increases consistently up to the 8th forecast year.

IRF interpretations for orderings 5 and 6: INT and LnCPI dynamics

For the 5th ordering, the response of LnCPI to a standard deviation innovation to INT is positive but decreases sharply between the 1st and 3rd years, becomes negative between the 3rd and 7th years after which the response increases and becomes positive up to the 10th forecast year.

Considering the 6th ordering, the response of INT to a standard deviation innovation to LnCPI is positive and steadily increases between the 1st and 4th years after which it continues to decline, although still positive, up to the 10th forecast year.

Variance decompositions based on VECM results

The variance decomposition (VDCs hereafter) shows the proportion of the movements in the dependent variables as a result of their own shocks and shocks to other variables. VDCs, according to Bessler and King, may be referred to as out-of-sample causality tests. Sims stated that the variable that is optimally forecast from its own lagged values will have all the total variation in its forecast error explained by its own disturbances.

Like IRFs, VDCs are also sensitive to ordering. The table is presented in Appendix C. A ten (10) year forecast horizon is also used. We followed the 1st ordering as used in the IRF, i.e. X_t = *[lnRGDP lnMS lnCPI INT]'*. However, we experimented using different orderings and observed only marginal variations in the outputs. This might be due to the fact that the correlations among the various innovations are not large.

Shocks to LnRGDP in forecast year 1 accounted for 100% variations in itself. In the 10th year, shock to itself accounted for 71.48% variations while shock to LnCPI accounted for 17.83% variations in LnRGDP.

In the 1st year, shocks to LnMS accounted for 99.88% variations in itself while shocks to LnRGDP only accounted for 0.12%. In the 10th year, shocks to itself (LnMS) accounted for 90.01% variations in itself while shocks to LnRGDP accounted for 9.51% variations in LnMS.

For LnCPI, in the 1st year, shocks to itself explains 88.28% variations in itself while shocks to LnMS accounted for 11.08% variations in LnCPI. In the 7th year, shocks to LnCPI and LnMS respectively accounted for 71.88% and 19.89% variations in LnCPI.

For INT, in the 1st year, shocks to itself and LnCPI accounted for 98.06% and 1.35% variations in INT respectively. In the 10th year, shocks to itself and also LnCPI respectively accounted for 85.69% and 7.44% variations in INT.

From the foregoing, it is clear-cut that shocks to money supply appears to be the most important in explaining the variations in itself and inflation. This relationship between money supply and prices (inflation) seem to support (at least a bit) the Friedman's *quantity theory of money* in which he stated that inflation is always and everywhere a monetary phenomenon.

In the case of INT and CPI, CPI, other than INT itself, is the most important in explaining variations in INT. This finding is also somewhat similar to Fishers hypotheses (though not on the basis of a one-to-one relationship).

Conclusion and Areas of Future Studies

The study examined the dynamics amongst four variables, the nominal rate of interest, nominal money supply, inflation and real output. Following the results of the long run VECM estimate, Granger Causality, IRFs and VDCs, the nominal money supply proved to play the most significant role in explaining the variations and dynamics amongst these variables. The long-run money neutrality hypothesis was refuted because nominal money supply showed to be non-neutral in the long run with respect to its effect on the long run real output. Thus, policy makers need to give adequate attention to money supply as an intermediate policy variable. There is also a need for appropriate inflation – targeting policies because of the significance of the CPI in explaining variations in the long run real output as reported by the VECM and VDC estimates. These findings are consistent with that of Tahir and Mohammad (2005) who examined the relationship among same variables in Pakistan.

Further studies can focus on a methodology such as the structural VEC (unlike the theoretical standard VEC) which has theoretical underpinnings for the structural parameters of a system.

References

1. Friedman M, Meiselman D (1963) The Relative Stability of Monetary Velocity and the Investment Multiplier in the United States. The Journal of Developing Areas 41: 185-202.
2. Sim CA (1972) Money, income and causality. American Economic Review 62: 540-552.
3. Vladimir T, Dana V (2006) The relationship between money and output in the Czech Republic: Evidence from VAR analysis. Eastern European Economics 44: 23-39.
4. Patrick JC, James NM (2004) Long-Run monetary neutrality and long-horizon regressions. Journal of Applied Econometrics 19: 355-373.
5. Busari TD (2009) Money demand functions in Nigeria: Issues and further considerations. Applied econometrics and macroeconometric modelling in Nigeria. Lagos: Royal Bird Ventures Ltd.
6. Brillembourge A, Arif RR (1990) Money, output and prices: Has money mattered historically? Journal of Money, Credit and Banking 11: 358-365.
7. Geweke J (1986) The Super neutrality of Money in the United States:An Interpretation of the Evidence. Econometrica 54: 1-22.
8. Hall RE, Taylor JB (1997) Macroeconomics (5th ed.). New York: W.W. Norton.
9. Lucas RE (1980) Two Illustrations of the Quantity Theory of Money. American Economic Review 70: 1005-1014.
10. Walsh CE (2001) Monetary Theory and Policy. MIT Press, Cambridge.
11. Bernanke B, Blinder A (1992) The Federal Funds Rate and the Channels of Monetary Transmission. American Economic Review 82: 901-921.

12. Christiano L, Eichenbaum M, Evans C (1994) Identification and the Effects of Monetary Policy Shocks. FRB Chicago Working Paper.

13. Cushman D, Zha T (1997) Identifying Monetary Policy in a Small Open Economy under Flexible exchange rates. Journal of Monetary economics 39: 433-448.

14. Hodrick RJ (1992) Dividends yields and expected stock returns: alternative procedures for inference and measurement. Review of Financial Studies 5: 357-386.

15. Rangarajan C, Arif RR. (1990) Money, output and prices: A macroeconometric model. Economic and Political Weekly 25: 837-848.

16. Dutta SR, Gangadhar D (2000) Dynamics of money, output and price interaction – Some Indian evidence. Economic Modelling, 17: 559-588.

17. Saadet K, Adnan K, Evrim T (2006) Fisher hypothesis revisited: a fractional cointegration analysis. Emerging Markets Finance & Trade 42: 59-76.

18. Rudebusch GD (1998) Do Measures of Monetary Policy Shocks in a VAR Make Sense? International Economic Review 39: 907-941.

19. Saghaian SH, Reed MR, Merchant MA (2002) Monetary impacts and overshooting of agricultural prices in an open economy. American Journal of Agricultural Economics 84: 91-103.

20. Qayyum A (2008) Does Monetary Policy Play Effective Role in Controlling Inflation in Pakistan? MPRA.

21. The relative impact of national monetary policies and international exchange rate on long-term variations in relative agricultural prices (2004) Center for Agricultural Policy and Trade Studies. Department of Agribusiness and Applied Economic.

22. Walter E (2010) Applied Econometric Time Series (2nd ed.). Wiley, USA.

23. Engle RF, Granger CW (1987) Co-integration and Error Correction: Representation, Estimation, and Testing. Econometrica 55: 251-276.

24. Hendry D (1986) Econometric Modelling with Cointegrated Variables: An Overview. Oxford Bulletin of Economics and Statistics 48: 201-212.

25. Granger CWJ (1986) Developments in the Study of Cointegrated Economic Variables. Oxford Bulletin of Economics and Statistics 48: 213-228.

26. Granger CWJ (1988) Some Recent Developments in a Concept of Causality. Journal of Econometrics 39: 199-211.

27. Miller S, Russek F (1990) Cointegration and Error Correction Models: the temporal causality between government taxes and spending. Southern Economic Journal 57: 221-229.

28. Bessler D, King J (1985) A Note on Tests of Granger Causality. Applied Econometrics 16: 335-342.

29. Olayiwola K, Okodua H (2013) Foreign direct investment, non-oil exports, and economic growth in Nigeria: a causality analysis. Asian Economic and Financial Review 3: 1479-1496.

30. Lutkepohl H (1991) Introduction to Multiple Time Series Analysis. Springer-Verlag, London.

31. Sims CA (1980) Macroeconomics and reality. Econometrica 48: 1- 48.

32. Dickinson D, Liu J (2007) The real effects of monetary policy in China: An empirical analysis. China Economic Review 18: 87-111.