Technical Attachment

IV.1 Weighted Monetary Aggregates

Table 1 : Summary Statistics

Aggregates	Maximum	Minimum	Mean	Standard Deviation	Skewness	Kurtosis	Coefficient of variation
lnM_3	13.46	10.40	11.94	0.95	0.014	-1.20	0.079
lnM_3D	13.36	10.40	11.87	0.92	0.058	-1.20	0.077
lnM_3L	13.35	10.40	11.87	0.92	0.054	-1.20	0.077

Table 2 : Correlation with Output, Prices and Reserve Money

	lnGDPC	lnWPI	lnM_0
lnM_3	0.99405	0.99527	0.96162
lnM_3D	0.99438	0.99540	0.96272
lnM_3L	0.99436	0.99537	0.96272

Table 3 : Income Elasticity of Demand for Money

$lnM_3(R)$	$lnM_3D(R)$	$lnM_3L(R)$
1.5786	1.5817	1.5810

where lnGDPC : log of real gross domestic product
lnWPI : log of wholesale price index
lnM_0 : log of reserve money
lnM_3 : log of simple sum broad money aggregate
lnM_3D : log of divisia money aggregate
lnM_3L : log of linear money aggregate
(R) : denotes in real terms

Period of Data Series : 1977-78 to 1996-97 **Frequency of Data :** Annual

Remarks : It could be seen from the statistics presented above that there is hardly any significant difference in the information content between the simple sum monetary aggregate on the one hand and superlative monetary aggregates such as divisia and linear monetary aggregates on the other.

IV.2 Money Multiplier

Panel A

Table 4 : Unit Root Tests

Variable	Dickey Fuller (DF) trend	5% critical value	Augmented Dickey Fuller (ADF)(1) trend	5% critical value	Stock and Watson (SW)(4)*	1% critical value
lnM_3	-4.27	-3.41	-14.34	-3.41	-25.45	-29.20
lnM_o	-2.42	-3.41	-15.57	-3.41	-22.42	-29.20
lnm_b	-4.97	-3.43	-3.42	-3.42	-	-
c	-2.60	-3.43	-2.91	-3.42	-	-
r	-4.43	-3.43	-2.10	-3.43	-	-

* Stock and Watson unit root test with fourth order autocorrelation
where, lnM_3 : log of broad money
lnM_o : log of reserve money
lnm_b : log of broad money multiplier
c : currency-deposit ratio
r : reserve-deposit ratio

Period of Data Series : 1970-71 to 1996-97 **Frequency of Data :** Monthly

Remarks : The monthly data for the period April 1970 to March 1997 for the variables such as lnM_3, lnM_o, lnm_b, c and r were tested for presence of unit root prior to undertaking the cointegrating regression. The SW unit root test with fourth order autocorrelation could not reject the null hypothesis of presence of unit root in lnM_3. In the case of lnM_o, the null hypothesis of presence of unit root could not be rejected by both DF and SW. The null hypothesis of presence of unit root in lnm_b could, however, be rejected by both DF and ADF tests indicating that the series is stationary. For both 'c' and 'r', the null hypothesis of presence of unit root could be rejected by DF and ADF tests.

Panel B

The impulse response function of 1.0 percentage point change in reserve requirements (CRR) on broad money multiplier was estimated by simulating the following model with two equations and one identity. In the equation for 'c', index of industrial production (iip) was included to reflect the behavioural nature of currency-deposit ratio.

(i) $c = 0.04951^* + 0.70489^* c(-1) + 0.00014^* iip(-1) - 0.0017^* T$
(ii) $r = 0.01926^* + 0.86335^* r(-1) + 0.42492^* \Delta r$
(iii) $m_b = (1 + c) / (c + r)$

* Significant at 5 per cent level
where, iip : index of industrial production
Δr : changes in reserve requirements
T : time trend

IV.3 Demand for Money

Table 5 : Unit Root Test (Annual Data)

Variable	Dickey Fuller (DF) trend	5% critical value	Augmented Dickey Fuller (ADF)(1) trend	5% critical value
$lnRM_3$	-2.32	-3.54	-2.61	-3.54
lnGDPC	-1.30	-3.54	-1.00	-3.54
lnCMRT	-3.62	-3.54	-3.81	-3.54

where, $lnRM_3$: log of real broad money
lnGDPC : log of GDP at constant prices
lnCMRT : log of call money rate (annual weighted monthly averages)

Period of Data Series : 1970-71 to 1996-97 **Frequency of Data :** Annual

Remarks : The annual data on real broad money and real GDP were tested for the null hypothesis of presence of unit root which could not be rejected at the five per cent level of significance. However, call money rate was found to be stationary. Hence, for the long run cointegrating vector for real money demand, only GDP was used as an explanatory variable. However, call money rate was used for estimating the error correction modelling.

The error correction model for the money demand function estimated following the Engle-Granger is as follows:

$$\Delta lnRM_3 = -0.011 + 0.442^* \Delta lnRM_3(-1) + 0.788^* \Delta lnGDPC + 0.406 \Delta lnGDPC(-1) - 0.045 \Delta lnCMRT - 0.208^* Err(-1)$$

$R^2 = 0.45$ DW = 1.76 Durbin's-h = 1.49

* Significant at 5 per cent level
where, Err : Error correction term
(-1) : denotes lag of one period

IV.4 New Monetary Aggregates

Panel A

Table 6 : Information Efficiency of New Monetary Aggregates : Non-Nested Models

Tests statistics	Goal Variable : lnSWPI				
	M_1 vs M_2	M_1 vs M_3	M_2 vs M_3	M_3vs L_1	M_3vs L_2
Cox's Test	-3.60	-3.48	-1.86*	-5.36	-5.02
Wald's Test	-2.90	-2.79	-1.61*	-5.11	-4.72
Fisher and McAlwer Test	3.08	2.93	1.62*	7.85	6.58
Akaike Information Criteria	-4.67	-4.05	0.62	-0.49	-1.08

* Not significant at the conventional 5 per cent level
where, lnSWPI : log of seasonally adjusted wholesale price index
M_1, M_2 and M_3 : relevant monetary aggregates
L_1, L_2 : relevant liquidity aggregates

Period of Data Series : 1993-94 to 1996-97 **Frequency of Data :** Monthly

Remarks : The relevant test statistics were found to be significant at the conventional 5 per cent level except for the model M_2 vs M_3. Hence, the superior information content of M_2, L_1 and L_2 *vis-a-vis* M_1 and M_3 could not be rejected.

Panel B

Estimated Cointegrated Vectors for New Monetary Aggregates

(i) $lnRM_2 = -0.24 + 1.15\ lnSIIP - 0.027\ lnG91 + 0.23\ lnREERT$

(ii) $lnRM_3 = 2.81 + 0.78\ lnSIIP - 0.052\ lnG91 + 0.10\ lnREERT$

(iii) $lnRL_2 = 2.94 + 0.79\ lnSIIP - 0.054\ lnG91 + 0.07\ lnREERT$

where, lnRM : log of relevant real monetary aggregate
lnRL : log of relevant real liquidity aggregate
lnSIIP : log of seasonally filtered index of industrial production
lnG91 : log of yields on 91-day Treasury Bills (weekly averages)
lnREERT : log of trade based real effective exchange rate

IV.5 Causality between Nominal Money and Nominal Income

X causes (→) Y	'F' Statistics	Level of significance
Nominal Money → Nominal Income	5.51	1.0 %
Nominal Income → Nominal Money	3.55	3.8 %

Period of Data Series : 1970-71 to 1996-97 **Frequency of Data :** Annual

IV.6 Transmission Mechanism of Monetary Policy

Panel A

Money, Interest Rate, Credit and Output

$lnSM_3 = C + \Sigma lnSM_3 + \Sigma G91 + \Sigma lnSNFC + \Sigma lnSIIP$

$G91 = C + \Sigma lnSM_3 + \Sigma G91 + \Sigma lnSNFC + \Sigma lnSIIP$

$lnSNFC = C + \Sigma lnSM_3 + \Sigma G91 + \Sigma lnSNFC + \Sigma lnSIIP$

$lnSIIP = C + \Sigma lnSM_3 + \Sigma G91 + \Sigma lnSNFC + \Sigma lnSIIP$

Σ : denotes $\sum_{k=1}^{p} \alpha_{ij,\,t-k}$, i = 1, .. 4, j = 1, .. 4

Table 7 : Block Exogeneity Test

	$lnSM_3$	G91	lnSNFC	lnSIIP
$lnSM_3$	85.51*	0.66	0.94	0.44
G91	3.87*	60.32*	1.23	1.77
lnSNFC	4.46*	5.26*	257.76*	0.92
lnSIIP	2.87*	2.98*	1.76**	1.95**

* Significant at 5 per cent level.
** Significant at around 10 per cent level.

where, C : intercept term
$lnSM_3$: log of seasonally adjusted nominal broad money
G91 : yields on 91-day Treasury Bills (weekly averages)
lnSNFC : log of seasonally adjusted non-food bank credit
lnSIIP : log of seasonally filtered index of industrial production

Period of Data Series : 1993-94 to 1996-97 **Frequency of Data :** Monthly

Remarks : The block exogeneity test for the four variable vector autoregression (VAR) model shows that (i) money supply is purely exogeneous, (ii) interest rate depends on money supply and its own lag, (iii) supply of non-food credit depends on liquidity, interest rates and its own lag and (iv) output depends on liquidity, interest rates and its own lag.

Panel B

Money, Interest Rate, Exchange Rate and Inflation

$M_{3g} = C + \Sigma M_{3g} + \Sigma G91 + \Sigma NER + \Sigma \Pi$
$G91 = C + \Sigma M_{3g} + \Sigma G91 + \Sigma NER + \Sigma \Pi$
$NER = C + \Sigma M_{3g} + \Sigma G91 + \Sigma NER + \Sigma \Pi$
$\Pi = C + \Sigma M_{3g} + \Sigma G91 + \Sigma NER + \Sigma \Pi$

Σ : denotes $\sum_{k=1}^{p} \alpha_{ij, t-k}$, i = 1, .. 4, j = 1, .. 4

Table 8 : Block Exogeneity Test

	M_{3g}	G91	NER	Π
M_{3g}	9.02*	1.22	1.28	1.58
G91	2.46**	61.97*	0.85	1.66
NER	3.22**	1.12	13.90*	0.12
Π	4.85*	2.90**	6.68*	14.07*

* Significant at 5 per cent level.
** Significant at around 10 per cent level.

where, M_{3g} : year-on-year growth rate of broad money supply
G91 : yields on 91-day Treasury Bills (weekly averages)
NER : nominal exchange rate (rupee/US $)
Π : inflation rate

Period of Data Series : 1993-94 to 1996-97 **Frequency of Data :** Monthly

Remarks : The block exogeneity test for the four variable vector autoregression (VAR) model shows that (i) year-on-year growth of broad money supply (M_{3g}) is purely exogeneous, (ii) interest rate depends on year-on-year growth of money supply and its own lag, (iii) nominal exchange rate (NER) depends on year-on-year growth in money supply and its own lag, (iv) inflation rate (Π) depends on money supply, interest rates and exchange rate. Although there is evidence of interaction between interest rates and exchange rate, the effect was found to be weak in VAR framework.