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Money-Income Causality in Bangladesh: An Error Correction Approach

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The causal relationship between money and income remains a contentious and lively issue in the literature. Even though the literature on this issue is voluminous, however, for Bangladesh it is quite nascent. A few earlier studies suffer from methodological deficiency as they did not take into consider the time series properties of the variables. The objective of this paper is to look on the causality between money and income in Bangladesh. The paper differs from the earlier ones regarding data used and econometric techniques applied. The main contribution of the paper is to address the issue of short run dynamics of the money income relationship within a long run relationship. The empirical results show that money supply and income are cointegrated, implying that there is stable long run relationship between them. The estimated error correction model shows that there is bidirectional causality between money and income, implying that monetary policy should be undertaken to realise the basic macroeconomic goals of achieving higher level of output.

I. INTRODUCTION

The explanatory power of money over aggregate economic activity remains a contentious and empirical issue in the literature. The causal nexus between money supply and output has an important implication for the theoretical debate on whether money matters. Besides, the conduct of monetary policy with the aim of macroeconomic stabilisation hinges upon, among other things, whether money is causally linked to the ultimate policy goals. However, to achieve higher output, full employment and price level stability based on controlling the growth of money supply crucially depends on two prerequisites: first, development of an effective procedure for controlling the rate of growth of money stock and second, close identification of the linkages between the desired growth rate of money and the final

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objectives (Zaki 1995). Despite a large and growing body of theoretical and empirical literature, there has not emerged any consensus regarding the overall evidence of causality.

A good number of studies have been conducted on the money and in real economic activity both in developed and developing countries; however, for Bangladesh it is quite nascent. A few early studies conducted by Jones and Sattar (1988) and Chowdhury, Dao and Wahid (1995) suffer from methodological deficiency as they did not take into consider the time series properties of the variables. The salient aim of this paper is to take another look at the causality between money supply and the output growth. This paper differs from the existing studies in the following ways. First, we use a most recent quarterly data set over the period 1974-2008 to examine the dynamic linkage between money and income.

Second, the analysis is intended to be comprehensive in that it takes into account of various modeling issues that arise in causality framework. It studied the stationary properties of the considered variables in the context of Bangladesh. The paper also applied Augmented Dicky Fuller (ADF) and Phillips-Perron (PP) tests to examine the time series properties of money supply and income. Johansen and Juselius test has been applied to examine the cointegration properties of the variables.

Finally, the paper examines both short-term and long-term dynamic relationships between the considered variables within an error-correction framework. By and large, this paper is an improvement over the existing literature on money supply and other variables in terms of the data used and techniques employed.

This paper is divided into five sections. Following introduction, a survey of the literature is presented in section II. Section III sets out the framework for the analysis of causality, cointegration and error correction models. It also identifies and defines the variable considered. Section IV examines and discusses the time series properties of the variables. Finally, section V concludes the paper.

II. REVIEW OF THE LITERATURE

II.1 Theoretical Debate

There has been a long debate in the literature on the causal nexus among money, income and prices, which dates back to 1752 following the publication of David Hume's "Of Money". Hume concludes that there exists a proportional relationship between money supply and the absolute price level. The classical school explained that changes in prices, the most important target variable in achieving stabilisation, is basically due to changes in money supply. However, Keynesians criticised and rejected the proportionality between money supply and prices due to its instability in explaining the causes and remedies for the great economic debacle like Great Depression of 1930s. The Keynesians held the view that money does not play an active role in changing income and prices nor does it causes instability in the economy. According to them, it is not the quantity of money but the effective demand which is caused by autonomous spending, that constitutes investment by business and government spending is the main source of instability. In fact, a change in money supply is diluted by the opposite change in the velocity. Thus the change in wages, the price level and the rate of inflation are non-monetary phenomena and are caused by structural factors. However, they believe that change in income causes changes in money stock via demand for money implying that the direction of causation runs from income to money without any feedback (Froyen 2004).

The Keynesian ideas came under serious criticism by Monetarists (lead by Milton Friedmen) in the backdrop of the presence of high inflation in different countries after World War II due to the adoption of cheap monetary policy. The Monetarists argue that money plays an active role and leads to the changes in income and prices. There is unidirectional causation that runs from money to income and prices. The argument is that for increasing expenditure (without increase in taxes) government adopts cheap monetary policy i.e. print money which accrues in the hands of taxpayers which leads to the persistent rise in the price level. This argument attributes to the Monetarists contention that inflation is always and everywhere a monetary phenomena (Blanchard, Johnson and Melino 2003). The proponent of Monetarists is the New Classical School / Rational Expectation School, which argues that money supply along with information asymmetries causes the change in income and prices. While the opponent is the Real Business Cycle School/New Classical Macro Economics, which treats money supply as endogenous and concludes that monetary policy is irrelevant. They held the view that neither the money supply nor the information asymmetries but the random change in production technology (i.e. technological shock) is the dominant source of changes in the income and price level in the economy. The Banking School also treats money supply as an endogenous variable which depends on business condition. That is money supply passively responds to the demand for it (Blanchard, Johnson and Melino 2003).

The unidirectional causation from money to income and prices has challenged in the last decades. Fischer (1962) claims the possibility of reverse causation and concludes that there is mutual interaction between money and other macro variables. Friedman and Schwartz (1963) also support this argument by stating that though the influence of money to economic activity is predominant, there is also the possibility of influences running the other way (at least in the short run). The Banking school also supports the reverse causation between money and income, thereby arguing for endogeneity of money supply (Froyen 2004).

The above discussion reveals that there is a linkage between money and aggregate output in the economy. However, it is not clear whether the causality is unidirectional or bidirectional. This debate is further intensified by the empirical studies.

II.2 Empirical Studies

Sims (1972) has opened up the new and active area of research on the empirical causal relationship between money and income. Based on Granger causality, Sims developed a test of causality and applied it to the U.S. data and found the evidence of unidirectional causality between money to income as claimed by the Monetarists. However, this result was challenged by the succeeding studies. By applying the Sims test in Canadian economy Barth and Bennett (1974) found bidirectional causality between money and income. Applying Sims test to the U.K. data Williams, Goodhart and Gowland (1976) found unidirectional causality from income to money, which is opposite of the Sims U.S. result. However, Sims result was supported by Brillembourg and Khan (1979) who use a longer data set. Analysing the Canadian data Hasio (1979) found feedback between money supply (M1) and GNP, while unidirectional causal flow from money to income, when M2 is used as measure of money. Hasio (1981) also found the same result from U.S. money and income data. Using the data set for six industrialised countries Dyreyes, Starleaf and Wang (1980) found bidirectional causality between money and income in the U.S., while they found unidirectional causality from money to income in Canada, contrary to Barth and Bennett (1974). However, they got the unidirectional causality from income to money in the U.K., which supports the result of Williams. Goodhart and Gowland (1976). Biswas and Saunders (1988) provide further empirical evidence on the money-income relationship from the U.S. data which supports Sims.

Using Singapore data Lee and Li (1983) found bidirectional causality between income and money and unidirectional causality from money to prices. Joshi and Joshi (1985) found bidirectional causality between money and income in India, while for the same country Rangarajan and Arif (1990) found unidirectional causality from money to income. Biswas and Saunders (1999) found that income and money supply are cointegrated in India. Thus, establishing a stable relationship between these two variables over longer time period. Upon establishment of cointegration between money and income this study conducted error correction estimates and found the existence of feedback between the two variables. Khan and Siddiqui (1990) found unidirectional causality from income to money in Pakistan. Using Geweke's approach Kee-Giap Tan and Chee-seng (1995) found bidirectional causality between money and income in Malaysia. This result supports Zubaidi and Yusop (1996).

Some of the recent studies also establish the causal relationship among money, income and price. Using time series data from 1960 to 2008 Climobi and Uche. (2010) found that M2 appears to have a strong unidirectional causal effect on the real output as well as on prices. The similar result has also found by Majid (2007) for the Malaysian economy. Yadav (2009) examined the cointegration and causality between money and income for the Indian economy. Using the data for the period 1950/51-2006/07 the study found the bidirectional causality between GNP and money supply. Psaradakis, Morten and Mortin (2002) applied different econometric techniques to examine the money output relationship. Using a VAR model with time varying parameters for the U.S. data for the period 1959:1-2001:2 the paper found that causality relationship between money and output changes over time.

II.3 The Bangladesh Perspective

As to the empirical evidence on Bangladesh, there are a few studies (Jones and Sattar 1988, Chowdhury, Dao and Wahid 1995, Ahmed 2000) linking money, prices, income and interest rate, but no substantial study using appropriate econometric methodology considering the time series properties of data.

With the aid of Granger causality test based on monthly data (June 1974 through December 1985), Jones and Sattar (1988) were able to examine the causal link between money–income and money–inflation in Bangladesh. Using several arbitrary lag lengths they concluded that money causes prices in Bangladesh in the short run, with a lag in general of twelve month, which disappears in the long run. They also found the evidence of unidirectional impact of money on output, with a lag of twenty four to thirty six months. The implication of their result is that monetary expansion could have a significant impact on output growth, although as a consequence the economy may experience moderate to high inflation in the short run.

By applying multivariate vector autoregressive (VAR) model Chowdhury, Dao and Wahid (1995) explore the relationship between money, prices, output and the exchange rate in Bangladesh. Using quarterly data for the period 1974 to 1992 the study concluded that the inflationary process of Bangladesh cannot be explained solely by the "monetarist" or the "structuralist" explanation. That is, there is no straightforward cause and effect relationship between money and inflation, while money supply exerts a significant unidirectional impact on real output.

Ahmed (2000) attempts to investigate the issue of multivariate causality among money, interest rate, prices and output for three South Asian countries namely, Bangladesh, India and Pakistan in a multivariate framework using quarterly data for the period 1967-1996 for India, 1972-1997 for Pakistan and 1974-1998 for Bangladesh. The study concludes that monetary policy has crucial importance in determining output in Bangladesh. This study also found that interest rate and money as block cause output and price but output and price do not cause interest and money in Bangladesh.

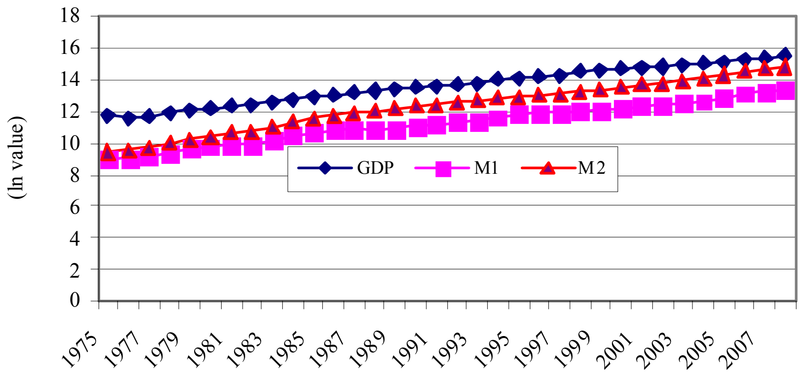
It is evident from the above studies that causal relationship between money and income is unidirectional in Bangladesh. However, the reliability of the above result may be undermined as they did not examine the time series properties of the data such as stationarity and co-integration and using arbitrary lag length they conclude whether the relationship among variables is short run or long run. This study is an improvement over the existing studies as it examined the stationarity and co-integration approach and applied the error correction approach to understand the short run implication of long run relationship among considered variables. Consequently, two issues need to be considered. The first issue is the existence of stability of the relationship between money and income over longer period of time. It is important to determine whether a stable relationship between monetary changes and nominal income changes in the long run. If so, then monetary policy will have important implications on the Bangladesh economy in the long run. The second issue is related to the impact of monetary changes on nominal income in the short run. The subject matter of this study is to provide short run dynamics of the money-income relationship in Bangladesh, i.e. how do money affect nominal income in the short run.

III. DATA AND METHODOLOGY

III.1 Data

This study is based on annual data covering 1974 to 2008 taken from the IMF, International Financial Statistics (IFS) CD-Rom supplemented by IMF, IFS Yearbook. Some of the early literature (Ibrahim 1999) shows that M2 is a preferable intermediate target to stabilise the economy and M2 is found to be cointegrated with other macrovariables and is thus superior as a long run policy variable; while Jones and Sattar (1988) and Chowdhury, Dao and Wahid (1995) use both narrow money (M1) and broad money (M2) to examine the causal relationships. The present study considered broad money as monetary stock. The graphical representation of the variables shows that there is co-movement between GDP and broad money, as shown in Figure 1. Nominal GDP is used as a measure of aggregate economic activity.

Figure 1: Relationship between Monetary Aggregates and GDP



III.2 The Analytical Framework

III.2.1 Granger Causality Test

We relied on the Granger Causality test due to its wide applicability to examine the direction of causality between money and income. The basic idea of the Granger Causality is that X causes Y if Y can be explained better by the present and lagged values of X than by the past values of Y alone assuming that both X and Y are stationary variables. This test assumes that the information relevant to the prediction of the respective variables is contained solely in the time series data on these variables (Gujrati, 2003). For illustrative purpose using a two variable system, the test is based on the following regression:

$$Y_t = \alpha + \sum_{i=1}^{m} \beta_i Y_{t-1} + \sum_{i=1}^{n} \varphi_i X_{t-1} + \varepsilon_t \qquad (1)$$

$$X_t = \chi + \sum_{i=1}^{m} \phi_i X_{t-1} + \sum_{i=1}^{n} \mu_i Y_{t-1} + \nu_t \qquad (2)$$

where, ε_t and ν_t are white noise error term and assumed to be stationary, and m & n are the number of lags to be specified. Equation (1) postulates that current Y is related to past values of itself as well as that of X and equation (2) proposes a similar behaviour for X. Given the above specification, the following cases can be distinguished:

(i) unidirectional causality from X to Y i.e. X causes Y if H_0: $\varphi_i = 0$, i = 1, …..n, can be rejected and (ii) does not hold;

(ii) unidirectional causality from Y to X i.e. Y causes X if H_0: $\mu_i = 0$, i = 1, …..n, can be rejected and (i) does not hold;

(iii) feedback or bilateral causality is said to occur if both (i) and (ii) hold; and

(iv) independence is suggested if neither (i) nor (ii) hold.

In addition, the framework can be generalised to include more variables in the system.

The implementation of Granger causality test needs to estimate the unrestricted and restricted version of equations. To test whether X causes Y, the unrestricted regression involves the estimation of equation (1) using OLS. From this regression we obtain the unrestricted residual sum of squares (RSS_{ur}). Then, another version of (1) that restricts the coefficient of all lagged X's to zero is to be performed and obtained the restricted residual sum of squares (RSS_r). To test case (i) above, we rely on the following statistic:

$$F = [(RSS_r - RSS_{ur})/m] / [RSS_{ur} / (n – k)]$$

Which follows F distribution with m and (n – k) df. Here m is equal to the number of lagged X terms included in the equation (1) and k is the number of parameters estimated in the unrestricted equation. X is said to Granger cause Y if the computed F statistics is significant at the conventional level. The same procedure can be applied to test causality from Y to X.

The Granger causality test assumes that the disturbance term of the regression is serially uncorrelated. However, the non-stationarity of the variables may destroy this assumption (Serletis 1988), which makes the OLS estimation biased and inconsistent and thus decrease the credibility of the regression result. Intuitively, a time series is said to be stationary if its mean and variance do not systematically vary over time. In contrast, time series is non-stationary if its mean and variance are variant with time. Granger causality test may not be valid if non-stationarity in the data is not handled properly. The study thus examined whether the considered time series is stationary or not.

The number of lagged terms to be included in the causality test is an important practical question since the direction of causality may depend critically on the number of lagged term included. If we use too few lags we will omit potentially valuable information contained in the more distant lagged values, the causality result is thus distorted. On the other hand, if we use too may lags we will be estimating more coefficient than necessary, which in turn introduces additional estimation error into forecasts and may cause an absence of causality between them (Feige and Pearce 1979). The study used Schwartz information criteria to make such choice.

III.2.2 Cointegration Test and Error Correction Models

A salient feature of most economic time series is inertia or sluggishness i.e. they have the tendency to move together. Thus we need to test for the possible cointegration of the variables as a guide for model specification. Presence of cointegration between two variables led to the causality in the Granger sense as least in one direction (Miller 1998). There are two channels of causality between cointegrated variables–the standard Granger test and the error correction specification. Non-causality conclusion may result from failure to take the cointegratedness into account.

The notions of cointegration provide the basis for modeling both the short run and long run relationship simultaneously. If Y_t and X_t are cointegrated, then Granger representation theorem (Engle and Granger 1987) says that the relationship between the two variables can be expressed as the error correction mechanism as follows:

$$\Delta Y_t = \lambda_1 Z_{t-1} + \sum_{i=1}^{k} \delta_i \Delta X_{t-i} + \sum_{j=1}^{k} \pi_j \Delta Y_{t-j} + u_{1t} \quad (3)$$

$$\Delta X_t = \lambda_2 Z_{t-1} + \sum_{i=1}^{k} \tau_i \Delta X_{t-i} + \sum_{j=1}^{k} \zeta_j \Delta Y_{t-j} + u_{2t} \quad (4)$$

where, $Z_t = Y_t - \gamma X_t$, and u_{1t} and u_{2t} are white noise error terms. In these two equations, the series Y_t and X_t are cointegrated when at least one of the coefficients λ_1 or λ_2 is not zero. This error correction model allows us to study the short run dynamics of the long run relationship between Y_t and X_t. If $\lambda_1 \neq 0$ and $\lambda_2 = 0$, then X_t will lead Y_t in the long run. The opposite will occur if $\lambda_2 \neq 0$ and $\lambda_1 = 0$. If both $\lambda_1 \neq 0$ and $\lambda 2 \neq 0$, then feedback relationship exists between Y_t and X_t , which will adjust in the long run. In addition, short run dynamics between Y_t and X_t are characterised by the coefficients δ_i's and ζ_j's. If δ_i's are not all zero, movements in the X_t will lead to Y_t in the short run. If ζ_j's are not all zero, movement in the Y_t will cause X_t in the short run. If γ can be obtained so that Z_t can be constructed, the remaining parameters in equations (3) and (4) can easily be estimated. Engle and Granger (1987) propose a two-step procedure. The first step involves OLS regression of Y_t on X_t and yield a consistent estimate for γ. The next step is the OLS estimation of equations (3) and (4) with Z_t replaced by estimated Z_t.

III.3 Empirical Methodology

Testing for causality and cointegration between two variables, money and income, is done on the following steps: First the time series properties of each variable examined by unit root tests. In this step it is tested whether money and income are I(0), that is they are stationary. This is accomplished by applying augmented Dickey-Fuller (ADF) test. This test is based on the following regression equation with a constant and a trend of the form:

$$\Delta Y_t = a_1 + a_2 t + bY_{t-1} + \sum_{i=1}^{m} \rho_i \Delta Y_{t-i} + \upsilon_t \tag{5}$$

where, $\Delta Y_t = Y_t - Y_{t-1}$ and Y is the variable under consideration, m is the number of lags in the dependent variable, is chosen by Schwarz criterion and υ_t is the white noise error term. The null hypothesis of a unit root is that the coefficient of Y_{t-1} is zero. The rejection of null hypothesis implies that the series is stationary and no differencing in the series is necessary to induce stationary. The ADF is widely used due to the stability of its critical values as well as its power over different sampling experiment.

The second step involves searching for cointegration between variables. This can be understood from the graphical representation of the two series and to see whether they have any common stochastic trend and can be tested either by Engle-Granger two step cointegration procedures or by Johansen-Juselius cointegration technique. We relied on Johansen-Juselius cointegration technique. In this technique two test statistics are used to identify the number of cointegrating vectors, namely the trace statistic and the maximum eigenvalue test statistic. The Trace test statistic for the null hypothesis that there are atmost *r* distinct cointegrating vectors is

$$\lambda_{trace} = T \sum_{i=r+1}^{N} \ln(1 - \lambda_i) \tag{6}$$

where, λ_i's are the N-*r* smallest squared canonical correlations between X_{t-k} and ΔX_t (where $X_t = (M2_t \text{ Income}_t)^{/}$ and where all variables in X_t are assumed I(1)), corrected for the effects of the lagged differences of the X_t process.

The maximum eigenvalue statistic for testing the null hypothesis of at most *r* cointegrating vectors against the alternative hypothesis of *r* + 1 cointegrating vectors is given by

$$\lambda_{\max} = -T \ln(1 - \lambda_{r+1}) \tag{7}$$

Johansen (1988) shows that equations (6) and (7) have non-standard distributions under the null hypothesis and provide approximate critical values for the statistic, generated by Monte Carlo methods.

The third step involves the estimation of error correction model as specified in equations (3) and (4). Finally, causality and feed back relationship among time series are tested using standard F tests.

IV. ANALYSIS OF THE RESULT

In light of the methodology presented above the time series properties of the variables involved are examined and the empirical results are discussed in this section. At first both money and income variables are tested for the unit roots suggested by ADF test and Phillips-Peron test. Unit root test identifies whether the variables are stationary or non-stationary. The test is applied to both the original series (in logarithmic form) and to the first differences. Further, both the models with and without trend are tried. The lag parameters are determined by Schewarz's criterion. The results are reported in Table I.

TABLE I

UNIT ROOT TESTS (AUGMENTED DICKEY FULLER) FOR THE PERIOD 1974 TO 2008

	Series in Levels	First Differences
Without Trend	-2.142314 [8]	-3.141494** [7]
LM2		
LNGDP	-1.748507 [6]	-6.801368* [5]
With Trend		
LM2	-1.454595 [8]	-4.096095* [7]
LNGDP	-0.065432 [6]	-7.089567* [5]

Notes: (i) * and ** indicate significance at 1% and 5% respectively.

(ii) Figures in the parentheses represent the optimal lag length as determined by Schwarz information criteria.

(iii) The Phillips–Perron test also gives the similar results.

The test results indicate the presence of unit roots in the original series i.e. LM2 and LNGDP are non-stationary in their level. The results further suggest that first differences remove these unit roots, implying that these variables are first difference stationary i.e. I(1).

Since both variables are I(1), then it is necessary to set out cointegration tests to determine whether there exists a stable long run relationship between money and income in Bangladesh. We relied on the Johansen's approach to establish the cointegrating vectors. The result is presented in Table II.

TABLE II
JOHANSEN AND JUSELIUS TEST OF COINTEGRATION

Data Vector	Lag	Hypothesis	Λ Trace	λ Max
LM2 , LNGDP	3	r <=0	20.40772**	18.63563**
		r <=1	1.772096	1.772096

Notes: i) we have experimented with a number of lags and found 3 to be the optimal lag length. The null hypothesis states that there doesn't exist at most *r* cointegrating relationship among the variables.

ii) ** indicates significance at 5% level.

Table II reports the maximum eigen-value and trace tests of Johansen and Juselius (1991). These are complementary versions of the same test to determine the cointegration rank, *r*. Both the test suggest that nominal income and the money supply are cointegrated.[1] This result indicates the existence of a stable long run relationship between nominal income and money supply in Bangladesh. That is monetary policy will have some important long run implications to changes in nominal income on Bangladesh economy.

The cointegration between money supply and income implies long run equilibrium relationship. However, in the short run there may be disequilibrium. Therefore, we can treat the error term in the cointegrating relation as the equilibrium error, which is used to tie the short run behaviour of the variables. The error-correction mechanism first used by Sargan and later popularised by Engle and Granger corrects for disequilibrium. Therefore, the error-correction models (ECM) are applied to explore the direction of causality. Any ECM has an interesting temporal causal interpretation in the Granger sense. That is when two series are seen to be cointegrated the absence of causal relationship between them is ruled out in the error correction framework, while such a possibility exists in the Granger test. Therefore, we also employ Granger causality to examine the direction of bivariate causality. The results are reported in Tables III, IV and V.

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[1] The visual plot of the data (as shown in Figure 1) also shows that both series share the same stochastic trend, implying that they are cointegrated.

TABLE III

ESTIMATION OF ERROR CORRECTION MODEL

Independent Variable: LNGDP

Dependent Variable: LM2

Constant	Zt-1	$\Delta(LM2)_{t-1}$	$\Delta(LM2)_{t-2}$	$\Delta(LM2)_{t-3}$	$\Delta(LNGDP)_{t-1}$	$\Delta(LNGDP)_{t-2}$	$\Delta(LNGDP)_{t-3}$
0.068535	0.070365*	-0.494589	0.095438	-0.285373	-0.020475	-0.258569	0.174939
[6.69301]	[2.22376]	[-4.93739]	[0.89047]	[-3.32992]	[-0.08821]	[-0.75755]	[0.81127]

Note: Figures in the parentheses represent t statistic.

TABLE IV

ESTIMATION OF ERROR CORRECTION MODEL

Independent Variable: LM2

Dependent Variable: LNGDP

Constant	Zt-1	$\Delta(LM2)_{t-1}$	$\Delta(LM2)_{t-2}$	$\Delta(LM2)_{t-3}$	$\Delta(LNGDP)_{t-1}$	$\Delta(LNGDP)_{t-2}$	$\Delta(LNGDP)_{t-3}$
0.011319	0.050713*	-0.040955	-0.044216	-0.038508	1.517708	-1.11557	0.369629
[3.07945]	[4.46484]	[-1.13900]	[-1.14932]	[-1.25180]	[18.2155]	[-9.10519]	[4.77530]

Note: Figures in the parentheses represent t statistic.

TABLE V

DIRECTION OF CAUSALITY

	Granger Causality		Error Correction		
	F-values	Causation	t (err)	F-values	Causation
LNGDP does not cause LM2	1.90620	LNGDP≠>LM2	2.22376*	19.96913*	LNGDP=>LM2
LM2 does not cause LNGDP	2.43743*	LM2 =>LNGDP	4.46484*	114.1857*	LM2 =>LNGDP

Note: *, ** and *** indicate significance at 1%, 5% and 10% respectively.

The results of Granger causality and error correction models are explored in Tables III, IV and V. It can be seen that Granger test provides unidirectional causality from money to nominal income, which coincides with the earlier studies of Bangladesh, while error correction models provide bi-directional causality between money and income in the short run. These results are in line with Lee and Li (1983), Joshi and Joshi (1985).

It is also clear from Tables III and IV that both money supply and nominal income, respond to a deviation from long run equilibrium. The coefficient of the error correction term in both equations is statistically significant, implying that both variables respond to the discrepancy from long run equilibrium (Biswas and Sunders 1999). From Table IV, we see that the coefficient of the error correction term is not only statistically significant but also positive. This implies that changes in the money supply do causally affect Bangladesh's nominal income in the short run. Analogously, we can say that changes in nominal income also affect the money in Bangladesh, from the information provided in Table III. By and large, the empirical results of this study reveal that in the short run M2 supply is not truly exogenous. From the monetary policy point of view, M2 may not be a target variable for determining short run changes in nominal income in Bangladesh. This may be the one reason that the monetary authorities of many developed countries have suspended money supply as a control variable to achieve ultimate policy goals of increasing output.

V. SUMMARY AND CONCLUSIONS

The paper applies cointegration and error-correction models to explain the causal relationship between money supply (M2) and nominal income in Bangladesh. The main contribution of the paper is to address the issue of both short run and long run relationship between money and income in Bangladesh. The paper is an improvement over the early studies in the sense of data used and methodological point of view. The study found that nominal income and money supply are cointegrated, indicating that there is a stable long-term relationship between them. The implication of this result is that the monetary authority should try to provide long run price stability or a low average rate of inflation (Biswas and Sunders 1999). This type of monetary policy can provide stable economic environment, which helps economic agents in their decision making (Eichenbaum 1997). Thus it can be concluded that changes in money supply will have an important implications for changes in Bangladesh's nominal income in the long run. The existence of cointegration leads us to examine the short run dynamics in the money income relationship in Bangladesh. We applied the error correction models to make inference about the short run impact of monetary changes on nominal income. They indicate the feedback relationship between the two, which is consistent with some of the early studies.

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APPENDIX A

Exploratory Analysis of the Data

The descriptive statistics for the variables are as follows:

TABLE 1
DESCRIPTIVE STATISTICS OF THE VARIABLES

	LM2	**LNGDP**
Mean	11.79023	11.87015
Median	12.01247	11.91275
Maximum	13.88221	13.46885
Minimum	9.418971	9.597968
Std. Dev.	1.355435	1.108062
Skewness	-0.280535	-0.244335
Kurtosis	1.806552	1.768452
Jarque-Bera	8.405735	8.484961
Probability	0.014953	0.014372

From the above Table it is clear that the mean and median are fairly close to each other suggesting that these data are more or less normal. The values of the skewness are moderate and the values of the kurtosis are below three, suggesting that the variables have a flat distribution relative to normal. The Jarque-Bera test results suggest that we do not reject the null hypothesis of normal distribution for at 5% level of significance.

APPENDIX B

Test of Stationarity (Autocorrelation Function (ACF) and Correlogram)

Before pursuing formal tests, we proceed with the graphical representation of the so called "sample correlogram" based on autocorrelation function, that gives us an initial clue about stationarity.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|********	.|********	1	0.976	0.976	113.47	0.000
.|*******|	.|. |	2	0.952	-0.019	222.37	0.000
.|*******|	.|. |	3	0.927	-0.047	326.42	0.000
.|*******|	.|. |	4	0.903	0.034	426.16	0.000
.|*******|	*|. |	5	0.877	-0.073	521.02	0.000
.|*******|	.|. |	6	0.851	-0.001	611.25	0.000
.|****** |	.|. |	7	0.824	-0.054	696.47	0.000
.|****** |	.|. |	8	0.799	0.038	777.35	0.000
.|****** |	*|. |	9	0.771	-0.063	853.45	0.000
.|****** |	.|. |	10	0.745	0.010	925.18	0.000
.|****** |	.|. |	11	0.718	-0.026	992.42	0.000
.|***** |	.|. |	12	0.693	0.019	1055.7	0.000
.|***** |	.|. |	13	0.667	-0.044	1114.8	0.000
.|***** |	.|. |	14	0.641	0.006	1170.0	0.000
.|***** |	.|. |	15	0.615	-0.023	1221.3	0.000
.|***** |	.|. |	16	0.591	0.020	1269.1	0.000
.|**** |	.|. |	17	0.565	-0.054	1313.3	0.000
.|**** |	.|. |	18	0.541	0.011	1354.2	0.000
.|**** |	.|. |	19	0.515	-0.025	1391.7	0.000
.|**** |	.|. |	20	0.493	0.020	1426.3	0.000
.|**** |	*|. |	21	0.467	-0.062	1457.7	0.000
.|*** |	.|. |	22	0.443	0.017	1486.3	0.000
.|*** |	.|. |	23	0.418	-0.035	1512.1	0.000
.|*** |	.|. |	24	0.396	0.015	1535.3	0.000
.|*** |	.|. |	25	0.370	-0.055	1556.0	0.000
.|*** |	.|. |	26	0.347	0.008	1574.3	0.000

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|** |	.|. |	27	0.322	-0.026	1590.3	0.000
.|** |	.|. |	28	0.300	0.010	1604.3	0.000
.|** |	.|. |	29	0.276	-0.037	1616.3	0.000
.|** |	.|. |	30	0.253	-0.007	1626.5	0.000
.|** |	.|. |	31	0.230	-0.022	1635.0	0.000
.|** |	.|. |	32	0.207	-0.012	1642.0	0.000
.|* |	.|. |	33	0.183	-0.031	1647.5	0.000
.|* |	.|. |	34	0.160	-0.020	1651.8	0.000
.|* |	.|. |	35	0.136	-0.020	1655.0	0.000
.|* |	.|. |	36	0.115	0.009	1657.3	0.000

Figure 4: Correlogram of LM2, 1974-I to 2008-IV.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******|	.|*******|	1	0.971	0.971	112.32	0.000
.|*******|	.|. |	2	0.942	-0.028	218.88	0.000
.|*******|	.|. |	3	0.914	0.007	320.06	0.000
.|*******|	.|. |	4	0.888	0.031	416.52	0.000
.|*******|	.|. |	5	0.866	0.046	509.06	0.000
.|*******|	.|. |	6	0.847	0.033	598.25	0.000
.|****** |	.|. |	7	0.827	0.000	684.23	0.000
.|****** |	.|. |	8	0.807	-0.030	766.71	0.000
.|****** |	.|. |	9	0.784	-0.035	845.40	0.000
.|****** |	.|. |	10	0.761	-0.027	920.12	0.000
.|****** |	.|. |	11	0.736	-0.029	990.77	0.000
.|***** |	.|. |	12	0.711	-0.030	1057.3	0.000
.|***** |	.|. |	13	0.685	-0.046	1119.6	0.000
.|***** |	.|. |	14	0.656	-0.050	1177.4	0.000
.|***** |	.|. |	15	0.628	-0.023	1230.9	0.000
.|***** |	.|. |	16	0.602	0.002	1280.5	0.000
.|**** |	.|. |	17	0.576	0.002	1326.4	0.000
.|**** |	.|. |	18	0.552	-0.005	1368.9	0.000
.|**** |	.|. |	19	0.528	-0.007	1408.3	0.000

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|**** |	.|. |	20	0.504	-0.007	1444.5	0.000
.|**** |	.|. |	21	0.480	-0.004	1477.7	0.000
.|*** |	.|. |	22	0.457	-0.004	1508.1	0.000
.|*** |	.|. |	23	0.433	-0.010	1535.7	0.000
.|*** |	.|. |	24	0.410	-0.016	1560.7	0.000
.|*** |	.|. |	25	0.386	-0.020	1583.1	0.000
.|*** |	.|. |	26	0.362	-0.019	1603.0	0.000
.|*** |	.|. |	27	0.338	-0.016	1620.6	0.000
.|** |	.|. |	28	0.315	-0.015	1636.0	0.000
.|** |	.|. |	29	0.291	-0.017	1649.3	0.000
.|** |	.|. |	30	0.268	-0.018	1660.8	0.000
.|** |	.|. |	31	0.246	-0.015	1670.5	0.000
.|** |	.|. |	32	0.223	-0.013	1678.6	0.000
.|** |	.|. |	33	0.201	-0.010	1685.3	0.000
.|* |	.|. |	34	0.179	-0.010	1690.7	0.000
.|* |	.|. |	35	0.158	-0.016	1694.9	0.000
.|* |	.|. |	36	0.136	-0.021	1698.0	0.000

Figure 5: Correlogram of LNGDP, 1974-I to 2008-IV.

The correlogram up to 36 lags for both series is shown in figures 4 and 5 respectively. From the figures we see that the autocorrelation coefficient starts at a very high value at lag 1 and declines very slowly, implying that all these time series are nonstationary. They may be nonstationary in mean or variance or both.