The Long-Run Dynamic Relationship between Broad Money Supply and the GDP of Bangladesh: A VECM Approach

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Abstract
After commencing the cash economy money appeared as an engine of economic growth. The endeavor has given in this study to uncover out the underlying relationship between broad money supply (M_2) and GDP of Bangladesh and ascertain the influence of M_2 on GDP in selected study period. The Johansen Cointegretion test signifies that broad money supply and GDP are close-fitting and moving together in the long run. After fitting the Vector Error Correction Model it is discerned that there is an establishment of long run association between M_2 supply and GDP. The parameters of this model demonstrate that causality is running from broad money supply to GDP, meaning that M_2 manipulates the GDP enduringly. It is originated in the post estimation specification tests that there is no auto-correlation at lag order and residuals are normally distributed.
Keywords: Money Supply, GDP, VECM, Forecasting, Impulse Response Function

1. Introduction

Money is remarkably significant for any economy for its necessity and diverse characteristics. If money supply increases by expansionary monetary policy of central bank, interest rate will go down. Consequently, cash flow and lending activities will be prolonged. As a result, investment will gear up and gross output level is also expected to increase defining a positive relationship between money supply and economic growth. It is believed that, the channels through which monetary policy affects output are continually changing. And it might be too complex to identify all the transmissions mechanism in an economic system. From the perspective of liquidity, money can be classified in two types. One is Narrow money (M_1) and another one is defined as broad money (M_2). If the performance and effective circulation of broad money can be ensured, GDP growth is likely to go up. Besides, if monetization of the economy increases, GDP is also expected to increase startlingly. One of the most important determinants of economic growth is variation in the quantity of money and the country that devotes more time to study the behavior of aggregate money supply hardly experiences much variation in their economic performances (Robinson, 1952). It is expected from this study that the causality of broad money supply and GDP can be revealed and it will be helpful for the policy makers to formulate a more realistic monetary policy which can create an upbeat pressure on GDP the of Bangladesh. The amount of money floating around the economy and available for spending is need to studied fervently for clues to economic growth. Nevertheless to say, Money Supply has a powerful effect on economic activity which is directly linked to inflation also. If money supply grows faster than real GDP, inflation results since velocity stays relatively stable. Thus, it deserves special concentration on the study of money supply mechanism on GDP to ascertain the causality, sensitiveness, and cointegration exists between them.

2. Objective of the Study

The broad objective of this study is to explore the collision of money supply with the nominal GDP of Bangladesh. The specific objectives are to:

- Examine the role of Broad Money (M_2) supply in economic growth of Bangladesh
- Assess the causal relationship between M_2 and GDP since independence.
- Validate whether broad money supply eventually affects the GDP of Bangladesh and to what extent.

3. Literature Review

Sauer and Scheide (1995) revealed a causal relationship between M_1 and real domestic spending within a cointegration framework. Whereas, Estrella and Mishkin (1997) disclosed monetary aggregates are not helpful in predicting GDP irrespective of the chosen forecasting horizon. For Germany, Kirchgassner and Savioz (2001) demonstrate real GDP growth depends on M_1 and real interest rate. Furthermore, Fritsche (2002) found that M_1 is one of the best indicators for business cycle turning points, computed by the index of industrial production.

Lee and Li (1983) investigated causality among money, income and prices for Singapore and concluded bi-directional causality between income and money and uni-directional causality from money to prices. Joshi and Joshi (1985) founded a bi-directional causality between money and income in India. Abbas (1991) performed a causality test between money and income for Asian countries and found bi-directional causality in Pakistan, Malaysia and Thailand. Bengali et al. (1999) identified a bi-directional causality between money and income and uni-directional causality from money to prices in Pakistan.

Mehrara et. al (2010) examined the dynamic causal relationships among money, GDP and prices for Iran using annual data over the period 1960-2008. Here, they used Gregory-Hansen co-integration technique, allowing for the presence of potential structural breaks in data to empirically examine the long-run co- movement between the variables. The results suggested the presence of a long-run relationship between these variables.

Mohamadpour et. al (2012) unveil the relationships between monetary policy and GDP in Malaysia for quarterly data from 1991 to 2011. Here, the cointegration analysis and Vector Error Correction Models (VECM) were indicated a possibility of long-run equilibrium relationship between real GDP regards to M1, M2, M3, and real interest rate. However, results of trace and maximum Eigenvalue methods suggested two co-integration equations among the variables. Altogether, VECM analysis indicates monetary supply variables included in the model (M1, M2, and M3) are statistically significant and have long-term influence on GDP. Findings of this study suggested increasing money supply would eventually increase the real GDP in Malaysian economy.

Daniela and Mihali (2010) analyzed the relationship between money supply and gross domestic product for Romania. Analyzing the data of money supply (M3) and of GDP over ten years through the Augmented Dickey-Fuller they obtained that both series are non-stationary. Applying the co-integration analysis method it is concluded that the two series have a cointegration relationship between them and moving together in the long run.

4. Methodology and Data Source

Economic growth is a major concern for any developing countries because employment, human development, social welfare, poverty elevation is mostly depends on the substantial GDP growth. In this study I used following econometric techniques to show the impact and causality of broad money supply on the GDP of Bangladesh.

4.1 Semi Log Model

For better analyzing the time series data of different variables the significance of finding growth rate is high. For the estimation of constant growth rate following semi log model has been estimated.

$$LogY = \beta_0 + \beta_1 T + U_i$$

Where, Y is the depended variable, $\beta_0$denotes intercept, β_1 indicates regression co-efficient, T represents time, and U considered as the error term.

Trend compound growth rate can be estimated as follows;

*Growth rate = (Antilog β_2 - 1)*100*

4.2 Johansen Cointegretion Test

Johansen test is a superior procedure for cointegretion testing of several time series. Johansen Cointegration (JC) Test is used for series that are integrated of the same order. it is safe to proceed with Johansen Cointegration Test if all the variables are stationary after first difference in Augmented Dicker Fuller (ADF) unit root test. JC test permits more than one cointegrating relationship. Thus, it is more generally applicable than the Engle–Granger test which is based on the augmented Dickey–Fuller test for unit roots in the residuals from a single cointegrating relationship. Johansen test has been used in the study because it addresses many of the limitations of the Engle-Granger method. It avoids two-step estimators and provides comprehensive testing in the presence of multiple cointegrating relations. Its maximum likelihood approach incorporates the testing procedure into the process of model estimation, avoiding conditional estimates. Moreover, the test provides a framework for testing restrictions on the cointegrating relations B and the adjustment speeds A in the Vector Error Correction model.

There are two types of Johansen test, either with trace or with eigenvalue, and the inferences might be a little bit different. The null hypothesis for the trace test is the number of cointegration vectors. Just like a unit root test, there can be a constant term, a trend term, both, or neither in the model. For a general VAR (p) model:

$$X_t = \mu + \phi D_t + \pi_p X_{t-p} + ... + \pi_1 X_{t-1} + e_t, \qquad t = 1,...,T$$

At the core of the Johansen method is the relationship between the rank of the impact matrix C = AB′ and the size of its eigenvalues. The eigenvalues depend on the form of the VEC model, and in particular on the composition of its deterministic terms (see The Role of Deterministic Terms). The method infers the cointegration rank by testing the number of eigenvalues that are statistically different from 0, then conducts model estimation under the rank constraints. Although the method appears to be very different from the Engle-Granger method, it is essentially a multivariate generalization of the augmented Dickey-Fuller test for unit roots.

4.3 Vector Error Correction Model (VECM)

If cointegration is detected between series we know that there exists a long-term equilibrium relationship between them so we apply VECM in order to evaluate the short run properties of the cointegrated series. The VEC model extends the single equation error correction model to allow y and x to evolve jointly over time as in a VAR system. A vector error correction model (VECM) is a restricted VAR that has cointegration restrictions built into the specification, so that it is designed for use with nonstationary series that are known to be cointegrated.

The VEC specification restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing a wide range of short-run dynamics. Cointegration term is known as error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. There are two possible specifications for error correction:

1. The long run VECM:

$$\Delta X_t = \mu + D_t + \pi X_{t-p} + \Gamma_{p-1}\Delta X_{t-p+1} + ... + \Gamma_1 \Delta X_{t-1} + \varepsilon_{t,} \qquad t+1,...,T$$

Where,

$$\Gamma_i = \pi_1 + ... + \pi_i - I, \qquad i = 1,..., P-1$$

2. The transitory (Short run) VECM:

$$\Delta X_t = \mu + \phi D_t - \Gamma_{p\_1}\Delta X_{t-p+1} - ... - \Gamma \Delta X_{t-1} + \pi X_{t-1} + \varepsilon_{t,} \qquad t+1,...,T$$

Where,

$$\Gamma_i = (\pi_{i+1} + ... + \pi_p), \quad i = 1,..., P-1$$

The chief objective of estimating VECM is to define the exact long run relationship between broad money supply and GDP in Bangladesh. The error correction terms of VECM describe how the time-series adjust to disequilibrium. In VECM the cointegration rank shows the number of cointegrating vectors.

4.4 Lagrange-multiplier Test

The VEC lagrange-multiplier (VECLMR) technique has been used to test the serial serial correlaion in the residuals.

Here the Hypothesis is,

H_0: no autocorrelation at lag order
H_1: autocorrelation at lag order

If the H_0 can rejected on the basis on VECLMR estimates it can be concluded that there is a auto correlation in the residuals and vice versa.

4.5 Normality test of VECM

In this study Jarque-Bera test approach has been adopted to test the normality of VECM. By adopting Vector error correction normality test it can be confirmed that whether the errors are normally distributed or not.

Here the Hypothesis is,

H_0: errors are normally distributed
H_1: errors are not normally distributed

The Null Hypothesis (H_0) can be strongly rejected if Most of the errors are both skewed and kurtotic and vice versa.

4.6 Augmented Dicky-Fuller (ADF) Test

Time series stationarity is the statistical characteristics of a series such as its mean and variance over time. If both are constant over time, then the series is said to be a stationary process (i.e. is not a random walk/has no unit root), otherwise, the series is described as being a non-stationary process (i.e. a random walk/has unit root). Differencing a series using differencing operations produces other sets of observations such as the first-differenced values, the second-differenced values and so on.

x level x_t

x 1st -diiferenced value $x_t - x_{t-1}$

x 2nd *-diiferenced value* $x_t - x_{t-2}$

Dicky-Fuller (DF) test is widely used to test the unit root of time series data. DF Unit Root Test are based on the following three regression forms:

I. Without Constant and Trend: $\Delta y_t = \delta y_{t-1} + u_t$

II. With Constant : $\Delta y_t = \alpha_0 + \delta y_{t-1} + u_t$

III. With Constant and Trend: $\Delta y_t = \alpha_0 + \beta T + \delta y_{t-1} + u_t$

Hypothesis:

H_0 :δ = 0 (Unit root or Non stationary)
H_1 :δ≠ 0 (Stationary)

Decision rule:

If t* > ADF crtitical value, ==> not reject null hypothesis, i.e., unit root exists.
If t* < ADF critical value, ==> reject null hypothesis, i.e., unit root does not exist.

There is a scope to arise autocorrelation in Dicky-Fuller (DF) test. Thus to avoid this problem I used Augmented Dicky-Fuller (ADF) test to check the unit root of the variables.

4.7 Impulse Response Functions for VECM

Impulse response function (IRF) describes how the economy reacts over time to exogenous impulses, which usually call 'shocks'. These functions illustrate the reaction of endogenous macroeconomic variables such as output, consumption, investment, and employment at the time of the shock and over subsequent points in time. In this study it will be possible to say whether monetary shock affects the GDP of Bangladesh over time by estimating IRF. From the well specified VECM, it can be estimated and interpret the IRFs. Whereas IRF from a stationary VAR die out over time, IRF from a co-integrating VECM do not always die out. Because each variable in a stationary VAR has a time-invariant mean and finite, time-invariant variance, the effect of a shock to any one of these variables must die out so that the variable can revert to its mean. In contrast, the variables modeled in a cointegrating VECM are not mean reverting, and the unit module in the companion matrix imply that effects of some shocks will not die out over time. These two possibilities gave rise to new terms. When the effect of a shock dies out over time, the shock is said to be transitory and when the effect of a shock does not die out over time, the shock is said to be permanent.

4.8 Data Source

Data for this study has been collected form the Central Bank of Bangladesh. All time series data of broad money and GDP is available in the e-portal of Bangladesh Bank (Central Bank). It deserves special mention that, the variable GDP which is considered for the analysis is in nominal term. From 1974 to 1989 M_2 is formulated by adding narrow money (M_1) and time deposits. Here, narrow money consists of currency outside the bank and demand deposits. Counting procedure for M_2 has changed slightly from 1990 to till date. Net foreign assets and net domestic assets are considered to construct M_2 at the present.

5. Results and discussion

In this section, a quantitative study has been conducted based on the real time data. In this instance time series econometrics (i.e. JC test, VECM, Lagrange-multiplier test, ADF test, IRF), semi log and ARMAX model has been estimated and interpret the results and probabilities, as well as provide further explanation of the method behind.

5.1 Historical Trend of M_2 and GDP

It is appeared in the figure below that quantity of broad money supply was minimal initially and starts increasing modestly after 1985. Trend of M_2 was almost same between the periods of 1974 to 1985. It seems after 1990 M_2 is in upward trend and continue to soar. Here it is noted that in 1973 supply of broad money was counted for 1244.5 crore and in 1990 it stood up at 25004.4 crore with a growth of 19%. Total broad money goes to 517109.5 crore in 2012.

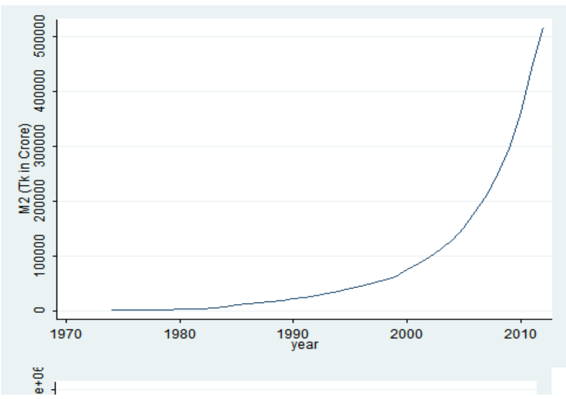


Figure 1: Trend of M_2 supply from 1974 to 2012

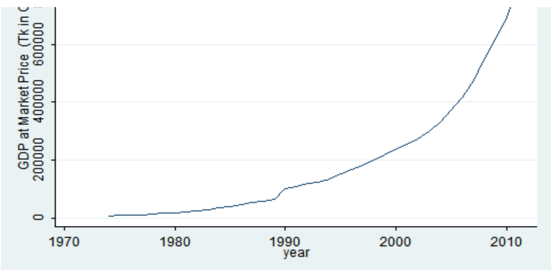


Figure 2: Trend of GDP from 1974 to 2012

From the trend line of GDP it seems that it is moving with the similar pattern of M_2. Initially the GDP of Bangladesh was low. Then it is flickered that GDP is in upbeat trend as quantity of M_2 increases. It is evident that after 1990s the GDP of Bangladesh is going tremendously higher. So there is a similar trend subsists between GDP and M_2

5.2 Growth of M_2 and GDP

It is essential to derive the constant growth rate of GDP and M_2. From the derivation of growth rate, it can be stated that whether any differential exists between GDP and M_2.

The estimated log linear model helps to scan the constant growth rate of GDP and M_2 over the time period. Here the adjusted R^2 is found 0.98 for both estimates which indicates the models are explained 98% of total variation. From the regression co-efficient it is evident that the growth rate of GDP and M_2 are correspondingly 12%, and 15% and statistically significant at 1%. It seems that growth of M_2 is notably higher than the growth of GDP during the period of 1974 to 2012.

Table 1: Estimates of Log Linear Model

	Whole Period		Fixed ER regime		Floating ER Regime	
	GDP	**M_2**	**GDP**	**M_2**	**GDP**	**M_2**
Co-efficient	0.12	0.15	0.13	0.16	0.12	0.17
Adj. R^2	0.98	0.98	0.98	0.98	0.98	0.98
T-statistics	51.96***	61.08***	40***	39.2***	67.9***	59.7***
Standard Error	0.002	0.058	0.003	0.004	0.001	0.002

Note: ** p<0.05, *** p<0.01

From the below table a comparative view can be found of the growth rate of GDP and M_2 for the pre floating exchange rate period and post fixed exchange rate period. Here the adjusted R^2 is significantly higher for the both results which indicate the better reliability of the model. The estimated semi log model postulates that growth rate of GDP and M_2 are 13% and 16% respectively during fixed exchange rate period and regression co-efficient is statistically significant at 1 percent level. It seems growth rate of M_2 is prominently higher than the growth rate of GDP in that period. Besides, the model based on floating exchange rate period denotes that growth rate of GDP and M_2 are correspondingly 12% and 17%. It is appeared that growth rate of M_2 is remarkably higher than the growth rate of GDP which is similar to the pre floating exchange rate period models' outcome. It is also notable that growth rate of M_2 is significantly higher in floating, fixed and entire exchange rate period compared to that of GDP. Moreover, it is appeared that there is no any momentous change in GDP growth rate during the different time period.

7.3 Cointegration Analysis

If the log likelihood of the unconstrained model that includes the cointegrating equations is significantly different from the log likelihood of the constrained model that does not include the cointegrating equations, we reject the null hypothesis of no cointegration. Johansen's approach derives two likelihood estimators for the cointegration (CI) rank. One is trace test and another one is maximum Eigen value test. The trace statistic either rejects the null hypothesis of no cointegration among the variables or does not reject the null hypothesis that there is one cointegration relation between the variables.

Table 2: Johansen Cointegration Test

Trend: Restricted constant; Sample (1980-2012)				
Rank	Parameter	Eigenvalue	Trace Statistic	5% Critical Value
0	20		34.45	24.6
1	24	0.618	2.6707*1*5	12.97
2	26	0.077		
No. of observation		33	Lag	6

Note: Trace statistic is significant at 1% and 5% level with rank 1

It seems in Table 1 that, there is cointegration between log M_2 and log GDP. In the output above, we strongly reject the null hypothesis of no cointegration between the variables of rank 0 and fail to reject the null hypothesis of at most one cointegrating equation of rank 1. Thus we accept the null hypothesis that there is one cointegrating equation in the bivariate model. Hence, it can be avowed that M_2 and GDP are cointegrated and moving together in the long run.

5.4 Fitting Vector Error Correction Model (VECM)

Since the variables are cointregrated we are allowed run the VECM. It is proved in JC test that GDP and M_2has long run association. So fitting the VECM is now considerable for further analysis.

The first model is error correction model and this one is our target model where GDP is dependent variable. Here the error correction term is -1.253 and probability value is very small and found less than 5 percent, meaning that error correction term is significant. Since the co-efficient is negative and statistically significant, it can be said that there is a long run causality running form independent variable such as $M_2$to GDP, meaning that broad money supply has influence on GDP in the long run. Furthermore, it seems first four lag of GDP and all six the lag of M_2 is significant. So, these variables can explain the dependent variable individually.

Table 3: Estimates of VECM, Trend: restricted constant

	1st Difference of log GDP			1st Difference of log M_2		
	Coef.	z	P>|z|	Coef.	Z	P>|z|
Cointegrating Equation of Lag 1	-1.25	-5.15	0	0.175	0.6	0.552
lag Difference of log GDP	0.457	2.67	0.008	-0.2386	-1.15	0.249
lag Difference of log M_2	-0.538	-2.17	0.03	0.599	2	0.046
R^2 of 1st Diff. of log GDP			0.92	R^2 of 1st Diff. of log M_2		0.93
No. of Observation		33				
Log likelihood		121.03				

Above estimates of VECM demonstrates co-efficient of determination for 1st difference of log GDP is 0.92 and co-efficient of determination for 1st difference of log M_2 is 0.93 which signifies the model explain 92 percent and 93 percent of total variation respectively.

5.5 Postestimation Specification Testing

Inference on the parameters in α depends crucially on the stationarity of the cointegrating equations, so we should check the specification of the model.

Now, testing for serial autocorrelation in the disturbance term we find out that there is no autocorrelation at lag order (Table-4).It seems p value is higher than 5% critical values which allow accepting the null hypothesis of having no auto correlation in lag order. So, it can be stated that this model has goodness of fit and explain the co integrating relationship accurately among the variables.

Table 4: Lagrange-multiplier test

lag	Chi Square	Degrees of freedom	Prob> Chi^2
1	0.5721	4	0.96611
2	5.4765	4	0.2418

Whether the residuals are normally distributed or not we run the normality distribution test. Here Jarque-Bera test method is used for this diagnostic check.

Table 5: Jarque-Bera test

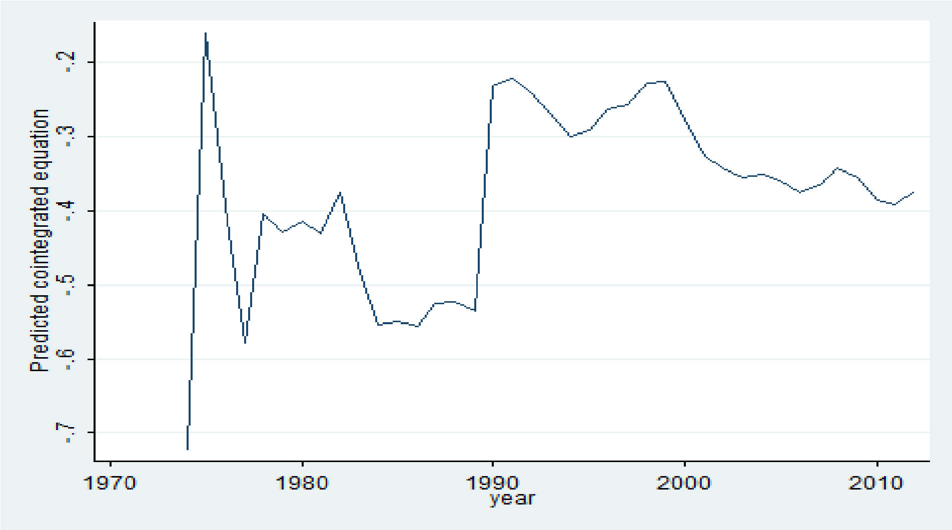
Equation	Chi Square	Degrees of Freedom	Prob> chi2
1stDifferen	1.971	2	0.37331
1stDifferen	0.128	2	0.93797
All	2.099	4	0.71759

In the test null hypothesis is designed as Residuals are normally distributed. In the first model GDP is dependent variable and the probability is 37.3 percent which is more than 5 percent. In this case we accept the null hypothesis, which indicates residuals are normally distributed. For the second model p value is also more than 5%, which allow us to accept the null hypothesis. Now as a whole the probability value is 71.75 percent which is more than 5 percent, meaning that we cannot reject the null hypothesis rather we accept the null hypothesis. So it can be confirmed that residuals are normally distributed which is desirable outcome. Now it is proved that model is well specified and can be accepted because it doesn't have autocorrelation problem and residuals are normally distributed.

5.5.1 Stationary Test for Co-integration Equation

Estimates of ADF Unit Root Test for Error Term

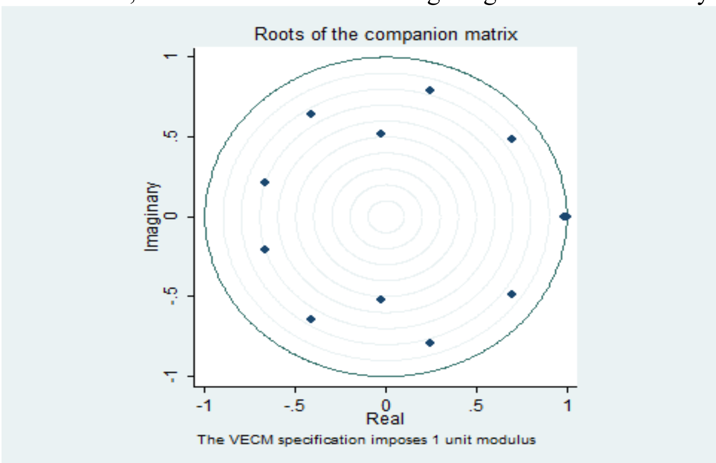
Test Statistic	1% Critical Value	5% Critical Value	No. of observation	P value
-4.547	-3.62	-2.964	38	0.0002



It is very significant to check whether stationary exists in the variables after co-integration test. Above Augmented Dickey-Fuller estimates obviously signifies the stationary in the error term of the variables such as M_2 and GDP. Hence, it can be stated that the model is correctly specified and the conclusion from the simulation is satisfactory.

5.5.2 Stability Check

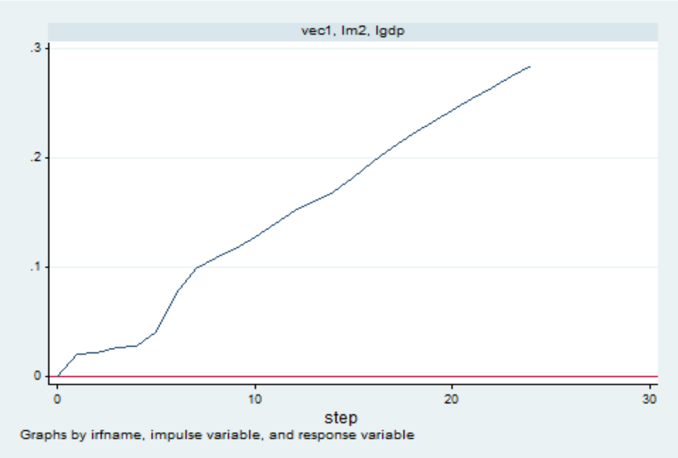
By the stability check it can be affirmed that whether number of cointegrating equations are correctly specified. The companion matrix of a VECM with *K* endogenous variables and *r* cointegrating equation *K-r* unit eigenvalues. If the process is stable, the moduli of the remaining *r* eigenvalues are strictly less than one.



From the above graph, the plotted eigenvalues of the companion matrix can be observed. The graph of the eigenvalues shows that none of the remaining eigenvalues close to the unit circle. The outcome of the stability check does not indicate that the VECM model is misspecified.

5.6 Impulse-response functions for VECMs

In this state the IRF has bent estimated to identify the shock of money supply on GDP. There are two outcomes of the results. When the effect of a shock dies out over time, the shock is said to be transitory. When the effect of a shock does not die out over time, the shock is said to be permanent.



Finding out impulse response functions it seems that there is a positive effect on GDP if there is a exogenous shock on money supply, and if there is a positive shock on money supply GDP has an exogenous positive shock. It can be stated from the estimates that the shock of M_2 is permanent on GDP where the effect of a shock does not die out over the time.

5.7 Forecasting with VECM

Cointegrating VECM are also used to produce forecasts of both the first-differenced variables and the levels of the variables. Comparing the variances of the forecast errors of stationary VARs with those from a cointegrating VECM reveals a fundamental difference between the two models. Whereas the variances of the forecast errors for a stationary VAR converge to a constant as the prediction horizon grows, the variances of the forecast errors for the levels of a cointegrating VECM diverge with the forecast horizon. Because all the variables in the model for the first differences are stationary, the forecast errors for the dynamic forecasts of the first differences remain finite. In contrast, the forecast errors for the dynamic forecasts of the levels diverge to infinity.

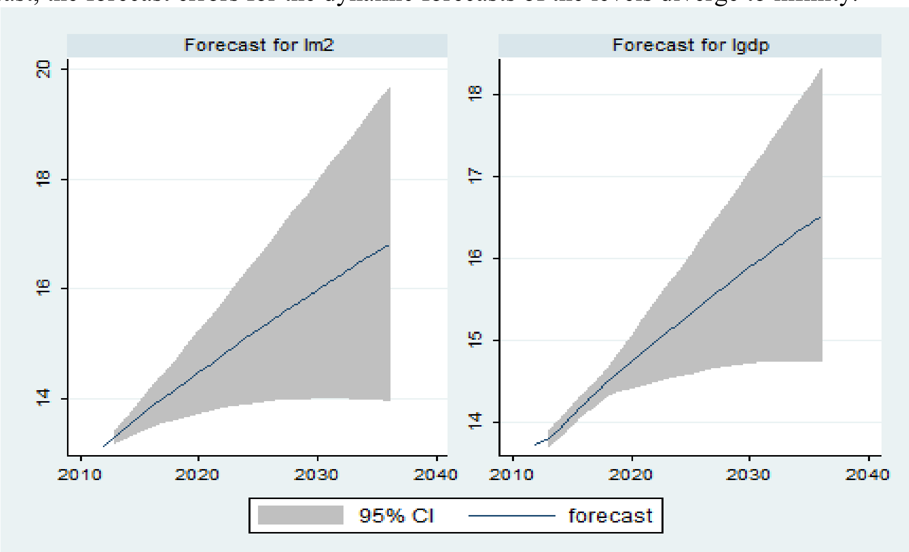


Fig 5: Forecasting of M_2 and GDP

Here, i obtain dynamic forecasts of the levels and generate graph of these dynamic forecasts, along with their asymptotic confidence intervals. As expected, the widths of the confidence intervals grow with the forecast horizon. It seems that M_2 grows along with the GDP with similar trend during the forecasting period 2013 to 2035. Which signifies GDP is optimistically impacted with the growth of M_2.

6. Conclusion

It is evident that broad money supply and GDP are cointegrated at rank 1 in johansen test, meaning that these two variables are moving together. Consequently, VECM model is fitted and seems GDP and M_2 has relationship both in short run and long run, which indicates there is an influence of M_2 on the GDP. Here, no autocorrelation is found at lag order. After that, the impulse response function is estimated to examine whether there is a permanent or transitory shock of broad money supply on GDP. It is found that there is a positive effect on GDP if there is an exogenous shock on broad money supply and the shock of M_2 is appeared permanent on GDP. In the present context of Bangladesh, beside the broad money supply it is very requisite to ensure that money is going to productive sector rather than unproductive sector. In order to meet the targeted growth, liquidity and investment friendly interest rate is obligatory and apart from this other relevant issues like producer and consumer confidence, political stability, necessary infrastructure and level playing field for all is very essential. Finally, it can be acknowledged confidently from the study that expansionary monetary policy has momentous impact on GDP as well as economic expansion. It is also noteworthy to take accommodating fiscal and monetary policy to stimulate economic growth and prosperity. Only fiscal or monetary policy can't bring fruitful outcome for the Bangladesh economy.

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Appendix

Year	GDP at Market Price (Tk in Crore)	M2 (Tk in Crore)
1973-74	7108.6	1244.5
1974-75	12574.1	1259.6
1975-76	10745.8	1396.8
1976-77	10536.1	1739.8
1977-78	14636.5	2141.0
1978-79	17281.9	2760.0
1979-80	19798.5	3244.9
1980-81	23326.3	4136.0
1981-82	26514.4	4548.7
1982-83	28842.3	5899.2
1983-84	34992.2	8385.8
1984-85	41696.2	10534.2
1985-86	46622.7	12338.1
1986-87	53920.1	14353.1
1987-88	59713.6	16408.0
1988-89	65959.8	19078.1
1989-90	100329	22297.6
1990-91	110518	25004.4
1991-92	119542	28526.0
1992-93	125370	31535.6
1993-94	135412	36403.0
1994-95	152518	42212.3
1995-96	166324	45690.5
1996-97	180701	50627.5
1997-98	200177	55869.1
1998-99	219697	63027.1
1999-00	237086	74762.4
2000-01	253546	87174.2
2001-02	273201	98616.0
2002-03	300580	113994.5
2003-04	332973	129721.2
2004-05	370707	151446.4
2005-06	415728	180674.2
2006-07	472477	211504.4
2007-08	545822	248794.9
2008-09	614795	296499.7
2009-10	694324	363031.2
2010-11	796704	440519.9
2011-12	914784	517109.5

Developing Country Studies
ISSN 2224-607X (Paper) ISSN 2225-0565 (Online)
Vol.4, No.14, 2014

Vector error-correction model

Sample: 1980 - 2012

		No. of obs	= 33
		AIC	= -5.881142
Log likelihood =	121.0388	HQIC	= -5.514939
Det(Sigma_ml) =	2.23e-06	SBIC	= -4.792773

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lgdp	11	.044705	0.9270	266.7589	0.0000
D_lm2	11	.054131	0.9300	279.0987	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_lgdp						
_ce1						
L1.	-1.25338	.2432365	-5.15	0.000	-1.730115	-.7766453
lgdp						
LD.	.4571578	.1711237	2.67	0.008	.1217615	.7925541
L2D.	.3186017	.1550978	2.05	0.040	.0146157	.6225878
L3D.	.3546423	.1411169	2.51	0.012	.0780582	.6312264
L4D.	.1995995	.1352144	1.48	0.140	-.0654159	.4646149
L5D.	.0027163	.0794446	0.03	0.973	-.1529922	.1584248
lm2						
LD.	-.5382375	.2474968	-2.17	0.030	-1.023322	-.0531528
L2D.	-.7699622	.2270241	-3.39	0.001	-1.214921	-.3250031
L3D.	-.6498488	.2403544	-2.70	0.007	-1.120935	-.1787628
L4D.	-.7066321	.2357187	-3.00	0.003	-1.168632	-.244632
L5D.	-.4765827	.2272807	-2.10	0.036	-.9220447	-.0311207
D_lm2						
_ce1						
L1.	.1753117	.2945226	0.60	0.552	-.401942	.7525653
lgdp						
LD.	-.2386295	.2072049	-1.15	0.249	-.6447437	.1674847
L2D.	-.0174409	.1878	-0.09	0.926	-.3855221	.3506402
L3D.	.1038019	.1708713	0.61	0.544	-.2310996	.4387034
L4D.	-.1528772	.1637242	-0.93	0.350	-.4737708	.1680165
L5D.	.0778571	.0961954	0.81	0.418	-.1106824	.2663965
lm2						
LD.	.5992729	.2996811	2.00	0.046	.0119087	1.186637
L2D.	.2293549	.2748918	0.83	0.404	-.3094232	.768133
L3D.	.0651354	.2910328	0.22	0.823	-.5052784	.6355493
L4D.	.2471432	.2854197	0.87	0.387	-.3122691	.8065555
L5D.	.4018463	.2752026	1.46	0.144	-.1375408	.9412334

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	1	20903	0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
lgdp	1	.	.	.	.	.
lm2	-.7479096	.005173	-144.58	0.000	-.7580486	-.7377707
_cons	-4.260878	.0796948	-53.46	0.000	-4.417077	-4.104679

Johansen tests for cointegration

Trend: rconstant Number of obs = 33
Sample: 1980 - 2012 Lags = 6

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value	1% critical value
0	20	105.1447		34.4590	19.96	24.60
1	24	121.03884	0.61836	2.6707*1*5	9.42	12.97
2	26	122.37421	0.07774			

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
.9886485	.988649
.6993845 + .4875771*i*	.852567
.6993845 - .4875771*i*	.852567
.2457001 + .7901496*i*	.827469
.2457001 - .7901496*i*	.827469
-.4091781 + .6437522*i*	.762787
-.4091781 - .6437522*i*	.762787
-.670084 + .2095992*i*	.7021
-.670084 - .2095992*i*	.7021
-.02418005 + .5196861*i*	.520248
-.02418005 - .5196861*i*	.520248

The VECM specification imposes a unit modulus.