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Monetary Sector Analysis of Bangladesh- Causality and Weak Exogeneity

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Abstract
Money supply can affect both income and price level – which is the baseline theory of monetarist. Keynesians view, on the contrary, is that money does not play an active role in changing income and prices. In reality, change in income causes increased demand for money which changes money stocks, implying that the direction of causation runs from income to money without any feedback. Granger Causality test on Bangladesh economy shows the proof of Keynesian view, i.e. real GDP causes an increase in money supply. Analysis delineates that there is a significant cointegration relationship between real GDP, broad money and CPI. A VECM analysis shows significant error correction terms for both broad money and CPI but not for GDP. Then a weak exogeneity test is done for GDP. This monetary sector analysis proves that GDP is weakly exogenous implying that GDP has a smaller role in short-term adjustments.
Keywords: VECM, Monetary Sector, Granger Causality, Weak Exogeneity.

1. Introduction

Every economic policy of the government aims to increase income or the GDP growth of the country. Bangladesh is a developing country and here financial inclusion has not happened yet in a greater extent. Monetization of the economy, i.e. broad money[1] to GDP ratio is around 63 percent in FY14, which is lower than many emerging economies like Malaysia, India. Money supply can affect both income and price level – which is the baseline theory of monetarists. They claim that changes in income and prices in an economy are caused by the changes in money supply. Hence, the direction of causation runs from money to income and prices without any feedback, i.e., unidirectional causation.

However, there is great debate on the role of monetary policy. Keynesians view, on the contrary, is that money does not play an active role in changing income and prices. In reality, changes in income cause changes in money stocks via demand for money implying that the direction of causation runs from income to money without any feedback. Similarly, changes in prices are mainly caused by structural factors.

There are many other factors that affect income and price level. Real factors such as increase in productivity, labour or capital can increase income. Fiscal policy also can affect income and prices. Again price level can be increased by supply and demand shocks. Objective of this research is to net out impact of money supply on these two variables or in brief, find out the effectiveness of monetary policy in Bangladesh. Although there are some research on this area in Bangladesh, these are not beyond criticism. In this article research questions include, 1. Whether there is long-run relation among money, prices and income? 2. Is there any short-run adjustment dynamics that leads to long-run equilibrium? 3. Is there weak exogeneity of any of the variables? 4. Whether the causality among themselves are bidirectional or unidirectional?

Granger causality test shows that Money did not cause GDP to grow, rather money supply was increased keeping pace with GDP growth. The long-run relation between money, prices and GDP are significant. But role of GDP is weaker than other two variables for restoring long-run equilibrium from any short-run fluctuations. Results show that GDP is weakly exogenous.

The remainder of the paper is organized as follows. Section 2, provides a literature review on developed and developing countries. In section 3, research methodology and data sources are discussed. In Section 4, econometrics model and results are described. At the end of the paper conclusion and some policy recommendations are delineated.

2. Relevant Literature

There are long list of literature on the role of monetary policy for enhancing GDP growth. After the Great Depression, Keynes (Keynes, 1936) argued about the impotance of monetary policy and advocated for fiscal policy as the dominant policy tool. However, Milton Friedman's (Friedman, 1968) research raised monetary

[1] Broad money (IFS line 35L..ZK) is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.

policy from an obsolete instrument to an effective instrument for growth and low inflation. Monetarist view money supply can influence growth. Friedman (1968) quoted "True, money is only a machine, but it is an extraordinarily efficient machine. Without it, we could not have begun to attain the astounding growth in output and level of living we have experienced in the past two centuries ….." (page 12). Sims(1972) found unidirectional causality from money to income using post-war quarterly US data. However replicating Sim's test on Canadian economy Barth and Bennett (1974) showed bidirectional causality. Again Williams, Goodhart and Gowland (1976) using UK data found evidence of unidirectional causality from income to money using Sim's method. Saatcioglu and Korap (2008) investigated the long-run relationships between monetary aggregates, prices and real output level in the quantity theory of money perspective for the Turkish economy. Results showed that monetary aggregates seem to have an endogeneity for the long-run evolution of prices and real income.

In developing countries there are lots of literature regarding the relationship among money, prices and income. Lee and Li (1983) found bidirectional causality between income and money on Singapore economy. They also found unidirectional causality from money to prices. Ahmed (2000) did analysis of SAARC countries and found similarities and dissimilarities among the countries. His results show that money does not influence real GDP in both India and Bangladesh which does not commensurate with the monetarist view. Khan and Siddiqui (1990) and Hossain (2008) investigates on Pakistan and got similar result- real GDP influences money supply. Jones and Sattar (1988), Parikh and Starmer (1988), Chowdhury *et.al* (1995) were among the few studies that were conducted on Bangladesh. Jones and Sattar (1988) found that in short-run money supply created inflation and also GDP growth. Chowdhury *et.al* (1995) applied a VAR analysis. They found significant impact of money supply on output. There are also some contemporary research on the effectiveness of the monetary sector of Bangladesh. Hossain (2011) shows bidirectional relationship between money and income in Bangladesh using data range 1974 to 2008. Shams (2012) used a VECM model and revealed a bidirectional causality between money and income and unidirectional causality from money to prices. His data range is from 1973 to 2010. Last two papers used data from just after independence of Bangladesh in 1971. First 4/5 years most of the macro data are highly volatile. In this regard, here in this research data has been taken from 1979 so that no outlier problem exists. Hossain (2011) analyzed using nominal GDP, so one cannot certainly claim the increase the income.

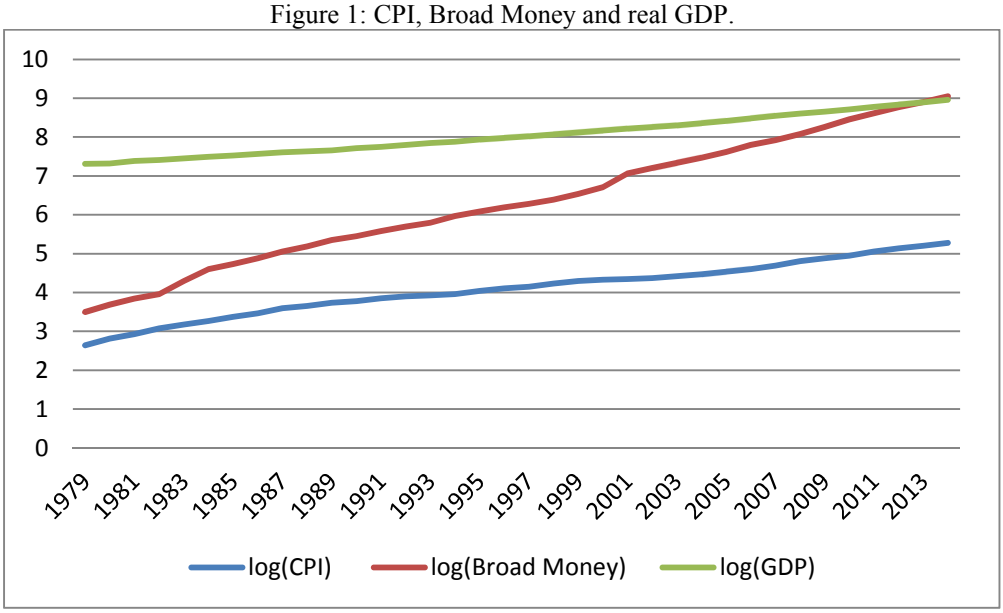
3. Methodology and Data

A trivariate model estimation is done here using an appropriate econometrics methodology. Due to the obvious non-stationarity of most time series data, OLS regression is not appropriate due to spurious regression problem. Nonstationarity of variables are verified with ADF test (Dicky and Fuller, 1979). After the ADF test, log length criteria is tested. Then econometrics properties of the variables are tested – normality, homoskedasticity and autocorrelation. Following Eangle and Granger (1987) and Johansen (1988) cointegration relationship is found out. Finally, the methodology used here is the VECM (vector error correction model) where one can investigate short run dynamics to reach long run equilibrium. Weak exogeneity of variables were also tested to find out the variable that has least contribution to restore equilibrium. The research also found out Granger causality among the variables to reveal bidirectional or unidirectional causality.

In the analysis GDP, Broad money and CPI inflation data were needed. GDP and Broad money data were taken from WDI (World Bank) source. CPI inflation data were taken from different sources of Bangladesh Bureau of Statistics (BBS). The data were with different base year. Author estimated the whole database using the same base year 2006[1]. Here data rage is 1979 to 2014.

[1] In Bangladesh fiscal year starts in July and ends in June next year. In the analysis all the data are fiscal year data. So year 2006 means fiscal year 2005-06.

Figure 1: CPI, Broad Money and real GDP.



4. The Model and Results

For a VECM analysis, first step is to find out stationarity status of the variables. Augmented Dickey-Fuller test and Phillips-Paron test of stationarity were done with level and intercept. All the variables were non-stationary. Then, tests were done with first difference. All the variables were stationary which implies that with first differences variables are I(0). If we run a VAR/VECM in levels of variables that are I(1), most likely is that the impulse responses of these variables will not tend to decay, because they are I(1). Results are shown in Appendix 1.

Second step is to find the lag length criteria. All the test were done with 4 lags. All the criteria (Likelyhood Ratio test, Final Prediction Error, Akaike Information Criterion, Schwarz Information Criterion, Hannan-Quinn Information Criterion) suggested ideal lag length 1. Results are shown in Appendix 2.

Third step is to find out the statistical properties of the VAR residuals. Three properties are tested i.e. serial correlation test, heteroskedasticity test and normality test. Serial correlation test shows that upto lag order 4 no serial correlation exists among the residuals. Heteroskedasticity test shows that residuals are homoskedastic at 5 percent level of significance including cross terms. Excluding cross terms residuals are homoskedastic at 1 percent level of significance. Results are shown in Appendix 3 and Appendix 4. As the number of observation is not large, residuals did not pass the Jaques-Berra normality test. However, three quantile-quantile (Q-Q) plots are shown for three residuals in Appendix 5. A closer look at the graph indicates that residuals are not far from normality. One can proceed with these sound econometrics properties of the residuals.

Fourth step is to find out long term relationships among variables. Here cointegration test is needed. If variables are cointegrated then we can find the Granger causality relation among variables. At the same time we can run VECM to find out long-run and short-run relationships. Johansen cointegration test is done. As all the lag length criteria suggested 1 lag in VAR, so zero lag is used to run the cointegration test.

It would be better to explain 0 lag VECM model. Let m is broad money, p is CPI and y is real GDP. Now as m_t, p_t and y_t are cointegrated then in the long run,

$$E[b_1 m_{t-1} + b_2 p_{t-1} + b_3 y_{t-1} + b_4] = 0 \quad (1)$$

Here E is expected value and b_1, b_2, b_3 and b_4 are coefficients. VECM of lag order 0 can be shown as follows

$$\Delta m_t = \mu_m + \alpha_m(b_1 m_{t-1} + b_2 p_{t-1} + b_3 y_{t-1} + b_4) + \nu_t \quad (2)$$

$$\Delta p_t = \mu_p + \alpha_p(b_1 m_{t-1} + b_2 p_{t-1} + b_3 y_{t-1} + b_4) + \upsilon_t \quad (3)$$

$$\Delta y_t = \mu_y + \alpha_y(b_1 m_{t-1} + b_2 p_{t-1} + b_3 y_{t-1} + b_4) + \eta_t \quad (4)$$

Here Δ indicates change, μ are constants and α are error correction terms. ν_t, υ_t and η_t are error terms. BothTrace test and Maximum eigenvalue test show 1 cointegrating equation at 1 percent level of significance. Results of the Trace test are shown inTable 1.

Table 1: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.01 Critical Value	Prob.**
None *	0.699095	60.60045	35.45817	0.0000
At most 1	0.349623	18.56678	19.93711	0.0167
At most 2	0.095413	3.509670	6.634897	0.0610

Trace test indicates 1 cointegrating eqn(s) at the 0.01 level
* denotes rejection of the hypothesis at the 0.01 level
**MacKinnon-Haug-Michelis (1999) p-values
Results of the Maximum Eigenvalue test are shown in Table 2

Table 2: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.01 Critical Value	Prob.**
None *	0.699095	42.03367	25.86121	0.0000
At most 1	0.349623	15.05711	18.52001	0.0374
At most 2	0.095413	3.509670	6.634897	0.0610

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.01 level
* denotes rejection of the hypothesis at the 0.01 level
**MacKinnon-Haug-Michelis (1999) p-values
The results of the cointegration test reveal that the three variables Broad Money, CPI and real GDP are cointegrated that means they have long-term relationship. The next task is to run the VECM with zero lag. The results are shown in Table 3.

Table 3: Long-run Equation

Long run equation	Coefficient
BM(-1)	1
CPI(-1)	2.52**
GDP(-1)	-6.2**
Cons	33.21

Significant at 1% (**) and 5% (*)

It is seen that all the variables are significant and long-term relationship are similar to research findings of William et. al. (1976). When GDP is increasing, money supply is also increasing. However, the relationship between CPI and broad money is reverse, i.e. if CPI increases broad money decreases in the long-run. This needs some explanation. Here the data are yearly or low frequency data. It could be that prompt actions on monetary policy have created an opposite relation between broad money and CPI. The following table (Table 4) is showing the short run relationships between the variables.

Table 4: Short-run Equations

Short run equations	D(LM2)	D(CPI)	D(GDP)
EC(-1)	-0.035*	-0.047**	0.008*
	(-1.99)	(-6.909)	(2.274)
Cons	0.159 **	0.075**	0.046**
	(15.88)	(19.526)	(21.281)

Significant at 1% (**) and 5% (*)

Broad money and CPI have significant, negative error correction term. These are also less than one which implies convergence to equilibrium. GDP has a significant EC term, but this is not negative and not less than one. In such a scenario, GDP has smaller or no contribution to adjust to equilibrium. In this backdrop, weak exogeneity test of GDP is done. Here null hypothesis is $_y\ \alpha_y=0$ in equation (4). The results are shown in table 5 and 6 below.

Table 5: Long-run Equation (Weak Exogeneity of GDP)

Long run equation	Coefficient
M2(-1)	1
CPI(-1)	3.08**
GDP(-1)	-7.12**
Cons	38.34

Significant at 1% (**) and 5% (*)

Table 6: Short-run Equations (Weak Exogeneity of GDP)

Short run equations	D(LM2)	D(CPI)	D(GDP)
EC(-1)	-0.035*	-0.043**	0.000
t-statistics	(-2.09)	(-6.89)	NA
Cons	0.159 **	0.075**	0.047**
t-statistics	(15.88)	(19.74)	(20.61)

Significant at 1% (**) and 5% (*)

Results show weak exogeneity of GDP with Chi-square value 3.86 and p-value 0.049. The test result implies that GDP has some degree of exogeneity in the model. Then the Granger causality test is done to explore the direction of causality among the variables in Table 7.

Table 7: Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Prob.
LCPI does not Granger Cause LM2	35	0.09223	0.7633
LM2 does not Granger Cause LCPI		18.7873	0.0001
LGDP does not Granger Cause LM2	35	5.89010	0.0210
LM2 does not Granger Cause LGDP		0.35309	0.5565
LGDP does not Granger Cause LCPI	35	33.9022	2.E-06
LCPI does not Granger Cause LGDP		0.09844	0.7557

The results are similar to many other studies on developing countries. CPI does not Granger cause broad money, but broad money has an influence on CPI. Again, GDP affects broad money, but broad money does not have influence on GDP, reflects unidirectional causality from GDP to broad money. Again, GDP affects CPI, but CPI does not affect GDP.

Explanation of the empirical results shows more weight on Keynesian view, rather than the monetarist view. Like many other studies (Williams et.al.,1976; Hossain, 2008;) money supply increased because of increased money demand generated from high GDP growth.

5. Conclusion

The paper unveils some breakthrough results for the economy of Bangladesh. Many earlier research on Bangladesh supports monetarist view that money supply causes GDP growth. But this research proves that rather than the money supply, the real factors are playing important role for the growth process in Bangladesh. There are several reasons to believe that real factors are important for the growth than monetary factors. In Bangladesh households do not have enough access to financial institutions or a larger proportion of the population are out of financial sectors. In 2014, broad money to nominal GDP ratio was 63percent. Nonetheless, money acts as the medium of exchange. If it is not available according to demand, then the GDP growth process would be hampered. Monetary policy can have effectiveness in a developing country like Bangladesh, when here will be financial deepening. In such a scenario fiscal policy can have a greater role than monetary policy in Bangladesh. The country should come up with economic policies to increase productivity, enhance capital accumulation and make the workforce skilled.

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Appendices

Appendix 1: ADF test results

ADF test for broad money

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.811458	0.8034
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

ADF test for CPI

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.903235	0.0551
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

ADF test for GDP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		4.755246	1.0000
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

Appendix 2: Lag length criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	51.55598	NA	9.65e-06	-3.034749	-2.897336	-2.989200
1	245.9288	340.1525*	9.01e-11*	-14.62055*	-14.07090*	-14.43836*
2	250.9019	7.770486	1.18e-10	-14.36887	-13.40698	-14.05003
3	258.3373	10.22355	1.36e-10	-14.27108	-12.89695	-13.81559
4	263.1678	5.736326	1.92e-10	-14.01049	-12.22412	-13.41836

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 3: Serial Correlation test
Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 1979 2014
Included observations: 35

Lags	LM-Stat	Prob
1	12.12557	0.2063
2	6.732269	0.6650
3	3.726901	0.9285
4	8.570991	0.4778

Probs from chi-square with 9 df.

Appendix 4: Heteroskedasticity Test
Residual Heteroskedasticity Tests: Includes Cross Terms
Sample: 1979 2014
Included observations: 35

Joint test:

Chi-sq	df	Prob.
68.04575	54	0.0947

Individual components:

Dependent	R-squared	F(9,25)	Prob.	Chi-sq(9)
res1*res1	0.363095	1.583590	0.1744	12.70832
res2*res2	0.152138	0.498437	0.8615	5.324828
res3*res3	0.586472	3.939491	0.0032	20.52653
res2*res1	0.345072	1.463570	0.2155	12.07752
res3*res1	0.245107	0.901920	0.5383	8.578747
res3*res2	0.401136	1.860635	0.1063	14.03976

Appendix 5: Broad Money (Resid01), CPI (Resid02) and GDP (Resid03)