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# The Interrelationship between Money Supply and Nominal GDP in Bangladesh

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**Abstract**

The interrelationship between money supply (M2) and nominal GDP has been an area of investigation by monetary economists. Examining this relationship has been of crucial importance for an economy like Bangladesh where growth and inflation confront each other. This paper attempts to unveil this relationship through empirical exercises. Taking data from 1975 to 2013, this work finds M2 positively impacts nominal GDP. The Granger causality test suggests an unidirectional causality from M2 to GDP in a positive fashion. The error correction model is used to understand the short run dynamics of the long run relationship of M2 and nominal GDP. Autoregressive distributed lag (ARDL) models suggest money supply and nominal GDP are cointegrated. Short run and long run relationships have been analyzed in this paper to understand the relationship of GDP and M2. The analysis and inference of ARDL model will help formulate better monetary policy in Bangladesh for maintaining flexible inflation in order to achieve desired economic growth.

Key words: Macroeconomics, money supply (M2), monetary policy, econometrics and Model Construction and Estimation.

JEL classification: B22, E51, E52, C01and C51.

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## 1.Introduction

Causality between money supply and nominal GDP has emerged as a recurrent issue in recent decades. There is theoretical debate whether money supply can augment output. This study suggests that proper money supply is linked with nominal GDP growth. According to the quantity theory of money the money supply is positively related with GDP. This study has attempted to establish the causal relationship of the stipulated variables with the help of ARDL model as an analytical tool.

Econometric analysis with the help of ARDL model is pursued in this study to understand the causal relationship between money supply and nominal GDP.

## 2.Literature Review

Very few studies are found linking money supply and GDP in Bangladesh. No substantial study is made using appropriate econometric methodology taking into account the times series data. To fill-up the gap this study is conducted. Rahman (2009) uses the ARDL approach and examines the importance of exports, foreign direct investment, and remittances to GDP of South Asian countries. A number of studies attempts to use IIP as a proxy of GDP, which may be inappropriate for a country like Bangladesh pointed out by Dua (2001). The ARDL method is useful for small sample. Contrarily, the Johansen cointegration technique, mentioned by Johanson (1990) requires larger samples for the result appropriateness identified by Ghatak (2005).

The banking school suggests that money supply as an endogenous factor depends on business attribute. The demand for money is passively depend on money supply mentioned by Blanchard (2003). Sims (1972) has shown new and active arena of research on the empirical causal relationship between money and GDP. Khan (1990) suggests in Pakistan unidirectional causality prevail between money and GDP. Empirical evidence on Bangladesh linking money, prices income and interest rate is found by Chowdhury (1995). According to Biswas (1999) GDP and money supply are cointegrated in India. The empirical results show that money income are cointegrated in Bangladesh, implying that there is stable long run relationship between them elaborated by Hossain (2011). Granger causality test depend on monthly data ranging June 1974-December 1985 the article prepared by Jones (1988) were able to determine the causal link between money- GDP and money-inflation in case of Bangladesh. Depending on relationship of cointegration between money and GDP study conducted error correction estimates and established the presence of feedback between the two variables articulated by Abdullah (1996).

## 3.Long run and Short run Relationship between money and nominal GDP

**Model Specification:**

The broad money (M2) and nominal GDP data ranging 1975 to 2013 are used in our ARDL exercise. According to the quantity theory of money we know that MV=PY. Or, M=Y+P-(-V). In developing country like Bangladesh the percentage change of income velocity of money (GDP/M2) over the year is negative. In our quantity theory of money if we assume velocity (V) is constant then nominal GDP (PY) is a function of money supply (M). In this study we have deployed ARDL approach to measure the short-run and long-run impact on GDP due to change in money supply.

$$gdp = \alpha + \beta M_2 + \varepsilon \quad (1)$$

Granger Causality Test:

Granger causality test is used to examine the causality between M2 and GDP. Based on this test, it's possible to determine the direction of causality between two variables.

Table-1: Granger Causality Test

| Null Hypothesis: | F-Statistic | Probability |
|---|---|---|
| M2 does not Granger cause GDP | 3.196 | 0.054 |
| GDP does not Granger cause M2 | 1.128 | 0.336 |

Source: Statistics Department of BB and Bangladesh Bureau of Statistics (BBS).Year:2014

**4. The ARDL Bounds Test Approach**

It is generally used Error Correction Model (ECM) to estimate short run and long run elasticity in the presence of cointegation. But, Inder (1993) presents a comparison of different approaches to estimate long run economic relationships and concludes that Unrestricted Error Correction Models (UECM) give precise estimates and valid t tests even in the presence of endogenous variables.

A relatively recent alternative approach to cointegration analysis has been put forth in a series of studies by Pesaran and Pesaran (1997), Pesaran and Smith (1998) Pesaran and Shin (1999), and Pesaran et al. (2001). This approach employs ARDL procedure using the bounds test for cointegration analysis. This approach has been advocated to correct for the small sample bias (see Pesaran and Shin, 1999).

The ARDL ‘‘Bounds test’’ approach is based on the ordinary least square (OLS) estimation of a conditional unrestricted error correction model (UECM) for cointegration analysis developed by Pesaran et al. (2001). It is used here to test for the existence of a long run relationship as well as to make an estimation of long and short run coefficients for the study. From the ARDL we can derive a dynamic error correction model (ECM) following a simple linear transformation, where the ECM integrates short run dynamics with long run equilibrium without losing long run information.

The above specification in (1) is transformed into ARDL specification as in Pesaran et al. (2001):

$$\Delta gdp_t = \beta_0 + \sum_{i=0}^{i=1}\beta_{1i}\Delta gdp_{t-i} + \sum_{i=0}^{i=1}\beta_{2i}\Delta m2_{t-i} + \beta_3 gdp_{t-1} + \beta_4 m2_{t-1} + \varepsilon_t \qquad (2)$$

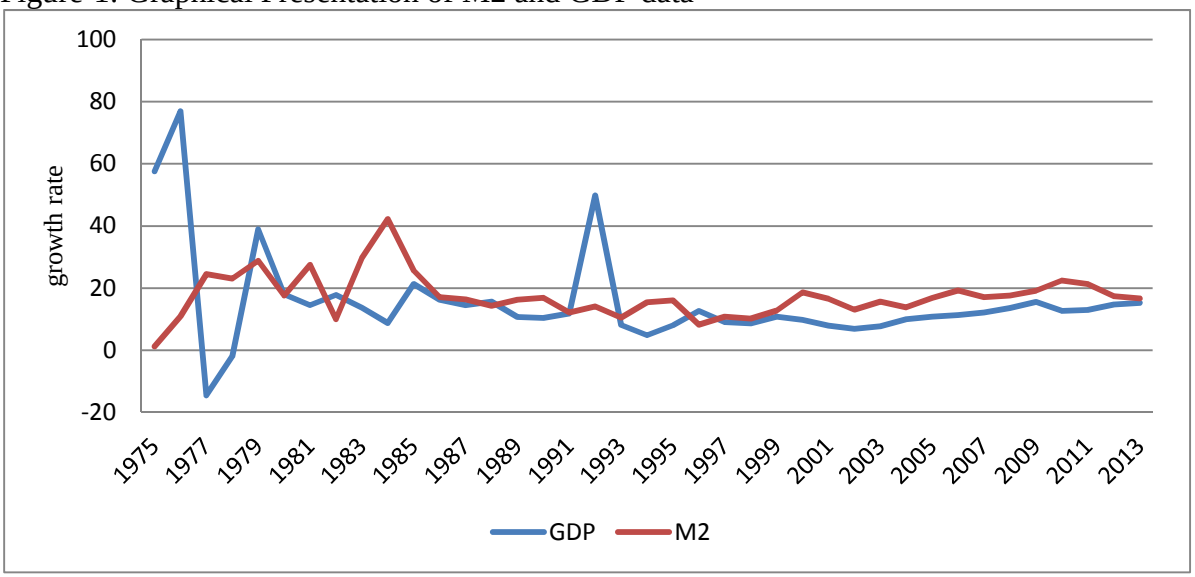
Where; Δ shows the first differences of the variables. We then test for co-integration using the bounds test procedure. The bounds test is based on the Wald or F-Statistic and follows a non- standard distribution (Pesaran, 2001). The null hypothesis is: no co-integrating relationship among the variables. The null hypothesis of no co-integration is tested by using ARDL UECM in (1) without the difference lagged variables.

The ARDL restricted ECM model is defined as:

$$gdp_t = \beta_0 + \sum_{i=0}^{i=1}\beta_{1i}\Delta gdp_{t-i} + \sum_{i=0}^{i=1}\beta_{2i}\Delta m2_{t-i} + \gamma ecm_{t-1} + \varepsilon_t \qquad (3)$$

The coefficients of the lagged difference variables provide the short run dynamics of the model converging to the equilibrium path while we expect $\gamma$ to be < 0 for it implies stability of the model. The coefficient of the *ecm* term signifies the speed of adjustment to equilibrium after a shock. The graphical relationship between M2 and GDP is shown in figure-1.

Figure-1: Graphical Presentation of M2 and GDP data




Source: Statistics Department of BB and Bangladesh Bureau of Statistics (BBS), 2014

## 5. Empirical Results and Analysis

### Unit Root Test for Stationarity

The choice of most appropriate unit root test is difficult in practice. Ender (1995) suggested that a safe choice is to use unit root test—the Augmented Dickey–Fuller (ADF) (1981) test. The Augmented Dickey-Fuller (ADF) test is widely applied for unit root tests. Therefore, to test stationarity, we conducted the widely used method of unit root tests—the ADF test—on the variables M2 and nominal GDP for Bangladesh. The unit root tests were performed at level and at first difference with the trend and intercept term. The optimum lag was selected by using the Akaike Information Criterion (AIC). A summary of the ADF unit root test result is presented in Table- 2.

Table - 2: Augmented Dicky Fuller Test of Unit root

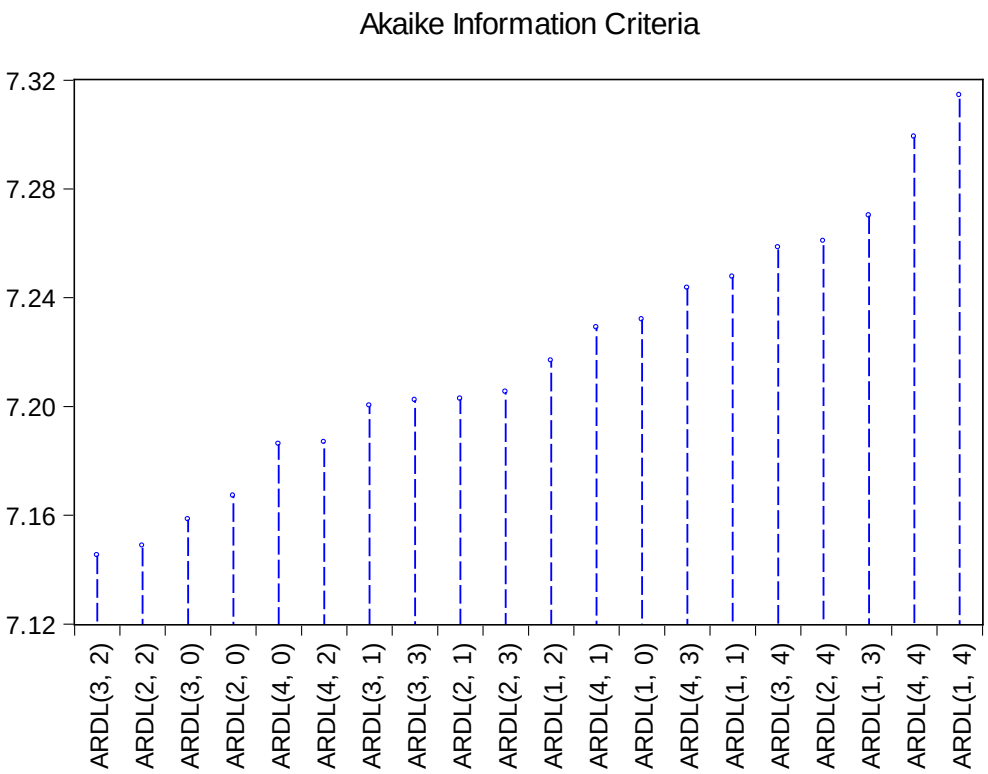
| Variables | Model | T-statistic | Integration |
|---|---|---|---|
| GDP | Trend and intercept | -6.005[0.000] | I(0) |
| M2 | Trend and intercept | -5.499[0.000] | I(1) |

Source: Statistics Department of BB and Bangladesh Bureau of Statistics (BBS), 2014

Table-2:Shows that GDP is I(0) and M2 is I(1), which is in a mixed form. None of variable is I(2).This suggest to perform ARDL Bound test approach (Pesaran, 2001).

## 6. Model Selection Criterion

The criterion for variables lag order selection is presented in the following graph. On the basis of the Akaike Information Criterion (AIC). the optimal lag length has been selected. According to the AIC, among the top 20 model our best model for this study is ARDL (3,2) model.




Source: Statistics Department of BB and Bangladesh Bureau of Statistics (BBS), 2014

**Results of the ARDL Bounds Tests:**

In order to determine the presence of a long run relationship between the variables M2 and nominal GDP the bounds test is conducted. The result of Bounds test is presented in Table-3.

It is evident from Table-3 that the computed F-statistic based on Wald test is 6.045 which exceeded the all upper bounds value. As the co-integration exists among the variables used in the model, therefore, the result presented for the long run are reliable.

Table-3: Bounds Test Result

| F-statistic = 6.045 | | |
|---|---|---|
| Level of Significance | Lower Bound Value | Upper Bound Value |
| 10% | 3.02 | 3.51 |
| 5% | 3.62 | 4.16 |
| 2.5% | 4.18 | 4.79 |
| 1% | 4.94 | 5.58 |

Source: Statistics Department of BB and Bangladesh Bureau of Statistics (BBS), 2014

Table-4: Long Run Estimation

| Dependent Variable: GDP | | | | |
|---|---|---|---|---|
| Variables Name | Coefficient | T-Ratio | Std. Error | P-Value |
| M2 | 0.401936 | 0.233080 | 1.724457 | 0.0953 |
| C | 6.238098 | 4.324278 | 1.442576 | 0.1599 |

Source: Statistics Department of BB and Bangladesh Bureau of Statistics (BBS), 2014

Table-5: Short Run Estimation and ECM

| Dependent Variable: GDP | | | | |
|---|---|---|---|---|
| Variables Name | Coefficient | T-Ratio | Std. Error | P-Value |
| D(GDP(-1)) | 0.133802 | 0.142892 | 0.936381 | 0.3568 |
| D(GDP(-2)) | -0.127510 | 0.100318 | -1.271051 | 0.2138 |
| D(M2) | 0.061721 | 0.228660 | 0.269926 | 0.7891 |
| D(M2(-1)) | -0.428651 | 0.220000 | -1.948417 | 0.0611 |
| CointEq(-1) | -1.144009 | 0.275178 | -4.157337 | 0.0003 |
| Cointeq = GDP - (0.4019*M2 + 6.2381 ) | | | | |

Source: Statistics Department of BB and Bangladesh Bureau of Statistics (BBS), 2014

According to the AIC an ARDL (3,2) model is selected in this study. Long-run and short run estimated coefficient of ARDL is presented in Table 4 and Table 5. The estimated coefficient of GDP is 0.40, which is significant at 10% level. GDP coefficient suggests that nominal GDP rises by 40 basis point due to 1 unit change in M2. The error correction term is -1.14 and significant at 1% level, which implies that disequilibrium in long-run equilibrium, is adjusted to steady path if there is shock in the system.

**Autocorrelation Diagnostic checking**

Breusch-Godfrey Serial Correlation LM test and unit root of the model residuals are examined to see if there is any autocorrelation. The LM test is performed at different lags which are given below:-

| Lag | LM F-statistic | P-value |
|---|---|---|
| 1 | 0.273 | 0.605 |
| 2 | 0.224 | 0.801 |

The F statistic value of LM test up to lag 2 is insignificant at 5% level of significance, suggesting there is no autocorrelation in the model residuals.

Correlogram Q-staitstics up to 16 lags shows that none of the statistics is significant. This result also conform to the findings from Breusch-Godfrey Serial Correlation LM test that there is no serial correlation in the residuals. The plots and Q-statistics probabilities upto 16 lags are given in Annexure

**Heteroskedasticity Test**

It is likely that time series data shows variability over time that is residuals can be heteroskedastic. So, Autoregressive Conditional Heteroskedasticity (ARCH) test is used to see whether the conditional variances of errors identical or varying across time. The following table gives the result of ARCH test for heteroskedasticity.

| Lag | Chi-Square value | p-value |
|---|---|---|
| 1 | 0.065 | 0.799 |

The above results shows that the probability values of chi-square for selected lag are greater than 5% level of significance, which suggests the null hypothesis that there is no ARCH up to the order specified by the lag cannot be rejected.

**Model Specification Test**

The model specified in this study is correctly formed according to Ramsey RESET (Regression Specific Error Test) test which is a general test to check the correctness of the specification of the model. The results of Ramsey RESET test is furnished in the following manner:

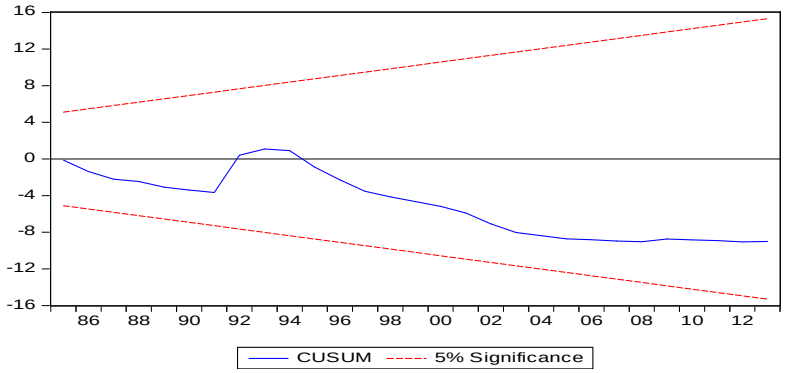
| Omitted variables | F statistic | p-value |
|---|---|---|
| Squares of regressors | 0.306 | 0.585 |

The p values of F statistic indicates the null hypothesis that the coefficients of omitted variables (squares of fitted regressors) is zero cannot be rejected at 5% level of significance. It means that the model without any quadratic terms of specified regressors is a good fit.

**Stability Test**

Cumulative sum (CUSUM) test has been examined to test the stability of long run coefficient. The result obtained is given in the following figure-2:

Figure-2: Stability test of coefficient




Source: Statistics Department and Bangladesh Bureau of Statistics (BBS), 2014

It can be seen from the above Figure that the plot of CUSUM stays within the critical 5% bounds which confirms the stability of coefficient in the long run.

## 7. Conclusion

This article has attempted to understand the causal relationship between broad money (M2) and nominal GDP of Bangladesh. The short run and long run relationship of money and nominal GDP is articulated lucidly in this paper. The outcome of the study will help the policy maker to take agenda relation to improvement of GDP due to variation of money supply approach. The expansionary, contractionary and accommodative money supply has role to improve the growth of the country, as money supply and nominal GDP is cointegrated. This study supports the earlier study on money and GDP.

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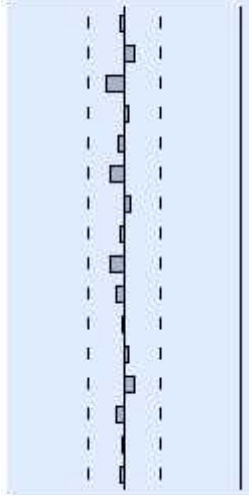
Annexure

Date: 12/07/16 Time: 15:11
Sample: 1975 2013
Included observations: 36
Q-statistic probabilities adjusted for 3 dynamic regressors



| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob* |
|---|---|---|---|---|---|---|
| | | 1 | -0.040 | -0.040 | 0.0619 | 0.804 |
| | | 2 | 0.093 | 0.091 | 0.4079 | 0.816 |
| | | 3 | -0.159 | -0.154 | 1.4591 | 0.692 |
| | | 4 | 0.036 | 0.019 | 1.5139 | 0.824 |
| | | 5 | -0.052 | -0.024 | 1.6351 | 0.897 |
| | | 6 | -0.117 | -0.153 | 2.2611 | 0.894 |
| | | 7 | 0.052 | 0.065 | 2.3880 | 0.935 |
| | | 8 | -0.028 | -0.018 | 2.4263 | 0.965 |
| | | 9 | -0.116 | -0.179 | 3.1067 | 0.960 |
| | | 10 | -0.078 | -0.055 | 3.4248 | 0.970 |
| | | 11 | -0.013 | -0.015 | 3.4334 | 0.984 |
| | | 12 | 0.035 | -0.022 | 3.5014 | 0.991 |
| | | 13 | 0.097 | 0.111 | 4.0579 | 0.991 |
| | | 14 | -0.073 | -0.105 | 4.3872 | 0.993 |
| | | 15 | -0.012 | -0.082 | 4.3959 | 0.996 |
| | | 16 | -0.027 | 0.025 | 4.4476 | 0.998 |

*Probabilities may not be valid for this equation specification.