World Review of Business Research
Vol. 1. No. 4. September 2011. Pp.33-43

"Quantity Theory of Money and its Applicability: The Case of Bangladesh"

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The relationship between money and inflation is one of the important topics in macroeconomic research. The Quantity Theory of Money (QTM) is one of the classical macroeconomic models that explain the linkage between money and prices. The current study investigates this relationship for Bangladesh economy over the period of 1976 to 2006. To check the stationarity properties, I have employed Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test and found all the concerned variables are stationary either in the level form or in the first differenced form. Using Johansen cointegration method, the empirical findings indicate that there exists long run cointegrating relationship among some of the concerned variables. Then applying the Granger causality test, I have revealed a unidirectional causal relationship running from money supply to inflation which provides evidence in support for quantity theorist's view.

Field of Research: The Empirical Investigation of the Quantity Theory of Money in Bangladesh Economy.

1. Introduction

The Quantity Theory of Money (hereafter denoted QTM) is considered as one of the main building blocks in the construction of economic theory. The main implication of the QTM is that long run movements in the price level are determined primarily by long run movements in the excess of money over real output. However, conventional economic growth theories suggest that inflation negatively affects overall economic performance of any country. Several economic studies also reveal that high inflation distorts the decisions of private agents concerning investment, saving, production which in turn slower economic growth. There is also evidence that even moderate levels of inflation damage real growth. Considering various negative consequences of inflation on the economy, there is a consensus among world's leading economists that the price stability should be the prime objective of monetary policy (King,1999) and the central banks should be committed to maintain low inflation (Blejer et al, 2000).

Several empirical studies across the world have explored the relationship between inflation and other macro economic variables using cross sectional and time series data for both developed and developing countries. Despite having several empirical works regarding the causality between money and price across the globe, few researchers make attempt to investigate this relationship in Bangladesh. So far in my knowledge,

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there is no previous empirical study which tests the validity of the quantity theory of money in Bangladesh.

This article draws on recent developments in the theory of econometric techniques to test whether the QTM holds as a long run equilibrium relation in Bangladesh. With an intention to discover the linkage between money and prices in Bangladesh, the present study is going to investigate the cointegration and causal relationship among money, prices, inflation and output in Bangladesh over the period 1976-2006 by using the cointegration approach and Granger causality analysis. The following two questions are addressed in this study:

1. Is there a long run equilibrium relationship between money and prices in Bangladesh?
2. Is causality running in either direction or both directions?

This article is organized as follows. Next section presents the review of literature. The section after that explains the Quantity Theory of Money. Then the following section discusses the methodology and attributes of data. Econometric results and their discussions follow in the subsequent section with concluding remarks.

2. Literature Review

The direction of causality between money and prices has been tested in different countries to examine the validity of the QTM relationship in an empirical way. Tan and Baharumshah (1999) examined the dynamic causal chain among money, real output, interest rate and inflation in Malaysia using monthly data from 1975 to 1995 and found that price does Granger causes M2 through short run channel. Masih and Masih (1998) investigated the causality between money and prices in Thailand, Malaysia, Singapore and the Philippines from January 1961 to April 1990. They found a unidirectional causality running from money supply to prices.

Pinga and Nelson (2001) investigated the relationship between money supply and aggregate prices for 26 countries and found ambiguous results. They found no causal relationship between prices and money in Malaysia. They also found that aggregate prices cause money supply in Chile and Srilanka. However, they revealed that most countries exhibited mixed evidence of money supply endogeneity, with bidirectional causation between money supply and aggregate prices as a common result.

Jones and Uri (1987) examined the causality between money and prices in the US over the period 1959:Q1 to 1986:Q2. The results of the study showed bidirectional relationship between the measures of money growth and inflation. Darrat (1986) examined the direction of causation between money and prices for Morocco, Tunisia and Libya over the period 1960:Q1 and 1980:Q2 and revealed a unidirectional causal relationship running from money to prices for all the concerning countries. Benbouziane and Benamar (2004) also found the same results for Morocco and Tunisia.

Ashra et al (2004) examined the relationship between money, output and price level for India and found bidirectional causality between money and price level. Having used a large panel of low and high inflation countries, Gravwe and Polan (2005) found that the QTM prediction that an expansion of the money stock does not increase output in the long run was confirmed. Herwarts and Reimers (2006) analyzed the dynamic relationship between money, real output and prices for an unbalanced panel of 110 economies. They revealed homogeneity between prices and money for high inflation countries. Their findings suggest that central banks can improve price stability by controlling monetary growth.

Emerson (2006) examined the long run relationship between money, prices, output and interest rates in the United States using quarterly data for the period 1959 to 2004 and their results supported the main hypothesis of the QTM. Nwafor, Nwakanma, and Thompson (2007) investigated the QTM via Keynesian Liquidity Preference Theory in a developing economy of Nigeria from 1980:Q3 to 2005:Q4 and found a long run relationship among real income, aggregate money demand, real interest rate, and expected inflation rate. Wanaset (2009) examined the validity of QTM in case of Thailand by using cointegration and causality test and showed that this theory appeared to hold as a long run equilibrium relation in both period of time, pre and post bank of Thailand adopting inflation targeting policy in 2000. Aslan and Korap (2007) tried to test the validity of the QTM for Turkish economy by using some contemporaneous estimation techniques and concluded that monetary authorities followed an accommodative monetary policy inside the period given the endogeneity of the monetary variables.

Ghazali, Amin, Muhammad and Samsu (2008) examined the relationship between money and prices in Malaysia by employing Johansen cointegration method, Yoda-Yamamoto causality test and found a unidirectional causality running from money supply (M1, M2 and M3) to Consumer Price Index (CPI). Their empirical results supported the quantity theorist's view. Quayyum (2006) made an attempt to investigate the linkage between excess money supply growth and inflation in Pakistan and concluded that excess money supply growth had been an important contributor to the rise in inflation in Pakistan during the study period, thus supporting the monetarist proposition of inflation as a monetary phenomenon.

Mehra P. Yash (1989) examined long run relationship of QTM by using Granger (1988) cointegration test in USA covering period during 1952:Q1 to 1988:Q4 and revealed that the QTM was consistent with data.

3. The Quantity Theory of Money

The Quantity theory of money is one of the well known macroeconomic models that explain the relationship between the money circulation in the economy and the level of prices of goods and services sold. In general, the QTM refers to the proposition that changes in the quantity of money lead to, other factors remaining constant,

approximately equal changes in the price level. The equation of exchange, introduced by Irving Fisher identifies the exact mathematical relationship between the concerned variables and his version took the following form:

$$MV=PT$$

The equation of exchange can be used to form a rudimentary theory of inflation:

$$P=MV/T$$

Where M is the money supply that includes currency in circulation plus checkable deposits, V is the income velocity of money which has been defined as being equal to the money value of income and output divided by the money stock, P is the general price level and T is the overall level of transactions in the economy.

However, now a day, contemporary economists make use of a simplified equation of exchange that takes the following form: MV=PY where Y is the measure of aggregate output level under the simplifying assumption that the economic transactions volume in the economy in a given time period would be proportional to the aggregate output.
Let us express quantity theory in terms of the growth rates:

$$m+v=p+y$$

Where the lower case letters denote the growth rates. The QTM relationship requires that there exists a proportional relationship between the growth rates of money supply and price level and that money must be neutral which is resulted from stationary velocity of money and unaffected real output level in the long run following the permanent changes in the growth rate of money supply.

4. Methodology, Variables and Data Set

Existence of unit root has been tested to check the stationarity of the variables. Macro variables are well known for their non stationarity. Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) have been performed to find the existence of unit root. Both the tests found that some of the variables are non stationary and thus cannot be regressed without making them stationary. Then cointegration test was conducted to find out possible linear combination of the variables that can be considered stationary. If the variables are cointegrated, then Granger causality test has been done to check the possible direction of causality.

In time series analysis, non stationary data may lead to spurious regression unless there exists at least one cointegrating relationship. The Johansen procedure is applied to test for cointegration. This method provides a unified framework for estimation and testing of cointegration relations in the context of Vector Autoregressive (VAR) error correction models. For this approach one has to estimate an Unrestricted Vector of

Autocorrelation of the form:

$$\Delta x_t = \alpha + \theta_1 \Delta x_{t-1} + \theta_2 \Delta x_{t-2} + \theta_3 \Delta x_{t-3} + \cdots\cdots + \theta_{k-1} \Delta x_{t-k+1} + \theta_k \Delta x_{t-k} + u_t$$

Where Δ is the difference operator, x_t is a $(n \times 1)$ vector of non-stationary variables (in levels) and u_t is also the $(n \times 1)$ vector of random errors. The matrix θ_k contains the information on long run relationship between variables. If the rank of $\theta_k = 0$, the variables are not cointegrated. On the other hand if rank (usually denoted by r) is equal to one, there exists one cointegrating vector and finally if $1 < r < n$, there are multiple cointegrating vectors. Johansen and Juselius (1990) have derived two tests for cointegration, namely the trace test and the maximum Eigen value test. The trace statistic evaluates the null hypothesis that there are at most r cointegrating vectors whereas the maximal eigen value test, evaluates the null hypothesis that there are exactly r cointegrating vectors in x_t .

According to cointegration analysis, when two variables are cointegrated then there is at least one direction of causality. Granger causality, introduced by Granger (1969, 1980, 1988), is one of the important issue that has been much studied in empirical macroeconomics and empirical finance. Engle and Granger (1987) have indicated that the existence of non-stationarity, can give misleading conclusions in the Granger causality test. It is only possible to infer a causal long run relationship between non stationary time series when the variables are cointegrated.

If y and x are the variables of interest, then the Granger causality test determines whether past values of y add to the explanation of current values of x as provided by information in past values of x itself. If past changes in y does not help explain current changes in x, then y does not Granger cause x. Similarly, we can investigate whether x Granger causes y by interchanging them and repeating the process. There are four likely outcomes in the Granger causality test: (1) neither variable Granger causes each other, (2) y causes x but not otherwise, (3) x causes y but not otherwise, (4) both x and y Granger cause each other.

In this study the causality test between money supply and inflation will be conducted. For this the following two sets of equation will be estimated:

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots\cdots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \cdots\cdots + \beta_l y_{t-l} + u_t$$
$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots\cdots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \cdots\cdots + \beta_l x_{t-l} + v_t$$

For all possible pairs of (x, y) series in the group. The reported F-statistics are the Wald statistics for the joint hypothesis $\beta_1 = \beta_2 = \beta_3 = \cdots\cdots = \beta_l = 0$

As explained in the introduction, this paper examines the long run relationship and the direction of causality between money and price level of Bangladesh. The measure of Real GDP (RGDP) can be considered as an indicator of economic development. However, Inflation (INF), Interest Rate (INT) and Money Supply (Money) have also been considered in this study as the measurement of the Quantity Theory of Money.

The Data for all the variables have been collected from World Development Indicators managed by the World Bank. Our data set spans over the period of 1976-2006 for which 31 observations are available at most. Expansion of data set is not possible due to unavailability of data. Also since the relationship is dynamic one, so inclusion of very old data can produce us with wrong outcomes. Small sample size might be problematic in finding the long run relationship. Eviews 5.0 and Microfit 4.1 have been used as statistical software packages for all the tests run in this study. All the econometrics results are available on request.

5. Results Obtained

Unit root tests were conducted to determine the order of integration of the data series for each of the variables. Table 1 shows the ADF statistics and corresponding critical values of all the variables in their level and first differenced forms. For getting more robust result, Phillips Perron test has been conducted and obtained the uniform results for the variables. (Table 2)

Table 1: Augmented Dickey Fuller(ADF) Unit Root Test for the selected variables

Panel 1: Levels			
	ADF Statistics (Only Constant)	ADF Statistics (Constant & Trend)	Decision
Inflation	-5.064539	-6.494905	Stationary
Interest Rate	-2.179494	-2.751951	Non Stationary
Money	2.508091	3.132331	Non Stationary
RGDP	14.21289	4.545634	Stationary
Panel 2: First Differences			
	ADF Statistics (Only Constant)	ADF Statistics (Constant & Trend)	Decision
Inflation	Not Applicable	Not Applicable	Not Applicable
Interest Rate	-3.175639	-3.195106	Stationary
Money	2.720155	1.246093	Stationary
RGDP	Not Applicable	Not Applicable	Not Applicable

Note: All regression is estimated with and without trend. Selection of the lag is based on Schwartz Information Criterion (SIC). Eviews 5.0 software automatically selects the most significant lag length based on this criterion.

Table 2: Phillips Perron Unit Root Test for the Variables

Panel 1: Levels			
	PP Test Statistics (Only Constant)	PP Test Statistics (Constant & Trend)	Decision
Inflation	-4.928933	-7.702600	Stationary
Interest Rate	-1.784276	-2.079057	Non Stationary
Money	10.23366	4.896304	Non Stationary
RGDP	14.21289	7.325677	Stationary

Panel 2: First Differences			
	PP Test Statistics (Only Constant)	PP Test Statistics (Constant & Trend)	Decision
Inflation	Not Applicable	Not Applicable	Not Applicable
Interest Rate	-2.856443	-2.760668	Stationary
Money	Not Applicable	Not Applicable	Stationary
RGDP	Not Applicable	Not Applicable	Not Applicable
Note: All regression is estimated with and without trend. Selection of bandwidth is based on Newey-West Bandwidth Criterion. Eviews 5.0 software automatically selects the most significant bandwidth based on this criterion.			

Here it is worth mentioned that unit root tests have non-standard and non-normal asymptotic distribution which are highly affected by the inclusion of deterministic terms, e.g., constant, time trend etc. A time trend is considered as an extraneous regressor whose inclusion reduces the power of the test. However if the true data generating process were trend stationary, failing to include a time trend also results in a reduction in power of the test. In addition, this loss of power from excluding a time trend when it should be present is more severe than the reduction in power associated with including a time trend when it is extraneous (Lopez et al, 2005).So, in this study I have also considered time trend for more robust results.

From table 1 and table 2, the null hypothesis of unit root in levels of some of the variables at 90%, 95% and 99% confidence level cannot be rejected. It is clear that some of the concerned variables are non stationary in their level. However, all the concerned variables are stationary in the first differenced form. The above results also imply that the variables would yield spurious results unless the variables are cointegrated.

These results, however, allow us to proceed to the next stage of testing for cointegration. Results of Johansen test for cointegration is given in table 3 and 4.

Table 3: Johansen Test for Cointegration (Maximum Eigen Value Test) (No intercepts or trends in the VAR)					
List of variables included in the cointegrating vector: INF INT RGDP MONEY					
Null	Alternative	Statistics	95% Critical Value	90% Critical Value	Conclusion
r=0	r=1	50.3325	23.9200	21.5800	At Least Three Cointegrating Relationship
r<=1	r=2	32.9538	17.6800	15.5700	
r<=2	r=3	11.3370	11.0300	9.2800	
r<=3	r=4	0.83280	4.1600	3.0400	

Table 4: Johansen Test for Cointegration (Trace Test) (No intercepts or trends in the VAR)					
List of variables included in the cointegrating vector: INF INT RGDP MONEY					
Null	Alternative	Statistics	95% Critical Value	90% Critical Value	Conclusion
r=0	r=1	95.4561	39.8100	36.6900	At Least Three Cointegrating Relationship
r<=1	r=2	45.1236	24.0500	21.4600	
r<=2	r=3	12.1698	12.3600	10.2500	
r<=3	r=4	0.83280	4.1600	3.0400	

The Granger causality test has been done with specific lag period and the results are reported in table 5. Lag length has been chosen by using Schwarz Information Criterion (SIC).

Table 5: Granger Causality Tests

Hypothesis	F-Statistics	P-Value	Granger Causality
RGDP does not Granger Cause INF	8.87013	0.00131	Bidirectional Causality RGDP↔INF
INF does not Granger Cause RGDP	3.82680	0.03610	
INT does not Granger Cause INF	0.44378	0.64676	Unidirectional Causality INF→INT
INF does not Granger Cause INT	3.82813	0.03606	
Money does not Granger Cause INF	6.16501	0.00691	Unidirectional Causality MONEY →INF
INF does not Granger Cause Money	0.11694	0.89015	
MONEY does not Granger Cause INT	0.91942	0.41234	No Causality
INT does not Granger Cause MONEY	0.36399	0.69867	
RGDP does not Granger Cause INT	1.04019	0.36878	No Causality
INT does not Granger Cause RGDP	1.05242	0.36466	
RGDP does not Granger Cause Money	1.46671	0.25063	Unidirectional Causality MONEY →RGDP
Money does not Granger Cause RGDP	4.09292	0.02955	

6. Discussion on Results Obtained

Now, summarizing the results that I have obtained, I see that some of the macroeconomic variables (Inflation and RGDP) are stationary with constant and trend in the level form. However, both the ADF and PP test reveal non stationarity among some of the variables which is somewhat expected. So before applying cointegration test, it need to be checked whether the variables are stationary or not in the first differenced form. Tests of cointegration tell that at least three of the variables are cointegrated. The Granger causality test shows that there is bidirectional causality between economic activities and inflation. The test further reveals that there is a unidirectional causality running from inflation to interest rate and money supply to inflation. However, there is no causal relationship between money supply and interest rate, economic activities and interest rate. So, in this current study I have found that in Bangladesh money causes output and inflation, which is a standard economic phenomenon. This study also provides evidence in supporting the well known fisher effect for Bangladesh economy.

7. Conclusion

This paper has empirically examined the monetarists' view that money supply has been the key determinant of inflation in Bangladesh. I have employed annual data and applied cointegration using the Johansen approach and application of Granger causality approach to study the money prices interaction. This study finds convincing evidence in support of the quantity theory of money using time series data from the Bangladesh economy for the period 1976-2006. Empirical results suggest that prices and money move together in the long run which goes in line with previous research in other developing countries.

The study reveals that the money supply growth has been an important contributor to the rise in inflation in Bangladesh during the study period. The results suggest that

inflation in Bangladesh is a monetary phenomenon. This may occur because of the implementation of weak monetary policy adopted by central bank of Bangladesh to achieve the high priority growth objectives. So, monetary policy should be conducted with proper care. It has been argued that the policies triggered to output growth through money supply only have short run effect on real output but generate inflation. In my study, unidirectional causality running from money to inflation and money and RGDP has been found. So, expansionary monetary policy could accelerate economic activities in Bangladesh at the expense of high price level.

My findings have important policy implications. For example, under a floating exchange rate system, monetary policy can be conducted to achieve price stability through monetary targeting if money growth is considered the primary, if not the sole determinant of long term inflation. Monetary targeting may therefore be considered an option at least for a transitional period, given that under the present market-based exchange rate system, the Bangladesh Bank has gained an effective control over the monetary base and that there exists both a stable money demand function [Hossain 2003,2004] and a situation of monetary stability as envisaged by monetary economists for a monetary rule (Friedman 1960, Laidler 1986). Additionally, the formulation of monetary policy must consider development in the real and financial sector and treat them as constraints on the policy (Gordon 1985). But further research should be done especially investigating the validity of long run fisher effect in Bangladesh economy.

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