

A Vector Autoregressive (VAR) Cointegration and Vector Error Correction Model (VECM) Approach for Financial Deepening Indicators AND Economic Growth in Nigeria

H. A. Chamalwa*, H. R. Bakari

Department of Mathematics and Statistics, Faculty of Science University of Maiduguri

*Corresponding author: Chamalwa@gmail.com

Abstract The Study Investigate the relationship between economic growth (GDP) and some financial deepening indicators (money supply and credit to private sector), using a data obtained from the Central Bank of Nigeria (CBN) statistical bulletin for the period 1981-2012. The study employed the conventional augmented dickey fuller test to test for stationarity among the three variables (GDP, money supply and credit to private sector, Johansen cointegration technique to determine the order or the cointegrating equation. Granger causality test was used to check for causal relationship among the variables (i.e uni-directional, bi-directional or feedback) and then the Vector Error Correction to check for a short-run or long-run relationship among the three variables. The results indicate that all the three variables are non-stationary at levels, but became stationary after first differencing once. The three variables are cointegrated with at most one cointegrating equation; b-bidirectional causality runs among the three variables. The VECM suggested a long-run relationship among the three. Test for adequacy performed on the residuals of the VECM indicates that they are homoskedastic, have no serial correlation and are normally distributed suggesting that the model is good.

Keywords: cointegration, differencing, growth, money, relationship

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1. Introduction

Financial deepening indicators are the economic conditions that improve competitive efficiency of the financial market which in turn stimulate the non-financial sectors of an economy; hence, this link between these financial deepening indicators and economic growth has received considerable attention in the developing economy in recent times. This is sequel to the tremendous contribution the financial sector has on the economic development and policy implication. Nigeria in recent times has undertaken various financial reforms aimed at overhauling the financial sector in an attempt to improve both growths and general development of the economy though. It is evident that the intent performance of the Nigerian financial sector is undermined due its vulnerability to distress, macroeconomic volatility [1].

Financial deepening has the potential of subduing risk and vulnerability for disadvantage groups and improving individuals and household's ability to access basic needs such as health care, and education which in turn reduces poverty.

The relationship between economic growth and financial deepening has been a wide-ranging subject of

experiential research in recent time. Practical evidence suggests that there is a significant (positive) relationship between financial development and economic growth. The issue, therefore, is to ask whether financial deepening actually causes economic growth or vice versa. It was found that the relationship between financial development and economic growth in the Nigerian context to be positive according empirical evidences.

There are no gainsaying the fact that there is some correspondence between the trend in some financial deepening indicators and economic growth. Though, multi-dimensional as it is; the most widely used indicators are the ratio of real values of financial assets to real income or wealth, the maturity of the financial instrument (money supply), real interest rates and the real ratio of the credit to income and credit to private sector to name but few.

The financial deepening indicators considered in this study are: money supply (M_2) and credit to private sector. Money supply simply means the entire stock of currency and other relevant liquid instrument in a country's economy at a particular time; it is commonly means the safe assets that household and businesses can use to make payments or to hold as short-term investment. The money supply could include cash, coins and balance held. In current (checking) and saving account economist are

optimistic that money supply and its policy implication centered towards controlling the interest rate and increasing or decreasing the inflow of money in the economy.

Data on money supply is collected, recorded and published annually, bi-annually, quarterly, monthly etc. by the open bank of the counting analysis is then carried out on the level/trend of money supply from time to time to check/assess it on both public and private sectors of the economy; especially its impact on inflation price level and the business cycle at large.

It is crystal clear that an attempt to increase the money will have a direct effect on lowering the interest rate, generate more investment, which in turn stimulate spending by putting more into the hands of consumers. Various standard measures of money supply are available these are: monetary base M_0 , M_1 , M_2 and M_3 depending on type and size of the amount in which the instrument is reserved. In practice not all of the classification is widely employed, the usage varies from country to country.

2. Review of Related Literature

[2], in her study on the causality between financial deepening indicators and economic growth in Nigeria; Evidence from Bootstrap rolling wider approach, posited that financial deepening has predictive power and that there causal relationship between M_2 , GDP and RGDPCC but episodic asymmetric and time varying.

[3], in a study on the evaluation of Nigerian financial sector reforms using behavioral models observed that the performance of the financial sector have been greatly influenced by these reforms which began in 1986. Gradual interest in the capital base of the firms has rekindled the public confidence in the sector by 3.6 percent, and also the reduction of government ownership of financial sector/institution have induced performance including financial deepening, but interest in Nigeria here been accompanied by decline in bank credits as a result of very high (negative) lending rate and its attendant effect and recommend that monetary authority should direct their efforts towards achieving positive interest regime, increase the scope of financial reform; and these reforms should be seen as a process rather than event to consolidate the emerging confidence in these institutions.

[4] in his study on the financial deepening and economic growth in Pakistan: An application of cointegration and VECM approach find out that financial deepening; foreign direct investment, inflation, and economic growth are cointegrated and that long run relationship exist among the variables. The results of the VECM shows the existence of short run relationship among the variables and error correlation model for GDP and FDI shows the adjustment effect back towards the long run. The granger causality test shows that unidirectional relationship among the variables.

[5], explore the relation between banking sector control and financial deepening using a structural error correlation model for Tunisia. The results financial repression has had significant and negative on financial development. [6] States that savings and economic growth are positively cointegrated indicating a stable long run equilibrium and that there is unidirectional causality between savings and economic growth.

[7] Find out that there are other several factors other than interest rate influence financial deepening in Sri Lanka. This confirms the reo-structurist hypothesis claiming that financial deepening has reduced provision of credit to informal sector. [8] Find out that economic growth and development of country depends largely on the role of financial deepening. [9] explores the relationship among financial deepening, FDI and economic growth for India. The outcome of the study shows the existence of long run relationship among variables. Furthermore, the ECM reports bi-directional causality between FDI and economic growth and unidirectional causality between financial deepening to FDI.

[10] finds that financial deepening has a direct and robust impact on the growth of the real GDP per capita for Turkey; but unlike what is obtained in other countries financial development has a negative relationship with economic growth, and conclude that inclusion of additional variables in order to account for economic and cultural variations between different provinces can also the reliability of the results.

The study of relationship between financial development and economic growth for Pakistan by [11], the results shows that financial development and real interest have positive impact on the economic growth and that a long run relationship is observed between them. [12] in a study on the causality by multivariate cointegration and ECM techniques, revealed that the short run effect of financial development cause economic growth.

Financial deepening and economic growth in Nigeria, shows that financial deepening index is low in Nigeria and the financial system has not sustained an effective intermediation [13]

3. Material and Methods

The study employed the conventional dickey fuller test to test for stationarity, as most of financial time appears to be non-stationary; that is they possesses trend. The variable(s) needs to be stationary to avoid spurious regression, a situation where estimated coefficients are very deceptive.

3.1. Augmented Dickey Fuller Test

In the case of dickey fuller test for stationarity, problem of autocorrelation usually arises. To tackle this problem [14] developed a test called Augmented Dickey Fuller test (ADF). As presented below which must be satisfied for stationarity to exist:

$$\Delta Y_t = \beta_1 + \alpha Y_{t-1} + a_i + \varepsilon_t \text{ (Constant only)} \quad (3.1)$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \alpha Y_{t-1} + a_i + \varepsilon_t \text{ (Trend and Constant)} \quad (3.2)$$

$$\Delta Y_t = \alpha Y_{t-1} + a_i + \varepsilon_t \text{ (No trend, no Constant)} \quad (3.3)$$

The hypotheses to be tested are:

H_0 : the variable has unit root

H_1 : the variable doesn't has unit root

Decision

If t statistics value is $>$ ADF critical value we fail to reject H_0 and otherwise

3.2. Johansen Test of Cointegration

[15] Proposed a test of cointegration has all the desirable statistical properties. The test starts with a VAR representation of the variables as:

$$A_k(L)X_t = \mu_0 + \varphi\Delta_t + \varepsilon_t \tag{3.4}$$

We assumed that the system is integrated of order one I (1), if there are signs of I (2) variables, must be transferred into I (1) before setting the VAR.

The VAR can be transferred to VECM using the difference operator

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-1} + \varphi\Delta_t + \varepsilon_t \tag{3.5}$$

Where Γ , and Π are matrixes of variables. The lag length is k taken on each variable.

VECM can be written into a more component form as:

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \mu_0 + \varphi\Delta_t + \varepsilon_t \tag{3.6}$$

Where the number of cointegrating variables is directly proportional to the number of stationary relationship in the Π -matrix

If there are no cointegration all the rows in Π will be zero while some will be non-zero if there is stationary combination.

The rank of the matrix Π determines the number of the independent variables as well as the number of the cointegrating variables. The rank is given by significant eigenvalues found in Π where each stands for a significant stationary relation.

Moreover, if the matrix has a reduced rank, there is cointegrating relationship among the X' variables. Therefore, rank (Π) = 0. It means non-stationary relationship exist among the X' variables; as such it is advisable to differenced it first before modeling. If rank (Π) = p then Π has full rank, therefore all the variables must be cointegrated. This technique was utilized in this study for determining the order or number of cointegrating equation among the variables

3.3. The Direct Granger Method

This assesses the causality by regressing each variable on it lagged values and that of other variable [16]

$$Y_t = \beta_0 + \sum_{j=1}^j \beta_j Y_{t-j} + \sum_{k=1}^k \delta_k X_{t-k} + \mu_t \tag{3.7}$$

This approach also allows for the determination of the causal relationship in the reverse direction

$$X_t = \alpha_0 + \sum_{j=1}^j \alpha_j X_{t-j} + \sum_{k=1}^k \phi_k Y_{t-k} + v_t \tag{3.8}$$

The model must be fully specified; else it will lead to spurious regression.

In the model specified above, X_t and Y_t are the variables; μ_t and v_t are mutually uncorrelated error terms; t denotes time period and k number of lags.

The hypotheses to be tested are:

$$H_0: \delta_k = 0 \text{ against } H_1: \delta_k \neq 0$$

$$H_0: \alpha_i = 0 \text{ against } H_1: \alpha_i \neq 0$$

If $\delta_k \neq 0$ but $\alpha_i = 0$ then X_t cause Y_t and if $\alpha_i \neq 0$ but $\delta_k = 0$ then Y_t cause X_t if both $\delta_k \neq 0$ and $\alpha_i \neq 0$ then causality runs both ways. This was applied on the three

variables (GDP, Credit to private sector, and Money Supply) taken two at a time, to check for causality and its direction among the variables

3.4. Vector Error Correction Model (VECM)

VECM is an appropriate modeling strategy when the variables are cointegrated. It is useful when long-run forecast is desired; as VAR doesn't explicitly takes into account the long-run relationship.

According to Pfaff (2007) a bivariate I(1) vector $(Y_{1t}, Y_{2t})' = Y_t$ with cointegrating vector $\beta = (1, -\beta)$ where $\beta' Y_t = (1, -\beta) (Y_{1t}, Y_{2t})' = Y_{1t} - \beta_2 Y_{2t} \rightarrow I(0)$

An ECM exist in the form

$$\Delta Y_{1t} = \alpha_1 + \gamma_1 (Y_{1t-1} - \beta_2 Y_{2t-1}) + \sum_{i=1}^k \varphi_{1i} \Delta Y_{1t-i} + \sum_{i=1}^l \varphi_{2i} \Delta Y_{2t-i} + \varepsilon_{1t} \tag{3.9}$$

$$\Delta Y_{2t} = \alpha_2 + \gamma_2 (Y_{1t-1} - \beta_2 Y_{2t-1}) + \sum_{i=1}^k \varphi_{1i} \Delta Y_{1t-i} + \sum_{i=1}^l \varphi_{2i} \Delta Y_{2t-i} + \varepsilon_{2t} \tag{3.10}$$

We can then estimate ECM; but we can actual estimate $Y_{1t-1} - \beta_2 Y_{2t-1}$, Where $0 < \gamma_1 < 1$ and $0 < \gamma_2 < 1$

The VECM discussed above was estimated for the cointegrated variables.

4. Results and Discussions

4.1. Results

Table 1. UNIT ROOTS TESTS

Variables	Level		First Difference	
	ADFTest Stat	Critical Values(1%)	AD Test Stat	Critical Values (1%)
Gdp	4.699273	-3.679322	-5.217766	-3.711457
Money supply	28.592750	-3.699871	-4.441919	-3.769597
Credit to private sector	-0.461047	-3.737853	-6.321851	-3.724121

Table 2. JOHANSEN COINTEGRATION TESTS

Hypothesized	Trace		0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.886379	73.671105	29.79707	0.0000
At most 1	0.305171	10.59923	15.49471	0.2374
At most 2	0.001401	0.040647	3.841466	0.8402

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

* denotes rejection of the hypothesis at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized	Max-Eigen		0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.886379	63.07182	21.13162	0.0000
At most 1	0.305171	10.55858	14.26460	0.1778
At most 2	0.001401	0.040647	3.841466	0.8402

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

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Table 3. NORMALIZED COINTEGRATING COEFFICIENTS (COINTEGRATING EQUATION)

GDP	MONEY SUPPLY	CREDIT TO PRIVATE SECTOR
1.000000	4.024788(2.40360)	-8.3163613(2.10086)

Table 4. GRANGER CAUSALITY TESTS

Null Hypothesis:	Obs	F-Statistic	Prob.
MONEY does not Granger Cause GDP	28	14.7349	1.E-05
GDP does not Granger Cause MONEY		5.76502	0.0033
CREDIT does not Granger Cause GDP	28	8.80689	0.0003
GDP does not Granger Cause CREDIT		4.33421	0.0117
CREDIT does not Granger Cause MONEY	28	7.52646	0.0008
MONEY does not Granger Cause CREDIT		17.8574	3.E-06

Table 1. VECTOR ERROR CORRECTION ESTIMATE

Vector Error Correction Estimates
Date: 11/29/14 Time: 04:06
Sample (adjusted): 4 32
Included observations: 29 after adjustments
Standard errors in () & t-statistics in []

Cointegrating Eq:	CointEq1		
CREDIT(-1)	1.000000		
GDP(-1)	-0.120285 (0.02690) [-4.47095]		
MONEY(-1)	-0.484120 (0.05882) [-8.23117]		
C	282945.1		
Error Correction:	D(CREDIT)	D(GDP)	D(MONEY)
CointEq1	0.328725 (0.10485) [3.13519]	-1.806571 (0.31491) [-5.73672]	-0.314183 (0.13356) [-2.35243]
D(CREDIT(-1))	-0.302211 (0.31833) [-0.94936]	1.579318 (0.95610) [1.65184]	0.228848 (0.40549) [0.56438]
D(CREDIT(-2))	-2.402138 (0.36025) [-6.66799]	2.143992 (1.08200) [1.98151]	-1.030119 (0.45888) [-2.24485]
D(GDP(-1))	0.087311 (0.05554) [1.57215]	0.160134 (0.16680) [0.96003]	0.109992 (0.07074) [1.55485]
D(GDP(-2))	0.129796 (0.05809) [2.23425]	0.024412 (0.17448) [0.13991]	-0.029816 (0.07400) [-0.40292]
D(MONEY(-1))	0.942989 (0.38543) [2.44657]	-3.856857 (1.15763) [-3.33167]	-0.105986 (0.49096) [-0.21588]
D(MONEY(-2))	2.502939 (0.45059) [5.55478]	2.364695 (1.35334) [1.74731]	1.821661 (0.57396) [3.17386]
C	-154123.0 (52164.9) [-2.95453]	547651.2 (156675.) [3.49545]	496.6800 (66446.9) [0.00747]
R-squared	0.965389	0.920844	0.892099
Adj. R-squared	0.953852	0.894458	0.856132
Sum sq. resid	9.61E+11	8.66E+12	1.56E+12
S.E. equation	213865.0	642336.1	272418.4
F-statistic	83.67856	34.89970	24.80318
Log likelihood	-392.3889	-424.2821	-399.4067
Akaike AIC	27.61303	29.81256	28.09702
Schwarz SC	27.99021	30.18975	28.47420
Mean dependent	504745.1	1394277.	478541.4
S.D. dependent	995555.8	1977198.	718213.7
Determinant resid covariance (dof adj.)		2.94E+32	
Determinant resid covariance		1.12E+32	
Log likelihood		-1193.464	
Akaike information criterion		84.16990	
Schwarz criterion		85.44290	

Table 6. VECM

Included observations: 29 after adjustments
D(GDP) = C(9)*(CREDIT(-1) - 0.12028464586*GDP(-1) - 0.484120230284
*MONEY(-1) + 282945.124216) + C(10)*D(CREDIT(-1)) + C(11)
*D(CREDIT(-2)) + C(12)*D(GDP(-1)) + C(13)*D(GDP(-2)) + C(14)
*D(MONEY(-1)) + C(15)*D(MONEY(-2)) + C(16)

	Coefficient	Std. Error	t-Statistic	Prob.
C(9)	-1.806571	0.314914	-5.736716	0.0000
C(10)	1.579318	0.956098	1.651837	0.1134
C(11)	2.143992	1.081996	1.981515	0.0608
C(12)	0.160134	0.166802	0.960030	0.3480
C(13)	0.024412	0.174482	0.139912	0.8901
C(14)	-3.856857	1.157634	-3.331671	0.0032
C(15)	2.364695	1.353337	1.747307	0.0952
C(16)	547651.2	156675.4	3.495450	0.0022
R-squared	0.920844	Mean dependent var		1394277.
Adjusted R-squared	0.894458	S.D. dependent var		1977198.
S.E. of regression	642336.1	Akaike info criterion		29.81256
Sum squared resid	8.66E+12	Schwarz criterion		30.18975
Log likelihood	-424.2821	Hannan-Quinn criter.		29.93069
F-statistic	34.89970	Durbin-Watson stat		2.145332
Prob(F-statistic)	0.000000			

Table 7. WALD TEST

Test Statistic	Value	Df	Probability
F-statistic	3.185987	(2, 21)	0.0619
Chi-square	6.371975	2	0.0413
Null Hypothesis: C(10)=C(11)=0 Null Hypothesis Summary: Equation: Untitled			
Test Statistic	Value	Df	Probability
F-statistic	7.993469	(2, 21)	0.0026
Chi-square	15.98694	2	0.0003
Null Hypothesis: C(14)=C(15)=0 Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
		C(14)	-3.856857 1.157634
		C(15)	2.364695 1.353337

Restrictions are linear in coefficients.

Table 8. RESIDUAL ANALYSIS

TESTS	VALUES	P-VALUES
Breusch-Godfrey Serial Correlation LM	1.355473	0.2817
Breusch-Pagan-Godfrey Heteroskedasticity	15.35886	0.0815
Jarque-Bera Normality	4.307240	0.116063

Table 9. MODEL SUMMARY^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.990 ^a	.981	.980	1689457.66824	.981	746.957	2

Table 10. ANOVA^a

Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	4264030263758318.000	2	2132015131879159.000	746.957	.000 ^b
	Residual	82773749170094.390	29	2854267212761.876		
	Total	4346804012928412.500	31			

a. Dependent Variable: gdp

b. Predictors: (Constant), credit to private sector, money supply

Table 11. COEFFICIENTS^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1123367.960	376172.746		2.986	.006
1 money supply	6.109	.603	2.057	10.124	.000
credit to private sector	-3.360	.629	-1.085	-5.339	.000

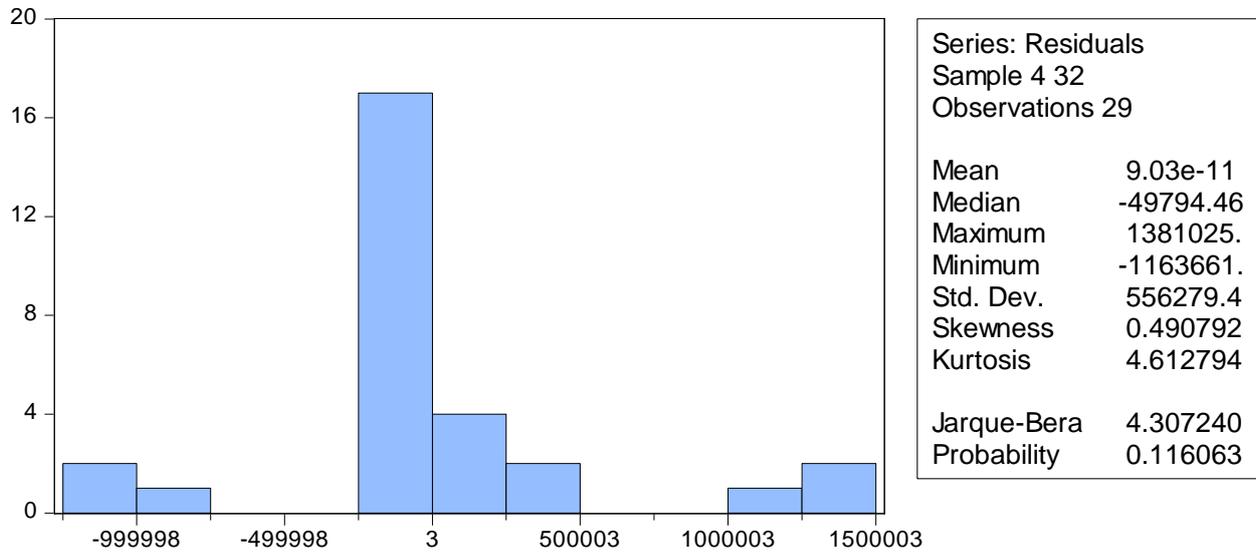


Figure 1.

4.2. Discussion of Results

The results of the ADF unit roots test presented in Table 1 revealed that all the three variables (GDP, Money supply and Credit to private sector) are all non-stationary (has unit roots) at levels; but become stationary after differencing once, since the critical values are all less than the ADF test statistics at 1% level of significance.

Table 2 Johansen test of cointegration presents the Trace and Maximum Eigenvalue performed to determine the order of integration; which both indicates that we reject the null hypothesis that none of the variables is cointegrated since $p\text{-value } 0.0000 < 0.05$, but revealed that there is at most one cointegrating equation or error since $p\text{-values}$ is greater than 0.05 for both trace and Max. Eigenvalue i.e the three variables have long run relationship. The results of the normalized cointegrating coefficients are 4.024788 and -8.316313 as long run coefficients for Money Supply and Credits to Private Sectors respectively. Meaning that whenever money supply goes up GDP goes up but whenever Credits to Private Sector goes up GDP goes down. Normally when the GDP goes up credits to private sectors should also go up so the sign should have been positive; this is the weakness of the model. But since the three variables are cointegrated we can run the VECM (Table 3).

Table 4 presents the results of the Granger causality test for the variables; revealing a bidirectional causality running from Money supply to GDP, GDP to Money supply; credits to private sector to GDP, GDP to Credits to private sector and Credits to private sector to Money supply and money supply to Credits to private sector while Table 5 presents the VEC estimates.

Table 6 contains the VECM and its coefficients as well as their t-statistic and p-value. C(9) is the coefficient of the cointegrated model (long run) with GDP as the dependent variable while C(10), C(11), C(12), C(13),

C(14) and C(15) are short run coefficients. C(9) is the speed of adjustment towards long run equilibrium which is negative and significant; meaning money supply and credits to private sector has long run influence on the GDP.

Table 7 shows the results of the Wald test performed to test whether Credits to private sector and money supply has any short run effect on GDP which revealed that both Credits to private sector and money supply has effect on GDP in the short run.

The results of the residual analysis performed to test for the adequacy of the model as contained in Table 8 revealed that the residuals have no serial correlation, they are homoskedastic and are normally distributed since all the p-values are greater than 0.05. The results of the regression analysis performed indicated a very high R^2 (0.981) meaning total variability in GDP is being explained by the variations in credit to private sector and money supply (Table 9). Similarly, Table 10 suggested that the model is a good fit; Table 11 indicates that both credit to private sector and money supply contribute significantly to economic growth (GDP); which is in line with the results of VECM.

5. Conclusion

This study examines the relationship among money supply, credit to private sector (financial deepening indicators) and GDP (Economic growth) for the period 1980-2012 for Nigeria. It explores the long-run relationship among the three variables: money supply, credit to private sector and GDP in the Nigerian financial context.

The three variables all have trend (non-stationary) but are cointegrated with at most one cointegrating equation. Bidirectional relationship runs among the three variables i.e past has influence on the present values.

There exist long-run relationships among the variables with -1.807 as the speed of adjustment towards equilibrium. Short-run change in both money supply and credit to private sector has short-run influence on GDP (Economic growth). Financial deepening indicators have increased over the period of the study.

6. Recommendations

Reference to the findings and conclusion reached at the end of the study; the following are recommended:

Improved corporate governance, financial system risk management and macroeconomic stability should be sustained

Adequate policies and efficient supervision of all financial institution should be provided and sustained in order to stimulates economic growth

Central bank of Nigeria (CBN) should reduce interest rate in the economy so that investors may raise their investment and financial output

Provision of credit to private sector holds great potentials in promoting economic growth

Government has to intensify the financial sector and carry out crucial measures to reinforce the long run relationship between financial deepening and economic growth in order to maintain sustainable economic growth.

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