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July 2000

Preprint from *Indian Economic Journal*, 48(1), July-September, 2000.

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Abstract

A new specification is employed to test for the degree of endogeneity of commercial bank credit, and its response to structural variables relevant to the Indian context. Our specification allows us to both identify money supply in a single equation, and disentangle the contribution of the Central and the Commercial Banks to the money supply process. Bank credit reacted more to financial variables and had dissimilar responses to food and manufacturing prices and output. Instead of interest rates, sectoral returns played a major role. Monetary policy broadly succeeded in preventing an explosive growth in money supply and reined in inflationary expectations. But by targeting manufacturing prices it harmed real output. The estimated structure implies that it would be more efficient to target agricultural prices for inflation control. A monetary contraction should be completed earlier than in the past, and should coincide with a rise in food prices. Information available in the systematic structural features can be exploited in designing monetary policy.

Key words: Money supply endogeneity, identification, information, sectoral prices

JEL Classification: C22, E51, O11

Acknowledgements

We thank Raghbendra Jha, Tirthankar Roy, Kunal Sen and an anonymous referee of the IGIDR discussion paper series for very constructive comments, and T.S. Ananthi for help with the word processing. The paper was presented at the India and Southeast Asia Meeting of the Econometric Society, Delhi, and is a revised version of IGIDR discussion paper DP-96-130.

The Money Supply Process in India: Identification, Analysis and Estimation

1.Introduction

We employ a new specification to examine the degree of endogeneity of commercial bank credit, and its response to structural variables unique to the Indian context. Our specification allows us to both identify money supply in a single equation, and disentangle the contribution of the Reserve Bank of India (RBI) and the Commercial Banks to the money supply process. Features of the Indian financial sector help in the design of the test and demonstrate the impact of structure on the money supply process. Prior to the nineties high powered money was endogenized through the automatic financing of the Government deficit. But monetary control was sought to be imposed by a direct regulation of credit generation by banks, combined with measures such as a cut in public investment to reduce demand. Did this succeed? Did banks fulfil profit motives and endogenize credit even when it conflicted with central banks objectives? To what extent were they able to expand credit to meet demand? What was the degree of control the RBI was able to impose? How have structural variables influenced the process?

With financial reforms, banks have greater freedom; capital inflows make it more difficult to control high powered money; and money demand will become unstable as close financial substitutes develop. But if deep structural aspects of bank behavior are successfully modelled it can aid in the design of policy even in the new era. Although loans create deposits, loans are determined both by supply and demand. They depend on profit maximization by banks; and on RBI monetary policy that changes base money. It is a common perception that macroeconomists either believe money supply to be endogenous, or believe it can be controlled. But the facts seem to lie somewhere between these positions. We discover that although the RBI has been able to affect the base money, banks have been able to circumvent controls and expand credit when there were profits to be made.

In Post Keynesian monetary theories credit is created only in response to demand, and financial institutions adapt according to the profit motive to create it when required. Palley (1994) shows how banks, by altering incentives facing depositors, can expand broad money on an unchanged base. Changes in bank assets imply a change in broad money supply. Foster (1992) in an approach that emphasizes structure derives and estimates a stable aggregate money supply function. The latter captures the persistent tendencies, resulting from a historical process, in which banks adapt according to their evolutionary advantage. His final equation is similar to ours. A structural variable, real estate prices, enters the supply function he estimates. A standard money supply function does not include such a variable.

The model and empirical tests are derived from basic monetary theory in Section 2. Our parsimonious specification aims to achieve a purposive simplification. It gives information on both the endogeneity of bank credit and the role of structural features. It does so in a single equation format that manages to avoid identification problems. The model is estimated with OLS for yearly and quarterly data. Time series ARIMA modelling is also used. This allows us to distinguish between short- and long-run effects. A cointegrating vector and long-run regression are obtained. The results are discussed in Section 3. Details are in the Appendix. Section 4 concludes.

2. Designing the Tests

2.1 The Simultaneity Bias

Consider a simple stylized downward sloping money demand and upward sloping money supply as a function of the nominal rate of interest. For identification to be possible there must exist a variable that shifts one of the functions but leaves the other unchanged. The shifting function will then identify the other. There must exist a subset of variables that change money supply while leaving money demand unchanged, or vice versa. Otherwise only a scatter of market equilibrium points will be estimated.

But such a subset of variables does not exist. If money supply is endogenous, variables affecting money demand also affect supply. It is necessary to estimate a simultaneous equation system, with money demand, supply and the market equilibrium condition. In an imperfectly identified single equation the independent variables would be correlated with the error term so that the parameter estimates would be inconsistent. In addition, diagnostic tests are often invalid after the specification searches that accompany most econometric work. Cooley and LeRoy (1981) point out that in estimates of money demand most researchers reproduce signs of coefficients according to their prior beliefs, partly because they stop searching after "satisfactory results" are obtained. Sims (1980) argued that invalid "incredible identifying restrictions" were often used in macroeconomic modelling. Once disequilibrium is considered supply is not determined by "nature" or technology through maximization by agents facing given prices. Supply would not then be independent of demand. If rational expectations are formed over a model, variables affecting demand would influence supply decisions. From a systemic perspective all variables must enter each function. In modern empirical work (Bordo and Jonung 1987) stochastic trends affect both money demand and supply elements. There is no variable that can be excluded from money demand or supply, to identify the other.

2.2 Earlier Empirical Studies

Have these issues been tackled in the numerous Indian empirical studies of money? The studies can be divided into: (i) subsets of macroeconometric models, and (ii) single equation estimations of either money demand or the money multiplier. We concentrate on the modelling of money supply. The first set of models can be sub-classified as Keynesian-Structuralist or Monetarist[1]. In the former, prices are determined from the cost side, and the monetary sector is somewhat sketchy. Base money is endogenized through automatic financing of the budget deficit. Nominal interest rates were rigid before the reform of the nineties; therefore credit rationing is sometimes invoked to model periods of tight monetary policy. In Monetarist models money determines prices through the quantity of money; the implication is that the Reserve Bank of India (RBI) can control the latter. Structural variables such as agricultural output and price, asset prices such as gold, real estate and share prices are neglected, but these may influence the speculative demand for money and the incentives of banks to create credit. Jadhav (1990) provides a survey, and points out that shortcomings continue. A satisfactory combination of key monetary and structural features is still lacking.

Single equation forecasting exercises (for example, Rao, Venkatachalam and Vasudevan 1981) that became popular in the eighties sought to go beyond the balance sheet approach for determining the components of money supply. The latter was the Reserve Bank (RBI) approach in the seventies in which the money multiplier was assumed to be constant even in incremental terms.

In the mid-seventies, a fruitful debate centering on the money multiplier improved the analytical understanding of money supply determination. Protagonists of the money multiplier approach, such as Gupta (1976) challenged the RBI viewpoint that the multiplier had little bearing on the operational aspects of monetary policy. This led to a resurgence of interest in the money multiplier on the part of the RBI, as evidenced by important RBI studies (Singh et. al. 1982, Rangarajan and Singh, 1984). As many of these studies are based on a subset of equations rather than a fully specified macromodel they are examined below.

This set largely ignores simultaneous equation bias and identification problems. Chitre in his (1986) study of the money multiplier, modelled demand and supply for money as equated through the call money rate, and the general level of prices. Quarterly real income and the interest rate on fixed deposits were exogenous. The elasticity of the currency to deposit (C\D) and the reserve to deposit (R\D) ratios, the call rate and anticipated inflation are all subject to simultaneity bias. But these elasticities, and therefore, the bias in the elasticity of the reserve multiplier were expected to be small. Chitre ran regressions for each component of the money multiplier.

Nachane and Ray (1989) used time series analysis to improve the forecasts of the money multiplier. They believed this to be an advance over Chitre's method since it allows an endogenous specification of lags. Even so, they admit that the techniques they use cannot simultaneously take care of lags and feedback; they ignore the latter.

Following these seminal studies, a number of authors sought to obtain more accurate predictions of the money multiplier. These were an important policy input. To target the money stock from a given base or high-powered money, it was necessary to predict the money multiplier, so that the bank's contribution to raising money supply could be quantified. The consensus was that the money supply function is stable.

Monetary control also requires stability of money demand; the Reserve Bank view[2] is that this is satisfied, although the income elasticity of demand for money has been rising. Rao and Singh (1995) argue that in spite of the overwhelming international evidence on instability of money demand, money, income and a relevant interest rate are cointegrated, demonstrating long-run stability. Even so, their view is that targeting of nominal income, or velocity, is superior to targeting some monetary aggregate, since velocity can be derived independently or residually, without trying to invert a questionable money demand schedule.

Existing studies have not adequately analyzed the interactions between the players who determine money supply. But changes ushered in by the financial reforms have turned attention towards this structure. If banks managed some autonomy to maximize profits even in a regime of direct credit controls, then these motives will dominate in a liberalized era. Answers to the questions we pose will be both informative and important.

2.3 The Model

Money supply is a multiple of reserve money. The expansion depends on the money multiplier. The money multiplier in turn is a function of C\D, and R\D. Households' choice of C\D would depend on income, the rate of interest on time deposits, anticipated inflation and other seasonal and lagged variables. Banks' choice of R\D is compounded of required reserves and excess or borrowed reserves. The former are statutorily determined and have been used by the RBI to offset changes in base money, H. Prior to the reforms, monetary tightening was achieved by cutbacks in government capital expenditure, and by draconian use of SLR (statutory liquidity ratio) and CRR (compulsory reserve requirements).

Bank's decision to hold excess reserves depends upon output as reflecting the demand for credit, the call money rate as reflecting the cost of borrowing reserves, and other interest rates as reflecting the opportunity cost of holding reserves or the incentive to lend. As nominal interest rates were rigid, changes in asset prices and inflation rates reflected these opportunity costs. The call money rate was fixed at a ceiling of 15 percent in December 1973, and was constant at 10 percent from April 1980 until it was relaxed in the nineties. Banks did, however, develop methods such as buy-back arrangements in Government securities. These carried much higher effective interest rates and allowed them to breach the ceiling, especially in periods of tight liquidity (RBI, 1987). Even in countries where interest rates are variable, collinearity among the different interest rates poses a major problem in estimation. Income and interest rates are the variables determining the demand for money also.

We propose to sidestep the identification problem by estimating M_3-H (broad money with high powered money subtracted from it), as a function of a range of output, price and interest rate variables. As this is not the money balance, the resulting regression cannot be a demand for money equation. It has an advantage over the components regression approach to estimating the money multiplier, because it gives the aggregate response of credit to structural price variables that function as proxies for interest rates, and reflect deeper determinants of variables commonly used in component regressions for the money multiplier. The approach is in line with modern indirect methods of inference as used for example in the New Empirical Industrial Organization. The idea is to obtain information about unknown economic variables from observed outcomes. Abstracting from shocks to H allows us to concentrate on adaptations in inside money or credit.

If the components of M3 and of H are substituted, it turns out that M_3-H is bank deposits minus reserves. If reserves could be neglected, and if deposits and currency are perfect complements, or the currency ratio is fixed, it could be estimating money demand. But the degree of substitutability between currency and deposits is high and variable in a developing country because of a varying speed of monetization, financial intermediation and the presence of black money. Moreover, Granger causality tests (reported in the Appendix) validate the absence of simultaneity bias; M_3-H is caused by the variables we have selected; reverse causality is largely absent; the pattern of coefficients suggests that it is money supply and not demand that is identified.

Again, if reserve requirements are exogenous, our equation could be estimating the demand for deposits, with reserves added to M_3-H like an error in the measurement of the dependent variable. Coefficients can be consistently estimated with a random error in the dependent variable. But in India there have been frequent changes in reserve requirements. They have functioned as the main instrument of monetary control, and therefore are systematically linked to the endogenous variables. The average CRR rose from 9 per cent in 1984 to 15 per cent by 1989, the SLR was nearly 40 per cent. Therefore the estimated equation cannot be interpreted as measuring demand for deposits.

Bank credit responds to our explanatory variables, but it is total money supply that determines them.

This imposes some restrictions on the structure of variances and covariances so that the explanatory variables can be taken as exogenous in the determination of bank credit. In addition to the causality results, therefore, theory suggests that our single equation estimator will be efficient, given Indian monetary intervention. To see this consider the following simplified model of bank credit supply and money demand:

$$m_t - h_t = \beta r_t + v_t \quad (1)$$

The supply function can also be written as:

$$m_t = \beta r_t + v_t + h_t \quad (2)$$

The money demand is:

$$m_t = \alpha r_t + u_t \quad (3)$$

m_t, r_t and h_t are deviations from their respective means, where M is a measure of broad money, R a generic price variable entering demand and supply and H the monetary base. Let $\text{var}(u_t) = \sigma_u^2$, $\text{var}(v_t) = \sigma_v^2$, $\text{var}(h_t) = \sigma_h^2$, $\text{cov}(u_t v_t) = \sigma_{uv}$, $\text{cov}(u_t h_t) = \sigma_{uh}$, $\text{cov}(v_t h_t) = \sigma_{vh}$. We are interested in estimating ß without bias. Since

$$\hat{\beta} = \frac{\sum r_t m_t}{\sum r_t^2} = \beta + \frac{(1/T)\sum r_t (v_t + h_t)}{1/T\left(\sum r_t^2\right)} \quad (4)$$

It follows

$$p\lim \hat{\beta} = \beta + \frac{p\lim\left[(1/T)\sum r_t (v_t + h_t)\right]}{p\lim\left[1/T\sum r_t^2\right]} \quad (5)$$

Since

$$\beta r_t + v_t + h_t = \alpha r_t + u_t \quad (6)$$

$$r = \frac{u_t - v_t - h_t}{\beta - \alpha} \quad (7)$$

It follows

$$p\lim\left[(1/T)\sum r_t (v_t + h_t)\right] = \text{cov}\left(r_t (v_t + h_t) = \frac{1}{\beta - \alpha}\left(\sigma_{uv} + \sigma_{uh} - \sigma_v^2 - \sigma_h^2 - 2\sigma_{vh}\right)\right) \quad (8)$$

and

$$p\lim\left[(1/T)\sum r_t^2\right] = \mathrm{var}(r_t) = \frac{1}{(\beta-\alpha)^2}\left(\sigma_v^2 + \sigma_h^2 + \sigma_v^2 + 2\sigma_{vh} - 2\sigma_{uh} - 2\sigma_{uv}\right) \tag{9}$$

Therefore

$$p\lim \hat{\beta} = \beta + (\beta-\alpha)\frac{\left(\sigma_{uv} + \sigma_{uh} - \sigma_v^2 - \sigma_h^2 - 2\sigma_{vh}\right)}{\left(\sigma_v^2 + \sigma_h^2 + \sigma_v^2 + 2\sigma_{vh} - 2\sigma_{uh} - 2\sigma_{uv}\right)} \tag{10}$$

ß is expected to be positive and α negative. Therefore the sign of the bias depends on the relationship between the variances and covariances. From the institutional structure of the Indian monetary sector, we can take cov ($u_t v_t$) = σ_{uv} to be zero, cov ($u_t h_t$) = σ_{uh} to be small and positive because of the limited accommodation of shocks to money demand. But cov ($v_t h_t$) = σ_{vh} will be large and negative, because of the monetary control policies adopted in India, where excessive rise in money supply was neutralized by a rise in statutory reserve requirements. With such a configuration of signs the bias will approach zero and the estimate of ß obtained will be consistent. The relationship between the variance covariances allows consistent estimation.

3. The Model and the Results

The variables gross domestic product in agriculture (GDPA), gross domestic product in non-agriculture[3] (GDPNA), wholesale price index for food (WPIF), wholesale price index for manufacturing (WPIM), the ratio of WPIF to WPIM (RFMWPI), call money rate (CMR), and the Bombay stock exchange index (BSEI), were regressed on M_3-H as the dependent variable. A double log formulation was used. The first set of regressions (I) were with yearly data for the period 1960-61 through 1991-92, giving 32 observations. BSEI was not included in this set as data on this variable were available only after 1980-81. The second set of regressions (II) used quarterly data over the period 1980-81 to 1992-93. To get around collinearity problems between the different price series, the quarterly regression (II) was run with BSEI and RFMWPI as the price variables. The number of observations were 52. With the quarterly data set binary correlations were obtained between the innovations in M_3-H and each of the other variables. The cointegrating vector and long-run regression were estimated. The variables were kept in level form, as the latter procedures correct for unit roots and time series structure.

If the equations estimate the behavioral response of banks, what are the expected values of the coefficients? The coefficient on CMR should be negative and that on income variables positive. A negative coefficient for CMR would also imply stability of the money market. The control of inflation has been a major objective of monetary policy. Before the nineties, Government expenditure had been cut in inflationary periods to reduce monetization of the deficit, and other direct measures taken restrict credit. If the Reserve Bank has been able to control credit expansion of banks, the coefficients on the price variables should be negative at least over the medium-run. But if credit responds to a demand led rise in profitability, the coefficients of the price variables would be positive. With rigid nominal interest rates, a rise in price would imply lower real interest rates that could stimulate investment or speculative demand. If such an effect is not observed, implicit interest rates, that take account of costs of credit rationing, must be rising in periods of inflation. Strongly positive coefficients on BSEI, gold or food grain prices indicate accommodation of demand for speculative credit. Price bubbles on these assets are sustained for some time, therefore banks make extra normal profits because of higher charges on and turnover of such loans. If structuralist-sectoral considerations are unimportant, the coefficients on agricultural and non-agricultural prices and outputs would be similar; otherwise sectoral relative prices and returns, normally neglected, should enter the money supply decision. If the equation is estimating demand for money the coefficient on BSEI would be negative; rising stock prices raise the opportunity cost of holding money.

PLACE TABLE 1 HERE

The results are presented in Tables 1-3. Table 2 reports the quantitative regression results. The regressions are corrected for serial correlations in the residuals. Table 1 gives the signs of the coefficients, for the yearly (I) and quarterly (II) regressions, and the contemporaneous correlations between innovations in the ARIMA residuals of M_3-H (the details of computation are in the Appendix), with the similar innovations for each of the explanatory variables used. This is also the column 0 in Table 3.

PLACE TABLE 2 HERE

Table 3 gives the lagged innovations in the ARIMA residuals of M_3-H with innovations in time zero for the ARIMA residuals of each of the other variables. These are bivariate correlations, but the results give additional information on the temporal structure of the monetary adjustment. The significance tests for the correlation coefficients are reported in brackets. With the number of degrees of freedom we have, any coefficient greater than 0.2 works out to be significant. Each variable has at least one significant correlation coefficient. As the correlations are calculated between the innovations in the ARIMA residuals for each series, they are not spurious correlations arising from trending time series. They are useful for understanding the relationships between the variables. The regression results in turn demonstrate that the correlations are not purely bivariate phenomena. They reflect aspects of the money supply process. Price series that included intermediate goods were also tried in lieu of WPIM and gave similar results.

PLACE TABLE 3 HERE

A cointegrating vector was obtained between the I(1) variables d(M_3-H), GDPNA, WPIF, WPIM and BSEI, where d is the difference operator. The cointegrating regression reported below gives evidence of a long-run relationship between the variables, and the other regressions and correlations fill up the picture of the relationships in the shorter periods. All of these results together give a well rounded interpretation of the money supply process in India. The number of observations was not sufficient to estimate an ECM relationship between all the variables. The coefficients of the equation given below are the cointegrating vector. Each of the coefficients were found to be significant (see the Appendix).

$$D(M_3\text{-}H) = -10.324\ WPIF - 53.44\ WPIM + 0.1009\ GDPNA - 1.0007\ BSEI$$

The adjustment coefficient vector alpha' is:

alpha' = (3.0181, -0.0027, -0.00008, 0.9042, -0.115)

We can interpret the adjustment coefficients as the speed of adjustment towards the estimated equilibrium state, such that a low co-efficient indicates slow adjustment and a high co-efficient indicates rapid adjustment.

The use of the structural variables gives very interesting insights, on the process of monetary adjustment in India. It turns out that bank credit responds more to price as compared to output variables; there is some flexibility in response to demand and profit opportunities available to banks.

The returns to an asset rise with its price[3] and provide a capital appreciation component that can stimulate a speculative bubble. In efficient capital markets bubbles should not arise, but real world capital markets, especially in developing countries, are not perfectly arbitraged or efficient. Therefore creditors have an incentive to feed a bubble. Such bubbles can explain the positive coefficients for WPIF, CMR and BSEI in Table 1. The coefficient for BSEI is high and significant in the quarterly regression (II). The coefficient of gold price was also positive in the yearly regression but was insignificant and therefore was dropped subsequently. Credit responds to demand created by these bubbles in asset prices.

Price variables also capture generalized inflation that with fixed nominal interest rates would reduce real interest rates and raise the demand for credit as physical investment rose. But the empirical results imply that bank credit is less accommodating in response to a rise in nonagricultural prices. The coefficient of WPIM is negative in the yearly regression; the correlation coefficient for WPIM is negative in the first quarter; summing up over all quarters it is lower than that for WPIF. Implicit interest rates facing industry rise in periods of tight liquidity. Banks have an incentive to expand credit in periods of rising WPIM. Their real cost of borrowing falls if the nominal CMR is held at its ceiling. If they do not do so, it is likely that they themselves face high effective interest rates, or restrictive credit policies.

There is a different pattern in the response of M_3-H to agricultural as compared to non-agricultural variables. Structuralist positions, that the relation between the two sectors is important for a developing economy, are therefore validated.

3.1 The Results

Let us systematically examine the results.

1. The response of M_3-H to quantity variables is less than that to price variables. On balance the correlations are positive with both GDPA and GDPNA. They are negative in some quarters. The positive coefficient for GDPNA reflects the rise in the demand for credit as incomes rise. In the yearly regression the coefficient of GDPA is negative. This reflects a fall in the demand for credit for stocking food grains in a year with a good harvest.

2. M_3-H rises with WPIF. Banks accommodate the demand for credit for holding food stocks, from private and public agencies.

3. The innovation correlations of M_3-H with WPIM are positive but less than those for WPIF. The coefficients in the quarterly regressions are positive but that in the yearly regression is negative (and significant at the ten percent level). This indicates a tightening in RBI monetary policy responding to a rise in manufacturing prices. A sequence consistent with the correlations is: an adverse agricultural shock is accommodated by a rise in money supply, but as the shock spreads to industry and stagflation occurs the demand for credit falls, with some help from tight money policies.

4. There has been a heated debate in India on the agricultural terms of trade. In order to comment on this, and to further elucidate the hypothesis made in 3, we compute innovation correlations for RFMWPI. That is, the ratio of the wholesale prices of food to those of manufacturing. The correlations with M_3-H are positive but low. Two conclusions arise. First, the two prices move together. Otherwise the variation in relative prices would be closer to that of the nominal prices. Even if monetary policy targets manufacturing prices, it is not able to cause a large deviation in the equilibrium relation between the two prices. Second, the periods when RFMWPI is rising are periods of moderate expansion in M_3-H, lower than those of the individual price variables. These observations are consistent if a sharp inflation in food prices, causes manufacturing prices to rise even more. That is, in periods of high industrial growth, mark-ups fall and productivity rises, so that the relative terms of trade are turning in favor of agriculture. Nominal agricultural prices would then be growing below trend. At the same time speculative demand for credit could be low as there would be no positive bubbles in financial asset prices, with physical investment being the more attractive

option. The expansion in M_3-H would then be moderate. These are the predictions of the models developed in Goyal (1994, 1995).

5. The positive correlation of M_3-H is highest with BSEI, positive for the first three quarters, and positive in the quarterly regression (II), reflecting strong accommodation of demand arising from booming stock markets.

6. The quarterly regression coefficients are all positive. So are the sums of the correlations for the four quarters. Some of the coefficients of the long-run regression are negative, however. The dominant negative coefficients in the cointegrating regression, show that the change in M_3-H is decelerating, so that a stable long-run relationship exists between the variables.

7. The regression coefficients satisfy expected values for a money supply function. Significant correlation coefficients are lower for the past indicating that on balance it is M_3-H that responds to other variables. Granger causality tests also support such a conclusion (Appendix). For the true causality structure all the significant variables must be included, but in bivariate regressions (not reported) of the innovations of each of the variables on lagged values of themselves and M3-H, the only variable innovations that M3-H did influence were GDPNA and BSEI. The conclusion follows that bank credit does impact on real sector performance and on speculative cycles.

8. Banks have been able to expand credit in line with profitability, even in a controlled regime. But profitability seems to have risen most with speculative demand fuelled by asset prices. Rise in bank credit in response to output growth or fall in real interest rates (rise in WPIM) has been moderate. Controls and selective credit policies, seem to have successfully targeted inflation in manufacturing prices. Credit expansion has more flexibly responded to agricultural price inflation -- partly because government food procuring and stocking agencies generate a large demand for credit.

Mechanisms for the control of the money supply have not been effective in preventing an expansion of credit in response to speculative demand. The high coefficients of some price variables demonstrate this. There is a very high positive correlation of M_3-H with BSEI and CMR; and a positive correlation with WPIF. When the profitability of lending becomes very high controls become ineffective. The positive coefficient for the CMR indicates that rather than reflecting the cost of borrowing for banks, it reflects high earning opportunities. It may be capturing the effect of other interest rates the data for which is not available. The money market is stable, because the positive coefficient for CMR is small in the correlations, insignificant in the quarterly regressions, and does has a negative value in many quarters. The qualification that the CMR has been on its ceiling since 1985, should be kept in mind in interpreting these results.

The small response of M_3-H to nominal output variables, indicates successful post-facto nominal income targeting by the RBI. Monetary control has been strong enough to prevent inflationary expectations from really setting in. Even so, the short-run and sectoral effects of monetary policy have been less than satisfactory. Restraints on money growth seem to bite in periods of industrial stagflation and perhaps deepen the latter[4]. The systematic pattern of the coefficients suggests that more satisfactory short-run monetary policy targeting rules can be developed. There is an efficiency gain to be had by taking account of the structure of the Indian economy.

3.2 Interpreting History

We illustrate the formal argument by referring to monetary/fiscal responses to specific shocks. Can our model help to interpret history? The drought and terms of trade shocks over 1965-67, led to a fiscal tightening, with a cut in budget deficits and public investment. Monetary policy was non-accommodating but not severe. Fiscal and monetary policy were closely linked, as the budget deficit was automatically financed. The oil price plus agricultural supply shock over 1973-75 lead to a similar response. In both cases there was an unnecessary loss of output. A greater reliance should have been placed on food supply policies. The lesson was learnt by the 1979-80 crisis. There was no cut in public investment, no long-term adverse effects on output, and a rapid recovery. Monetary policy seems to have a delayed response. Money supply was decreased only in mid 1979 and in mid 1973, with specially severe measures undertaken in 1974. In both cases inflation was well under way. The policy measures were jerky because of the reliance on quantitative controls. They were successful, however, in preventing the build up of inflationary expectations. Our empirical analysis is picking up both this delayed response and the overall control. Although there was a steady rise in the fiscal deficit from the mid-seventies, the rise in money supply was much lower, testifying to successful control. This was helped by the long-term fall in the velocity of broad money as financial deepening took place (see Joshi and Little 1994).

The lessons of history were forgotten in the nineties. The response to the balance of payments crisis included a cut in public investment, an artificial agricultural supply shock as procurement prices for food grains were raised, and a monetary tightening to sterilize capital inflows. The structural reforms were necessary, but their macroeconomic counterparts made it more difficult for them to succeed. It is sometimes argued that while short-run sharp inflation in India is caused by supply shocks, a rising trend rate of inflation is due to fiscal and monetary laxness. The revenue deficit does need to be decreased but our analysis suggests that short-term monetary shocks may be worsening stagflation, and leading to secular low growth and high inflation.

Our data period covers the imposition of a ban on indigenous liquidity generating mechanisms such as badla[5] and repurchase options by banks. The ban was imposed after the stock market scam in 1992, because the scam although based on insider trading, included misuse of repurchase options. In 1995 bridge loans from banks to finance corporations were also banned. A severe credit crunch followed, with nominal interest rates on gilts rising as high as 14 percent. Capital inflows, large by Indian standards, started in 1994, but were largely sterilized. Purchase of rupees to prevent a threatened depreciation of the rupee in 1995 further squeezed liquidity. Real loan rates of interest rose above 22% and were partly responsible for a slowdown in industrial growth. Even as liquidity rose credit to industry did not rise because demand was low and new regulations made lending to industry more risky. Again monetary policy was targeting industrial inflation and damaging output growth.

In the seventies the RBI had relied on credit controls on banks, but found these ineffective because banks managed to take advantage of loopholes in the definition of deposits or credit, to use cash credit, and mobilize non-deposit resources. With the acceptance of the money multiplier approach, the RBI then moved towards closer monitoring of reserve requirements. But these are also blunt instruments. Controls either do damage by preventing flexible adjustment to shocks, or just serve to stimulate ingenuity in discovering loopholes. Self-enforcing mechanisms that enhance market incentives to direct credit in desirable directions are preferable. Examples are raising the attractiveness of physical investment and imposing taxes on short-term capital gains to curb speculative lending. Prudential norms and computerized transactions can prevent a repetition in the misuse of repurchase options. Endogenous liquidity generation allows money markets to function smoothly and should not, and in the long-run, cannot be destroyed. Attempts to do so are inconsistent with the stated policy objectives of deepening money markets and moving towards open market operations as the method of monetary control. But more flexibility needs to be combined with policies that raise returns to productive as compared to speculative loans.

Base money was endogenized by the automatic financing of the budget deficit but the link will be weakened by the financial reforms started in 1991. First limits were set on ad hoc treasury bills. In 1997 they were abolished, and temporary shortfalls in liquidity with the government were to be met by negotiable ways and means advances, thus granting more autonomy to the RBI.

Yet the endogeneity of base money is likely to increase, as the economy becomes more open. With an exchange rate managed to maintain export competitiveness, monetary policy becomes less effective, and interest rates have to be linked to world rates.

Banks have demonstrated their ability to circumvent controls to satisfy the profit motive. Financial reforms will enhance this ability, but it can be constructive if these incentives push banks in desirable directions. This can happen if it is profits from lending to industry that rise. Interventions can be fine tuned as the Reserve Bank moves from the blunt instrument of compulsory reserve requirement to open market operations, but knowledge of the structure of past responses should be used to improve targeting and attainment of the ultimate objectives of low inflation and high growth. Monetary tightening should not coincide with a rise in manufacturing prices.

4. Conclusion

Indian bank credit is shown to have responded to demand for speculative credit. Responses to food and non-food price and output are dissimilar. Monetary policy has succeeded in preventing explosive growth in money supply but it has targeted non-food prices. It would be more efficient to target agricultural prices for inflation control. The overall rate of growth of the monetary base was adequate, but its timing can be improved if a contraction of base money is completed earlier than it has been in the past, and coincides with a rise in food prices. Details of such a targeting rule can easily be worked out. Information available in the systematic structural features of the Indian economy can be exploited in designing monetary policy.

Whenever incentives to expand credit were high enough banks found ways around a variety of quantitative controls. Price bubbles in assets that lead to expansions in broad money, can better be controlled through a combination of the carrot and the stick, working through the market. The carrot could be raising incentives for productive investment; the stick, taxes and regulation.

Credit turns out to be the endogenous outcome of incentives facing agents. But in our data set, as interest rates were imperfectly flexible, these incentives were carried by a range of price variables. There was also evidence that Reserve Bank monetary control had intensified shocks to real output, while being unable to prevent the expansion of credit in response to a speculative profit motive.

Appendix

"Microfit 386" was used to test for the order of integration. Next, ARIMA processes were identified by applying the law of parsimony to the significant ARIMA equations. In the case of choice between AR and MA process, the latter was chosen. The model does not have a good fit for GDPA, as the Q statistic is not satisfactory. The results are given below:

Variables	ARIMA processes (AR I MA)
M_3-H	(1 2 0)
GDPA	(1 0 0)
GDPNA	(3 1 0)
WPIF	(1 1 0)
WPIM	(0 1 1)
CMR	(1 1 1)
BSEI	(0 1 1)
RFMWPI	(0 1 1)

PLACE TABLE 4 HERE

Table 4 gives the diagnostic tests for the order of integration. The estimated equations follow. The difference operator is d.

$dd(M_3\text{-}H) = -0.72937\, dd(M_3 - H)(-1)$

$GDPA = -0.07879\, GDPA(-1)$

$dDGDPNA = -0.92015\, dGDPNA(-1) - 0.66114\, dGDPNA(-2) - 0.71032\, dGDPNA(-3)$

$dWPIF = -0.081596\, dWPIF(-1)$

$dWPIM = -0.47701\, e(-1)$

$dCMR = -0.51574\, dCMR(-1) + 0.35550\, e(-1)$

$dBSEI = 0.29801\, e(-1)$

$dRFMWPI = 0.32155\, e(-1)$

The identified ARIMA processes were estimated for each variable and the residuals obtained. The residuals are called innovations. In the last step we calculated the correlations at lags +3 to -3 between the various innovations and the innovations in M_3-H.

Since these innovations are stationary series, we can use them to determine the direction of Granger causality. The idea of Granger causality is simple. It develops the statistical implications of the fact that the future cannot cause the past. In the case of two stationary variables X and M3-H, consider the regression of X on a number of lags of itself and on a number of lags of M3-H. These variables are stationary because they are innovations of our variables, where X is a vector referring to all our exogenous variables. If the lagged values of M3-H are not statistically significant in explaining X, the null hypothesis that M3-H does not cause X could not be rejected. But a cautionary note is in order: instantaneous causality only describes a non zero correlation between the joint distributions of two sets of random variables. A Granger causality analysis only indicates that a set of variables contains useful information for improving the predictions of another set of variables.

To test the causality we first regress innovations in M3-H on lags of itself and on all the lagged variables (Table 5). The lag length chosen is two. No lag was statistically significant beyond two. This establishes that innovations in our variables do contain useful information to improve the predictions of M3-H. In particular, innovations WPIM, CMR and BSEI cause innovations in M3-H.

PLACE TABLE 5 HERE

To determine whether innovations in M3-H cause innovations in other variables, we examine the VAR representation of the system. We partition the variables in two blocks, one contains only innovations in M3-H and other innovations in all other variables. We found that coefficients of innovations in M3-H in all the equations are statistically insignificant: innovations in M3-H do not cause innovations in all other variables. The coefficients for M3-H were all zeros, except for -0.002 in the equation with WPIF as the dependent variable.

Next we turn to the long-run relationship among the variables. The long-run relationship between a number of series can be looked at from the viewpoint of cointegration. Let x_t be a vector of 5 component time series. In our analysis

x_t = f(D(M_3-H), GDPNA, WPIF, WPIM, BSEI)

are each integrated of order one. Then x_t is said to be cointegrated if there exists a vector such that

$s_t = a'x_t$

is I(0). Stationarity of s_t implies that the n-variables do not drift away from one another over the long-run, thus obeying an equilibrium relationship. The Engle and Granger (1987) approach can deal with the possibility of one linear combination of variables that is stationary, but in practice, when there are more than two variables in a multivariate setting, more than one stable linear combination can exist. The more cointegrating vectors there are, the more stable the system. Johansen and Juselius (1990) have developed a maximum likelihood testing procedure on a number of cointegrating vectors.

Statistical tests giving the evidence for the number of cointegrating vectors using the variables specified in the x_t vector are reported in Table 4. The statistics confirm the rejection of no cointegrating in favor of one cointegrating vector at the 90% confidence level. Both the trace and maximum eigenvalue tests suggest the acceptance of the hypothesis of one cointegrating vector. There was a ceiling on the CMR for much of the period, and it was not very significant in the regressions, so it has not been used in the cointegration analysis.

PLACE TABLE 6 HERE

We tested the significance of the coefficients of the cointegrating vector found by consecutively putting each of the coefficients equal to zero and keeping all other coefficients the same. The Chi-Square statistics are:

Variable	Chi-Square Values
GDPNA	14.6765 (.005)
WPIF	22.2373 (.000)
WPIM	22.0116 (.000)
BSEI	22.2818 (.000)

The bracketed values are the probability that the critical values are greater than the reported values. All of our co-efficients are significant.

Data Sources

M3, H, CMR, and gold prices were collected from the Report on Currency and Finance (RBI), 1980-81 through 1992-93; WPIF, WPIM from RBI Bulletins; annual data on GDP agriculture and GDP non agriculture from the Economic Survey 1992-93. An RBI mimeo on Quarterly estimates of GDP: 1970-71 to 1990-91 (R. K. Das) provided quarterly data on output variables. This paper gives the series up to 1990-91. For the period after that the series were extrapolated keeping the share of different quarters constant. Data on BSEI were collected from the Bombay Stock Exchange.

Footnotes

1. A more recent macromodel that can be classified as structuralist is Krishnamurthy and Pandit (1985). Ahluwalia (1979), and Rangarajan and Arif (1990) are in a more monetarist vein.

2. See the results reported in the Chakravarty Committee Report (RBI 1985). At his convocation address at IGIDR in 1995 the then RBI Governor, Rangarajan, reiterated this view.

3. GDPA and GDPNA are measured in current prices.

4. Returns to an asset rise with its price, provided real returns are not affected. But, from the Fisher equation, if the nominal rate of interest is fixed, the real rate of interest will fall with expected inflation.

5. Joshi and Little (1994) argue that in the presence of significant short-run variability in money demand and the money multiplier, and information and implementation lags, Indian monetary policy has been overactive in response to exogenous shocks. We make a slightly different point. Information available in the systematic structural features of the Indian economy has not been exploited in designing monetary policy.

6. Badla is an indigenous system that was used to carry settlements in the share markets over to the next period.

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Table 1: Qualitative Results of Regressions with M_3-H as the Dependent Variable.

Variables:	Yearly	Quarterly (I)	Correlation	Quarterly (II)
CONS	-	-ve	-	-ve (insig)
GP	+ve (insig)	-	-	-
CMR	+ve	+ve (insig)	-ve	+ve (insig)
GDPA	-ve	+ve (insig)	-ve	+ve (insig)
GDPNA	+ve	+ve	+ve	+ve
WPIF	+ve	+ve	-ve	-
WPIM	-ve (insig)	+ve	-ve	-
BSEI	-	-ve (insig)	+ve	+ve
RFMWPI	-	-	+ve	+ve

Table 2: Quantitative Results of Regressions with M_3-H as the Dependent Variable.

Variables:	Yearly	Quarterly (I)	Quarterly (II)
CONS	-	-2.192 (-3.42)	-1.887 (-1.48)
GP	.196 (0.84)	-	-
CMR	1.240 (4.75)	.033 (0.86)	.018 (0.24)
GDPA	-1.994 (-3.89)	.031 (1.55)	.028 (0.70)
GDPNA	2.072 (3.73)	.087 (4.92)	1.021 (7.31)
WPIF	2.368 (2.89)	.792 (5.07)	-
WPIM	-1.532 (-1.41)	1.016 (5.70)	-
BSEI	-	-.024 (0.55)	.405 (8.84)
RFMWPI	-	-	.165 (0.56)
	R^2 (adjusted)	R^2 (adjusted)	R^2 (adjusted)
	.990	.989	.960

*Figures in the bracket are t-ratios

Table 3: Comovement in (M_3-H) and Nominal Variables: Correlations Between Innovations from ARIMA Processes.

Innovations at time 0 in:	Innovation in (**M_3-H**) at time:						
	-3	-2	-1	0	+1	+2	+3
GDPA	.119	-.203	.096	-.040	.161	-.216	.150
	(0.81)	(-1.42)	(0.66)	(-0.27)	(1.12)	(-1.51)	(1.03)
GDPNA	.043	.074	-.251	.260	.014	-.317	.216
	(0.28)	(0.49)	(-1.74)	(1.83)	(0.09)	(-2.22)	(1.45)
WPIF	-.047	-.012	.134	-.026	.020	.076	.215
	(-0.32)	(-0.08)	(0.93)	(-0.18)	(0.14)	(0.52)	(1.48)
WPIM	-.080	.141	-.027	-.097	.158	.202	-.009
	(-0.54)	(0.98)	(-0.19)	(-0.67)	(1.10)	(1.41)	(-0.06)
CMR	.334	.045	-.121	.325	-.052	-.133	-.006
	(2.38)	(0.31)	(-0.84)	(2.36)	(-0.36)	(-0.91)	(-0.04)
BSEI	-.031	-.317	.127	.363	.008	.044	-.005
	(-0.21)	(-2.29)	(0.88)	(2.67)	(0.05)	(0.30)	(-0.03)
RFMWPI	.039	.001	.010	.016	-.035	-.081	.231
	(0.26)	(0.006)	(0.07)	(0.11)	(-0.24)	(-0.56)	(1.61)

The values in brackets are t statistics, the formula used for calculating these is:

$t_{n-2} = r(n-2)^{0.5} / (1-r^2)^{0.5}$

Table: 4 Calculated Values of T(b-1) for the Dickey-Fuller Test Based on Estimated OLS Autoregressive Coefficient

Name of Variable	Level	First Difference	Second Difference	Degree of Integration
M3-H	2.16	-10.85	-84.73	I(2)
GDPA	-74.02			I(0)
GDPNA	0.43	-50.57		I(1)
WPIF	-8.76	-54.03		I(1)
WPIM	1.05	-54.03		I(1)
CMR	-3.09	-84.15		I(1)
BSEI	-10.36	-69.24		I(1)
RFMWPI	-14.92*	-65.65		I(1)

The critical values are -12.9 except for the * superscript. In this case, it is 19.8. The critical values are taken from Table B.5 of Hamilton.

Table 5: Results from Causality Test

Name of the Variables	Estimated Coefficients	T-Statistics
Constant	46.74	0.28
LM3-H	-0.06	-0.41
LLM3-H	-0.67*	-5.40
LGDPA	-0.01	-0.75
LLGDPA	-0.002	-0.14
LGDPNA	-0.08	-0.60
LLGDPNA	0.17	1.28
LWPIF	-32.94	-1.30
LLWPIF	2.01	0.08
LWPIM	64.20*	2.13
LLWPM	-21.56	-0.58
LCMR	-234.33*	-2.22
LLCMR	252.43*	2.35
LBSEI	4.07*	3.21
LLBSEI	-20.11**	-1.89

Note: The figure with * is strongly significant and with ** are weakly significant.

Table 6: Critical Values for Tests of the Number of Cointegrating Vectors

Null	Alternative	LMAX	Critical Value (90%)	LTRACE	Critical Value (90%)
r=0	r=1	32.82	30.90	70.72	64.84
r<=1	r=2	17.79	24.73	37.90	43.95
r<=2	r=3	12.12	18.60	20.11	26.78
r<=3	r=4	7.99	12.07	7.99	13.32
r<=4	r=5	.00	2.69	.00	2.69