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DEMAND FOR MONEY IN AN OPEN ECONOMY SETTING: A CASE OF INDIA

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INTRODUCTION:

Due to the monetarist revolution of 1970s, macro-monetary theory received a different explanation for effectiveness of all economic policies in general, and of monetary policy in particular. Before the monetarist revolution however, macroeconomists, prompted by Keynesian analysis, were used to thinking that an increase in the money supply necessarily reduces domestic interest rate. It was believed that the reduction in the interest rate then further bumps up domestic investment and leads to a higher GDP. The link between investment and GDP was quite famous, thanks to the Keynesian autonomous investment multiplier process. This explanation, now popularly recognized as the "Keynesian Chain", was the only available explanation for monetary policy transmission mechanism, until monetarists proposed an alternative route.

Monetarists, and especially their leader Milton Friedman, implemented the idea of how an "excessive" money supply can be disastrous to the economy because "all inflations are always and everywhere (were seen as) a monetary phenomenon". Moreover, Friedman successfully showed that an increase in money supply can lead to an increase in interest rates. Further he also argued that since an excessive increase in money supply definitely leads to higher prices and probably leads to higher interest rate, it is neither necessary nor desirable to have an excessive increase in money supply. However the whole monetarist explanation above is based on their belief that the demand for money is a stable function of some explanatory variables such as the permanent level of GDP, the price level and probably the interest rate. If demand for money was successfully shown to be a stable function, then velocity of money (which is inversely proportional to the demand for money) is argued to be stable. And if demand for money is stable then the excessive increase in money supply was most likely to make changes in price level and real GDP. Hence estimating the demand for money function inhibited a special importance. Economists throughout the 1970s and 1980s were busy estimating the demand for money function to confirm (or to reject) the Monetarist assertions.

Then came the era of "more flexible exchange rate", prompted by the breakdown of the Bretton Woods System in 1973. The capital flows became of prime importance in any economic analysis, and especially in the monetary economic analysis in which capital inflows and outflows were included in broadly defined money supply measurements. Hence estimation of demand for money in open economy setting was seen to be of a major relevance.

While some studies already exist about the demand for money stability for India in a closed economy setting, there have been none in the last 10 years or so. Moreover the Indian economic conditions have drastically changed with the advent of the economic liberalization process since 1991. There is a more refined and reliable data available now and the interest rates are somewhat more flexible in 1990s than ever before. For all these reasons it is believed that estimating the stability of demand for money function for Indian conditions will be a worthwhile project.

In this paper we intend to do the following things: Section 1 summarizes the main theoretical arguments of the Monetarists and exposes the role of the demand for money stability in their analysis. It also includes a survey of demand for money stability studies for India. Section 2 surveys the Indian monetary conditions and points out the changes in them in recent years. More recent data from the Indian economy are used to estimate the demand for money function and to explain the regression results. Data description, methodology and empirical results are included in section 3 and section 4. The last section provides the summary and conclusion.

SECTION 1: THEORETICAL IMPORTANCE OF DEMAND FOR MONEY STABILITY

The origin of demand for money idea can be traced in the "Cambridge equation" that was initially proposed by such Cambridge economists as A.C. Pigou, Alfred Marshall and Richard Allen. They claimed that economy's money supply can always be expressed as the proportion of its nominal GDP. For example if the nominal GDP is 500 and money supply is 300 then one can always say that money supply is 60% of the nominal GDP. Thus in an equation form it means that:

$$M = K.P.Y$$

Where K is the proportion of nominal GDP kept in money terms (60% in the above example), P is the general price level as measured by one of the price indexes and Y is the real GDP. Hence P.Y = nominal GDP.

Thus, Cambridge economists emphasized the store of value function of money and first introduced the idea that people would like to hold some proportion of nominal GDP in money terms.

In more significant ways however, the demand for money's theoretical explanation was first systematically offered by John M. Keynes, in his path-breaking book General Theory of Employment, Interest and Money (1936). As the textbook model of Keynesian demand for money has made it clear, (see for example, Kulkarni, Dolan and Lindsey, 2005) there are three motives for money demand: Transactions, Precautionary and Speculative. The most important is the speculative demand for money. Transactions demand for money is mainly determined by national income and the speculative demand for money is primarily determined by interest rate. Hence according to Keynes, the main determinants of demand for money are interest rate and the national income.

Nonetheless the demand for money function was most unstable for Keynesian economists, because of their perceived risk of the existence of a liquidity trap. Liquidity trap is the money market situation when interest rate goes to such a low level that everyone expects it to be higher in the future. Hence the demand for bonds that is primarily determined by price of bonds which is expressed as the inverse of interest rate in the economy, approaches to zero and the demand for money approaches to infinity. This creates a horizontal portion for the demand for money curve, aptly called the "liquidity trap". Thus in Keynesian analysis, the demand for money is seen not only as significantly determined by interest rate, but it is also the reason for the existence of liquidity trap. It is popular in traditional monetary theory now, to believe that the effectiveness of monetary policy is severely limited by the existence of the Keynesian liquidity trap. (See Kulkarni (2003), chapter 8).

This unstable demand for money was to a Keynesian mind, the main reason for the argument that "Money does not matter". In case of the liquidity trap, Keynes (and later on Keynesians) believed, changes in money supply are unable to be effective. Monetary policy does not change interest rate in liquidity trap, hence there is no change in investment or GDP. Thus monetary policy is completely ineffective because of the unstable demand for money function.

The Keynesian analysis came under severe criticism by Monetarists (especially Friedman) in 1950s and 1960s. Friedman observed that too much money supply growth in earlier years has led to increases in inflation. This meant that the quantity theory of money, which proposed that an excessive money supply necessarily leads to an increase in price level, was not a bad theory after all. Friedman revised the quantity theory through his famous "Restatement". (see Friedman (1959) in bibliography). In his revision, he paid more careful attention to the primary determinants of the demand for money.

Theoretically, he presumed that, the demand for money is determined by the permanent level of GDP, wealth, human capital, the interest rate on bonds, the interest rate on equities and a measure of expected or actual inflation in terms of the general price level. Friedman and monetarists found that, among all these expected determinants, the most significant were only two: the permanent level of GDP and the general price level. Hence to a monetarist the interest rate is, at best, only an insignificant determinant of the demand for money and the demand for money is a stable function of GDP and price level. This stability of money demand also shifted the focus from the Keynesian argument that, “Money does not matter (in Liquidity Trap)”, to the Monetarists argument that, “Money does matter”! Thus issue of the stability of money demand was the basis for the totally opposite views of these two macroeconomic camps.

Just as the theoretical arguments were foundations of disagreements between Keynesians and monetarists, the empirical investigations of the demand for money stability were also strong reasons for controversy between monetarists and Keynesians. An extensive survey of demand for money functions estimated using developed countries’ data is seen in Laidler (1977) and in Judd and Scadding (1982). In essence these studies are divided into two categories: one searches for the acceptable form of the demand for money function, and the other tries to explain the causes of instability in the money demand function.

After searching through a variety of specifications, Goldfeld (1973) concluded that a preferred specification of a short term money demand function will use: a) a narrow measure (like M1 or M2 in USA); b) measured real income rather than permanent income or wealth; c) a short-term interest rate like the Treasury bill rate or commercial paper rate as a measure of interest rate; and, d) a lagged dependent variable to allow for an incomplete adjustment.

Nonetheless, further observations of Goldfeld’s study showed that his estimation of money demand function was not very useful for predicting future changes in money demand. As Jadhav (1994) puts it, “Going by the estimated money demand function, real money balances ought to have declined mildly in 1974 followed by a recovery in 1975. In stead, in actuality, the real money balances declined steadily falling by about 9% during the first quarter of 1974 to second quarter of 1976" (See Jadhav in reference list, page 55).

Boughton (1981) points out that apart from the findings for the USA, similar instances of demand for money instability were detected in several other developed countries as well. Research efforts after this time concentrated on explaining the reasons for demand for money instability. One explanation presented "financial innovation" as one reason for instability. The argument of "financial innovations" claims that the reduced transaction costs of converting money into other financial assets (and vice versa), allows money holders to keep smaller money balances. In such an environment, it is legitimate to expect that the demand for money has shifted to the left (downwards). Despite the intuitive appeal of this explanation of "financial innovation", explicit incorporation in econometric investigation has proven to be difficult, simply because reliable data on transactions costs are hard to obtain.

Several other efforts were made to re-establish the stability in money demand function. Alternative measures of transactions, wealth and interest rates were also considered. Laumas and Spencer (1980) tried permanent income (instead of current real income), Friedman F. (1978) and Lieberman (1980) incorporated wealth in an otherwise conventional form of the money demand function. On the whole, however, "reopening of the pre-1973 agenda did not help to clarify the issues that it had posed". These efforts did bring about some improvement on the temporal stability of some money demand functions but much of the unsatisfactory behavior has remained embarrassingly unexplained" (Jadhav (1994) in the bibliography, page 56). In this paper we shall try to use newer data to explain the demand for money stability (or instability) in case of India. Nonetheless before we get to the job of estimating the exact demand for money function, we find it useful to describe the monetary sector of Indian economy.

SECTION 2: SURVEY OF INDIAN MONETARY CONDITIONS AND DEMAND FOR MONEY ESTIMATION

Indian economy's monetary sector is characterized by a dichotomy between a developed banking and financial sectors in urban areas and a crude monetary sector dominated by private money lenders, and other unsophisticated methods of financing in rural areas. After independence, the Indian economy has made some strides in terms of growth in the banking sector in the rural areas, but there is still a clear need for more work to be done.

In years just after independence, Indian financial markets were beset by excessive regulation, the exploitation of the poor and needy in rural areas by private money lenders, and banking institutions that lacked direction. In late 1960s, the situation further worsened to the point that the government thought of a drastic "solution" in terms of a country-wide nationalization of the banks. The decade of 1970s was characterized by further clutches on banks in an emergency era and an outpacing inflationary period. It was only in the 1980s that some aspects of the Indian monetary sector started becoming moderately competitive and relatively regulation free even if all major banks and majority of the deposits were still in public sector. In the 1990s economic liberalization became a big boost for increased financial capital from abroad and then improved stock market activities. However, vast part of the rural sector of the Indian economy is still underdeveloped, uneducated and its participation in the sophisticated monetary sector is questionable.

Second the freedom of interest rate movements has been a suspect. There are still some strict restrictions by the Reserve Bank of India on interest charged on loans and the interest rate that can be offered on deposits by banks. Even though some private banks have prospered in recent times, the large commercial banks are still nationalized and their functioning is decided by policy makers rather than the market forces.

It is interesting to notice from Table 1 that the Indian economy has experienced a moderately increased growth after Independence (1947) despite all the regulations and restrictions put on it. The GDP has increased steadily, interest rates have come down in recent times and in the last 8 years prices have increased at a reasonable rate. However, considering its serious problems of development such as its population explosion (1 billion in 2003) and very low per capita income (roughly $600.00), the performance of Indian economy seemed inadequate until 2002. In recent years Indian economy is the second fastest growing (second only to China) in the world, thanks partly to the outsourcing as well as the technological revolution in a loosely managed and moderately taxed information technology sector.

In monetary economic literature, several Indian economists have performed empirical investigations of the money demand function. An early survey of demand for money functions is observed in Vasudevan (1977). A more recent and comprehensive survey of demand for money studies is found in Jadhav (1994, Chapter 5). The main consensus of these reviews is that the most suitable demand for money function for India contains a lagged value of the dependent variable (viz. quantity of money demanded), real GDP and some kind of interest rate measure on the right hand side of the equation. There are also some attempts to "modify" the demand for money function with an inclusion of some such independent variables as a buffer stock (see for example Paul and Kulkarni (1987) and Thornton (1989)). Similarly Barari (1997) tests the effect of financial regulations on the demand for money in India. Bhole (1985) used two separate demand for money functions for M1 and M3 for the annual data between 1952 and 1980. He also used a linear rather than the more conventional log linear model, but obtained generally satisfactory results. Subrahmanyam (1998) concluded that Indian demand for money function is quite rigid and the rigidity is mainly occurring due to inflation bias. Erratic changes in price level, especially in 1970s, have created a bias in demand for money behavior in that decade.

In the present study, following the most successful form of the log linear model, we assume the demand for money function and test the relationship of the following form:

For the closed economy the traditional form of demand for money function is:

Log(M1/P) = e0 + e1.Log(Y) - e2.R + e3.INF + eps1 ---------------------- (1)

And for the open economy, the demand for money function is assumed to be of the form:

Log(M1/P) = a0 + a1.Log(Y) - a2.R + a3.INF

+ a4.Log (FR) + a5.Log (ER) + eps2 -------------------------- (2)

Where P = general price level measured by consumer price index

Y = real GDP, measured as nominal GDP divided by price level,

R = nominal interest rate

INF = inflation rate

M1 = money supply measured as M1 in case of India.

FR = stock of foreign reserves minus gold

ER = Exchange Rate, measured as domestic currency units (Rupees) per unit of foreign currency (US dollar)

eps= error term that measures all remaining explanatory variables.

The expected signs of the estimated variables from our theory of earlier section are easily explained as follows:

Since a0 is a constant term, the expected sign can be positive or negative. (Hence a0 < or > 0). An increase in the real GDP is expected to make an increase in the real money demand, hence the expected sign for estimated coefficient a1 is positive. (Hence a1 >0). An increase in interest rate will make an economy demand lower quantity of money, hence the expected sign of the estimated coefficient of a2 is negative. (Hence a2 < 0).

An effect of the last time period's money demand on this time period's quantity of money demanded is expected to be positive. This is because the higher quantity of money demanded last year will make people demand higher money this year as well.

The expected sign for foreign reserves is positive as the increase in foreign reserves would make people demand more money in domestic currency. This positive effect is limited by the sterilization activities of the domestic central bank, but assuming the sterilization is incomplete, the effect will be positive. (Hence a4 > 0).

Last but not least, the effect of exchange rate on the quantity of money demanded is also positive. Explanation is as follows: As exchange rate (measured as the number of domestic currency units per unit of the foreign currency) goes up, imports are expected decline and exports are expected to go up. This will make an increase in real GDP and as the real GDP increases it leads to higher quantity of money demanded. (Hence a5 > 0).

For our purposes, the signs of last two explanatory variables are the most relevant to investigate the demand for money behavior in an open economy setting.

The estimation of Equation 1 and 2 is based on several assumptions: 1) The money market of the economy is supposed to be clear so that the quantity of money demanded is same as the quantity of money supplied. Hence the dependent variable is no different than M1 money supply measured in India. This assumption is pretty standard for demand for money estimation, as economists have realized that there is no other clear measure of quantity of money demanded. 2) Interest is assumed to be fully flexible. Without the interest rate flexibility the money market equilibrium is not guaranteed. In case of India this is quite a critical assumption. The Reserve Bank of India controls the interest rates heavily but one can argue that in the long run, even the controlled interest rate move in the same direction as the market determined interest rates. 3) The same argument can also be made for Exchange Rate at least until the point of time when Indian government controlled the exchange rate a great deal. Therefore the market determined exchange rate and government's fixed exchange rate are assumed to be moving in the same direction. In Indian case, researchers use these assumptions by sometimes stating them explicitly, but usually assuming them to be given, implicitly.

SECTION 3: DATA ANALYSIS

Empirical study for money demand in India is based on annual time series data which include M1, consumer price index, nominal GDP, money market rate, foreign reserves and exchange rate over the sample period of 1968-2004. Summary statistics for all series employed in the regression equations are listed in Table 3. Two plots are available, Figure 1 for log value of real money demand, log value of foreign reserves and log value of exchange rate, and Figure 2 for log value of real money demand, log value of real GDP, nominal interest rate and inflation rate. Time trend can be observed in money demand, real GDP, foreign reserves and exchange rate. This requires a unit root test to check stationarity of each series before conducting regression, the procedure is described in the following section.

SECTION 4: METHODOLOGY AND EMPIRICAL RESULTS

Many series in macroeconomics have a property called non-stationary (or integrated) which means the series explodes as time progresses and its mean and variance increase over time. Standard inference procedures is unsuitable for regressions which contain an integrated dependent variable or integrated explanatory variables, therefore, it is important to check whether a series is stationary (or not) before using it in a regression. To do this, Augmented Dickey-Fuller unit root test and Phillips-Perron unit root tests are carried out for each variable employed in estimation equation 1 and equation 2. Intercept term and deterministic trend are included in the test on all variables in level except for interest rate. For interest rate, only intercept term is included. Test results are summarized in Table 4.1 and 4.2. The order of integration is determined based on 5% significance level.

Both unit root tests indicate all variables except real interest rate being I(1) variable, and real interest rate, being I(0) variable, are stationary over time.

With non-stationary variables involved, spurious regression exists unless at least one cointegration vector is present. Therefore, it is necessary to conduct cointegration test to check whether a linear combination of non-stationary variables is stationary. Put it another way, even though individual time series is non-stationary with its mean and variance changing over time, certain linear combination of them can be stationary. Two approaches are available for this purpose, Engel and Granger test and Johansen Procedure. Engel and Granger test applies unit root test on the residuals of the regression. If the unit root test demonstrates that the residual is stationary, then the series are cointegrated. Compared to the static, single-equation Engel and Granger test, Johansen procedure consists of estimating a VAR model which includes both differences and levels of non-stationary variables.

Harris (1995) states that when the number of cointegration vector is unknown, and the need to allow all variables to be potentially endogenous, it is better to start with the multivariate VAR approach developed by Johansen (1988) for cointegration test rather than the static, single-equation Engel and Granger approach. Since standard Johansen approach is designed to handle I(0) and I(1) variables, we can apply the approach directly on both regression models.

The lag interval in Johansen cointegration test is determined by sequential modified Likelihood Ratio test statistics at 5% level from estimating regression equations by unrestricted vector autoregression. Several lag order selection criteria are reported in Table 5.1 and 5.2 for each regression. With all criteria agree on one lag, zero lag intervals should be placed on cointegration test. Johansen cointegration test on both regressions assumes linear deterministic trend in the series with an intercept but no trend in the cointegrating relations. Cointegration test results on two regression models are listed in Table 6.1 and 6.2. Trace test statistics indicate there exist cointegrating equations in each model, meaning that cointegrated variables share certain common stochastic trends. Even though some of them are non-stationary, they never drift apart over time, which further indicates a long-run relationship exist among variables.

It is straightforward to apply Vector Error Correction Model (VECM), which captures both the long run and short run relationship between non-stationary series when they are cointegrated. VECM is similar to VAR with the former approach investigating relationship of non-stationary time series variables and the latter on stationary time series variables. VECM incorporates the disequilibrium of the real money demand which can be expressed for each regression equation as follows:

$$ECT_1 = LOG\left(\frac{M1}{P}\right) - \alpha_0 - \alpha_1 LOG(Y) - \alpha_2 R - \alpha_3 INF$$

$$ECT_2 = LOG\left(\frac{M1}{P}\right) - \beta_0 - \beta_1 LOG(Y) - \beta_2 R - \beta_3 INF - \beta_4 LOG(ER)$$

and the corresponding VECM autoregression for each equation can be expressed as follows:

$$\Delta LOG\left(\frac{M1}{P}\right)_t = \phi_1 + \phi_2 (ECM_1)_{t-1} + \sum_{i=t-1}^{t-k} \phi_{3,i} \Delta LOG\left(\frac{M1}{P}\right)_i + \sum_{j=t-1}^{t-k} \phi_{4,j} \Delta LOG(Y)_j + \sum_{m=t-1}^{t-k} \phi_{5,m} \Delta R_m + \sum_{n=t-1}^{t-k} \phi_{6,n} \Delta INF_n + u_t$$

$$\Delta LOG\left(\frac{M1}{P}\right)_t = \lambda_1 + \lambda_2 (ECM_2)_{t-1} + \sum_{i=t-1}^{t-k} \lambda_{3,i} \Delta LOG\left(\frac{M1}{P}\right)_i + \sum_{j=t-1}^{t-k} \lambda_{4,j} \Delta LOG(Y)_j + \sum_{m=t-1}^{t-k} \lambda_{5,m} \Delta R_m + \sum_{n=t-1}^{t-k} \lambda_{6,n} \Delta INF_n + \sum_{q=t-1}^{t-k} \lambda_{7,q} \Delta LOG(eR)_q + v_t$$

where ECM_1 and ECM_2 are the error-correction terms derived from long-run cointegration regression. Basically, coefficient estimate on the lagged error-correction term characterizes the long-run relationship between explanatory variables and the real money demand, and coefficient estimate on differenced term captures short-run relationship between corresponding variable and the real money demand.

With zero lag intervals selected, Vector Error Correction Model (VECM) is applied on both regressions. From the statistics reported in Table 7.1 and 7.2, cointegrating equation for the first and the second regression model can be written, respectively, as follows:

$$LOG\left(\frac{M1}{P}\right) = -1.950389 + 1.053769 * LOG(Y) + 0.004673 * R - 4.363593 * INF$$

$$LOG\left(\frac{M1}{P}\right) = -0.201534 + 0.940667 * LOG(Y) - 0.016287 * R - 19.74936 * INF + 0.049450 * LOG(ER)$$

These co-integrating equations characterize the long-run relationship between each explanatory variable and the real money demand. As we expected, real GDP has a positive impact on the real money demand, and inflation shows strong and statistically significant negative effect on the real money demand in both cases. Exchange rate shows positive effect on the real money demand with insignificant statistics. The effect of nominal interest rate on the real money demand is positive in the first case, and negative in the second case with small magnitude in both cases. Those small magnitudes can be explained partially by the fact that nominal interest rate is controlled by Indian government, thus has no major impact on the real money demand. The sign change of the coefficient estimate on nominal interest rate due to the inclusion of exchange rate strengthens the importance of exchange rate as one explanatory variable for the real money demand, even though the effect of exchange rate is not statistically significant.

It is observed from VECM results that the coefficients on all error correction terms are negative, and statistically significant on money demand and inflation rate in the first case and statistically significant on inflation rate and exchange rate in the second case. Negative coefficients on error correction terms imply that all series converge in the long run. Due to the zero lag intervals, short-run equilibrium relationship is not examined in the model.

SECTION 5: SUMMARY AND CONCLUSIONS

In this paper we made a summary of Keynesian and Monetarists explanations of money demand determination. The main contrasting argument between these two camps is the importance of interest rates in determining the demand for money. While Keynesians are seen to be in firm belief that interest rate is quite crucial in determining money demand (a la liquidity trap), the monetarists hold a view that the real GDP and general price level (P) are the only significant determinants of it. We also carried out a thorough survey of demand for money studies applied to many economies in general, and to India in particular.

By using the modern times data in case of India, we find that the influence of interest rate on demand for money is small in magnitude and statistically insignificant in both cases, and that of real GDP is significant in the first case and insignificant in the second case. Inflation rate shows strong negative effect on money demand and statistically significant in both cases. Hence it appears that the monetarist belief that the interest rate is not very crucial determinant of the demand for money is supported.

Since foreign reserve exhibits abnormal effect when it comes into play, it is dropped through out the cointegration tests and the following vector error correction model. Another point is that the positive (but insignificant) effect of exchange rate on money demand is seen to be the test of monetary policy makers' ability to sterilize the domestic money demand. All in all the demand for money function for India does not have changed behavior because of her newly found love for openness. The demand for money in India is still significantly determined by real GDP and inflation rate alone, and exchange rate and foreign reserves do not make drastic changes in it.

FIGURE 1

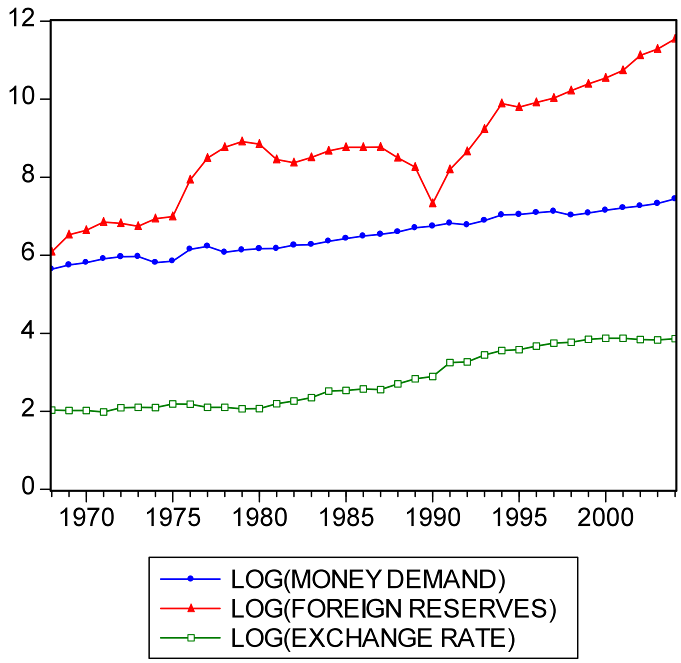

FIGURE 2

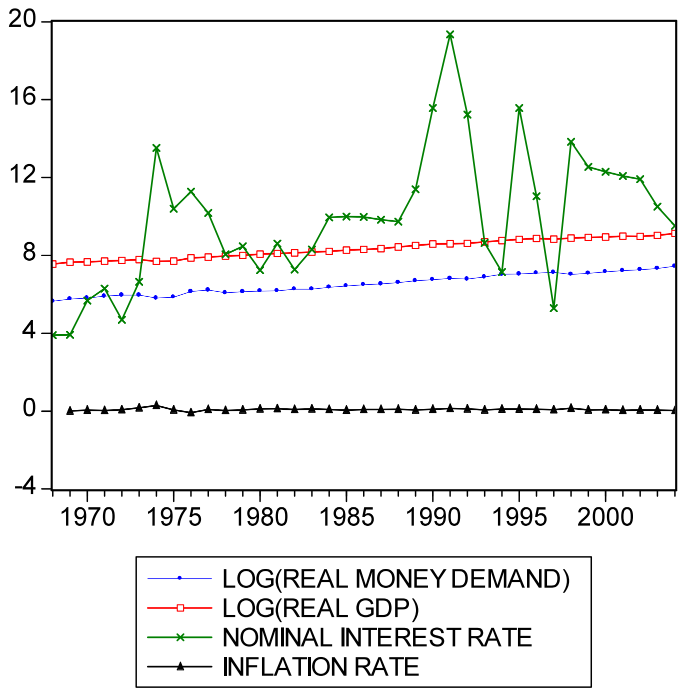

TABLE 1

INDIAN ECONOMY DATA: ANNUAL NUMBERS

Year	Nominal GDP	CPI	Money Supply	Interest Rate
1968	366.7	19.1	53.9	3.9
1969	403.9	19.2	60.4	3.92
1970	431.6	20.2	67.6	5.68
1971	462.6	20.8	76.5	6.3
1972	510.1	22.2	86.2	4.69
1973	620.1	25.9	101.0	6.64
1974	732.4	33.3	111.3	13.52
1975	787.6	35.3	122.3	10.40
1976	848.9	32.6	152.8	11.28
1977	960.7	35.3	178.5	10.18
1978	1041.9	36.2	157.6	8.05
1979	1143.6	38.4	176.9	8.47
1980	1360.1	42.8	204.6	7.24
1981	1597.6	48.4	232.5	8.61
1982	1781.3	52.2	273.7	7.27
1983	2075.9	58.4	308.6	8.3
1984	2313.4	63.3	365.6	9.95
1985	2622.4	66.8	412.4	10.0
1986	2929.5	72.6	478.7	9.97
1987	3332.0	79.0	543.2	9.83
1988	3957.8	86.4	632.8	9.73
1989	4568.2	91.8	746.9	11.39

1990	5355.3	100.0	853.6	15.57
1991	6168.0	113.9	1046.1	19.35
1992	7059.2	127.3	1120.9	15.23
1993	8097.7	135.4	1330.2	8.64
1994	9536.8	149.2	1695.0	7.14
1995	11189.6	164.5	1883.5	15.57
1996	12769.7	179.2	2148.9	11.04
1997	13212.2	192.1	2393.4	5.29
1998	15980.8	221.5	2484.6	13.83
1999	17556.4	234.7	2796.3	12.54
2000	19177.2	251.2	3206.3	12.29
2001	20940.1	262.5	3565.9	12.08
2002	22152.2	279.6	3977.5	11.92
2003	24401.5	293.6	4451.3	10.50
2004	27595.5	300.6	5139.6	9.52

Columns 1 and 3 (Nominal GDP and Money supply) are measured in billions of Rupees, CPI has 1980 as the base year, and interest rate is measured by Money Market Rate or (the rate charged by Financial Institutions for each other's loans).

Source: International Financial Statistics (IFS) Yearbook, published by International Monetary Fund, Washington D.C., 2003 edition. Last 2 year's figures are estimates as published by Reserve Bank of India Statistical Bulletin.

TABLE 2

INDIAN ECONOMY DATA: ER and Foreign Reserves

Year	**Exchange rate: Rs/dollar**	**Total Reserves Minus gold**
1968	7.62	439
1969	7.55	683
1970	7.57	763
1971	7.27	942
1972	8.08	916
1973	8.20	849
1974	8.15	1028
1975	8.93	1089
1976	8.88	2792
1977	8.20	4872
1978	8.18	6426
1979	7.90	7432
1980	7.93	6944
1981	9.00	4693
1982	9.61	4315
1983	10.49	4937
1984	12.45	5842
1985	12.66	6420
1986	13.12	6396
1987	12.87	6454
1988	14.94	4899

1989	17.03	3859
1990	18.07	1521
1991	25.83	3627
1992	26.20	5757
1993	31.38	10199
1994	35.18	19648
1995	35.93	17922
1996	39.28	20170
1997	42.48	22688
1998	43.49	27341
1999	46.75	32607
2000	48.18	37902
2001	48.03	45870
2002	46.55	67665
2003	46.05	79559
2004	47.50	102778

Source: Reserve Bank of India Bulletin, 2005. Also available at www.rbi.org.in. Reserves are in millions of US dollar, Exchange rate is market rate as reported in International Financial Statistics Yearbook, IMF Publications, various years.

TABLE 3 Summary Statistics

	Log(M1/P)	**Log(Y)**	**R**	**INF**	**Log(FR)**	**Log(ER)**
Mean	6.546240	8.358039	10.05361	0.080968	8.788348	2.830303
Median	6.512240	8.324921	9.960000	0.075250	8.718128	2.564518
Maximum	7.444120	9.124798	19.35000	0.285714	11.54033	3.874944
Minimum	5.751249	7.651427	3.920000	-0.076487	6.526495	1.983756
Std. Dev.	0.510166	0.475313	3.363559	0.056403	1.396352	0.727882
Skewness	0.067238	-0.021595	0.501482	0.819889	0.140730	0.313938
Kurtosis	1.678034	1.609552	3.255378	7.377338	2.231317	1.419420
Observations	36	36	36	36	36	36

TABLE 4.1 Augmented Dickey-Fuller Unit Root Test Results

Variable	**Level**	**1st Difference**	**2nd Difference**	**Order of Integration**
Log(M1/P)	-3.311397	-5.660296**	-8.451495**	I(1)
Log(Y)	-2.457181	-5.590862**	-4.994455**	I(1)
R	-3.499106*	-7.115973**	-5.549151**	I(0)
INF	-4.631801**	-6.697141**	-6.558240**	I(0)

Log(FR)	-1.676202	-4.620837**	-8.979399**	I(1)
Log(ER)	-2.134594	-5.193785**	-7.964988**	I(1)

*(**) denotes rejection of the hypothesis at 5% (1%) significance level.

TABLE 4.2 Phillips-Perron Unit Root Test Results

Variable	Level	1^{st} Difference	2^{nd} Difference	Order of Integration
Log(M1/P)	-3.169286	-9.594860**	-16.92106**	I(1)
Log(Y)	-2.511856	-5.746176**	-20.27390**	I(1)
R	-3.384649*	-10.23409**	-23.10519**	I(0)
INF	-4.843359**	-14.47242**	-33.19136**	I(0)
Log(FR)	-1.906141	-4.615863**	-15.39353**	I(1)
Log(ER)	-2.025755	-5.371064**	-13.48613**	I(1)

*(**) denotes rejection of the hypothesis at 5% (1%) significance level.

TABLE 5.1 VAR Lag Order Selection for the First Regression

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2.176203	NA	1.71e-05	0.374315	0.555710	0.435349
1	102.4433	177.5361*	8.02e-08*	-4.996564*	-4.089590*	-4.691395*
2	117.8347	22.38752	8.72e-08	-4.959681	-3.327127	-4.410376
3	129.3587	13.96851	1.29e-07	-4.688409	-2.330276	-3.894969

TABLE 5.2 VAR Lag Order Selection for the Second Regression

Lag	LogL	LR	FPE	AIC	SC	HQ
0	11.32990	NA	4.69e-07	-0.383630	-0.156886	-0.307338
1	154.4623	234.2167*	3.72e-10*	-7.543172*	-6.182710*	-7.085418*
2	171.8044	23.12272	6.62e-10	-7.079053	-4.584874	-6.239837
3	195.8407	24.76467	9.59e-10	-7.020647	-3.392750	-5.799970

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

TABLE 6.1 Johansen Cointegration Test Results on Variables in the First Regression

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.722944	77.07459	47.85613	0.0000
At most 1 *	0.444387	32.15081	29.79707	0.0263
At most 2	0.281526	11.58192	15.49471	0.1781
At most 3	0.000286	0.010001	3.841466	0.9200

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

TABLE 6.2 Johansen Cointegration Test Results on Variables in the Second Regression

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.785195	110.6575	69.81889	0.0000
At most 1 *	0.589619	56.82659	47.85613	0.0057
At most 2	0.368805	25.65317	29.79707	0.1394
At most 3	0.238681	9.548239	15.49471	0.3171
At most 4	0.000103	0.003619	3.841466	0.9509

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

TABLE 7.1 Vector Error Correction Model Applied on the First Regression

1 Cointegrating Equation(s): Log likelihood 92.79060

Normalized cointegrating coefficients (t-statistics in parentheses)

Log(M1/P)	Log(Y)	R	INF	C
1.000000	-1.053769	-0.004673	4.363593	1.950389
	(-16.9172)	(-0.52737)	(9.40590)	

Adjustment coefficients (t-statistics in parentheses)

D(Log(M1/P))	D(Log(Y))	D(R)	D(INF)
-0.125767	-0.040867	-0.272446	-0.172860
(-2.23745)	(-1.40964)	(-0.10710)	(-3.96888)

TABLE 7.2 Vector Error Correction Model Applied on the Second Regression

1 Cointegrating Equation(s): Log likelihood 136.3315

Normalized cointegrating coefficients (t-statistics in parentheses)

Log(M1/P)	Log(Y)	R	INF	Log(ER)	C
1.000000	-0.940667	0.016287	19.74936	-0.049450	-0.335838
	(-1.10814)	(0.44712)	(10.3595)	(-0.09154)	

Adjustment coefficients (t-statistics. in parentheses)

D(Log(M1/P))	D(Log(Y))	D(R)	D(INF)	D(Log(ER))
-0.017762	-0.008115	-0.307053	-0.039383	0.025955
(-1.47880)	(-1.35875)	(-0.59006)	(-4.65860)	(2.15106)

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