A Re-look at the Long-Run Stability of the Money Multiplier in India

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Results on long-run stability of M1 and M3 money multipliers in India are presented after the BoP crisis. Allowing for in-sample regime switching it is found that M3 money multiplier can be characterized by a one-time regime shift around the beginning of 1997, the time when money markets reform first begun in a big way, with issuance of ad hoc 14-day on tap T-Bills giving way to Ways and Means Advances. Results on the stability of M1 multiplier are less clear and relationship, if it exists, is statistically weak. Although evidence from CUSUM-SQ tests and recent (more powerful) unit root tests suggests that M1 and adjusted monetary base are cointegrated.

I. Introduction

For India, it is almost an accepted fact that till mid 90s, Reserve Bank of India (RBI), under Dr. Rangarajan, almost exclusively targeted money growth rate (Mohanty and Mitra, 1999) for whatever leeway it had in using its instruments, with effectively fully regulated financial markets. However, if recent official releases of RBI (various Annual Reports since 1997/98) are any indication, now it is moving to a multiple indicator targeting approach with repo rate as the chief operating instrument.

Introduction of the Liquidity Adjustment Facility (LAF) in 2000 to better manage liquidity in the repo/reverse repo market is a step in that direction, and RBI is actively using its refinancing window to move the short term interest rate in the direction it deems appropriate. Of late RBI has declared (in Annual Reports for the years 2001-02 and 2002-03) that it is using monetary base as the official *operating target*. Also, if results of Virmani (2004b) are anything to go by, a monetary policy reaction function with monetary base as the operating target does capture the behaviour of the Indian central bank fairly closely.

For a measure of money to be a suitable intermediate target of monetary policy (or even *one of the intermediate targets*, as is possibly the case given RBI's recently declarations on using 'multiple indicator targeting' for monetary policy), a long run stable relation between monetary base (assumed to be under the direct control of the central bank) and measures of money stock is a prerequisite.

Though there have been many studies that have modeled money multiplier for India[1] the evidence is rather inconclusive. While studies like Sen and Vaidya (1997) find no stable long run relation between monetary aggregates and reserve money, Darbha (2002) shows there does exist one. Also, all of these studies use data that belongs to the period before 1997. A re-estimation becomes important because April, 1997 marks an important 'break' in the Indian data, when the system of automatic monetization was replaced by the Ways and Means Advances facility. Also, introduction of the LAF in the year 2000 further added to the deepening of the money market reforms.

The plan of the study is as follows. In **Section II**, after a brief literature review, methodology followed in the study is discussed. **Section III** presents the results and **Section IV** concludes with a discussion of results.

II. Methodology

To check for the stability of the money multiplier, the *aggregate* relationship between a measure of money stock and reserve money is examined. As opposed to analyzing the relationship in aggregate, an alternative approach lies in studying the components of the multiplier separately. While studies like Singh et al (1982), Rangarajan and Singh (1984), Nachane and Ray (1989) and Darbha (2002) fall in the former category, studies of Chitre (1986), Nachane (1992) and Ray and Madhusoodanan (1992) contain examples of the latter.

Of the studies mentioned, another classification can be made on the basis of their broad focus. While studies of Nachane and Ray (1989), Chitre (1986) and Ray and Madhusoodanan (1992) deal with the predictability of the multiplier, studies of Nachane (1992) and Darbha (2002) look at the long-run relationship between measures of money stock and monetary base.

[1] See Chitre (1986), Nachane and Ray (1989, 1997), Ray and Madhusoodanan (1992), Sen and Vaidya (1997), and Darbha (2002)

In this study the latter approach is adopted, as concern here is whether there exists a stable long-run relation between the money stock and reserve money, which is more important from the point of view of selection of the operating target, than the behaviour of the components forming the base money.

Thus, in a sense, this study can be regarded as an extension of Darbha (2002), who analysed the stability of the multiplier for the period 1978 to 1996. As said earlier, many changes have happened in the Indian economy since 1996. It is important to see if those structural changes have any marked effects on the stability of the multiplier. Other than that, unlike Darbha and most previous studies, both monthly and quarterly data are used to analyse the behaviour of the multiplier. To avoid any 'contamination' sample belongs *only* to the period post BoP crisis – from April 1992 to Mar 2002, giving us 10 years of data.

The broad methodology used here is similar to Darbha (2002). As Virmani (2004a) showed both adjusted monetary base[2] (B) and measures of money stock (M1 and M3) are integrated of order 1, presence of cointegration would imply a stable long relationship between the two. Throughout the analysis seasonally adjusted data have been used[3].

We proceed by first performing residual based tests for cointegration in the usual Engle and Granger (1987) framework. However, instead of only relying on Dickey-Fuller (ADF) and Phillip-Perron (PP) tests, which are plagued with extremely low power in small samples (Schwert, 1989), statistically more powerful versions of these tests, namely, the DF-GLS[4] test of Elliott, Rothenberg, Stock (1996) and the modified PP test of Ng and Perron (2001) are also used. For all tests, the Modified Information Criterion of Ng and Perron (2001) has been employed for lag length selection.

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[2] Adjusted for changes in required reserve ratio following Rangarajan and Singh (1984)
[3] Using the procedure TRAMO/SEATS of EUROSTAT and implemented using DEMETRA
[4] Dickey Fuller – Generalized Least Squares; also referred to as DF tests with quasi-differencing

Following that, the study proceeds in the same fashion as Darbha, first checking for a possible regime using the methodology of Gregory and Hansen (1996) and then for the stability of the cointegration relation using the Lc, meanF and supF statistics developed by Hansen (1992) and the CUSUM-SQ plot of Brown, Durbin and Evans (1975). All estimations in this part of the study were done using MATLAB. Prof. LeSage's toolbox[5] was used for normal regression. Codes for other tests are available with the author.

III. Results

First the results of residual based cointegration tests using alternative unit root tests are reported for both monthly and quarterly data.

$$m_t = \alpha + \beta b_t + \upsilon_t$$

Monthly Data

Table 1a

Test	**M1 on B**		**M3 on B**	
	No Constant/Trend	*No Trend*	*No Constant/Trend*	*No Trend*
ADF	0.19 (k = 6)*	0.53 (k = 6)	-1.78 (k = 2)	-1.77 (k = 2)
PP	-0.86 (k = 6)	-0.70 (k = 6)	-2.66 (k = 2)	-2.64 (k = 2)
ERS (DF-GLS)	-1.1 (k = 30)	**-1.75 (k = 8)***	**-3.21 (k = 9)**	**-3.20 (k = 9)**
MZ of NP	-0.06 (k = 6)	**-4.66 (k = 6)**	**-36.48 (k = 1)**	**-4.43 (k = 1)**

** - Lag Length selected using Modified Information Criterion of Ng and Perron (2001)*
*** - Indicates rejection of null of no cointegration at 5% significance level*
*** - Indicates rejection of null of no cointegration at 15% significance level*

Quarterly Data

Table 1b

Test	**M1 on B**		**M3 on B**	
	No Constant/Trend	*No Trend*	*No Constant/Trend*	*No Trend*
ADF	-0.51 (k = 1)	-1.77 (k = 2)	-1.99 (k = 2)	-1.97 (k = 1)
PP	-0.89 (k = 1)	-0.69 (k = 2)	-2.24 (k = 2)	-2.23 (k = 1)
ERS (DF-GLS)	-0.02 (k = 10)	-1.60 (k = 2)	**-3.85 (k = 2)***	-1.15 (k = 6)
MZ of NP	-0.24 (k = 2)	**-6.71 (k = 2)**	**-32.87(k = 1)***	**-2.5 (k = 1)***

** - Lag Length selected using Modified Information Criterion of Ng and Perron (2001)*
*** - Indicate rejection of null of no cointegration at 5% significance level*

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[5] see http://www.spatial-econometrics.com

As the tables above show, conventional unit root tests fail to reject the null of cointegration. However, their more powerful versions, namely ERS and MZ of NP do suggest that there is indeed a long run relationship between M1/M3 and base money.

As Darbha (2002) finds, the rejection of cointegration by conventional unit root tests is probably because of a one time regime shift in the cointegration vector in the sample period. In Darbha's study that shift was noticed around the time of opening of the Indian economy. Since that period is not in our sample, it would be useful to see if there does exist a cointegration relation in the '90s, i.e. if a stable relation can be characterized by a possible one time in-regime shift or there ceases to be a cointegrating relation between the two.

Thus, now we turn to residual based test for cointegration by Gregory and Hansen (1996) which allows for an endogenous regime shift, where the time of shift need not be known a priori. This is what it makes this test more attractive compared to the traditional Chow test of structural stability. In most macroeconomic phenomena of interest the *exact* time of regime shift is hardly ever known. Without going into the analytical details of the test, which can be found in the original reference, we directly proceed to the results. We consider two cases, namely, the one in which we allow for a one-time shift in the intercept and the other in which we allow the slope also to undergo a one time shift.

- *Only Intercept Dummy:* $m_t = \alpha_0 + \alpha_1 \phi_{tr} + \beta b_t + \upsilon_t$

Monthly Data

Table 2a

Test	M1 on B		M3 on B	
	No Constant/Trend	*No Trend*	*No Constant/Trend*	*No Trend*
ADF	-2.31 ($n\tau$ = 97)	-2.28 ($n\tau$ = 97)	-4.05 (τ = 64)	-4.03 (τ = 64)
PP	**-5.31 ($n\tau$ = 17)****	**-5.29 ($n\tau$ = 17)****	**-5.96 ($n\tau$ = 62)****	**-5.97 ($n\tau$ = 62)****

*** - Significant at 5%*

Quarterly Data

Table 2b

Test	M1 on B		M3 on B	
	No Constant/Trend	*No Trend*	*No Constant/Trend*	*No Trend*
ADF	-3.07 ($n\tau$ = 29)	-3.01 ($n\tau$ = 29)	-3.49 ($n\tau$ = 20)	-3.44 ($n\tau$ = 20)
PP	-4.11 ($n\tau$ = 4)	-4.09 ($n\tau$ = 4)	**-4.25 ($n\tau$ = 19)***	**-4.24 ($n\tau$ =19)***

** - Significant at 15%*

While both monthly and quarterly data give very similar results ($n\tau$ = 4 quarters being equivalent to $n\tau$ = 12 months), for M1, ADF and PP tests point to different time of shift. Although, the shift indicated by ADF is statistically insignificant. Thus, while for M3 introducing a level dummy shift does suggest that there was a shift between the 57th and the 64th month starting April 1992, i.e. between December 1996 and July 1997. This is not unexpected as WMA was came into full force on 1st April 1997.

- *Both Intercept and Slope Dummy:* $m_t = \alpha_0 + \alpha_1\phi_{tr} + \beta_0 b_t + \beta_1 b_t + \upsilon_t$

Monthly Data

Table 3a

Test	M1 on B		M3 on B	
	No Constant/Trend	*No Trend*	*No Constant/Trend*	*No Trend*
ADF	-2.39 ($n\tau$ = 87)	-2.39 ($n\tau$ = 87)	**-4.22 ($n\tau$ = 55)***	**-4.19 ($n\tau$ = 55)***
PP	**-5.43 ($n\tau$ = 17)****	**-5.43 ($n\tau$ = 17)****	**-6.52 ($n\tau$ = 60)****	**-6.53 ($n\tau$ = 60)****

** - Significant at 15%*
*** - Significant at 5%*

Quarterly Data

Table 3b

Test	M1 on B		M3 on B	
	No Constant/Trend	*No Trend*	*No Constant/Trend*	*No Trend*
ADF	-3.28 ($n\tau$ = 27)	-3.23 ($n\tau$ = 27)	-3.98 ($n\tau$ = 17)	-3.92 ($n\tau$ = 17)
PP	**-4.27 ($n\tau$ = 4)***	**-4.26 ($n\tau$ = 4)***	**-4.39 ($n\tau$ = 19)***	**-4.39 ($n\tau$ = 19)***

** - Significant at 15%*

Introducing both level and regime shift, for M3, there is confirmation of a shift around the 58th month, though for M1, there is still no consensus on results from ADF and PP. Indication of 12th-16th month from the start of sample from the PP test is confusing, so does the evidence of 81st - 87th month (though statistically insignificant). From Table 1s the ERS and MZ tests of unit root do reject the null of no cointegration. So there is no clear cut evidence on a long run relationship between M1 and B for the period post liberalization. At best the relationship if it exists, is statistically weak.

Darbha (2002) however did find a stable long run relationship between M1 and B, but his sample ended in 1996. Contrary result in the study are possibly because of the deepening of the money market reforms and increased activity in the money market post introduction of Intermediate LAF first in 1998 and then the full fledged LAF in 2000, adding to the unpredictability of the multiplier for M1 (as non-reserve money part of M1 is quite small, difference being the deposits with RBI and demand deposits with banks)

Although, Gregory and Hansen's test for cointegration allows for regime shift, it is not a test of *parameter* stability in the cointegration relation itself. To test for stability of the parameter in cointegration relations the meanF, supF and Lc statistics of Hansen (1992) are now standard practice. While supF is analogous to the recursive Chow test, meanF and Lc statistics can themselves be interpreted as alternative tests for cointegration (see Hansen, 1992 for details and explanation) against the alternative of the parameter vector following a random walk. Results along with the 5% critical values are reported below in Tables 4.

Table 4a

Monthly

Test	**M1**	**M3**	**5% Critical Values**
Lc	0.35	0.33	0.623
meanF	3.39	3.35	6.22
supF	5.57	7.75	15.2

Quarterly

Table 4b

Test	M1	M3	5% Critical Values
Lc	0.28	0.50	0.623
meanF	3.53	**10.02***	6.22
supF	5.30	**16.34***	15.2

Although supF rejects the null of cointegration against the alternative of cointegration at 5% level for a one time regime shift, Lc which is a test of cointegration against the parameters following a random walk, fails to reject the null of cointegration. Note that using these tests evidence is stronger in for M1 than it is for M3 (though this could be because of the smaller sample that characterize results from quarterly data).

IV. Conclusion

Based on the tests above we can say that multiplier relation for M3 is better characterized by a one time regime shift than a random walk, and though for M1 the evidence is less clear of an in-sample regime shift, its multiplier definitely does not follow a random walk.. Finally if we look at the CUSUM-SQ plot of recursive residuals in **Exhibit 1**, it clearly shows that while multiplier for M1 is a stable, that for M3, there is a break in the relationship around 60^{th} month after which stability 'returns', consistent with results from the Gregory and Hansen test of cointegration. Thus, their evolution can be characterized by one-time regime shifts, first in the early '90s as shown by Darbha (2002) and then in around 1997 around the introduction of WMA and ILAF as shown in this study.

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Exhibit 1

CUSUM-SQ Plots for Multipliers for M1 and M3