

MONETARY POLICY IN INDIA: OBJECTIVES, REACTION FUNCTION AND POLICY EFFECTIVENESS

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In the first part of this paper, the policy reaction functions of the Reserve Bank of India (RBI) have been modeled to see how policy stance decisions respond to the changes in the goal variables. In the second part, the transmission effects of RBI's policy stances on the goal variables have been analyzed using the Granger causality test, and analysis of simple estimated models of relevant variables. It may be suggested from the results that the RBI should not be working simultaneously with instruments of quantity and price control and should shelve the cash reserve ratio (CRR) and concentrate more on price variables for conducting monetary policy.

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INTRODUCTION

It is evident from the recent theoretical literature and empirical findings that monetary policy is best suited to achieving the goal of price stability in any economy (McCallum (1989)). Therefore, the consensus is that the key (or even the only) objective of monetary policy framework is to achieve long-term price stability (low and stable inflation) (BIS, 1998; Svensson, 2000; Bernanke et al., 1999). It has also been recognized that, in the long run, the objective of price stability and economic growth need not necessarily conflict with each other. It is argued that the desired effects on goal variables can be obtained by having a clear choice of objectives and policy instruments and right strategic implementation of policy stances.

However, in the context of developing economy the role of monetary policy become more complex than the developed economies because of the supply constraints, underdeveloped financial market, and resource gap. The policy has to address multiple objectives of achieving and managing higher growth rate, while building potential to sustain growth and ensure macroeconomic stability for equitable development. While growth is important, rising prices hurt the poorest the most.

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In addition, governments in developing countries often tend to assign the monetary policy quasi-fiscal responsibilities too, which include creating conditions for equitable supply of credit to various sectors in magnitude and composition deemed fit by the government; financing government budget deficits; managing government debt; helping towards increasing exports while reducing the dependence on imports at the same time; and developing, regulating, and monitoring financial institutions. Thus, the objectives of monetary policy in most developing countries often appear to be vague and unclear. In the case of India, the preamble of the Reserve Bank of India (RBI) describes the basic functions of the Reserve Bank as:

“...to regulate the issue of Bank Notes and keeping of reserves with a view to securing monetary stability in India and generally to operate the currency and credit system of the country to its advantage.”
<http://rbi.org.in/scripts/AboutusDisplay.aspx#EP1>

The above objective means little in terms of the objective function of a modern central bank. Yet, the RBI has enshrined the dual objective of: (1) maintaining a reasonable degree of price stability in the economy through the regulation of monetary growth and (2) ensuring adequate expansion of credit to assist economic growth (Rangarajan, 1998) with the relative emphasis on these two objectives changing from time to time. Apart from these two main goals, the Reserve Bank of India (RBI) has also been engaged in maintaining orderly conditions in the foreign exchange market to curb destabilizing and self-fulfilling speculative activities (Reddy, 1999a). It is in this context, this analysis aims to examine the historical behavior of the policy stances of the Reserve Bank of India with respect to its multiple goals. Such an analysis is important and helpful for the Indian economy as well as other developing countries, which target monetary measures believing that they would simultaneously influence output, price and also exchange rate in the desired direction. However, the economy is not only supply constrained, but also demand constrained, and variables are expected to respond in different ways at different times. The transmission speed of interest rate is expected to be slow even while trying to integrate with the global economy by implementing broad ranging economic reforms.

The analysis has been done in two parts. In the first part, the policy reaction functions have been modeled to see how policy stance decisions respond to the changes in goal variables. In the second part, the transmission effects of the Reserve Bank of India's policy stances on the goal variables have been analyzed using the Granger causality test in VARs, and analysis of simple estimated models of relevant variables. Annual data for the period of 1970/71 to 2005/06, which is consistently available for the required variables, has been used.

The rest of the paper is organized as follows. In the following Section, the monetary policy regime of India is discussed including the role played by monetary instruments such as the cash reserve ratio (CRR), and intermediate interest rate/ indicator interest rate such as yield on short-run (1-5 years) Central Government Securities (CGS1), and the overnight inter-bank call money rate (CMR) in affecting the goal variables during the sample period. Discussion of the econometric model and plausible policy rules estimated using two different concepts is presented in Section 3. Policy effectiveness is analyzed in Section 4. The Concluding remarks are presented in a final section.

MONETARY POLICY REGIME IN INDIA

With the collapse of the Bretton Woods system of exchange management, as elsewhere, India too witnessed the rise of the monetarist approach to monetary policy but under significant fiscal dominance. The five yearly planning processes, which have been the hallmark of India's development strategy, emphasized upon judicious credit creation right from the advent of the first plan (1950-55). However, plan after plan the financial crunch kept on increasing. The deficit financing, which in the Indian context meant more of a RBI credit to the government, as well as market borrowing became part of the financing plan of the government. As a consequence of automatic monetisation of the (residual) deficit, there was a phenomenal growth in the reserve (base) money (M0) (Table 1), while foreign exchange reserve was almost completely drained out. The statutory liquidity ratio (SLR) requiring banks to invest in government securities increased from 27.5 per cent in 1970-71 to 38.5 per cent in 1991-1992 (Table 1) leading to the problem of liquidity management in the banking sector.

In order to control the money supply to the private sector, direct instrument of cash reserve ratio (CRR) was increasingly used, which constrained the market determination of the interest rate and affected the open market operations (OMO) of the RBI, particularly due to lower returns on the government securities. The features of the monetary (repression) regime until late 1990s have been well summarized in Rangarajan (2001) as: (1) The RBI as the central monetary authority prescribed all the interest rates on deposits and lending. (2) The commercial banks were required to allocate a certain percentage of credit to what were designated as 'priority sector'. (3) Credit to parties above a stipulated amount required prior authorization from the central bank. (4) After the nationalization of major commercial banks in 1969, nearly 85 per cent of the total bank assets came under the public sector. (5) Apart from small private banks, foreign banks were allowed to operate with limited branches.

Table 1
Growth Rates of Real GDP, M0, M1, M3, and WPI; Ratio (per cent) of Net Foreign Exchange to GDP, Policy Rates and Real Exchange Rate

	<i>Growth rates (annual per cent)</i>					<i>Levels (per cent)</i>			<i>Ratio (per cent)</i>		
	<i>Real GDP</i>	<i>M0</i>	<i>M1</i>	<i>M3</i>	<i>WPI</i>	<i>REER</i>	<i>CRR</i>	<i>SLR</i>	<i>CGS1</i>	<i>CMR</i>	<i>FER/GDP</i>
1971-76	2.3	10.3	12.6	15.4	13.3	-2.15	4.1	30.7	4.9	8.1	1.1
1976-81	3.6	20.2	12.6	19.9	4.7	-1.10	5.9	33.6	5.3	8.7	3.9
1981-86	5.6	14.7	13.6	16.5	9.3	-3.25	8.0	35.3	6.4	9.3	1.7
1986-91	6.0	18.2	16.1	17.4	6.7	-8.59	11.5	37.8	12.5	10.5	1.6
1991-96	5.0	17.4	18.5	17.7	11.0	-6.32	14.7	35.7	13.4	13.6	4.6
1996-01	6.5	9.4	12.1	17.0	5.2	-0.34	10.0	27.0	10.6	8.5	8.2
2001-05	5.7	12.8	14.3	14.5	5.2	1.06	5.2	25.0	6.7	5.9	15.9

Source: (Basic data): RBI Handbook of statistics on Indian Economy (various issues), RBI Handbook of monetary statistics 2006. Periods of predominantly non-congress governments. Periods indicate beginning and end of the financial years. M0: base money, M1 narrow money, M3: (M1+Time Deposit), WPI: whole sale price index, CRR: cash reserve ratio, SLR: statutory liquidity ratio, CMR: inter-bank call money rate, CGS1: yield on 1-5 year government securities, FER: foreign exchange reserve including gold, GDP gross domestic product at 1993-94 market prices, REER: 5-country real effective exchange rate (base year 1993-94=100).

The de-facto credit-targeting regime led to utter confusion about the monetary targeting. Therefore, inspired by the Radcliffe Committee on working of Monetary System in the United Kingdom (Chancellor-of-Exchequer, 1959) and the United State's Commission on Money and Credit (The-Commission-on-Money-and-Credit, 1961), a high powered committee (chaired by Sukhmoy Chakravarty), widely known as Chakravarty Committee was set up to lay down a system of conducting monetary policy. The Committee recommended a monetary targeting approach; the supply of the broad money aggregate (M3) to be regulated commensurate with the expected growth rate in real income and a tolerable inflation. The committee also wanted an agreement between the RBI and the government to limit monetary expansion through the process of monetisation of fiscal deficit. However, this part of the recommendation took almost thirteen years to fructify when automatic monetisation was abolished in 1997. In 2002, the government introduced fiscal responsibility and budget management Act (FRBM) to bring down the gross fiscal deficit to 3 per cent within a time frame. But, all these were done not during the political regime, which constituted the committee, but under a regime that got elected with substantial power for the first time.

The Chakravarty Committee report, while recommending monetary targeting for India, qualified it by arguing against 'mechanical application' of constant money supply growth rule to accommodate structural changes required to facilitate the growth process. It is in this context that Rangarajan (1998:64) considered the Indian monetary regime a flexible monetary targeting regime. Another important aspect was to pursue 4 percent target for inflation. However, it appears over time that the monetary authorities in India underplayed the importance of low inflation (Table 1).

Following the recommendations of the Committee on Financial Systems¹ (CFS), the financial sector reforms² (FSR) were started in 1992. The wide-ranging financial sector reforms have led to substantial reduction in the cost of banking (RBI, 1998a). The Statutory Liquidity Ratio (SLR) and the cash reserve ratio have been reduced from 38.5 per cent and 15 per cent respectively to 25 per cent and 4.75 per cent (average during 2005/06). During the same period the bank rate came down from 11 per cent to 6 per cent. However, the regime of interest rate administration is yet to be completely deregulated. The concept of priority sector lending continues to prevail and yet the benefits of financial sector reform remain a distant possibility for small borrowers both in rural as well as urban sectors.

Accompanying the reforms, there has been a considerable shift in the conduct of monetary policy by the Reserve Bank of India (RBI). In the macroeconomic policy, India's preference so far has been for the 'money-based' stabilization. However, since 2000-01, in addition to loosely targeting the broad money growth, the RBI takes into account information on an array of indicators, such as data on currency, credit extended, fiscal position, trade, capital flows, interest rates, inflation rate, exchange rate, refinancing and transactions in foreign exchange and actively uses a combination of open market operations, auction of government securities and private placements to maintain medium and long-term interest rates. In order to facilitate the movement of short-term money market rate within a corridor, a Liquidity Adjustment Facility (LAF) was established with effect from June 5, 2000 to be operated through repos and reverse repos instruments.

Another area of major challenge is the management of foreign exchange assets (FEA), which had been growing at a phenomenal rate during the second half of 1990s. From a level of about US\$26 billion in 1997-98, FEA crossed US\$ 162 billion in November 2006. With the large-scale build up of foreign exchange assets (FEA), the expected appreciation of rupee and resulting adverse effects on exports compels RBI to undertake heavy sterilization of foreign exchange flows, which resulted in depletion of its domestic assets holding. However, in order to continue sterilization, a market stabilization scheme (MSS) was brought in; in which case the Treasury Bills and dated securities issued for the purpose of the MSS are matched by an equivalent cash balance, which is held by the Government in the Reserve Bank at a cost.

Thus, historically, the main instrument for conducting monetary policy in India has been the cash reserve ratio (CRR), which still continues to be exercised. Though interest rate instruments have been also available, they have been considered relatively less effective because they have not been fully market determined as in developed countries. By increasing the CRR, the RBI is able to reduce the multiplier and influence the broader aggregates of money like broad money (M3) and narrow money (M1), which, in turn, affect output and inflation, the stated goal variables of RBI. However, following the implementation of the financial reforms in 1991 and since 1993, the RBI introduced several interest rate instruments, and market forces are now allowed a definite role in the determination of interest rates. Thus, efforts are on to make interest rate as a monetary policy instrument.

ECONOMETRIC MODEL AND ESTIMATION STRATEGY

The stated objective of the Reserve Bank of India (RBI) is to help output growth through adequate creation of credit whilst maintaining a reasonable control on inflation. In view of the persistent current account deficit, the response of the exchange rate to adjustments in the instruments is also an important consideration of policy stance. Therefore, in this analysis output gap, inflation and change in real exchange rate are considered to be the variables of interest.

For the purpose of the policy analysis, the RBI's reaction functions with call money rate (CMR), yield on short-run securities (CGS1), and cash reserve ratio (CRR) have been estimated in two versions. The first version of estimation is in the tradition of Taylor (1993) type rule with forward-looking behaviour suggested in a paper by Clarida, *et al.* (1998)³. The second version of estimation is a simple backward looking error correction estimation of the instrument variable with goal variables as the explanatory variables. The justification for such a specification is provided in the subsequent paragraphs.

Method 1: Policy Reaction Functions with Smoothing Behaviour

The methodology suggested in Clarida *et al.* (1998) is based on the deviations of inflation, output and other variables from their bliss (equilibrium) points. More specifically, it is based on expected deviations of actual from potential output, expected deviation of inflation from the target and deviation of the other variables of interest from their trends. The rule for the target policy rate can be written in general form as follows:

$$X_t^* = \bar{X} + \alpha_1(E[\Delta p_{t+n} | \Omega_t] - \Delta p^*) + \alpha_2(E[y_t | \Omega_t] - y_t^*) + \alpha_3(E[z_t | \Omega_t] - z_t^*) \quad (1)$$

Here \bar{X} is the long-run equilibrium policy rate; Δp_{t+n} is the rate of inflation (in fraction) between period, t and $t+n$; y is real output; and z is a variable besides inflation and output that is of concern to the central bank and a star on the variable gives its target value. E is the expectation operator and Ω_t is the information set available to the central bank at the time of setting the policy rate. The potential output is a measurable non-zero positive quantity obtained from processes such as the technology augmented population growth. Formulation such as this is desirable for the case of any developing country like India, where potential output needs to be increased by better utilization of scarce resources and developmental plans. Population growth is high and detrimental to growth, because every new hand is not equipped to produce rather they share the same old cake most of the time. However, in the absence of systematic data on unemployment to estimate the business cycle, it is difficult to obtain the potential output year after year. Nevertheless, the ex-post output gap can be estimated using statistical techniques such as the HP filter.

Equation (1) says that the RBI sets a target for the nominal policy rate (CRR or interest rates) X^* . The target is assumed to depend, especially, on expected inflation, expected output gap (GAPY) and changes in real exchange rate. \bar{X} , the long-run equilibrium policy rate is represented by either CRR or CGS1 or CMR taken in fractions; Δp_{t+1} is the rate of inflation (in fraction) forecasted between year t and $t+1$; y is real output. Further, due to persistent current account deficits and consistent pressure on nominal exchange rate, changes in real exchange rates are constantly monitored and therefore, z in this study is the change in real exchange rate (REER).

Variables represented by a lower case letter are taken in logs and a Δ before the variable indicates it is taken in first difference. Both, output and the real exchange rate are taken in logs. Thus, the above equation represents the policy stance with respect to the deviation from the targets of expected growth, exchange rate change, and inflation. The bliss points for inflation and exchange rate change are represented by Δp^* and $\Delta reer^*$.

The RBI is also supposed to follow smooth changes in policy rates to avoid disruption of the capital market and loss of credibility. In order to capture the smoothing factor, the partial adjustment of the policy variable is written as follows:

$$X_t = (1 - \rho)X_t^* + \rho X_{t-1} + v_t \quad (2)$$

Here, $\rho \in [0,1]$ is the degree of interest rate smoothing and v_t is a white noise error.

Combining (1) and (2) and letting $\beta = \bar{X} - \alpha 1 \Delta p^* - \alpha 3 \Delta reer^*$ yields the following policy rule:

$$X_t = (1 - \rho)(\beta + \alpha 1(E[\Delta p_{t+1}|\Omega_t]) + \alpha 2(E[GAPY_t|\Omega_t]) + \alpha 3(E[\Delta reer_t|\Omega_t])) + \rho X_{t-1} + v_t \quad (3)$$

In order to obtain an estimable equation, the unobserved forecast variables can be eliminated by writing the policy rule (4) in terms of the realized variables as follows:

$$X_t = (1 - \rho)(\beta + \alpha 1 \Delta p_{t+1} + \alpha 2 GAPY_t + \alpha 3 \Delta reer_t) + \rho X_{t-1} + \varepsilon_t \quad (4)$$

Now, ε_t is a linear combination of the forecast errors of inflation, output gap and currency appreciation and the exogenous disturbance ν_t . Thus ε_t can be expressed as

$$\varepsilon_t = -(1-\rho) \{ \alpha_1 (\Delta p_{t+1} - E[\Delta p_{t+1} | \Omega_t]) + \alpha_2 (GAP_t - E[GAP_t | \Omega_t]) + \alpha_3 (\Delta reer_t - E[\Delta reer_t | \Omega_t]) \} + \nu_t$$

Under the assumption that ε_t is orthogonal to the information set of the RBI, equation (4) can be estimated using the non-linear least squares technique. In the present study, it has been tested that the regressors are not correlated with the error term by conducting an OLS regression of each set of residuals on Δp , Δy , and $\Delta reer$. None of these variables were found to have any explanatory power for the residuals obtained in experiments presented in Table 2 and this ensures the statistical consistency of the results. This also, in a way ensures that ε_t is orthogonal to the information set of the RBI.

Important conclusions can be drawn from the sign and magnitude of the parameters α_1 and α_2 depending upon, whether X is interest rate or cash reserve ratio. If X is the nominal interest rate, then successful stabilization of output growth and inflation require that α_1 is greater than one ($\alpha_1 > 1$) and α_2 is positive. If α_1 were less than one (with $\alpha_2 > 0$), raising the nominal interest rate would not result in a rise in the real interest rate required for bringing down the output growth. However, in the Indian context, there is a negative relationship between contemporaneous inflation and growth (Singh and Kalirajan, 2003). Therefore, the values of α_1 and α_2 would need more careful interpretation, while discussing the results. Additional information regarding the relationship among target values of the goal variables can be obtained from the estimated coefficients. With a real interest rate rule, suppose the sample average of the real interest rate is taken as the long run equilibrium real interest rate \overline{RR} , then, the target inflation rate can be recovered as $\Delta p^* = (\overline{RR} - \beta - \alpha_3 \Delta reer^*) / (\alpha_1 - 1)$. However, when the authorities do not follow the real interest rate rule, the implied target inflation rate can be obtained from the formula, $\Delta p^* = (\overline{R} - \beta - \alpha_3 \Delta reer^*) / \alpha_1$, where an equilibrium nominal interest rate \overline{R} is used. The latter relationship is more plausible in the Indian context where CRR has been a key instrument and interest rates are not fully adjusted due to policy preferences for specific sectors and directed credit.

Empirical Evidence

While estimating equation (4), ex-post realized values of average inflation during the year are considered as the future values of inflation as there is no official forecast of inflation in India, neither any series of expected inflation is created through market research as is the case in some of the industrialized economies. Therefore, for the sake of simplicity such an assumption is essential. In order to ensure that the results are statistically appropriate with this assumption, as mentioned earlier, the residuals are tested for no correlations with the regressors of equation (4) as discussed earlier.

The values of the policy variables namely CRR, CMR and CGS1 are averages during the year. Similarly, the change in exchange rate is the average value for the year. All the variables are tested for unit root. Cash reserve ratio and yield on short-term securities are integrated of order one, while call money rate and goal variables are stationary. Therefore, the residuals from

the estimations are additionally tested for statistical consistency. The exchange rate is defined such that, an increase in the value of the exchange rate means appreciation of the domestic currency. In the estimation equation, a lagged value of the exchange rate change is also included as additional conditioning variable. The estimation results for the three chosen policy variables are presented in Table 2.

Table 2
Non-Linear Models of Policy Variables with Smoothing Behavior

Non-linear Regression Formula:

$$X = (1-\rho)^* [\beta + \alpha_1^* \Delta p + \rho_2^* \text{GAPY} + \alpha_3^* \Delta \text{reer} + \alpha_4^* \Delta \text{reer} (-1)] + \rho^* X (-1)$$

<i>Dependent Variable X</i>	<i>Cash reserve ratio (CRR)</i>	<i>Average yield on 1-5 years Treasury Bill (CGS1)</i>	<i>Average inter-bank call money rate (CMR)</i>
<i>Regressor coefficients</i>	<i>1972-2005</i>	<i>1972-2005</i>	<i>1972-2005</i>
ρ	0.838 (0.047)*	0.804 (0.089)*	0.231 (0.164)+
β	-0.010 (0.032)	0.028 (0.039)	0.052 (0.015)*
α_1	1.027 (0.354)*	0.564 (0.432)+	0.453 (0.178)**
α_2	2.371 (0.945)**	0.375 (1.059)	0.293 (0.425)
α_3	-0.407 (0.174)**	-0.523 (0.291)***	-0.278 (0.099)*
α_4	-0.441 (0.171)**	-0.173 (0.223)	0.043 (0.092)
R-Square	0.95	0.83	0.44
R-Bar-Square	0.94	0.80	0.33
S.E of Regression	0.01	0.02	0.03
F-statistics F (k-1, n-k)	98.60 [0.00]	26.31 [0.00]	4.20 [0.01]
Diagnostic Tests			
LM (1) serial correlation	0.04 [0.84]	0.03 [0.85]	2.60 [0.11]
LM (3) serial correlation	2.77 [0.43]	0.61 [0.89]	6.10 [0.11]
ARCH (3) test	0.44 [0.93]	1.40 [0.70]	3.84 [0.39]
Functional Form CHSQ (1)	0.001 [0.99]	2.94 [0.09]	2.22 [0.14]
Normality CHSQ (2)	2.99 [0.23]	1.96 [0.38]	4.57 [0.10]
Residual Unit root			
Test statistics (DF)	-5.34	-5.70	-6.29

Note: Unit root test statistics are presented corresponding to the SBC model selection criteria in an unit root test with third order ADF; *significant at 1% level, **significant at 5% level and ***significant at 10% level, +significant at 20 per cent; values in parenthesis () are standard errors and values in square brackets [] are p-values.

Two general observations can immediately be made from the fits. First, cash reserve ratio (CRR) is better explained than the yield on government securities (CGS1) and call money rate (CMR). Other important observations from the results of Table 2 are as follows. From the size of coefficients of ρ , it is clear that the RBI is more concerned with smoothing the yield on government securities (CGS1) and the cash reserve ratio than smoothing the call money rate. However, call money rate captures the effects of inflation and the real exchange rates more significantly than the yield on government securities. These reactions in the call money market could also be due to the policy stances taken by the RBI on cash reserve ratio. These two variables have a correlation coefficient of 0.62 (see Table 3), which provides support for such a possibility.

Table 3
Correlation Matrixes of Selected Policy Variables and Reserve Money (m0)

	<i>CRR</i>	<i>CMR</i>	<i>CGS1</i>	<i>M0</i>	ΔCRR	ΔCMR	$\Delta CGS1$	$\Delta m0$
CRR	1.00							
CMR	0.62	1.00						
CGS1	0.86	0.56	1.00					
m0	0.41	-0.02	0.48	1.00				
DCRR	0.10	0.12	-0.02	-0.36	1.00			
DCMR	0.05	0.52	-0.01	-0.07	0.34	1.00		
DCGS1	-0.03	0.26	0.20	-0.22	0.06	0.25	1.00	
Dm0	0.16	-0.06	0.00	-0.06	0.53	0.10	-0.25	1.00

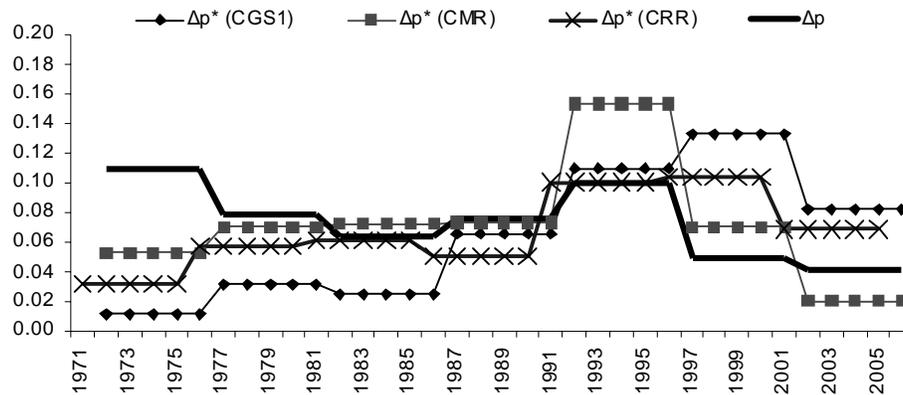
Note: CRR is cash reserve ratio, CMR call money rate, CGS1 yield on short-term securities, m0 log of base money. All rates are in fractions.

With respect to the explanatory power of the models, cash reserve ratio clearly, appears to be more precisely estimated than the interest rates. This is in line with expectations, as cash reserve ratio has been a more effective and direct tool than the interest rates. The size of the coefficient of inflation α_1 is more than one for CRR but less than one in both interest rate equations of CMR and CGS1, which means that the RBI has not been following policies of full stabilization and inflation is allowed to exceed a value that could reduce real interest rate. This is not surprising given that the RBI loosely targets broad money through the application of quantity control rather than the interest rate channel. The β coefficient is significant only in the equation for CMR. This means that there is no strong linkage between the targeted values of the goal variables and the long run average values of the instruments other than the CMR.

Further, considering the equation for the cash reserve ratio policy, it may be observed that the coefficient of inflation is 1.027 and the coefficient of output gap is 2.37. This means that CRR has to be reduced more to increase the output growth by one unit than it has to be increased for decreasing inflation by one unit. Thus, it appears due to the negative effect of inflation on growth that any attempt to lower the CRR (which would lead to an excess increase in money supply and hence, an increase in inflation) in the hope of increasing output may also result in a fall in output because of an increase in inflation. Therefore, the net effect on output growth may be lower than expected. The coefficient of the lagged exchange rate change is significant only in the equation for CRR. This shows a desperate attempt by the RBI to keep the currency in a band or allow a controlled depreciation obtained by increasing the CRR (or vice versa).

Because RBI is concerned about several goal variables, it is likely to fail arriving at the target or desired values. To see this, we calculate the implied bliss points for inflation with respect to all the three estimated equations in Table 2 and compare it with the actual inflation. For calculating implied target for inflation we use the formula, $\Delta p^* = (\bar{R} - \beta - \alpha_3 \Delta reer^*) / \alpha_1$, where an equilibrium nominal interest rate \bar{R} is obtained by taking five year average of CGS1, CMR and CRR respectively and $\Delta reer^*$ is also obtained taking five year average (period same as Table 1). The implied inflation targets are plotted in Figure 1. Clearly, there is hardly any consistency in the results. During the first half of 1970s, no policy variable appears to reflect a

Figure 1: Actual Inflation (Δp) and the Implied Bliss Points from the Estimates of Three Policy Variables Using Five Year Period Averages for the CGS1, CMR, and CRR as Nominal Policy Targets (Table 1 referred)



target that is near actual. However, during 1976-86, CMR and CRR appear to confirm closer correspondence with the outcome, while during 1986 to 1996 CRR and CGS1 have closer correspondence. Beyond 1996, only CMR has some correspondence while CGS1 and CRR perform worst. Thus, while CRR remained effective for most of the period, during recent period correspondence of CMR is better than other policy variables albeit with deterioration. It may be noted that RBI has diversified its goals during recent periods by taking the responsibility of management of foreign exchange flows in addition to macroeconomic stabilisation. This leaves the monetary policy in greater challenge.

It is obvious that some of the above observations are not encouraging, particularly with respect to the interest rate, as the data does not demonstrate the desired sophistication imbedded in modern central banking in developed countries, where the financial market is highly developed allowing for application of the interest rate channel of policy transmission all the time.

Method 2: Policy Reaction Function with Restricted Error Correction

With insignificant β in the non-linear estimation for interest rate, it can be inferred that the changes in the policy variables are not motivated by any bliss points of inflation or the exchange rate change. This appears to be consistent for a developing country, where the equilibrium output and corresponding inflation or exchange rate change are not achieved. Therefore, an alternative strategy of estimating policy could shed more light on the policy stances of the RBI i.e. some kind of long-term policy for the RBI with respect to output and inflation along with short-term adjustments in policy variables. This kind of reaction function for the RBI can be estimated in an error correction specification and using Hendry's general to specific approach (Hendry (1995)) to search statistically significant equation. In the exercise of specification search only those variables found relevant in specifying the model are retained. The error correction term is obtained from an underlying vector error correction model (VECM) of order one where order of vector auto regression (VAR) is obtained using selection criteria. The estimated cointegrated relationship is presented at the bottom of Table 4, while the test of cointegration applying the likelihood ratio tests on the maximum eigenvalue and the trace of the stochastic matrix (Pesaran, Shin and Smith, 2000), is presented in Table 5.

Table 4
Restricted Error Correction Models of Policy Variables

<i>Dependent Variable</i>	<i>ΔCRR (Change in cash reserve ratio)</i>	<i>ΔCGS1 (Change in yield on 1-5 year government security)</i>	<i>CMR (Change in call money rate)</i>
Regressors	1973-2005	1973-2005	1974-98
INTERCEPT	0.0003 (0.0.002)	0.008(0.004)*	0.050 (0.010)*
ECM (CRR) (-1)	-0.106 (0.024)*		
ECM (CGS1) (-1)		-0.082(0.037)*	
ECM (CMR) (-1)			-0.959 (0.184)*
Δ2p	0.175 (0.043)*	0.079 (0.105)	-0.06 (0.117)*
Δ2p(-2)		0.158 (0.093)***	
Δ2 reer	-0.075 (0.026)*	-0.085 (0.045)**	-0.104(0.078)*
Δ ² reer (-1)			0.109 (0.064)***
Δ ² reer(-2)		-0.082(0.044)***	
Δ GAPY	0.175 (0.043)*	0.210 (0.212)	
Δ GAPY (-1)			-0.547 (0.27)**
Δ GAPY (-2)		0.288 (0.152)***	
Δ feru		-0.34 (0.014)**	
DRAIN (-1)			0.119 (0.058)**
DCGS1(-1)		-0.206 (0.179)	
R-Square	0.53	0.45	0.64
R-Bar-Square	0.49	0.22	0.55
S.E of Regression	0.009	0.015	0.023
F-statistics F (k-1, n-k)	8.33 [0.00]	1.97 [0.09]	7.72 [0.00]
Diagnostic Tests			
LM (1) serial correlation	0.01 [0.92]	1.44 [0.23]	0.00 [0.99]
LM (3) serial correlation	1.45 [0.69]	4.01 [0.26]	3.82 [0.28]
ARCH (3) test	2.52 [0.47]	5.43 [0.14]	1.20 [0.75]
Functional Form CHSQ (1)	0.41 [0.52]	2.50 [0.11]	0.44 [0.51]
Normality CHSQ (2)	0.78 [0.68]	0.20 [0.91]	2.41 [0.30]
Residual Unit root test			
Test statistics (DF)	-5.50	-6.12	-5.27
ECM (CMR) = 1.0 CMR - 0.45581 Δp - 1.4283 GAPY + 0.41377 Δreer (0.185) (0.675) (0.116)			
ECM (CRR) = 1.0 CRR - 0.81467 Δp - 3.0353 GAPY + 1.1706 Δreer (0.416) (1.677) (1.171)			
ECM (CGA1) = 1.0 CGS1 - 0.48596 Δp - 4.8251 GAPY + 1.0275 Δreer (0.869) (5.098) (0.587)			

Notes: Unit root test statistics are presented corresponding to the SBC model selection criteria in a unit root test with second order ADF; *significant at 1% level, **significant at 5% level and ***significant at 10% level; values in parenthesis () are standard errors and values in square brackets [] are p-values. In F-statistics k is number of regressors including intercept and n is the number of observations.

Table 5
Cointegration Test with Unrestricted Intercept and No Trend

<i>Maximum Eigenvalue Test</i>				<i>Trace Test</i>				
<i>Null Hypothesis</i>	<i>Alternative Hypothesis</i>	<i>Statistic</i>	<i>95% Critical Value</i>	<i>Null Hypothesis</i>	<i>Alternative Hypothesis</i>	<i>Statistic</i>	<i>95% Critical Value</i>	<i>No. of vectors selected</i>
CRR: CRR Δp Dreer GAPY								
r = 0	r = 1	36.53	27.42	r = 0	r = 1	72.98	48.88	1
r ≤ 1	r = 2	22.87	21.12	r ≤ 1	r ≤ 2	36.46	31.54	
r ≤ 2	r = 3	11.97	14.88	r ≤ 2	r ≤ 3	13.58	17.86	
CMR: CMR Δp Dreer GAPY								
r = 0	r = 1	36.96	27.42	r = 0	r = 1	86.36	48.88	1
r ≤ 1	r = 2	25.30	21.12	r ≤ 1	r ≤ 2	49.41	31.54	
r ≤ 2	r = 3	16.67	14.88	r ≤ 2	r ≤ 3	24.11	17.86	
CGS1: CGS1 Δp Dreer GAPY								
r = 0	r = 1	26.70	27.45	r = 0	r = 1	60.67	48.88	1
r ≤ 1	r = 2	22.85	21.12	r ≤ 1	r ≤ 2	33.97	31.54	
r ≤ 2	r = 3	8.65	14.88	r ≤ 2	r ≤ 3	11.11	17.86	

Notes: No of observations = 33 VAR = 1; Number of vectors is indicated by r. CRR, CGS1 are tested to be I(1) and other variables are stationary. Due to this more than one cointegrated vectors are obtained.

Once again, the chosen policy variables are the cash reserve ratio (CRR), yield on short-term government securities (CGS1) and call money rate (CMR). The estimated models are presented in Table 4. All the three models have satisfactory statistical properties.

The results presented in Table 4 provide strong support for some of the earlier conclusions in addition to shedding more light on the priorities of policy makers. For example, in the long run as well as in the short run, all the policy instruments seem to be directed towards controlling inflation. Cash reserve ratio policy is also significantly explained by short-run and long run movements in output and real exchange rate change.

The policy stances on the interest rates are also intuitive. During the 1970s and early 1980s, there were smaller movements in yield on short-term securities and call money rates and the RBI did not actively use interest rates as monetary policy instrument. However, after the late eighties, there is more variation in interest rates. Most of the explanatory power for these models are therefore, derived from the later years of bank activities. The long and short-term interest rate policy stances with respect to inflation, exchange rate changes and output, are as expected (Table 4). The real exchange rate has a depreciating trend and too much sliding down is not considered conducive to the health of an economy with consistent trade deficit, as is the case in India. Therefore, all the three instruments are applied to keep the currency in band. However, during the recent years, there are serious concerns of managing foreign inflows, which has grown from 8.2 per cent of GDP during 1996/97-2000/01 to 15.9 per cent of GDP during 2001/02-05/06 (Table 1). The management invariably takes the form of sterilization, which affects the yield on government securities. Growth in foreign exchange reserves in US\$ is added to the model to factor in its effect on the policy variables and it is significantly found to affect CGS1 but not other variables. With increasing foreign currency inflows, RBI is increasing its foreign assets and draining domestic assets by reducing their prices.

On occasions, the RBI is reported to use forecasts about likely agricultural output from rain conditions. Therefore, variation of monsoon season rainfall from the normal (DRAIN) in fraction is also used to model policy variables. In the case of CMR it is found to be significant. When rain is better than normal (negative DRAIN), the RBI tends to increase interest rates, probably in fear of increased inflation. This may not be an appropriate policy for a supply side dominated economy, where it can be argued that with a favorable supply shock demand side stimulus will lead to better outcome. However, a positive sign of DRAIN also means that RBI reduces interest rate with adverse rainfall with an idea of boosting industrial output and compensating for the expected fall in agricultural output, which can be inflationary.

EFFECTIVENESS OF POLICY VARIABLES

The reaction functions estimated above demonstrate the intent of the RBI. However, from the above analysis, it is not clear whether the policy stance taken at time zero has effectively performed its job in the subsequent periods. More specifically, the questions, such as, did an increase in cash reserve ratio cause future inflation to fall or exchange rate to appreciate, are not addressed. An attempt is made in this section to examine the behaviour of the instruments available to the RBI in respect of their effects on the goal variables of output, and inflation. As mentioned earlier, the RBI has used both quantity and price control to implement its policies. Cash reserve ratio has so far been considered a powerful quantity control instrument of the RBI. As earlier, the price control instruments considered for examination are the yield on 1-5 year treasury bills (CGS1), which proxy the opportunity cost of base money, and the overnight inter-bank call rates (CMR) of the commercial banks. It is posited to know how these instruments affect future output gap, inflation and the exchange rate. In other words, the question addressed here is as to which instrument is most important for each of the goal variables.

Future outcomes are considered either as the result of the policy stances taken in the past, or in the current period in anticipation of the likely movements in the goal variables. It is not evident from the RBI publications that they work with published targets for inflation, output, or the exchange rate. However, some reference is made to the money supply growth. Therefore, it is not claimed here that the tests conducted below represent exactly the behaviour of the RBI per-se with respect to its targets. Instead, the objective is to discover what influence do policy stances taken in period zero have on the variables of interest in period one onwards.

Bernanke and Mihov (1997) have applied the idea of the Granger causality test on monthly data in a VAR setup to discover whether the central bank of Germany (Bundesbank) has been targeting money growth or inflation. For that, they have attempted to see whether the instruments have caused twelve period ahead forecasted inflation or money growth and have concluded that targets of money were missed in favor of meeting the requirements of lower inflation. In the context of the discussions of the present paper, tests of the Granger causality is considered useful in shedding light as to what follows after an instrument is increased or decreased. The test is applied in a VAR setup using ex-post realized values of the variables.

In order to implement the Granger non-causality test, a six variable VAR of order one is used to obtain the equations of the goal variables in terms of lagged values of instrument variables of cash reserve ratio, yield on short-term government securities and call money rate and goal

variables of output gap, inflation and change in real exchange rate. The order of the VAR for this test is selected based on the Schwarz Bayesian Criterion (SBC) model selection criteria. The OLS equations of the goal variables are used to test whether lagged values of the instruments are significantly different from zero or not. If an instrument is not found to help in explaining the variables of interest, it can be concluded that the particular instrument did not cause any effect to the goal variable. The results of this test are presented in Table 6. Since VAR includes I(1) variables also, unit root test results for stationarity of the residuals is also presented. In addition, the cointegration test results discussed with respect to the ECM for policy variables ensure six variable VAR to be consistent.

Table 6
Test Results: Policy Variables Granger Cause the Dependent Variable

<i>Instrument variable Granger cause the dependent variable</i>	<i>Equation dependent variable (goal variables of interest)</i>		
	<i>$\Delta reer$</i>	<i>Δp</i>	<i>GAPY</i>
Cash reserve ratio CRR (-1)	+ 0.73 [0.273]	+ 0.56 [0.211]	- 0.09 [0.629]
Yield on 1-5 year security CGS1 (-1)	- 0.80 [0.219]	- 0.37 [0.388]	+ 0.09 [0.159]
Call money rate CMR (-1)	- 0.92 [0.065]	- 0.99 [0.003]	+ 0.19 [0.613]
Equation Properties			
R-Square	0.25	0.38	0.12
R-Bar-Square	0.10	0.25	0.04
LM (1) serial correlation	[0.73]	[0.41]	[0.81]
LM (3) serial correlation	[0.84]	[0.17]	[0.24]
Functional Form CHSQ (1)	[0.02]	[0.10]	[0.45]
Normality CHSQ (2)	[0.91]	[0.90]	[0.92]
Heteroscedasticity CHQ (1)	[0.10]	[0.10]	[0.54]
Unit root test for residuals (DF)	-5.67	-6.24	-5.41

Notes: 1. P-values provided in the square brackets [] correspond to the test statistics of significance of the instrument variables in the OLS equation of the dependent variable, taken from the 6-variables VAR of order 1.
2. For the sake of clarity in presentation of the results coefficients of the variables being tested for causality only are presented. Period of estimation: 1972-2005. Unit root test statistics are presented corresponding to the SBC model selection criteria in an unit root test with second order ADF. Critical value for the unit root test at 5 percent significance level is -2.99

The results of Table 6 suggest that policy variables do not have any effects on the output gap. However, there is significant effect of increases in call money rates on reducing inflation but at the same time it also causes real depreciation of the currency. Probably, inflation is more responsive to call money rate than the nominal exchange rate as indicated from this result. It may be noted here that a high call money rate indicates liquidity constraint of the banks. Therefore, these effects can also be attributed to conditions of reserve money, and OMO in foreign exchange.

Neither the CRR nor the yield on the government securities (CGS1) appears to significantly affect any of the goal variables. The block non-causality test for testing the null hypothesis that the coefficients of the instrument variables are zero in the equation for all other variables in the above six variable VAR is rejected in the case of all policy variables (Table 7) indicating that the instrument variables have significant interaction in the system.

Table 7
Test Results for Block Granger Non-Causality

<i>CRR</i>	<i>CGSI</i>	<i>CMR</i>
9.62[0.087]	14.36 [0.013]	18.35 [0.003]

P-values provided in the square brackets [] correspond to the CHSQ (5) test statistics of significance of Policy variables in the equation of all other 5 variables in the 6-variables VAR of order 1.

Therefore, the loss of effectiveness of the policy variables, particularly cash reserve ratio and the yield on short-run securities, with respect to inflation and output growth need some explanation.

Inflation in India is a phenomenon affected both from the supply side as well as the demand side, which reduces the direct role of the demand side instrument. In addition, the style of conducting monetary policy in the RBI suggests the possibility of losing coordination in the application of different instruments and the process of money creation. It may be pointed out that the RBI does not work through a money multiplier, but there is some target for broad money growth calculated using income elasticity and on the other hand, the strategy of creating the base money is dependent on fiscal conditions, and foreign reserve position, a entirely different set of considerations (see Rangarajan and Mohanty, 1997; Vasudevan, 1999; Reddy, 1999b). CRR is used to moderate the liquidity for credit creation. This framework allows synchronized changes in both reserve money stock and cash reserve ratio. If reserve money stock and cash reserve ratio, both are increased (or decreased) together, then the direction of movement of multiplier is simply unknown and the desired effect of change in cash reserve ratio will not be obtained.

With the practice of creating reserve money beyond open market operations (OMO), similar situation can arise with respect to interest rate instruments as well. As demonstrated earlier, there is no evidence of the RBI targeting the real interest rate. Interest rate has a history of administrative control and does not fully represent the behaviour of the private sector. In the absence of fully market related interaction between the interest rate and the money stock, it is possible that the effect of interest rate on inflation and output gap is neutralized or even dominated by effects of such actions on base money as motivated from the fiscal deficit and movements in foreign exchange reserves (also see McKibbin, 1997).

In order to make the above point more transparent, issues related to monetary actions with respect to reserve money and the instruments, it may be useful to analyze the correlation matrix between the policy instruments and the reserve money (M0) presented in Table 3, which shows a high positive correlation between cash reserve ratio and base money (m0), yield on short term securities and reserve money, and cash reserve ratio and call money rate. It is argued that, whenever policy instruments are exercised, action on the reserve money either accompanies or follows in such direction that tend to neutralize the effect (Singh, 2002). It may be noted that the call money rate is more about the liquidity constraints of commercial banks and depends upon the cash reserve ratio and reserve money in the system. Therefore, it captures the net effect of actions on CRR and the reserve money.

Policy ineffectiveness in the case of exchange rate change has additional explanations. Nominal exchange rate appreciation, in the presence of capital control as is the case in India,

may be more on account of movements in the current account and flows in the foreign exchange reserves (particularly remittances) rather than changes in the interest rate. Nevertheless, monetary policy can affect the real exchange rate through inflation. For example, a base money expansion (or a fall in cash reserve ratio) may cause both inflation and depreciation of the nominal exchange rate. With a dominant inflation effect, the real exchange rate will appreciate and adversely affect exports. However, the resulting deterioration in the current account may in turn cause nominal depreciation. With an overshooting exchange rate effect, the real exchange rate may depreciate improving the current account, which in turn appreciates the nominal exchange rate.

Therefore, knowledge of the responsiveness of the nominal exchange rate to the monetary expansion and the current account position is also important in the case of India. If nominal exchange rate appreciation is more affected from current account positions, then the role of monetary policy in controlling the exchange rate is limited compared to other policies oriented to improve the current account. However, in the short-run, monetary authorities can influence nominal exchange rate appreciation through the process of sterilization.

From these discussions, it would appear that there is ample potential for loss of coordination in the application of different instruments and in the process of money creation. It was pointed out earlier that the RBI does not work through money multiplier, but there is some target for broad money growth calculated using income elasticity. At the same time, considerations for creating base money are dependent on fiscal conditions, and foreign reserve position, which are an entirely different set of considerations. Therefore, it is not surprising that the cash reserve ratio becomes a relatively weaker instrument in controlling inflation in India than the reserve money itself, which directly determines narrow money that is found to be a causal monetary aggregate to inflation in India (Chand and Singh, 2005).

The above analysis clearly demonstrates the pitfalls of working simultaneously with instruments of quantity and price control. It may be suggested that the RBI should shelve the cash reserve ratio and concentrate more on interest rates for conducting the monetary policy. It should accelerate capital account convertibility to reduce dependence on sterilization and let the currency float more freely. This would also help in the process of financial deepening, and developing interest rate as a main instrument. With an effective interest rate as the main policy instrument, the amount of reserve money would be an outcome of a systematic process.

CONCLUSIONS

The central theme of this paper is to know whether the RBI does have an effective policy stance with respect to stability in inflation, output gap and exchange rate change. Accordingly, the objective of this paper is to identify the reaction function of the RBI and the impact of the RBI's policy stances on major macroeconomic variables of interest. The estimated reaction functions clearly suggest that all the three policy instruments namely cash reserve ratio, call money rate and yield on government security are increased when inflation and output gap rise or real exchange rate falls. However, the analysis of the effectiveness of the instrument on the goal variables is not encouraging. None of the policy instrument is found to cause changes in output significantly. Cash reserve ratio policy seems to lose its effectiveness due to parallel actions of the RBI in respect to the base money supply. There is no clear evidence to suggest

that the policy actions are reducing inflation except in the case of the call money rate, which fundamentally seems to be a result of the lower base money stock.

There is some evidence to suggest that the RBI is much involved in controlling the exchange rate depreciation through selling foreign exchange reserves in the short run. However, it appears that not much can be done towards stabilizing the currency, unless policy measures to improve the current account are implemented. From this analysis, it can be argued that it is difficult to work with instruments of quantity control and price control simultaneously. It may be suggested that the RBI should shelve the cash reserve ratio and concentrate more on price variables for conducting the monetary policy, as is the case in developed countries, which necessitates accelerating financial sector reforms steadily. With effective interest rate as the main policy instrument, the amount of reserve money would be an outcome of a systematic process.

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NOTES

1. The report of the Committee on Financial System (CFS) was submitted in 1991 and Mr. M. Narasimham was the chairman of the committee. Therefore, CFS is also known as the Narsimham Committee report (1991). Subsequent to this report, the government appointed another committee, the Committee on Banking Sector Reforms (CBSR), again with Mr. Narasimham as committee chair with an objective to review progress made in reform of the banking sector and to chart the actions needed to strengthen the foundation of the banking system. The CBSR was submitted in April 1998. For a summary see RBI (1998b).
2. The reforms include inter-alia the free floating of the exchange rate, decontrol of interest rates, development of securities markets, greater reliance on open market operations, auctions of government securities, phased decontrol of the capital account, and putting in place the prudential norms and mechanism for supervision of banking sector in line with international standards and practices. For a comprehensive detail with analysis see Reddy (1999b), Reddy (2005), IMF (1998), and Ahluwalia (1999).
3. There is no series of expected inflation or output, which could be used for estimating a forward-looking reaction function. We assume that the expectations are built based on the current inflation and past history. We have tested the residuals for correlation with the regressors by running OLS of residuals on explanatory variables and we find satisfactory results. The regression output can be supplied if required. Under this condition, using instruments could have distorted the results.

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