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TESTING OF MONEY MULTIPLIER MODEL FOR PAKISTAN: DOES MONETARY BASE CARRY ANY INFORMATION?

By

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Abstract

This paper tests the constancy and stationarity of mechanic version of the money multiplier model for Pakistan using monthly data over the period 1972M1-2009M2. We split the data into pre-liberalization (1972M1-1990M12) and post-liberalization (1991M1-2009M2) periods to examine the impact of financial sector reforms. We first examine the constancy and stationarity of the money multiplier and the results suggest the money multiplier remains non-stationary for the entire sample period and sub-periods. We then tested cointegration between money supply and monetary base and find the evidence of cointegration between two variables for the entire period and two sub-periods. The coefficient restrictions are satisfied only for the post-liberalization period. Two-way long-run causality between money supply and monetary base is found for the entire period and post-liberalization. For the post-liberalization period the evidence of short-run causality running from monetary base to money supply is also identified. On the whole, the results suggest that money multiplier model can serve as framework for conducting short-run monetary policy in Pakistan. However, the monetary authority may consider the co-movements between money supply and reserve money at the time of conducting monetary policy.

Resumen

Este artículo examina la constancia y la inmovilidad de la versión mecánica del modelo de multiplicación de dinero para Paquistán, utilizando datos mensuales obtenidos durante 1972M1-2009M2. Dividimos los datos en dos periodos: pre-liberalización (1972M1-1990M12) y post-liberalización (1991M1-2009M2) con el fin de analizar el impacto de las reformas del sector financiero. En primer lugar, examinamos la constancia y la inmovilidad de la multiplicación de dinero. Los resultados sugieren que esta multiplicación fluctúa para la totalidad del periodo y subperiodos. Después observamos la cointegración entre la oferta de dinero y la base monetaria y descubrimos que se halla entre dos variables para la totalidad del periodo y subperiodos. Las restricciones de coeficiente se cumplen únicamente durante el periodo de post-liberalización. Se observa una causalidad de doble dirección y a largo plazo entre la oferta de dinero y la base monetaria durante todo el periodo y el de post-liberalización. Durante este último, se descubrió la evidencia de una causalidad a corto plazo que va de la base monetaria a la oferta de dinero. En general, los resultados sugieren que el modelo de multiplicación de dinero puede servir de marco conceptual para implementar una política monetaria a corto plazo en Paquistán. Sin embargo, la autoridad monetaria puede también considerar los co-movimientos entre la oferta de dinero y la reserva de dinero en el momento en que se implemente dicha política.

Key Words: Money Multiplier, Reserve Money, Monetary Policy

JEL Classification: E51, E52, E58

TESTING OF MONEY MULTIPLIER MODEL FOR PAKISTAN: DOES RESERVE MONEY CARRY ANY INFORMATION?

1.- Introduction

The findings of economic theory have shown that apart from inflation, monetary policy is unable to exert lasting influence on macroeconomic variables such as gross domestic product (GDP), real wage rate and level of employment (Komaromi, 2007). Consequently, a large number of experts and policymakers have taken the view that the primary objective of the central banks is to control inflation and this has gained special attention in the recent years. However, there are misunderstandings and misperceptions among the policymakers regarding the tools and mechanisms the central bank employ to achieve the goal of price stability (Komaromi, 2007). Therefore, there is a need to define the chain of target variables that can be directly influenced by the central bank through which monetary policy measures affect the inflation rate. Many central banks are influencing economic trends by directly controlling the money supply, which is achieved by controlling the quantity of central bank money (monetary base). According to this view the transmission mechanism sets out from the quantity of monetary base as operational target and moves towards inflation through the money supply in the economy (Mankiw, 2005). This approach is based on the monetarist theory of inflation, which states that the price level is determined by the amount of money available in the economy. The control of money supply is an important policy tool in conducting the monetary policy and its success is heavily depends on the degree of controllability that the central bank has over money supply. Thus the central bank is responsible for controlling the growth rate of money supply by controlling the monetary base.

There are two main approaches to the determination of money supply. The money base approach (Friedman and Schwartz, 1963; Brunner and Multzer, 1964) and the portfolio approach (Goodhart, 1989). However, there is no consensus over the issue of the stability of money multiplier and the controllability of the monetary base. The proponent of the money base approach argued that the variations in money multiplier depend on the currency in circulation, demand deposits, time deposits and bank reserves. Variations in these factors may dominate in money stock in the short-run and become stable and predictable over the long-run (Brunner, 1997). The non-monetarist has pointed out that the determinants of money multiplier such as ratios of currency to demand deposits, demand to time deposits and bank reserve to total deposits are determined by portfolio behaviour of the agents and are sensitive

to the changes in relative rates of return, risk, innovations in the financial markets, income and preferences of the market participants. With the increasing role of market forces in the financial transactions and continuous improvements in asset-liability management, there is very little reason to believe on the stability of money multiplier and the controllability of the monetary base by the monetary authorities (Goodhart, 1989).[1]

In Pakistan, State Bank of Pakistan (SBP) implements monetary policy by setting monetary base (B) as operational target and broad money (M2) as an intermediate target in the monetary policy framework since the introduction of financial sector reforms in the late eighties.[2] The B is the main policy variable which is influenced by SBP using various policy tools. Therefore, the controllability of B is an important for the effective monetary targeting. SBP monitors the actual growth in B and makes adjustment through market interventions whenever growth in B deviates from its target. Whenever the actual B fall short of or increases beyond the target, the SBP may conduct open market operations (OMO) to absorb the liquidity in the system by replenishing (debiting) bank's reserves and increase (decrease) the amount of B (SBP, 2006-07). Through OMO, the SBP conduct monetary policy revolving around changes in the B to achieve the M target and the expected money multiplier. The success of OMO in keeping M within targets depends upon the accuracy of the estimated money multiplier and controllability of B.

The recent history of Pakistan provides abundant evidence on the role played by the monetary factors in the macroeconomy. It can demonstrate that changes in the money supply exert profound influence on inflation, output growth and other financial activities. Therefore, besides the stability of money multiplier, there is a need to address the issue of controllability of the B for the effective control of M by the monetary authority. The money multiplier model provides a starting point for assessing the relationship between monetary base and the money supply.

The objective of this paper is to test for the stationarity of money multiplier and to determine the long-run relationship between M and B for Pakistan using monthly data covering the period from 1972M1- 2008M4 without considering any behavioural content to the multiplier and its components using Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration and error correction modeling technique. The study also consider

[1] We use the word reserve money, high-powered money and monetary base interchangeably.
[2] The detail review of financial sector reforms can be seen in Khan and Khan (2007).

the behaviour of money multiplier, money supply and monetary base for pre-liberalization (i.e. 1972M1-1990M12) and post-liberalization (i.e. 1991M1-2009M2) periods.

The rest of the paper is organized as follows. Section 2 contains a brief review of empirical literature. Model specification and methodology is discussed in section 3. Results are interpreted in section 4. Estimation of vector error-correction model and the results of multivariate causality are given in section 5, while some concluding remarks are given in the final section.

2.- Review of Existing Literature

Most of the empirical research concerning the issue of stability and predictability of money multiplier used time series techniques. The studies, *inter alia,* Bomhoff (1977), Buttler *et al.* (1979), Fratianni and Nabli (1979), Chitre (1986), Johannes and Rasche (1979, 1981), Nachane and Ray (1989) and Ray and Madhusoodan (1992) assesses the predictability of the money multiplier using ARIMA modeling technique at aggregate level. At disaggregated level, Johannes and Rasche (1979, 1981) extended the time series approach using a "component" approach. Their results indicate that the predictive performance of the component ratios would be superior to the aggregate model. However, Haffer and Hein (1984) tested this claim and find that aggregate model yields quite accurate out-of-sample forecasts even when compared with a components approach. Hossain (1993) argue that only deposit to currency ratio equation remain stable, while the narrow and broad money multiplier equations were found to unstable. He concluded that in the presence of the instability in the components of money multiplier, it is very difficult for the authorities in Bangladesh to conduct monetary policy effectively through monetary targeting. Zaki (1995) argued that forecasts of aggregate money multiplier provided satisfactory results than the components of money multiplier. Recently many researcher, *inter alia*, Nachane (1992), Ford and Morris (1996), Baghestani and Mott (1997) and Sen and Vaidya (1997) used cointegration method to examine the link between the various monetary aggregates and the monetary base. The findings of these studies indicate that the instability in the money multiplier mainly caused by the absence of cointegration. However, Darbha (2002) tested the cointegration between monetary aggregates and reserve money for India using residual-based cointegration test developed by Gregory and Hansen (1996). He find that there exist a stable but time-varying, long-run relation between measures of money stock and reserve money. More recently, Downes *et al*. (2006) examined the stationarity of money multiplier for a group of six African countries using descriptive statistics and unit root tests approach. They find that when financial sector reforms are ignored the unit root hypothesis is accepted. However, once the

structural break (financial liberalization) is incorporated, the unit root hypothesis is rejected which implies non-stationarity of money multiplier.

In Pakistan many studies have been carried out regarding the stability of money multiplier and its components. Hamdani (1976), Mangla and Ladenson (1978), Bilquees (1993), Siddique and Ahmed (1994), and Qayyum and Ahmed (2001) have tested different models for the projection of money multiplier and its components. These studies concluded that besides the money stock, monetary base and currency ratio are the important determinants of money supply in Pakistan. Besides, Arby (2002) have tested the aggregate money multiplier and its components using Box-Jenkin (1976) methodology. These studies concluded that the aggregate model is superior over the component model because it produces better-projected values and exhibit stable behaviour in the short-term.

These mixed findings motivated us to examine the stationarity of the money multiplier and cointegration between money supply and monetary using Johansen (1988) and Johansen and Juselius (1990) cointegration method over the period 1972M1-2009M2. The present study has focuses mainly on the stationarity of the money multiplier as well as the cointegration between money supply and monetary base. We sub-divided that sample to pre-liberalization (1972M1-1990M12) and post-liberalization (1991M1-2009M2) periods taking care of the impact of banking sector reforms.

3.- The Model Specification

The money multiplier model suggests that the behaviour of money supply is determined by the monetary base, the commercial banks and the public. The money multiplier approach assumes that the monetary authorities being able to precisely control the monetary base so that the stock of monetary base is taken as given. The quantity of monetary base (B) may be held either by the commercial banks (C_b) or the public (C_p) so that

$$B = C_b + C_P \qquad (1)$$

Commercial banks hold a fraction of deposits (D) in the form of B (ρ , the reserve ratio) so that

$$C_b = \rho D \qquad (2)$$

Public also hold a fraction of their deposits (D) in the form of H (λ , the currency ratio) so that

$$C_p = \lambda D \tag{3}$$

The money supply (M) is defined as cash held by the public (C_p) and deposits (D) of the banking system

$$M = C_P + D \tag{4}$$

Where *M* is money supply.

Dividing equation (4) by equation (1) gives

$$\frac{M}{B} = \frac{C_P + D}{C_b + C_P} \tag{5}$$

Substituting equation (2) and (3) we obtain

$$\frac{M}{B} = \frac{\lambda D + D}{\rho D + \lambda D} \tag{6a}$$

$$\frac{M}{B} = \frac{(1+\lambda)D}{(\rho+\lambda)D} \tag{6b}$$

$$M = \left(\frac{1+\lambda}{\rho+\lambda}\right)B \tag{7}$$

Where $\left(\frac{1+\lambda}{\rho+\lambda}\right)$ is known as money multiplier, $\lambda = \frac{C_p}{D}$ is the currency to deposits ratio (currency ratio) and $\rho = \frac{C_b}{D}$ is the reserves to deposits ratio (reserve ratio). Equation (7) implies that $\frac{\partial M}{\partial B} > 0$, $\frac{\partial M}{\partial \lambda} < 0$ and $\frac{\partial M}{\partial \rho} < 0$. The deterministic form of the aggregate money multiplier model can be written as:

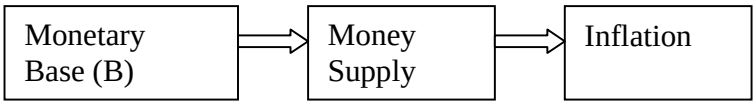
$$M_t = kB_t \tag{8}$$

This equation shows that money supply is a function of exogenous variable. According to the model, money supply is in proportion with monetary base, the proportionality factor (k) is called the money multiplier (Vane and Thompson, 1980). The transmission mechanism suggests that through money multiplier, the monetary base affects the money supply, whose growth rate determines the rate of inflation in an economy. In logarithmic form equation (8) can be rewritten as

$$LnM_t = \beta_0 + \beta_1 LnB_t + \varepsilon_t \tag{9}$$

Where, β_0 is the logarithm of k. For the multiplier model to be valid as a stable long-run equilibrium relationship, LnM and LnH are cointegrated such that $\beta_0 = 0$ and $\beta = 1$.[3] The requirement of cointegration is a necessary condition, while the coefficient restrictions represent the sufficient condition. The analysis can be summarizes with the help of following diagram.

Figure 1: Transmission of Money Multiplier Approach



It can be seen from the Figure 1 that the monetary base affects the money supply, whose growth rate determines the rate of inflation. Thus controllability of monetary base is inevitable to bring the price stability in the economy.

4.- Econometric Analysis

4.1. Data and descriptive Analysis

The study uses monthly data over the period January 1972 to April 2008. Broad definition of money (M2) is used in the analysis. M2 is defined as currency in circulation plus demand deposits plus time and foreign currency deposits with the schedule banks and other deposits with the State Bank of Pakistan (SBP). Reserve money is the sum of currency in circulation, cash in the tills, reserves of the schedule banks with the SBP and other deposits with the SBP. Data on these variables is taken from *International Financial Statistics CD-ROM (2008)* and *International Financial Statistics (April 2009).*[4] Money multiplier k is calculated as money supply (M2) divided by base money (B).

[3] Note that the intercept in equation (9) corresponds to money multiplier if the proportionality relation holds.
[4] Broad money is used in the analysis, which is defined as M1+Quasi money (lines 34+35) and line 14 for base money (IFS CD- ROM 2008) and up dated from International Financial Statistics Issue April, 2009.

The descriptive statistics for M, B and k are reported in Table 1. It can be seen from the Table 1 that mean value of k is 0.98 for the period 1972M1-2009M2. In the pre-liberalization period the average value k is 0.91, whereas is 1.05 for the post-liberalization period. This variation in the value of money multiplier could be indicative of increased confidence of the bankers on the financial system. Furthermore, the increase in the mean value of multiplier in the latter period could also be due to the consistency of financial reforms in the banking sector.

Table 1: Descriptive Statistics

Variables	Full Sample: 1972M1-2009M2				
	Mean	Maximum	Minimum	St. Dev	Observations
LnM	12.77	15.38	10.09	1.54	446
LnB	11.79	14.26	9.28	1.45	446
Lnk	0.98	1.24	0.71	0.12	446
Pre-Financial Liberalization: 1972M1-1990M12					
LnM	11.47	12.72	10.09	0.82	228
LnB	10.56	11.95	9.28	0.80	228
Lnk	0.91	1.04	0.75	0.07	228
Post-Financial Liberalization: 1991M1-2009M2					
LnM	14.13	15.38	12.76	0.73	218
LnB	13.08	14.26	11.97	0.62	218
Lnk	1.05	1.24	0.71	0.13	218

Similarly, the standard deviation of k shows high degree of variations between the pre-liberalization and post-liberalization periods. This higher volatility in k makes money multiplier non-stationary. These results therefore suggest that there was a shift in the mean of the multiplier between the pre-liberalization and post-liberalization period.

4.2 The Stationarity of Money Multiplier

The necessary condition for the stability of long-run money multiplier is not the constancy but stationarity of money multiplier. The stationarity of money multiplier implies that money supply and reserve money are stationary or money supply and reserve money are cointegrated with cointegrating parameter is equal to one (Sahinbeyoglu, 1995). The stationarity of money multiplier can be tested using the general specification of the following form:

$$k_t = \alpha_0 + \alpha_1 k_{t-1} + u_t \qquad \text{Or} \qquad (10)$$

$$\Delta k_t = \alpha_0 + \gamma k_{t-1} + u_t$$

Where u_t is a white noise error term and $\gamma = \alpha_1 - 1$. Under the null hypothesis k_t has a unit root, that is $\alpha_1 = 1$ and hence $\gamma = 0$, while in the alternative hypothesis money multiplier (k_t) is stationary, therefore, $\alpha_1 < 1$ or $\gamma < 0$. Thus, the money multiplier model holds in the short-run if the null hypothesis of unit root is rejected. We have used augmented Dickey-Fuller (ADF) unit root test to determine the stationarity of the money multiplier. ADF test is based on the following specification:

$$\Delta k_t = \alpha_0 + \mu trend + \theta D + \gamma k_{t-1} + \sum_{i=1}^{\omega} \varphi_i \Delta k_{t-i} + u_t \qquad (11)$$

Where ω is the number of lags that makes the residual white noise and D are the seasonal dummies. We apply this test on money multiplier using M2 (broad money). To capture the impacts of financial reforms we divided our sample into two sub-periods: pre-liberalization (1972M1-1990M12) and post-liberalization (1991M1-2008M4) period. Table 2 reports the results of the unit root test.

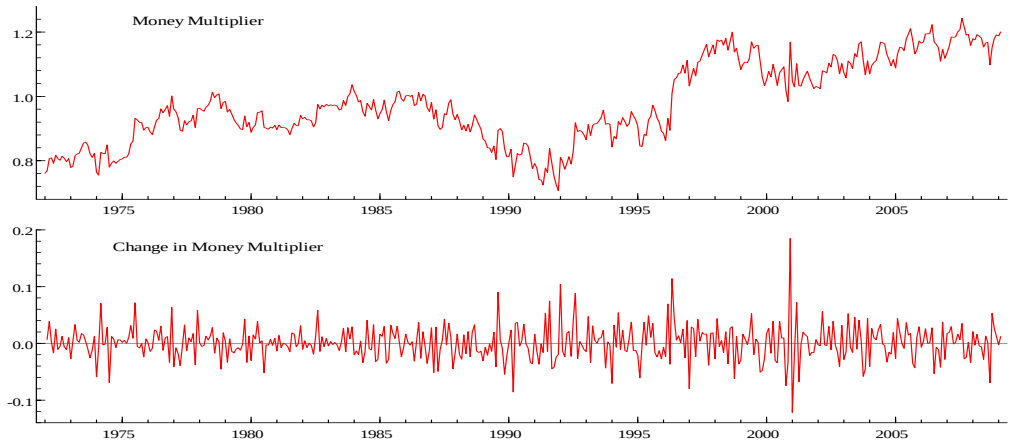
Table 2: Unit Root Test for Money Multiplier

Sample	Series	ADF	
		C+S	C+S+T
1972M1-2009M2	k	-1.26(12)	-2.04 (12)
1972M1-1990M12	k	-1.68 (12)	-0.85 (12)
1991M1-2009M2	k	-1.47 (7)	-1.97 (7)

Note: k is the money multipliers calculated as Money supply (M2) divided by reserve money. Numbers in (.) indicate number of lags.

As suggested by the ADF tests, money multiplier remains non-stationary for the entire sample period, pre-liberalization and post-liberalization periods with constant plus seasonal dummies and constant plus seasonal dummies plus time trend. Thus the ADF test supports the non-stationarity of the money multiplier. This result could be due to the structural shift resulted from the introduction of financial liberalization policies in the early 1990s. The non-stationarity of money multiplier can be examined by Figure 2.

Figure 2: Trends money multiplier in level and First Difference (1972M1-2009M2)



As can be seen from the figure that money multiplier shows a significant volatility since 1991. This could be due to the introduction of banking sector reforms and reforms in the exchange rate and payment systems. After 2001 the money multiplier not only stationary but also show some degree of stability.

4.3 Cointegration between Money Supply and Monetary Base

Unit root tests confirm the non-stationarity of money multiplier and inappropriateness for short-run policy purpose. The alternative way is to check the cointegration between M and the B to determine whether the money multiplier model holds true for long-run using Johansen (1988) and Johansen and Juselius (1990) cointegration technique. Testing for cointegration may be possible only when M and B is I (1) variables.

The stationarity of M and B is examined using ADF unit root test. Seasonal dummies are also included in the unit root test to capture the effect of seasonality. Table 3 reports the results for entire sample period (1972M1-2009M2), pre-liberalization (1972M1-1990M12) and post-liberalization (1991M1-2009M2) periods.

Table 3: Unit Root Tests

Series	Full Sample: 1972M1-2009M2		Post-Liberalization: 1972M1-1990M12		Pre-Liberalization: 1991M1-2009M2	
	Log-level					
	C+S	C+S+ T	C+S	C + S+ T	C+S	C+S+ T
LnM LnB	-0.47 (12) -0.61 (12)	-2.50 (12) -1.50 (12)	-1.02 (6) 0.50 (3)	-1.48 (7) -2.40 (2)	-1.55 (9) -0.40 (9)	-2.73 (9) -1.61 (8)
Log- first differences						
Δ LnM Δ LnB	-4.39(11)* -5.11 (12)*	-4.41(11)* -5.12 (12)*	-3.81 (5)* -13.02 (2)*	-3.90 (5)* -13.02 (1)*	-2.95(8)* -7.66 (7)*	-3.14 (8)* -7.64 (7)*
Critical values	99 Percent		95 Percent		90 Percent	
	-3.45	-3.98	-2.87	-3.42	-2.57	-3.13

Figures within parenthesis indicate length of lags. C+S+T stands for constant, seasonal dummies and time trend. * indicate significant at the 1 percent level respectively.

It is clear from the Table 3 that both M and B are non-stationary at their log-level for entire sample period, post-liberalization and pre-liberalization and stationary at their log-first difference. This means that both series are integrated of order one i.e. I (1) and justifies for testing cointegration between M and B.

The VAR model includes a set of seasonal dummies, two intervention dummies D98 (for 1998 nuclear tests) and D00 (for flexible exchange rate) which are orthogonal to the constant term. Initially we start with 12 lags to estimate VAR for the entire sample and sub-samples. The optimal lag length is selected by reducing the number lags until the model passes all the diagnostic tests. Trace and maximum eigenvalue tests are used to examine the cointegration between M and B. The results are reported in Table 4.

Table 4: Test of Cointegration Rank for the Money Multiplier Model[a]

Full Sample (1972M1-2009M2), lags = 8			
$H_0 : r$	Eigenvalues	$\lambda - Trace(T - nm)$	$\lambda - Max(T - nm)$
0	0.25	128.07 (0.000)*	123.64 (0.000)*
1	0.01	4.44 (0.363)	4.44 (0.362)
Pre-Liberalization Period (1972M1-1990M12), lags = 3			
0	0.41	119.89(0.000)*	115.05 (0.000)*
1	0.02	4.84(0.312)	4.84 (0.312)
Post-Liberalization Period (1991M1-2009M2), lags = 9			
0	0.23	53.99 (0.000)*	51.11 (0.000)*
1	0.01	2.88 (0.612)	2.88 (0.611)

Note: * indicate significant at the 1% level of significance

[a] 8 lag for full sample, 3 lags for pre-liberalization and 9 lags for post-liberalization are selected on the basis of lag selection criterion (i.e. AIC).

It can be seen from the Table 4 that both trace and maximum eigenvalue statistics supports the existence of one cointegrating vector between M and B for entire sample period and sub-periods. The existence of cointegration between M and B satisfies the necessary condition for the validity of money multiplier model. For the sufficient condition we normalized first cointegrating vector on the constant and B and then imposing zero restrictions on the constant terms (i.e. $\beta_0 = 0$) and unity restriction on the slope parameter ($\beta_1 = 1$). The normalized coefficients are reported in Table 5.

Table 5: Normalized Cointegrating Coefficients and Coefficient Restrictions
($LnM_t = \beta_0 + \beta_1 LnB_t + \varepsilon_t$)

Regressor	Coefficients		
	Full Sample: 1972M1-2009M2	Pre-Liberalization: 1972M1-1990M12	Post-Liberalization: 1991M1-2009M2
β_0	4.96 (0.86)*	-0.72 (0.29)*	0.25 (0.72)
β_1	0.99 (0.07)*	1.06 (0.03)*	1.11 (0.06)*
$\chi^2(1): \beta_0 = 0$	26.16 [0.000]*	4.18 [0.041]**	0.09 [0.767]
$\chi^2(1): \beta_1 = 1$	0.02 [0.876]	4.45 [0.035]**	1.81 [0.178]
Loading Coefficients			
ΔLnM_t	-0.009 (0.001)*	0.04 (0.004)*	-0.05 (0.007)*
ΔLnB_t	-0.01 (0.002)*	0.05 (0.006)*	-0.06 (0.018)**
Weak Exogeneity Test			
ΔLnM_t $(\alpha_1 = 0)$	$\chi^2(1)$ =116.11 [0.000]*	102.30 [0.000]*	49.66 [0.000]*
ΔLnB_t $(\alpha_2 = 0)$	$\chi^2(1)$ = 38.03 [0.000]*	51.57 [0.000]*	14.44 [0.000]*

- and ** indicate significant at 1 percent and 5 percent level respectively. Figures in (.) are the standard errors while figures in [.] are the p-values
-

It is evident from the Table 5 that the coefficient of B is positive and significant for all the cases. The size of the coefficient is 0.99, 1.06 and 1.11 for entire sample, pre-liberalization and post-liberalization showing almost one-to-one relationship between the money supply and the monetary base. However, the size of the coefficient of monetary base is relatively large for the post-liberalization period. The coefficient restrictions that $\beta_0 = 0$ and $\beta_1 = 1$ are satisfied only for the period of 1991M1-2009M2. The coefficient restrictions for the period 1972M1-2009M2 are satisfies partially, while for the pre-liberalization periods the coefficient restrictions are significantly rejected as judged by the χ2-statistics. These results imply that for the post-liberalization period long-run money multiplier model holds true for Pakistan. For the entire sample period money multiplier model holds partially, while for the pre-liberalization period money multiplier model does not holds. The variations in the results between pre-and-

post-liberation periods could be due to the structural changes in the financial sector during 1990s and on-ward.

The main features of these findings are the negative sign of the adjustment coefficients for the entire sample and post-reform periods. The adjustment coefficient suggest that for post-liberalization period changes in B converges M towards its long-run equilibrium path more rapidly relative to entire sample period in the short-run. Although the speed of adjustment is very slow but the important thing is the existence of short-run dynamics. The significance of the adjustment coefficients for M and B indicate the presence of two-way long-run causality between M and B. This implies that in Pakistan the monetary authority do not have any control over B. M and B affecting each other and B is not weakly exogenous. The non-weak exogeneity of B could be due to the changes in exchange rate policy, government spending, interbank interest rate, export subsidies, etc. These factors limit the control of SBP on B and SBP can only sterilize the impact of changes in B (SBP, 2006-07, p.62). Overall, weak-form money multiplier holds for entire sample period. For the post-liberalization period the results are consistent with the economic theory that there is one-to-one relationship between money supply and reserve money. Although, the short-run adjustment is marginal and negligible but the important thing is validity of the relationship.

5.- Causality between Money Supply and Monetary Base

At present, may central banks including SBP intend to achieve their monetary policy goals by setting short-term interest rate because the growth rate of monetary base is an endogenous variable and the direction of causality between M and B is precisely reverse, i.e. it is running from money supply to monetary base.[5] This may be due to the fact that the quantity monetary base is influenced by currency-deposit ratio and portfolio decisions of the private sector.

To determine the direction of causality between B to M we employ Granger causality test by estimating the following vector error-correction model (VECM):

$$\Delta LnM_t = \alpha + \sum_{i=1}^{\rho-1} \gamma_i \, \Delta LnM_{t-i} + \sum_{i=0}^{\rho-1} \delta_i \, \Delta LnH_{t-i} + \phi ec_{t-1} + \eta_t \qquad (12a)$$

[5] It is determined simultaneously with the rate of unemployment, output, prices, interest rates and other financial market variables (Komaromi, 2007).

$$\Delta LnH_t = \alpha + \sum_{i=1}^{\rho-1} \pi_i \Delta LnH_{t-i} + \sum_{i=0}^{\rho-1} \lambda_i \Delta LnM_{t-i} + \psi ec_{t-1} + \xi_t \qquad (12b)$$

Where ec_{t-1} is the lagged error-correction term and the parameter ϕ and ψ reflects the speed of adjustment towards the long-run equilibrium. The significance of ϕ and ψ indicates the existence of two-way long-run causality between M and B, while the significance of δ_i and λ_i indicate the existence of short-run causality among M and B. Table 5 reports the Granger causality results.

Table 5: Multivariate Vector Error-Correction Causality between Money Supply and Monetary Base.

Sample	Dependent Variable	Independent Variables		
	ΔLnM_t	ΔLnM_t	ΔLnB_t	ec_{t-1}
1972M1-2009M2	ΔLnM_t	-	11.35 [0.124]	-0.009 (-11.39)*
	ΔLnB_t	15.09 [0.035]**	-	-0.01 (-6.20)*
1972M1-1990M12	ΔLnM_t	-	0.89 [0.641]	0.04 (11.26)*
	ΔLnB_t	0.28 [0.869]	-	0.05 (7.49)*
1991M1-2009M2	ΔLnM_t	-	34.78 [0.000]*	-0.05 (-7.54)*
	ΔLnB_t	7.01 [0.536]	-	-0.07 (-3.85)*

Note: * and ** represents significant at the 1% and 5% level of significance. ec_{t-1} is the error- correction terms. By imposing zero restrictions on the coefficients of each variable using χ^2 test for each coefficient in all the equations. Figures in parentheses and squared parentheses represent t- statistics and p-values respectively.

The coefficients of the error-correction terms are negative and significant for the entire period indicating the existence of two-way long-run causality between M and B. Moreover, no evidence of short-run causality running from B to M observed for the entire sample period and the evidence of short-run causality running from B to M observed only for the entire sample period. The evidence of reverse causality that ΔLnM causes ΔLnB suggests that there is express correlation between B and M and the growth of B carries no direct information for the SBP or for inflation over the period 1972M1-2009M2. These results are very shocking and there is need for the monetary authorities to reformulate the monetary

policy keeping in mind the structural changes in the economy and the co-movement in M and B. For the pre-liberalization period M and B showing overshooting behaviour as indicated by the positive and significant coefficients of the error-correction terms in the long-run. No evidence of short-run causality between the variables is seen in the short-run for pre-liberalization period. These findings could be due to the controlled financial system during the period of 1972-1990. After 1990s financial sector reforms allows money markets to adjust back towards long-run equilibrium path.

For the post-liberalization period, the evidence of two-way long-run causality observed between M and B. While in the short-run the evidence of one-way causality running from B to M observed. This result is consistent with the economic theory and this could be the 1990s financial sector reforms that forces the money markets to adjust back towards long-run equilibrium path. This result suggests that the SBP may use M2 to influence inflation by controlling the growth of monetary base in the short-run.

6.- Conclusions

This paper examines the mechanistic version of money multiplier model for Pakistan using monthly data covering the period from 1972M1 to 2009M2. The analysis is sub-divided into three periods i.e. the entire sample period (1972M1 to 2009M2), pre-liberalization (1972M1 to 1990M12), post-liberalization (1991M1-2009M2). The results suggest that money multiplier is non-stationary for the entire period, pre- and- post-liberalization periods. Since M and B is integrated of order one (.i.e. I (1)) therefore, we have tested for cointegration and find the evidence of cointegration between M and B for all the periods. The broad conclusions emerging from this study are:

- Money multiplier remains non-stationary and unstable for the period 1972M1-2009M2, 1972M1-1990M12 and 1991M1-2009M2.
- There exists cointegration between the money supply and the reserve money for the periods 1972M1-2009M2, 1972M1-1990M12 and 1991M1-2009M2. The coefficients restrictions that $\beta_0 = 0$ and $\beta_1 = 1$ are satisfied only for the post-liberalization period. This implies that the monetary authorities may control money supply by controlling the reserve monetary to achieve the price stability. The variations in the size of parameters for entire period and sub-periods could be due to the changes in the conduct of monetary policy such as the removal of controls on interest rates, interest rate ceiling in the inter-bank money markets, deregulation of deposit and lending

rates and the introduction of indirect instruments including open market operations (OMO).

- Two-way long-run causality exists for the periods 1972M1-2009M4 and 1991M1-2009M2. One-way short-run causality running from B to M exists for the period 1972M1-2009M2. For the period 1972M1-1990M12 there is no evidence of short-run causality between M and B. The evidence of one-way short-run causality running from B to M exists for the post-liberalization period.
- Overall, the money multiplier model holds true for Pakistan only for the post-liberalization period. The monetary authority many control money supply growth by controlling the growth of base money to achieve the objective of price stability in the short-run.
- Finally, the evidence of this provides important information for the authorities to re-think about the current monetary policy strategy in Pakistan. The monetary authority may consider the relationship between money supply and reserve money as a policy guide rather than the constancy of the money multiplier for the conduct of the monetary policy in the short-run.

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