Financial Liberalisation in India and a New Test of the Complementarity Hypothesis

by

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Abstract

This paper reappraises the financial repression hypothesis for India in the light of the partial liberalisation of the financial sector in the early 1990s, using for the first time, state-of-art multivariate cointegration and vector error correction models (VECM). From this robust test we find that for the Indian economy over the sample period 1951-1999 money and capital are complementary, suggesting that higher real interest rates will raise the demand for money and lead to higher levels of investment. Furthermore, testing for a structural break in the early 1990s – to coincide with the liberalisation of the financial sector in India – suggests that these reforms have not significantly changed the complementary relationship between money and capital. The policy implication is that further financial liberalisation is required in India, to enhance investment and economic growth.

Keywords: complementarity, cointegration, VECM, investment, demand for money, real interest rates, India.

JEL Classification No. O11, O57

I. Introduction

Since the seminal work of McKinnon (1973) and Shaw (1973) there have been a number of tests of the complementarity hypothesis between physical capital and money. The complementarity hypothesis is a joint hypothesis whereby the demand for real money balances depends directly, *inter alia*, on the average, real return on capital and the investment ratio rises with the real deposit rate of interest. For there to be strict complementarity between investment and money balances both legs of this joint hypothesis must hold. The empirical literature to date, however, has focused almost exclusively on the estimation of either a single investment equation (for example, DeMelo and Tybout, 1986; Edwards, 1988; Morriset, 1993) or a single demand for money function (for example, Harris, 1979; Thornton and Poudyal, 1990). These empirical findings are therefore likely to be subject to simultaneous equation bias as either the demand for money relation or the investment relation is disregarded in the estimation process. On the other hand, although the estimates of Fry (1978), Laumas (1990), and Thornton (1990) avoid simultaneous equation bias by using the two-stage least squares method, they do not estimate the model as a system and do not therefore explicitly test both legs of the complementarity hypothesis. Most recently Khan and Hasan (1998) have tested the complementarity hypothesis by estimating both savings and demand for money functions for Pakistan using single equation cointegration methods. Their results suggest evidence of complementary between money and capital, but these findings are not robust because single equation methods ignore the interdependence between the investment (savings) leg and the money leg of the joint hypothesis. Furthermore the assumption that the explanatory variables are exogenous is not tested and hence to the extent that they are also endogenous the estimated coefficients are not unbiased.

There are two principal contribution of this paper. The first is to use the multivariate cointegration and vector error correction methodology (VECM) to simultaneously identify the money demand and investment demand equations for India, through tests of over-identifying restrictions and thereby provide a complete (joint) test of both legs of McKinnon's complementarity hypothesis. The second contribution is to examine the case of India in some detail, with particular reference to the liberalising financial reforms of the early 1990s, since with the exception of Laumas (1990) and Thornton (1990) which pre-date the reform period, the complementarity hypothesis has not been extensively tested for India.

Before 1990 the banking sector was subject to a range of regulations and controls including the cash reserve ratio and statutory liquidity ratio. Moreover, when the major commercial banks were nationalised in 1969, the government stipulated that bank lending to priority sectors including agriculture and small industry and business was to be given priority, and about 40 per cent of available bank funds (net of cash and liquid assets) have been allocated to these sectors. Loans to the government and priority sectors were made at concessional rates of interest, but higher lending rates were imposed on medium and large-scale enterprises. This policy suggests that the role of interest rates as a resource allocation mechanism has been distorted.

On the liability side, banks' deposit rates have been subject to ceilings and real deposit rates have been negative (averaging –0.24 per cent over the sample period), thus limiting the scope for obtaining funds from the private sector. This regime affected bank profitability and led to an inadequate provision of credit to sectors, which were not protected by the priority sector lending requirements. The repressed credit market and the underdeveloped capital markets have impeded the efficient allocation of resources and forced enterprises to reply on internal sources of finance.

McKinnon's complementarity demand for money hypothesis is specifically designed for developing economies where self-finance is predominant with repressed financial markets. As Laumus (1990) argues, the McKinnon's hypothesis deals with the effect of financial liberalization on the accumulation of capital formation, hence economic growth, through a policy of higher real deposit rates. The analysis of the complementarity hypothesis is therefore likely to be important for India.

The currently ongoing financial sector reforms (started in the early 1990's) aim at the de-regulation of the financial system, including the liberalization of interest rates, reducing credit controls, the development of the government securities' market, enhancing competition and efficiency in the nationalized commercial banks by lowering reserve requirements, introducing financial innovations and relaxing regulations. The interest rate liberalization policy is, *inter alia,* central to this study. The gradual de-regulation of the deposit rate is explicit in the financial reform programme with the view to increasing funds available for investment opportunities.

To the extent that this liberalisation policy has been effective is tested in this paper by a series of structural break tests. The conclusion is that the liberalisation of deposits rates has still to have a major impact on investment and money demand relations in India. Thus financial repression is still prevalent and further liberalisation measures required to raise the level of investment and economic growth.

The structure of the rest of this paper is as follows. In Section 2 the complementarity hypothesis is specified and related to the macroeconomic structure of the Indian economy. Section 3 examines the econometric methodology and the data set employed; Section 4 reports and analyses the extensive empirical results and Section 5 concludes.

II. The Complementarity Hypothesis

The complementarity hypothesis of McKinnon (1973) states that money and real capital assets are complements in developing economies because in the absence of deep financial markets and extensive financial intermediation, money balances have to be accumulated before relatively costly and indivisible investment projects can be undertaken. This hypothesis implies that the demand for real money balances (*M/P*) depends positively upon real income, *Y*, the own real rate of interest on bank deposits, *R*, and the real average return on capital, *r*. Critically, the positive association between the average real return on capital and the demand for money balances represents the complementarity between capital and money. This, however, is only one leg of the complementarity hypothesis. According to McKinnon, the investment to income ratio, *I/Y*, must also be positively related, *inter alia*, to the real rate of return on money balances. This is because if a rise in the real return on bank deposits, *R*, raises the demand for money, and real money balances are complementary to investment, it must also lead to a rise in the investment ratio. The complementarity hypothesis therefore postulates demand for money and demand for investment functions as follows:

$$M/P = L(Y, r, R) \qquad L_Y > 0,\ L_r > 0,\ L_R > 0 \qquad (1)$$

$$I/Y = F(r, R) \qquad F_r > 0,\ F_R > 0 \qquad (2)$$

where equation (1) is the real money demand function, equation (2) is the investment function and the partial derivatives of (1) and (2) are all expected to be positive. The complementarity hypothesis specifically requires that *both* $L_r > 0$ and $F_R > 0$.

Note that this hypothesis is in contrast to the neo-classical approach which postulates that money and capital are substitutes, in which case $L_r < 0$ and $F_R < 0$. Hence a rise in *r* raises the demands for capital goods, but reduces the demand for money as economic agents switch demand to the relatively higher yielding real capital assets. Similarly, a rise in the real yield on money balances, *R*, raises the demand for money, but reduces the demand for real capital assets, whose relative real return has fallen.

Drawing on Pentecost and Ramlogan (2000), the link between the two legs of the hypothesis and the assumptions invoked to test the model, can be demonstrated from the goods and money market equilibrium relations. The goods market equilibrium is given as:

$$S - I = G - T + CAB \qquad (3)$$

where *S* is private sector savings, *I* is investment, *G* is government spending, *T* is total tax revenue and *CAB* is the current account balance of payments. The money market equilibrium is written as:

$$DC + F = M = P.L(Y, r, R) \qquad (4)$$

where *DC* is domestic credit, *F* is the stock of foreign exchange reserves held by the central bank and *P* is the aggregate price level. If there is no international mobility of capital, so that $\Delta F \cong CAB$ and it is assumed that the government's budget is balanced, then combining these equations gives:

$$S - I(r, R) = \Delta L(.) - \Delta(DC / P) \qquad (5)$$

This says that the excess supply of non-bank private sector savings is identically equal to the flow excess demand for real money balances. Thus stock equilibrium, defined when there is money market equilibrium, implies that $S = I$ and simultaneously $M / P = L$, thus justifying the proposed model.

From an empirical perspective the main problem with the complementarity hypothesis is the inability to compute a sensible measure of the real return on capital in developing economies. McKinnon (1973) suggested that the real return on capital could be replaced by the investment to income ratio, *I/Y*, which is expected to vary directly with the average real return on capital. Furthermore, in McKinnon's initial model it is assumed that agents are unable to borrow to undertake investment and so have to save up before they can buy expensive, indivisible capital equipment. To the extent, however, that financial liberalisation gradually occurs and credit becomes available to businesses, investment may rise without a prior increase in money savings. In this scenario the availability of credit to domestic residents will lead to a rise in the investment ratio independently of money demand. This credit channel may be of some importance in the case of India, especially since the early 1990s when the authorities lifted interest rate deposit ceilings and began to encourage the liberalisation of the financial sector. The modified model now becomes:

$$M / P = L(Y, I / Y, R) \qquad L_Y > 0, L_{I/Y} > 0, L_R > 0 \qquad (6)$$

$$I / Y = G(DC / Y, R) \qquad G_{DC/Y} > 0, G_R > 0 \qquad (7)$$

where *DC/Y* is the ratio of domestic credit to income. The complementarity hypothesis now implies both $L_{I/Y} > 0$ and $G_R > 0$. This is the model tested in the next two sections of this paper.

III. The Empirical Methodology

The estimation strategy is to estimate the demand for money and investment ratio equations simultaneously as a system. This is implemented by employing the multivariate cointegration approach of Johansen (1988). In this case a VAR(*p*) can be re-parameterised as:

$$\Delta X_t = \Gamma_0 + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \cdots + \Gamma_{p-1} \Delta X_{t-p} + \Pi X_{t-1} + \varepsilon_t \qquad (8)$$

where $X_t = [m, i, y, d, R]'$ and lower case letters denote the logarithms of the associated variables in Section 2, such that $\log(M/P) = m$, $\log(I/Y) = i$, $\log(DC/Y) = d$ and $\log Y = y$. *X* is a 5 x 1 vector of variables that are integrated of order one, denoted I(1); Γ is a 5 x 5 matrix of coefficients and ε_t is a vector of normally and independently distributed error terms. The presence of *r* cointegrating vectors between the elements of *X*, implies that Π is of rank *r* (0<*r*<5) and that Π can be decomposed as: $\Pi = \alpha\beta'$, where α and β are both 5x *r* vectors and (8) can be re-written as:

$$\Delta X_t = \Gamma_0 + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \cdots + \Gamma_{p-1} \Delta X_{t-p+1} + \alpha(\beta' X_{t-1}) + \varepsilon_t \qquad (9)$$

The rows of β are interpreted as the distinct cointegrating vectors such that $\beta' X_t$ form linear stationary processes and the α's are the error correction coefficients.

The problem with the system (9) is that the β's are unrestricted and thus cannot identify typical long-run economic relationships. Each vector requires at least *r* restrictions, one of which is the normalisation restriction. These normalisation restrictions must be motivated by economic theory so that the identified cointegrating vectors can be interpreted as long-run economic relationships. In this context two cointegrating vectors are expected – one denoting the demand for real money balances and the other the investment function – so the β vector will be of dimension 5x2 and have the general form:

$$\beta^1 = \begin{bmatrix} 1 & \beta_{12}^1 \\ \beta_{21}^1 & 1 \\ \beta_{31}^1 & \beta_{32}^1 \\ \beta_{41}^1 & \beta_{42}^1 \\ \beta_{51}^1 & \beta_{52}^1 \end{bmatrix}, \qquad \beta^2 = \begin{bmatrix} 1 & \beta_{12}^2 \\ \beta_{21}^2 & 1 \\ \beta_{31}^2 & \beta_{32}^2 \\ \beta_{41}^2 & \beta_{42}^2 \\ \beta_{51}^2 & \beta_{52}^2 \end{bmatrix}$$

It may, of course, be possible to further restrict the β-matrix if the some of the variables do not influence the normalised variable. For example, if the first vector is the demand for real money balances and this is independent of the level of domestic credit, then the relevant β^1, β_{41}^1 will be zero. All such identifying restrictions can be tested and need not be zero or unit restrictions.

The data set used to estimate the system is annual data for India covering the period 1951 to 1999 (49 observations). The time series for broad money (money and time deposits), nominal GDP, gross fixed capital formation and domestic credit are taken from International Financial Statistics. The consumer price index is used as the deflator since the GDP deflator is not available for the whole sample period. The bank deposit rate for 1 to 3 years is taken from the Statistical Abstract of the India Union for 1951-70 and the Handbook of Statistics on the Indian Economy for 1971-

1999. The plots of the dependent variables, the real money and investment to income ratio are found in Appendix.

IV. Estimation and Results

This section starts with the unit root tests, and the Johansen cointegration test, then the unrestricted normalised cointegration vectors are presented. The weak exogeneity test is carried out to identify two cointegrating vectors, one for the demand for money and another for the investment income ratio. The restricted cointegration vectors are then presented and finally, the short-run dynamics using the vector error correction model (VECM) are reported.

The unit root tests using the augmented Dickey-Fuller (ADF) test are shown in Table 1. The results indicate that all the variables are non-stationary in levels and stationary in first differences; that is, they are integrated of order one, I(1).

According to the Johansen cointegration test, reported in Table 2, the maximum eigenvalue test result suggests that there are two cointegrating vectors, whereas the trace test indicates that there are three cointegrating vectors. Since the power of the trace test is lower than the maximum eigenvalue test (Johansen and Juselius, 1990) and, if there are deterministic variables in the model the critical values of the trace test are only indicative, it is therefore reasonable to conclude that there are two cointegrating vectors. The two cointegrating vectors may be identified as the demand for money and investment ratio equations.

The unrestricted normalised cointegrating vectors are reported in Table 3. According to the results, the first vector reading across the rows in Table 3(a) seems to be identified as the demand for money with a positive effect from the investment ratio, real income and the real deposit rate. The second vector may be interpreted as an investment equation, with a positive effect from the domestic credit ratio. These positive coefficients are consistent with the complementarity hypothesis set out in Section 2. The speed of adjustment coefficients, which indicate the average speed of adjustment towards the estimated equilibrium, corresponding to the cointegrating vectors are shown in Table 3(b). Restrictions on the speed of the adjustment coefficients indicate whether the variables in the system are weakly exogenous. If some variables are weakly exogenous, it means that there is no loss of information from not modelling the determinants of these variables and they can enter on the right hand side of the VECM in the short-run. It is argued that conditioning the system might be very useful for interpreting the empirical results (Hendry and Doornick, 1994).

The weak exogeneity test is conducted by the likelihood ratio (LR) test, and the results are given in Table 4. The LR test is, however, known to be too large in small samples, hence the small sample-adjusted (SSLR) test is also carried out. This is given as the product of the LR statistic and $(T-K)/T$, where T is the number of observations and K is the number of regressors in each equation[1]. The domestic credit to income ratio and the real rate of interest on bank deposits are found to be weakly exogenous in both cointegrating vectors according to the LR test. Real income is also weakly exogenous in the second cointegrating equation, according to the SSLR test. The weak exogeneity test results imply that there is no loss of information from not modelling y, d and R in the VECM.

With two cointegrating vectors, two exactly-identifying restrictions are imposed on the cointegration relations based on *a priori* economic theory. According to equation (6) the domestic credit to income ratio should have a zero coefficient imposed in the first cointegrating vector, which represents the demand for money. In the second cointegrating equation, which is the investment equation, two zero restrictions need to be imposed on theoretical grounds from equation (7), on real income and real money balances. These over-identifying restrictions are consistent with the data, and thus not rejected by the LR test given a χ^2 statistic of 1.287 (critical value 3.84 at the 5 per cent level). Jointly applying the restrictions on the adjustment coefficients and cointegration relations, the long-run relations are obtained.

The restricted cointegrating vectors are further analysed by examining their structural stability. This is important for India, where there were large institutional changes in the financial markets around 1990 due to financial liberalisation. To test for structural breaks, the Chow test is implemented by using the dummy variable approach and potential breakpoints, in particular focusing on the period of financial reforms from 1985 to 1995. In Table 5, the breakpoint refers to the point at which the sample is split in order to define the dummies. The F-statistics for the demand for money and investment equations are statistically insignificant and indicate the absence of parameter instability. Thus there appears to be no evidence of a structural shift in either equation[2].

The finding of stability is consistent with the recent empirical literature on the conventional demand for money, which shows the existence of stable demand for money despite financial deregulation and innovation in India (see Sen and Vaidya 1997, Pradhan and Subramaninan 2003 and Moore et al. 2005). A related explanation is suggested by Sen and Vaidya (1997), who argued that although there was a proliferation of new assets that were close to time deposits, there was little change in payments technology. Financial liberalisation has not developed the property of the demand for money as a medium of exchange for India. This may be reflected in the stability in money demand. This suggests that the financial reforms have yet to have much impact on the money demand and investment ratio relations in India.

As can be seen from the first cointegrating vector in Table 6, the demand for money is determined by the investment ratio, real income and real rate of interest and all coefficients have the expected signs, with the variables of *i* and *R*, in particular, statistically highly significant, confirming the complementarity hypothesis. The second cointegrating vector implies that investment is positively related to domestic credit and real rate of interest where again all coefficients have the expected signs. Although the domestic credit ratio is significant at 8 per cent the real interest rate on deposits is insignificant, perhaps reflecting the predominance of interest rate ceiling over most of the sample period. There is therefore strong empirical support for the complementarity hypothesis for the Indian economy over the sample period with the signs of both *i* in the demand for money function and *R* in the investment function being positive.

Further discussion will include the followings.

1. The demand for money is positively related to the level of aggregate income, being consistent with the transactions demand for money hypothesis. It is often argued that for developing economies, where there are limited opportunities to economize on cash balances, and little availability of other financial assets, the motives underlying money holdings encompass much more than the usual transactions and precautionary considerations, and hence the income elasticity of money demand has a tendency to be greater than unity (Laumus, 1990). In this study of India, however, the income elasticity is relatively low at 0.45. This finding is not exceptional for India, for

example, a much lower income elasticity for broad money is found in the study by Sen and Vaidya (1997) with the elasticity of 0.22 during the sample period 1980-94. Laumas (1990) also finds a low income elasticity of 0.14 for the demand for real time deposits during the period 1954-55 to 1974-75. The low income elasticity exhibits economies of scale in the holding of money.

2. The positive relationship of the demand for money with the investment income ratio supports the assumption of self-finance and indivisibility. If the average rate of return to physical capital should rise, then desired investment increases and so would occasion a rise in *i*, consequently the level of real money balances would rise. Thus where self-finance is important, a rise in *i* increases rather than decreases *m*. The estimated coefficient (0.68) suggests that a one percentage point increase in the investment ratio would increase the real money by about seven-tenths of a percentage point.

3. The cointegrating vector for the investment ratio supports the argument that the availability of credit raises the investment ratio, given that domestic credit increases the investment income ratio.

4. Both the demand for money and investment-income ratio are positively related to changes in the real rates of interest. The evidence is crucial regarding the importance of high real rates of interest for capital accumulation. The interest rate elasticity for real money is 0.057, and that for investment income ratio is 0.004. These are much larger than the ones found by Khan and Hasan (1998) for Pakistan at the elasticity of 0.003 and 0.0009 for real money and investment respectively[3]. This suggests that real money and investment may be more responsive to real interest rates in India than in Pakistan, and the policy of increasing the deposit rates for the growth of capital formulation may be more effective.

In the pre-reform periods, a low interest rate policy was pursued by many developing countries. This was not only to weaken the competitiveness in the private sector in obtaining funds by the government sector so that the government can borrow funds cheaply from the market, but it was also to lower the cost of capital for new investment projects. It was based on the traditional Keynesian hypothesis that capital accumulation was bounded by the cost of capital.

However, in the 1970s and 1980s the so-called 'financial repressionist' view by McKinnon (1973) and Shaw (1973) became prevalent for developing economies. They assert that interest rate ceilings in developing countries have caused destabilizing portfolio shifts from financial to tangible assets when inflation accelerates[4], and consequently such a reaction magnifies the initial inflationary shock. Therefore the real deposit rates of interest are often negative. McKinnon and Shaw consider that low real interest rates are major impediments to financial deepening, capital formation and economic growth. They attribute the increase in investment to a higher level of real interest rates, as it induces economic agents to save more.

The evidence of the positive relationship between the rate of interest and capital accumulation found in this paper for India, supports McKinnon-Shaw's financial repressionist view. The policy implication is apparent: a policy aimed at raising the real deposit rates would increase the funds available and improve investment opportunities. In this respect, financial liberalisation is a potentially important contributory factor.

Finally, Tables 7 and 8 present the dynamic, error correction model results. Since weakly exogenous variables do not need to be modelled in the short-run, the VECM consists of both money demand and investment income ratio equations. The conditional VECM, where the conditioned variables enter the model is estimated by

OLS with the full system as recommended by Hendry and Doornik (1994)[5]. Initially two lags of all the explanatory variables, plus one lag of both cointegrating vectors, were included in the model and the results reported in Table 7. The dynamic models have a very high degree of explanatory power and satisfactory diagnostics. From this general system we test down to derive the final parsimonious form reported in Table 8. In Table 8 the diagnostic test results are again very satisfactory with an absence of serial correlation, heteroscedasticity, and non-normality. Ramsey's RESET test for functional form is also not rejected at the 5 per cent level of significance.

The respective error correction terms are highly significant in each equation with the correct (negative) sign. The long-run demand for money vector is also significant in short-run investment model. The significance of the error correction terms indicates the accuracy of the identified long-run relationships.

Both coefficients of the error correction terms are fairly modest (0.17 and 0.23, respectively). This suggests that 17% for real money and 23% for investment of the previous year's discrepancy between the actual and the equilibrium values of the dependent variables are corrected each year. This adjustment mechanism appears to be much slower than in the case for Pakistan; 55% for money and 62% for the savings ratio (Khan and Hasan, 1998). This seems to reflect the different degree of financial deepening between the two countries, since a much slower adjustment (though from the lagged dependent variables) is often found in studies for the earlier sample period or of a low-income country with little financial development. For example, Fry (1978) finds that the elasticity of the lagged saving ratio is from 0.15 to 0.16 for four Asian developing countries for the period 1962–1972. Also, in the study of Thornton and Poudyal (1990) the elasticity of the lagged demand for money is 0.15 during the period 1974–1986 for Nepal, which is one of the world's poorest countries[6].

The weakly exogenous variables are statistically and theoretically well-determined in the demand for money function: the level feedback from income and real rates of interest is correctly signed. The negative impact from the lagged investment ratio on money is not unduly troublesome, as it can be interpreted as the adjustment effect.

Regarding the investment function, the real money (lagged one period) elasticity is found to be close to unity (1.06) suggesting that the investment ratio rises equi-proportionally with money growth after a lag of 1 year. The effect of real interest rates on investment is more apparent in the short run than in the long-run with the coefficent of the lagged real interest rate being statistically, though marginally, significant with the correct sign. The level feedback of the domestic credit is also correctly signed and statistically significant.

These results strengthen the support for the complementarity between money and investment found in the long-run.

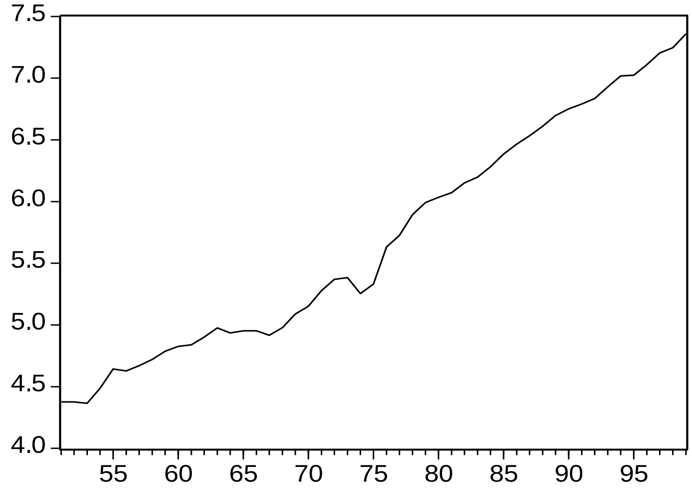
V. Conclusion

This paper has tested McKinnon's complementarity hypothesis for India over the second half of the twentieth century, using multivariate econometric techniques, and found strong support for the hypothesis. This result substantiates and strengthens the earlier findings of Laumus (1990) and Thornton (1990), regarding the strength of the finance motive for holding money and the complementarity between money and capital.

Empirical results reveal that the financial liberalisation policies are effective as a mechanism to increase the rate of capital formation in India. An innovation in this study is, however, to test for the significance of the financial liberalisation that began in the late 1980s and early 1990s. The results suggest, by rejecting the hypothesis that the money demand and investment ratio equations show a structural break between 1985 and 1995, that the financial liberalisation of the early 1990s still has some way to go in that India is still characterised by financial repression. The policy implication is that the Reserve Bank of India should continue to pursue a policy aimed at changing negative real interest rates to positive levels, if India is to secure greater levels of investment and more rapid and sustained economic growth in the twenty-first century.

Appendix

Real broad money in logarithm *(m)*



Investment to income ratio in logarithm *(i)*

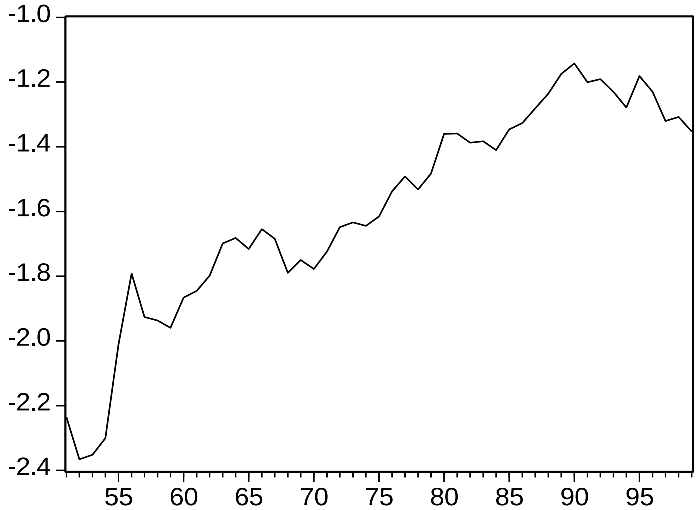


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Table 1 Unit Root Tests

Level	ADF	Lags	Differenced	ADF	Lags
m	- 2.163 (t)	3	Δm	- 3.786 *	3
i	- 1.519	4	Δi	- 4.712 *	3
y	- 0.503 (t)	4	Δy	- 4.997 (t) *	4
R	- 2.620	3	ΔR	- 5.776 *	4
d	- 1.470	3	Δd	- 3.015 *	2

Note:
* Significant at the 5% level.
Critical values at a 5%: no trend -2.86 and with trend -3.41 (Davidson and MacKinnon, p.708, 1993).

ADF is modelled as $\Delta X_{it} = \alpha + \beta \ X_{t-1} + \sum_{i=1}^{p} \delta_i \Delta X_{t-i} + e_t$.

Akaike Information Criteria are used for the choice of lag length (*p*) while ensuring white noise errors with the maxmum lag 4. (t): a deterministic trend is specified ADF tests as the trend is statistically significant at a 5% level.

Table 2 Johansen Cointegration Test

Null	Maximum Alternative	$\lambda_{\max}$	95% C.V.	Trace Alternative	λ_{trace}	95% C.V.
r = 0	r = 1	42.37 *	33.87	r >= 1	110.13 *	70.49
r <= 1	r = 2	33.89 *	27.42	r >= 2	67.76 *	48.88
r <= 2	r = 3	20.33	21.12	r >= 3	33.86 *	31.54
r <= 3	r = 4	10.34	14.88	r >= 4	13.52	17.86
r <= 4	r = 5	3.18	8.07	r = 5	3.17	8.07

Note:
* Significant at the 5% level. Unrestricted intercept with no trend.
The order of VAR (=3) is determined in the following process: Given an arbitrarily chosen maximum value of lag=4, the VAR is modelled then the appropriate order of augmentation is selected by Akaike's Information Criterion, while checking that the residuals satisfy white noise. The deterministic components are determined based on 'Pantula Principle'. See Harris (1995).

Table 3

a: Unrestricted Co-integration Vectors

m	*i*	*y*	*R*	*d*
1.000	-3.017	- 0.429	- 0.079	1.221
- 0.331	1.000	0.142	0.026	-0.404

b: The Speed of Adjustment Coefficients

m	*i*	*y*	*R*	*d*
0.005	0.317	-0.117	6.256	0.131
-0.959	-0.017	0.353	-18.876	-0.397

Table 4 Weakly Exogeneity Tests

$\chi^2(2)$	*y*	*R*	*d*
LR	6.358 *	0.988	2.186
SSLR	4.671	0.725	1.606

Note:
* Significant at the 5% level. LR= Likelihood Ratio test.
SSLR= The small sample-adjusted LR given by the product of LR and (T-K)/T, where T=No. of observations and K = No. of regressors in each equation (Bohm et al., 1980). Critical values with degrees of freedom=2: 5.99 (5%), 9.21 (1%).

Table 5 F – statistics for stability tests

Breakpoint	M F-statistics[Prob.]	I F-statistics[Prob.]
1985	1.527 [0.221]	1.106 [0.366]
1986	1.542 [0.217]	0.991 [0.423]
1987	1.488 [0.231]	0.692 [0.601]
1988	0.548 [0.701]	1.542 [0.217]
1989	0.411 [0.799]	1.627 [0.197]
1990	0.404 [0.804]	1.564 [0.211]
1991	0.453 [0.769]	1.475 [0.235]
1992	0.451 [0.770]	1.467 [0.237]
1993	0.432 [0.784]	1.493 [0.229]
1994	0.444 [0.776]	1.968 [0.133]
1995	0.453 [0.769]	1.968 [0.132]

Table 6 Restricted Co-integration Vectors

$$M = m - \underset{(25.296)}{0.683}\, i - \underset{(1.340)}{0.448}\, y - \underset{(4.071)}{0.057}\, R$$

$$I = i - \underset{(0.286)}{0.004}\, R - \underset{(1.818)}{0.300}\, d$$

t-ratio is in parenthesis.

Table 7 The General Error Correction Model Results

Variable	Δm	Δi
Δm_{-1}	0.178 (1.105)	0.951 (2.987)
Δm_{-2}	- 0.051 (0.320)	0.086 (0.271)
Δi_{-1}	-0.190 (2.675)	0.454 (3.178)
Δi_{-2}	-0.053 (0.660)	- 0.196 (1.204)
Δy	0.518 (2.876)	- 0.303 (0.837)
Δy_{-1}	- 0.295 (1.383)	0.631 (1.471)
Δy_{-2}	0.138 (0.830)	- 0.762 (2.271)
ΔR	0.010 (15.326)	- 0.002 (1.231)
ΔR_{-1}	- 0.001 (0.562)	0.006 (1.398)
ΔR_{-2}	- 0.001 (1.081)	0.003 (1.586)
Δd	0.482 (4.123)	0.385 (1.642)
Δd_{-1}	- 0.040 (0.258)	- 0.225 (0.720)
Δd_{-2}	0.211 (1.671)	- 0.655 (2.574)
M_{-1}	- 0.220 (4.497)	0.334 (3.393)
I_{-1}	- 0.017 (0.280)	- 0.080 (0.674)
Constant	- 0.647 (3.097)	0.858 (2.044)
R^2	0.94	0.82

Residual diagnostics: χ^2 (df)		
LM serial correlation (1)	1.058	1.097
LM heteroscedasiticity (1)	1.859	0.146
Ramsey's RESET test for functional form (1)	3.673	0.281
Normality: skewness and kurtosis (2)	0.039	1.173

t-ratio is in parenthesis.
Critical values at a 5%: df=1, 3.84, df=2, 5.99.

Table 8 The Error Correction Models

$$\Delta m = -0.475 + 0.209\Delta m_{-1} - 0.219\ \Delta i_{-1} + 0.516\Delta y - 0.249\Delta y_{-1} + 0.009\Delta R$$
(8.727) (2.248) (3.698) (4.851) (3.407) (17.018)

$$+ 0.524\Delta d - 0.171 M_{-1}$$
(6.251) (9.037)

$R^2 = 0.927$

$$\Delta i = 0.411 + 1.068\ \Delta m_{-1} + 0.442\ \Delta i_{-1} + 0.925\ \Delta y_{-1} - 0.501\ \Delta y_{-2} + 0.004\ \Delta R_{-1}$$
(1.239) (5.212) (3.276) (3.740) (1.784) (1.328)

$$+ 0.003\Delta R_{-2} + 0.437\ \Delta d - 0.771\ \Delta d_{-2} + 0.285\ M_{-1} - 0.234\ I_{-1}$$
(1.282) (3.193) (4.189) (3.667) (2.538)

$R^2 = 0.773$

t-ratio is in parenthesis.

Residual diagnostics: χ^2 (df)	Δm	Δi
LM auto (1)	0.473	0.439
LM hetero (1)	1.775	0.228
Ramsey’s RESET test for functional form (1)	2.838	0.960
Normality: skewness and kurtosis (2)	0.129	0.884

Critical value at a 5%: df=1, 3.84, df=2, 5.99.

Endnotes

[1] The SSLR is also distributed as χ^2_j , Bohm, Rieder and Tintner, (1980). Note that Green (1990) also adopts the small sample LR test for a sample size of 66 observations for a similar reason.

[2] Given the strength of the shifts in the financial sector in the post-reform period, we further conducted supplementary tests to determine the stability. By setting dummy 1=1990-99 and 0=otherwise, the long-run model was re-estimated to find that the small sample likelihood ratio is 0.13 and 3.90 for money and investment equations respectively with the critical value of 3.84 at the 5% significant level. The investment equation is marginally rejected in the null of stability at the 5%, but not rejected at the 1% level. Moreover, the Cusum test, which is based on the cumulative sum of the recursive residuals was conducted. The test finds parameters stability over the whole sample period for both demand for money and investment equations at the 5% significance level, except around 1990 for the investment function where stability is found at the 10% level. The error-correction dynamic model, shown in Table 8, is also not rejected the stability by the Cusum and recursive residuals tests.

[3] Pakistan also underwent financial reforms at the end of 1989 including the liberalization of interest rates by switching from an administered to market-based interest rate determination. The study for the period 1951/60 – 1994/95 by Khan and Hasan (1998) supports the complementarity hypothesis by a single equation cointegration analysis.

[4] It may be more likely that the household sector invests in unproductive inflation hedges such as land and property, rather than in financial investment.

[5] The estimation by Full Information Maximum Likelihood (FIML) arrives at more or less a similar result as in the case of OLS.

[6] Fry (1978) found little evidence to support the complementarity hypothesis for several Asian developing nations, whereas Thornton and Poudyal (1990) found strong support for the hypothesis for Nepal.