On the Endogeneity of the Money Multiplier in India

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Abstract

Citing a break in the statistical association between the broader money aggregates and reserve money in the the post-reforms period of the 1990s vis-a-vis the 1980s, this paper argues that an endogenous money multiplier framework is best suited for analyzing the money supply process in India and questions the simplifying assumptions tending to justify stability and predictability of the money multiplier especially in the context of a deregulated financial system with market determined interest rates. An empirical analysis conducted using monthly data for the period April 1980 through March 2000 establishes this and traces the source of the endogeneity of these multipliers to a range of macroeconomic variables.

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I. Introduction

The conventional money multiplier model relates changes in broader money aggregates (primarily) to reserve money changes. It is typically argued that reserve money is exogenous since it is the monetary liability of the central bank. Hence, it can be controlled. Further, it is also assumed that the money multiplier is stable and predictable. If this is true then, the conventional argument runs, the monetary authority could control the overall monetary/liquidity situation in the economy so long as reserve money is kept at a level consistent with desired broad money expansion. In practice, however, stability of money multiplier is a debatable issue. In any case this is an empirical proposition to be tested.

Contrary to this conventional wisdom, the post-Keynesian view is that money supply in an economy is an endogenous process. This view emphasizes the ability of the financial system as a whole to generate monetary liabilities, apart from the central bank's monetary stance reflected through reserve money creation, often through innovative liability management practices, in response to the real sector's needs. There have been some studies of this nature for the developed countries (see Howells and Hussein (1998) for G-7 country experiences with monetary endogeneity). In the Indian case Rath (1999) has modeled endogenous money supply in the post reforms period. Financial liberalization is often thought to generate new channels for monetary endogeneity as the financial system matures and acquires sophistication. Some factors responsible for this are bank lending, capital flows and unstable money multipliers. The last effect follows from greater interest rate flexibility following financial market liberalization.

In recent times, in international capital recipient countries such as India there appears to have been a steady rise in the value of the money multiplier. Monetary trends in the Indian economy, as indicated by movements in the broad money (M_3) and reserve money (M_0), in the post-reforms period of the 1990s *vis-à-vis* the pre-reforms period of the 1980s, point towards definite changes in the monetary process (RBI (1999)). M_3 grew at the decadal average of 17.2 per cent in the 1990s as well as the 1980s. In contrast, M_0 grew at a lower rate of 14.5 per cent in the 1990s than 16.8 per cent in the 1980s. The money multiplier, which is the interacting variable between the stocks of these two monetary aggregates, has correspondingly risen to 3.27 in the 1990s from 3.10 in the 1980s. This has enabled a relatively lower growth in reserve money to sustain the same growth in broad money in the post reform period.

Like many other developing countries, India also witnessed significant capital inflows in the 1990s, a process concurrent with structural and financial sector reforms. In response, the central bank pursued a combination of sterilization and foreign exchange market intervention in an attempt to contain the monetary and inflationary impact of such flows as also to tackle periodic pressure on the Indian rupee. The combined effect of such measures has been to reduce the rate of growth[1] in reserve money in the 1990s over the 1980s, thus implying in no uncertain terms that growth in broad money did not result from balance of payment induced reserve money expansion. As will be seen later (Table 2), one possible explanation is the upward drift of the money multipliers along with their greater volatility. Since the money multiplier reflects several asset holding ratios on the part of different economic agents, one source of money multiplier movements could be the relative interest rate changes in a deregulated interest rate regime.

[1] In addition there were cash reserve ratio (CRR) reductions,

Recently Baghestani and Mott (1997) have argued that the notion of an endogenous money multiplier leads to a better understanding of monetary impacts on the economy. Both changes in nominal money supply as well as the observed relationship between the money stock and real output are better explained through changes in the money multiplier, it is argued. They argue that the simplifying assumptions that produced money multipliers unaffected by economic variables might have been justified in a financial system with administratively controlled interest rates and limited availability of substitutes for money. There have been advances in payments mechanism and financial innovations that have made interest rates more responsive to asset holding decisions of economic agents. Besides, real income and yield spread measures could also be relevant to such decisions, the former as a scale variable and the latter because of portfolio considerations. Since the money multiplier is a function of an array of asset holding ratios, it becomes responsive to these macroeconomic variables and influences money supply changes in the economy.

In its conventional version, the money multiplier is negatively related to the three proximate determinants, *viz.*, currency ratio set by the depositors, excess reserve ratio set by the banking system and required reserve ratio set by the monetary authority. Given the interaction of these diverse agents setting an array of asset ratios, it is not difficult to perceive that even the conventional version could capture to some extent the sources of eventual endogeneity of the money supply process. Such potential economic impacts are however assumed away in the conventional analysis. But if the multiplier responds to macroeconomic variables, a process that may be concomitant with the financial evolution of the economy, then this would induce a further degree of endogeneity to the money supply process. In a financially liberalized set-up, such impacts could be conceived to emerge from relative interest rate movements across instruments.

Thus there is a need to reexamine the issue of the movement of different money multipliers and their stability. Identification of the determinants of these multipliers would facilitate an identification of the sources of endogeneity and variability of the money multipliers in recent times. This paper attempts to provide an answer to these questions within the Indian context.

This paper is organized as follows. In Section II we outline the conventional money multiplier model and permit the multiplier to depend upon some relevant macro-economic variables. Section III is a brief literature review. Section IV develops a time series (cointegration) approach to the stability of the multipliers using (monthly) Indian monetary data for the period March 1980 to March 2000. Section V examines the analytical case for multiplier instability and undertakes a multivariate co-integrated VAR to empirically identify the determinants of the multipliers. Seemingly Unrelated Regression Estimation (SURE) method is used to empirically estimate the multipliers, both narrow and broad in a simultaneous equation system so as to identify the determinants of alternative multipliers. We also conduct VAR analysis of the multiplier. The changing significance of variables across periods is taken as an indicator of their greater variability and instability. Section VI concludes the paper.

II. A Simplified Money-Multiplier Approach

Consider the following simple money multiplier model. There exists a system of reserves with a uniform CRR for both demand and time deposits. The salient feature of this approach is the role of certain fixed behavioural ratios, which aim to capture the portfolio behaviour of banks and non-bank public and relate these to money supply and the monetary base. In its simplest form, the money-multiplier is defined as per equation (1).

$$M^s = m(.)\,H \qquad (1)$$

where M^s = Nominal money stock;

m (.) = Money multiplier which is a function of the variables which we specify below. Let

H = Nominal reserve money [Cash (C) + Reserves (R)],

D = demand deposits.

Thus

$$H = C + R \quad \text{(cash + reserves)} \qquad (2)$$

$$M = C + D \qquad (3)$$

$$M/H = (C + D)/(C + R)$$

$$= (C/D + 1) / (C/D + R/D) \qquad (4)$$

where C/D is currency - deposit ratio and R/D is reserve - deposit ratio. Thus the money multiplier is a function of two behavioural parameters: currency-deposit ratio and reserve-deposit ratio. Typically two types of reserves are recognised *i.e.*,

$$R = \text{Required Reserves (RR)} + \text{Excess Reserves (ER)} = kD + ER \qquad (5)$$

$$\text{Where } ER/D = \varphi(r_{mkt}) \qquad (6)$$

Where φ is a decreasing function of the market rate of interest (r_{mkt}) *i.e.*, $d\varphi/dr_{mkt} = \varphi'(r_{mkt}) < 0$. The rationale for this assumption is that banks may want to hold excess reserves beyond the required level so that unexpected demands on them for cash payments to other banks can be facilitated without allowing total reserves to fall below the required minimum. However, these excess reserves are costly to hold as they earn no interest, and by reducing such reserves, a bank would be able to increase the investment on which it earns interest. Consequently, the opportunity cost of holding excess reserves can be represented by interest rates (r_{mkt}). The higher the r_{mkt}, the less will be the excess reserves held. Equation (5) and (6) together yield,

$$R/D = k + \varphi(r_{mkt}) \qquad (7)$$

Since $\varphi'(r) < 0$, reserve deposit ratio will be smaller, for a given value of statutorily determined k, the higher the rate of interest (r_{mkt}).

Substituting eq. (7) in eq. (4) yields:

$$M/H = (C/D + 1) / \{C/D + k + \varphi(r)\} \qquad (8)$$

$$i.e., M/H = m(r, k, C/D) \qquad (9)$$

with $m_1>0$, $m_2<0$ and $m_3<0$. Signs of the partial derivatives with respect to *r* and *k* follow from (7). For the partial derivative with respect to C/D to be negative we rely on the fact that

$$k + \varphi(r) = R/D < 1 \qquad (10)$$

Now if we express the RHS of (8) as

$$M/H = (C/D + 1) / (C/D + R/D)$$

$$= (C/D + R/D - R/D + 1) / (C/D + R/D)$$

$$= 1 + [1 - R/D] / [(C/D + R/D)] \qquad (11)$$

The second term on the right hand side of (11) (which is positive), decreases with any increase in C/D keeping R/D constant. This implies that *m* is inversely related to C/D.

Borrowed reserves (BR) respond to central bank's discount rate (r_D) because BR would be positively related to the difference between the central bank's discount rate and the market rate (r_D - r_{mkt}). It is standard to posit the money supply function emanating from the money multiplier model as:

$$m = m(r_D , r_{mkt} , \sigma) \quad (12)$$

where σ is the volatility in deposits.

Money supply (M) is a multiple of the base money (H) and varies directly with the high-powered base (H) and inversely with the reserve deposit ratio chosen by banks and the currency-deposit ratio chosen by the public. These are the three "proximate determinants". The identity (11) permits changes in money stock to be decomposed into changes in its "proximate determinants": the exogenous monetary base (H) and the two endogenous ratios (C/D and R/D). Movements in the multiplier largely reflect the behaviour of the public and banks. Over the very short run, monetary movements caused by changes in the multiplier predominate and precise control by the central bank is impossible. But over the long run, high-powered base is the more important determinant. Changes in the high-powered base have contributed about 90 per cent of the secular growth of the money supply in the US and UK, whereas changes in reserve ratio and currency ratio have contributed about 10 per cent (Cagan (1965); Friedman and Schwartz (1963)).

The non-bank public decides on how much of its wealth to hold in the form of currency. But typically although the demand for currency rises with wealth, the elasticity is less than one, so that an individual's currency-deposit ratio declines with increases in wealth. For the economy as a whole, as national wealth increases the currency-deposit ratio decreases. Second, in choosing the currency or deposits the non-bank public compares the expected return on these assets. Because holding currency yields no interest, an increase in interest paid on deposits reduces the demand for currency relative to deposits, thus decreasing the C-D ratio. Third, during times of banking crisis, an increased C-D ratio results from default risk being included in comparing currency with deposits. Fourth, as far as the information cost is concerned currency enjoys an anonymity premium meaning that it has higher value over deposits in certain types of (illegal) activities.

Banks' portfolio decisions on excess reserves and discount loans depend on expected return, which in turn influences the multiplier. The principal determinant is the expected return from alternative uses of the fund. Because reserves deposited with the central bank fetches no interest, an increase in market interest rate - the rate that a bank could obtain by investing its funds- increases the opportunity cost of holding excess reserves. Second, excess reserves tend to rise when the average level of deposit outflow or its variability rises, as banks require a greater cushion against outflows. Thirdly, an increase in market interest rate relative to the discount rate tends to raise the banks' profit from the discount borrowing. These portfolio considerations can be summarised in Table 1.

Table 1 here.

III. The Extant Literature on Money Multiplier – A Short Review

Money multipliers have not received vigorous attention in the recent literature. This literature has focused on forecasting money multipliers, both at the aggregate as well as the disaggregate level, under the implicit assumption that they are unaffected by macroeconomic variables. Thus Johannes and Rasche (1987) attempted to forecast the multiplier with the help of ARIMA modelling techniques at the aggregate level. At the disaggregated level, Johannes and Rasche ((1971), (1981)) extended the time series approach to predict money multiplier by using a ‘component’ approach. They attempted to model and forecast the separate ratios that comprise the multiplier. This approach was welcomed since certain events that influence the individual ratios might get masked in the aggregate model. Any gain in modeling the component ratios would be evident in superior predictive performance.

No conclusive evidence exists on the superiority of the components approach over the aggregate approach. Haffer and Hein (1998) test this claim and find that the aggregate model yields quite accurate out of sample forecasts even when compared with a components approach. One drawback with both these approaches is that they ignore the impact of interest rates and real income. Gauger and Black (1991) identify multiplier movements as a major source of volatility of aggregates but do not analyse factors causing such multiplier movements.

The simplifying assumption that produced multipliers unaffected by economic variables has been questioned with the financial environment getting more complex in recent times. There have been advances in payments mechanism and financial innovations with the potential of making asset holdings more responsive to interest rate movements. If multipliers are endogenous, there would be implications for understanding the money supply process and monetary-macroeconomic interactions in a liberalized financial environment as well as identifying a source of endogeneity of the money supply. (Ireland (1994)).

Some macroeconomic models that have incorporated such innovations seem to provide better understanding of the monetary impacts on the economy (Freeman and

Huffman (1991); Freeman, (1998)). They attribute changes in nominal money supply to changes in the money multiplier and argue that money multiplier movements help explain the observed relationship between the money stock and real output and, above all, innovations in money multipliers help predict innovations in real output. Manchester (1989), for example, finds that innovations in money multiplier may lead to improved understanding of the impact of monetary disturbances.

Gauger (1998) analysed US data on M1, M2 and M3 multipliers in a simultaneous equation framework and found evidence that these multipliers are affected by select opportunity costs, the yield curve and real income. Interest rate changes also bring about changes in the substitution patterns among monetary assets. It should be noted that the issue of substitution between monetary assets in alternative money supply measures has been proved in a robust manner by Davis and Gauger, (1996). In the Indian context on the basis of monthly monetary data for India for 1970-98 on currency with public, demand deposits and time deposits the study by Jha and Longjam (1999) employed a translog utility function and identified inter-monetary assets substitutability in the representative consumer's utility function.

The issue of inter-monetary assets substitutability in the representative consumer's utility function is important to the extent that it would imply that not all multipliers may be affected by all opportunity costs. The impact of an interest rate spread on a multiplier would depend on substitution patterns between these monetary assets. In general, with substitutable assets, an increase in a rate spread will have a negative impact on the multiplier component containing lower return asset and a positive impact on the multiplier component containing the higher return asset. Expected impacts are zero on non-substitutable assets.

IV. Stability of the Money Multiplier in India

A structural relationship among variables may not be time invariant. To discover whether this is the case, we need to subject these relations to tests for parameter stability with the type of instability unknown *a priori*. One such test is the Engle-Granger two-step method. If the money multiplier is stable, there must be a (cointegrating) long-run relationship between money stock and reserve money and this relation should be independent of the period of analysis. In the first step we need to ensure, through ADF tests, that the order of integration of the dependent variable is not higher than that of the independent variables. In the second step, we run an OLS regression on the levels of the variables in question and test the hypothesis of cointegration by determining the order of integration of the residuals of this regression through an ADF test.

The co-integrating relationship should be independent of the period of analysis, if stability obtains. We test for the stability over the period April 1980 to March 2000 and the sub-period April 1980 to March 1990 since deregulation in Indian financial markets came in the late 1980s. We expect the money multiplier to be stable in the sub-period but not over the entire period.

Empirical Evidence for Money Multiplier (In)Stability on the basis of a Residual based Approach to Co-integration

A simple statistical analysis indicates that in monthly data, the Indian money multiplier varied in the range of 2.17-3.72 with a mean value of 3.0. The volatility of the multiplier measured by its standard deviation, which had declined during the 1980s from the 1970s, however increased in the 1990s mainly due to frequent changes in the CRR. Its decadal movements are summarised in Table 2.

Table 2 here.

Keeping in view the movement in the alternative money multipliers, the key question is how stable are they and whether such stability is period specific. For the period under study, we found all of the monetary variables in their log level form to be I (1). Lag selection criterion uses the SBC/AIC values for different lags. The results are given in Table 3.

Table 3 here.

Next we conducted the Engle-Granger co-integration test, for which the results are reported in Table 4. As can be seen from the ADF test statistics compared with the appropriate critical values for the residual terms of the regressions, for the full period neither M_3 nor M_1 are co-integrated with M_0. This implies instability of the respective money multipliers. For the part period 1980M4 – 1990M3, the period prior to financial liberalisation, however, we find results exactly to the contrary where both broad money and narrow money aggregates were co-integrated with the reserve money thus implying stability of the money multipliers. This result also applies for the seasonally adjusted data as well (Rath, (1999)). One of the reasons for such instability in the money multipliers could be the impact of financial liberalisation on the monetary aggregates in the 1990s. To this we now turn.

Table 4 here

V. Analysis of Multiplier Movements in the Post-Reforms Period

Some of the assumptions of the money multiplier approach acceptable for a pre-liberalised financial system may no longer hold true as the financial system evolves towards greater maturity and sophistication. One such assumption is that banks and non-bank public maintain stable reserve-deposit and currency-deposit ratios. This implicitly assumes that the portfolios of banks and non-bank households are invariant to interest rates so that the portfolio decisions of these agents have a fairly stable relationship with relative rates of returns. Such an assumption may be valid in a financially repressed system characterised by a lack of depth in the financial market with few assets that are close substitutes to non-interest bearing reserves and deposits. In such a system, interest rates are set and administered and usually kept fixed for long periods of time. Since the government attempts to maintain parity between interest rates regardless of riskiness or liquidity premium of assets, changes in such rates are made ensuring that their differentials stay intact. In such a situation commercial banks have little freedom to adjust their portfolios as the government controls the direction and magnitude of banks' use of funds to a large extent. Under these conditions, the assumption of stable reserve and cash to deposit ratios may not be unrealistic. As financial liberalisation proceeds, government control on bank lending, especially to private corporate sector, is withdrawn. The introduction/creation of new assets (*e.g.*, auctioned government securities with a lowering of the maturity period for government securities and money market mutual funds) that could be considered as close substitutes to non-interest bearing reserves and deposits are undertaken in the liberalising financial system. Reserve-deposit and currency-deposit ratios may not remain stable in such a changed scenario since banks' holding of excess reserves and households' demand for bank deposits would vary with changes in relative rates of return.

Secondly, with financial liberalisation there is a shift in the monetary policy stance with greater reliance on market-based indirect measures and less on direct monetary control. Such a shift could have significant impact on day-to-day interest rate movements. These interest rates would in turn have implications for money supply as variations in the interest rate may affect the money multiplier. Starting with the late 1980s, India has deregulated its domestic financial sector, through, among other measures, removal of interest rates ceilings. There have had significant interest rate implications. For example, the liberalisation of interest rates requires that the statutory reserve requirements be considerably reduced which in a financially repressed economy was a principal component of direct monetary policy instrument. Otherwise the high interest rates that follow liberalisation would imply higher burden on the banking industry since no interest is paid on reserves. Hence a major impact in terms of monetary policy implementation has been greater reliance on market-based indirect methods of controlling money supply like open market operations and auctioning of treasury bills. When the central bank sells outstanding government bonds in the open market to the non-bank public, the non-bank public is induced to buy government bonds by lowering the bond prices or raising the interest rate. There would be interest rate effects on the money multiplier and as such, variability in the former would lead to variability in the latter.

Thirdly still another condition for stability of money multiplier is that the demand for bank credit should be interest-elastic, a condition likely to be satisfied when credit is rationed. Removal of interest rate ceiling might lead to a reduction in the private sector loan demand leading further to excess reserves with banks and an increase in the reserve-deposit ratio tending to reduce the money multiplier. This would be the case especially when demand for credit does not pick up because of real sector performance, expected deposit outflows from the banking system and holding of government securities in excess of the statutory requirements. On the other hand, as the opportunity cost of holding excess reserves rises with interest rate going up, banks may economise on excess reserves if the private sector loan demand is relatively interest-inelastic. This tends to increase the money multiplier. Thus interest rate deregulation can potentially make the money multiplier unstable to the extent that in a liberalised economy, emphasis must be placed on the behaviour of banks and their role in the money supply mechanism ((Papademos and Modigliani, (1990)).

The money multiplier may become unstable because of variation in households' portfolio choice between currency and deposits as well as various monetary assets *vis-à-vis* other non-monetary assets not covered in monetary aggregates on consideration of relative rates of return. As the deposit rates rise, people may like to move out of currency into deposit. This would tend to reduce the currency-deposit ratio and increase the money multiplier. Evidence from Asian countries shows that interest rate liberalisation has tended to increase the money multiplier and has marked impact on the growth of money supply (Tseng and Corker, (1991)).

Another aspect of financial liberalisation is the freedom of entry for banks and financial institutions in to the financial market. The resulting competitive pressure in the financial market leads to financial institutions becoming more innovative in their product design. Some such innovative are flexibility in withdrawing from saving deposits, automatic transfer facilities including a combination of features of current and savings accounts, automatic teller machines which allow withdrawal either from savings or current accounts. As a result the distinction between current and savings account thins down and, at the same time, deposits become more liquid and are increasingly perform the transaction functions of money with facilities for premature withdrawal and easy borrowing against the security of time deposits. As the deregulated banking sector competes with other financial institutions for deposits, the distinction between banks and non-bank financial institutions becomes blurred. While competing for funds, the deregulated institutions accelerate the growth of money supply not necessarily related to changes in the economic or financial conditions. As a result with the same reserve money, the impact of financial innovations may be reflected through an increased multiplier simultaneously with a decline in the velocity of circulation of money.

Further, interest rate changes may also bring about changes in the substitution pattern among monetary assets. In view of substitutability between monetary assets (Davis and Gauger (19960 and Jha and Longjam (1999)) covered under alternative monetary aggregates, not all multipliers may be affected by all opportunity costs. The impact of an interest rate spread on a multiplier would depend on substitution patterns between these monetary assets. In general, on substitute assets, an increase in a rate spread will have a negative impact on the multiplier component containing lower return asset and a positive impact on the multiplier component containing higher return asset. Expected impacts are zero on non-substitutable assets.

Moreover as Moore, Porter and Small (1998) find, if there is asymmetric adjustment across the movements of various rates of interest rates, there would emerge differential implications across the fixation of different rate spreads with corresponding impacts on the component assets. One factor of significance would be the responsiveness of various asset rates to changes in market rates of interest. In case of deposit rates adjusting rapidly to changes in market rates, the opportunity costs may remain the same along with asset holdings and the multipliers. Slow adjustment of deposit rates affects opportunity costs and induces portfolio adjustments that affect the multipliers. Asymmetric response with deposit rates respond more quickly to increases in market rates than to decreases. The falling market rates in recent years make these considerations relevant in determining various interest rate spreads of relevance to money supply process.

Real income impacts on levels of asset holdings are straightforward with a favourable effect on most of monetary assets resulting from real income growth. Asset holding ratios like the currency ratio would decline with rising income. But with evolving payment system (ATM, transfer to cash etc.), the currency ratio tends to rise. The yield spread could also have a role to play to the extent that steepness of yield curve is a good indicator of the source of asset shifts across or outside the monetary aggregates.

In a simultaneous equation framework, Gauger 91998 examined whether M1, M2, M3 multipliers in the US are impacted by economic variables like income and interest rates. He found this to be the case and also that the nature of multiplier responses to economic variables changed in the 1990s with significant impacts on the multipliers from select opportunity costs, the yield curve and real income. Given the fact that the Indian reforms started in the late 1990s we would test Gauger's hypothesis on Indian data. We need to first modify Gauger's model to account for specificity of Indian monetary compilation procedure. Further, we also modify the model to account for only two monetary aggregates, *viz*., narrow and broad money (M_1 and M_3) for which reliable data are available and also used for policy purposes by the monetary authority.[2]

In order to capture the likely impact on the money multipliers from a set of relevant macroeconomic variables, the narrow and broad money multipliers need to be represented in component ratio terms. Given that narrow money aggregate: $M_1 = C + DD$; broad money aggregate: $M_3 = C + AD$ where $AD = DD + TD$; and reserve money: $M_0 = C + R$ (assuming other deposits with RBI negligible), let us start with the respective multipliers as:

Narrow money multiplier:

$z_1 = M_1/M_0$

$= (C + DD)/M_0$

$= (C + AD - TD)/(C + R)$

$= (C/AD + AD/AD – TD/AD)/(C/AD + R/AD)$

$= (1 + c – t) / (c + r)$

$= (1 + k)/Denom \text{ where } Denom = (c + r) \text{ and } k = c – t \qquad (13)$

Broad money multiplier:

$z_3 = M_3/M_0$

$= (C + AD)/(C + R)$

$= (C/AD + AD/AD)/(C/AD + R/AD)$

$= (1 + c) / (c + r)$

$= (1 + c – t + t) / (c + r)$

[2] There are serious limitations of postal and other savings included in the other two aggregates (M2 and M4).

$= (1 + k + t)/Denom$

$= (1 + k + \Sigma d_j^2)/Denom$

$= (1 + k)/Denom + \Sigma d_j^2/Denom$

$= z_1 + nz_3$ (where $nz3 = t/c+r = \Sigma d_j^2/Denom$) (14)

Where

C is currency with public,

DD is demand deposits,

TD is time deposits,

AD is aggregate deposits comprising both demand and time deposits,

R is the bank reserves,

M_0 is the reserve money comprising both C and R assuming other deposits with RBI to be negligible,

M_1 is the narrow money aggregate,

M_3 is the broad money aggregate,

c (= C/AD) is the currency-deposits ratio,

t (=TD/AD) is the time deposits aggregate deposits ratio,

r (=R/AD) is the reserves-deposits ratio,

k (= c – t) is the difference between currency and time deposits ratio,

Denom (= c + r) is the denominator in the expressions for the multipliers,

d_j is the ratio of a monetary asset (here time deposits) to aggregate deposits,

z_1, z_3 and nz_3 are the narrow money, broad money and net z3 multipliers.

Portfolio allocation impacts on the component ratios can be captured by:

$d_j = d_j (rs_1, rs_2, rs_3, \ \ .., rs_n, y)$ (15)

where rs_i denote the opportunity cost of holding the respective monetary asset and y represents real income. Incorporating (15) into (13) and (14) we have the following specification in asset movements across monetary aggregates or out to non-money financial asset:

$$z_1 = z_1 (rs_1, rs_2, rs_3, \quad .., rs_n, y) \qquad (16)$$

$$z_3 = z1 + nz_3 (rs_1, rs_2, rs_3, \quad .., rs_n, y) \qquad (17)$$

Some of the relevant returns important for these portfolio shifts to be considered are the return on M_1 and net M_3 assets, the returns on assets outside the monetary aggregates (like treasury securities, CP rates *etc*.). Secondly since steepness of the yield curve could be an important source of asset shifts across or outside the monetary aggregates, a measure of this is desirable. We proxy this by the difference between the yields of a long-dated government security (10-year bond) and 91-day Treasury bill. In the system of equations for alternative multipliers three relative interest rate terms have been considered, v*iz.,* the interest rate spread (rs_1) between net M_3 assets and M_1 asset (*i.e.,* $rs_1 = r_{nm3} – r_{m1}$); the interest rate spread (rs_3) between a short-term market interest rate and net m3 asset (*i.e.*, $rs_3 = r_{mkt} – r_{nm3}$); and the yield curve measure (r_{yc}) proxied by the yield difference between a 10-year government bond and 91-day Treasury bill in the primary market. Secondary market data for yield spread has been used in the period since 1995-96 for which such data are available.

The calculation of returns on m1 and net m3 assets (r_{m1} and r_{nm3} respectively) involves three corresponding returns. While return on currency has been taken as zero, the Klein rate as estimated in Jha and Longjam (1999) has been applied to demand deposits since demand deposits afford the account holders certain banking facilities.

Return on time deposits has been proxied by 1-year time deposit rate. The own rates of return for various monetary categories (r_{m1}, r_{nm3} and r_{m3}) are measured by quantity-weighted averages of returns on related component assets for which data are available in the Report of the Working Group on Money Supply, RBI (1998) and various issues of the monthly RBI Bulletin. The own rates for narrow money and broad money are calculated as:

r_{m1} = (Return on currency * Currency share in M_1) + (Klein rate * Demand deposits share in M_1);

r_{m3} = (Return on currency * Currency share in M_3) + (Klein rate * Demand deposits share in M_3) + Return on time deposits * Time deposit share in M_3).

The rs1 return being the lowest level opportunity cost is also the primary opportunity cost expected to affect all the multipliers. rs3 being the higher level opportunity cost is expected to be significant only in the broad multipliers. A steeper yield curve is expected to induce shifts to higher return substitute assets and if transaction balances decline, then m1 declines. If funds flow over to broader aggregates, then there would be a positive impact on the broad money multiplier. In the event of availability of new asset alternatives, funds may flow out to non-monetary assets and impacts on the broad money multiplier sub-components may turn out to be negative.

Secondly, in the rate-spread impacts on the component assets, one factor of significance would be the responsiveness of various asset rates to changes in market rates of interest. In case deposit rates adjust rapidly to changes in market rates, opportunity costs may remain the same along with asset holdings and also the multipliers. Slow adjustment of deposit rates affects opportunity costs and induces portfolio adjustments that affect the multipliers.

Real income growth may exert positive impacts on the m1 multiplier through declining currency ratio. However if evolving payments system by allowing easy transfer to cash lead to a rising currency ratio, then the m1 impact may turn out to be negative. Real income growth may exert positive impacts on the nm_3 multiplier since the non-transaction assets in net M_3 are less closely related to transactions and income than are checkable deposits. However the nm_3 impact may turn out to be positive for the time deposit ratio based on the luxury goods characteristics of time deposits. Our estimation procedure allows an assessment of these theoretical patterns.

Co-integration Results for Individual Multiplier Equations

First we check whether regressors as in (16) and (17) are empirically relevant for alternative money multiplier equations. This is done by examining whether they have a long-term relation with the respective money multipliers. We have already seen in Table 4.3 that the narrow as well as broad money multipliers as well as the explanatory variables are I (1).

The cointegration results for these variables are given in Tables 5 - 6 below for both multipliers for the period April 1980 to March 2000. There is at the minimum one cointegrating vector among the regressors in the narrow money multiplier equation for the full period. The same is the result for broad money multiplier as seen in Table 6. Similar results are obtained for the partial netz3 multiplier reported in Table 7.

Tables 5, 6, 7 here.

Estimation Strategy using SURE Approach

Augmenting equations (16) and (17) with additive disturbance terms, our system of equations becomes:

$$z_{1t} = \alpha_0 + \Sigma\alpha_1 \, rs_{1t} + \Sigma\alpha_2 \, rs_{3t} + \alpha_3 \, r_{yc} + \alpha_4 \, y_t + e_{1t} \quad (18)$$

$$z_{3t} = z_{1t} + \beta_0 + \Sigma\beta_1 \, rs_{1t} + \Sigma\beta_2 \, rs_{3t} + \beta_3 \, r_{yc} + \beta_4 \, y_t + e_{2t} \quad (19)$$

Such a representation allows for each successive multiplier to be affected by the previous multiplier. Further since various monetary aggregates are simultaneously determined in the system, broad money needs to contain narrow money within itself. As such, the error terms in the two equations are expected to be not only contemporaneously correlated but also serially correlated, rendering their estimation through ordinary least squares method inappropriate. To ensure consistent and asymptotically efficient parameter estimates, we need to apply iteratively Seemingly Unrelated Regression (SUR) method. SUR involves generalised least squares estimation. As for serial correlation of the individual error terms, we have allowed for the following two forms of auto-correlation

Auto-correlation Model 1: $e_{i,t} = \rho_i \, e_{i,t-1} + u_{i,t}$ *(20)*

Auto-correlation Model 2: $e_{i,t} = \rho \, e_{i,t-1} + u_{i,t}$ *(21)*

We have used Zellner's feasible generalised least squares (FGLS) estimation to estimate our parameters using both the models of auto-correlation in our estimation. The auto-correlation coefficients are estimated by using $\rho_i = 1 - DW_i/2$ where DW_i is the Durbin-Watson statistic computed using the single equation, equation by equation by OLS residuals. If we specify model 2, the common estimate is the simple average of the individual estimates. Tables 8 and 9 report the results from using model 1 of the SURE approach for the simultaneous estimation of z1 and nz3 as well as z1 and z3 multipliers respectively.

Tables 8 and 9 here.

Estimation Strategy through the VAR Approach

The SURE results, while being quite revealing, in pointing out the limitations of using the standard approach to using money multipliers, are themselves limited in that they presume that the direction of causality is one way: from interest rate spreads, real income and yield curve measures to the money multipliers. But this is ideally an empirical proposition to be tested. Having already reported the SURE results[3], we now purport to analyze the mutual dependence of the select macroeconomic variables and money multipliers without imposing any prior direction of causality. The VAR approach is a natural candidate for this.

Tables 10 – 18 pursue the co-integration exercise indicated in Tables 5 - 7 for the multipliers (z1, z3 and nz3) by testing the issue of causation of the variables for the multipliers for the full period as well as part periods. Tables 10 – 12 deal with the narrow money multiplier while Tables 13 – 15 deal with the broad money multiplier and Tables 16 – 18 deal with the partial broad money multiplier.

Tables 10 to 18 here.

As can be seen from the likelihood ratio based chi-squared tests reported in Table 10, for the full sample period, the null of non-causality of the higher level interest rate spread and real income in the narrow money multiplier cannot be rejected. But the null

[3] This is the first such attempt for India and only second for any country.

hypothesis of non-causality of the lower level interest rate spread and yield curve measure in the narrow money multiplier can be rejected.

Table 11 reports the results from the likelihood ratio test for the part sample period of 1980s. The null hypotheses of non-causality of the lower level interest rate spread, higher level interest rate spread and real income in the narrow money multiplier are rejected. But the null of non-causality of the yield curve measure in the narrow money multiplier cannot be rejected.

As can be seen from the likelihood ratio test reported in Table 12 for the part sample period of the 1990s, the null hypothesis of non-causality of the higher level interest rate spread, yield curve measure and real income in the narrow money multiplier is rejected. But the null of non-causality of the lower level interest rate spread cannot be rejected.

To summarize, for rs1, the null hypothesis of its non-causality in the narrow multiplier cannot be rejected in the post-reforms as well as the overall period, while it is rejected in the pre-reforms period. The non-causality of rs3 is rejected for all the periods. While the yield curve measure causes the narrow money multiplier only in the post-reforms period, real income causes the narrow money multiplier in both the part periods, but not in the overall period. It is significant to note that for the overall period, it is only rs3 which causes z1 in a negative manner while all other variables are non-causing z1.

In the case of the broad money multiplier, Table 13 shows that in the full period null hypothesis of non-causality of each of the variable in the broad money multiplier can be rejected. Table 14 reports the results for the part period of 1980s. While the null of non-causality of yield curve measure cannot be rejected, others can be rejected. Table 15 gives the results for the 1990s. It can be seen that while the null of non-causality of lower level interest rate spread cannot be rejected, others can be rejected. Turning next to net broad money multiplier (nz3), Table 16 shows that in the full period null hypothesis of non-causality of each of the variable in the net broad money multiplier can be rejected. Table 17 reports the results for the part period of 1980s. While the null of non-causality of yield curve measure cannot be rejected, others can be rejected. Table 18 gives the results for the 1990s. It can be seen that while the null of non-causality of lower level interest rate spread cannot be rejected, others can be rejected.

Interpretation of the Results

Table 19 presents a summary of our findings on the basis of SURE and VAR estimation in a sequential fashion for pre-1990s, post-1990s and full period for the three categories of money multipliers (partial as well as full). As can be seen, parameter changes have occurred across periods and these have been captured, to some extent in our exercise. Some macroeconomic variables like certain opportunity costs, the yield curve and the real income appear to have exerted significant influence on the money multipliers.

Table 19 here.

Interestingly, VAR registers some differences with respect to SURE results. These differences are quite significant in certain time periods for specific categories of multipliers. It is significant to note that in the case of the VAR the null hypothesis of non-causality of money multipliers in all other variables are rejected for all the multiplier categories for all reference periods.

The rate spread (rs1) being the lowest level of opportunity costs turns is expected to be a key primary opportunity cost for narrow, broad as well as net broad multipliers.

An increase in rs1 should trigger an outflow of money from transaction deposits and as such, the coefficient is expected to be negative and significant. Furthermore, this impact alone may be sufficient to cause all other component ratios to increase for other multipliers as well, given that transactions deposits are the denominator in each of the component ratios. Such a result is registered by SURE for all the reference periods. As for VAR, the post-reforms period has witnessed non-significant rs1. This could be because saving deployment in high-yielding monetary assets does not result from outflow of money from transaction deposits, but directly from cash. A further contributory factor could be the reduction in the minimum maturity period over the post reform period for term deposits while offering better rates of interest.

Secondly, the rate spread (rs3) being the higher-level opportunity cost is expected to be insignificant in the narrow multiplier (z_1). VAR results are totally different from SURE in this regard and yield a significant rs3 coefficients for both narrow as well as broad money multipliers. When agents expect the short-term market interest rate to increase (for example in the call money sector), there could be an outflow from the shortest maturity term deposits. It may also be leading agents to park funds as demand deposits for eventual transmission to the targeted instrument. Such a rs3 impact on the multipliers could be attributed to the fact that the returns entering into this rate spread are not tracking each other quite well even in the post-liberalisation period. Had the deposit rate tracked the money market rate, then the incentive for asset shifting would have been reduced to a great extent. Once the financial market segments are integrated in a stronger manner, greater interest rate alignment would ensure improved responsiveness of deposit rates to general interest rate movements and this source of volatility of the money multiplier could be reduced.

Thirdly, as per the VAR results, the yield curve measure is seen to be exerting a positive and significant impact for the broad money multiplier (both full and partial) in the post-reforms as well as the full period. For the full period it is negative and significant, as expected. The fact that the sign is positive and significant (not negative and significant as expected) signifies that as the yield curve steepens, the outflow of fund expected from average transaction balances is not much. This reduces the possibility of the negative impact on the z1 multiplier. On the other hand, a steeper yield curve causes inflow to higher yield assets within nz_3. The incentives to move away to higher return non-monetary assets may be somewhat dampened by the general illiquidity characteristics of the long-dated government securities.

Fourthly, the coefficient on real income is uniformly positive and significant for the broad money multiplier (both full and partial) in all the periods. Results from VAR differ significantly from SURE in respect of the impact of income measure. The VAR results point to the importance of income in the asset holding decisions of the agents encompassing the broad spectrum of monetary assets. This is a result significant in the sense that even in the post-reforms period where relative rates should gain prominence *vis-à-vis* income factors, the latter still remain important determinants of money multipliers. What perhaps explains this is the fact that the post-1990s being a period of high economic growth has also been a period of high monetary growth leading to an upward drift in the money multipliers.

VI. Conclusions

In the context of debates on the stability properties of money multipliers, this paper purported to profile the behavior of alternative money multipliers. Still another motivation was to examine the extent to which monetary endogeneity in the Indian money supply process can be validated through an endogenous money multiplier framework when interest rates are market determined. The latter is important in view of a discernible disassociation between the growths of reserve money and broad money aggregates, so that innovations in the money multiplier seemed to have a major impact on the movement of broader money aggregates.

We have seen that money multipliers throw up useful insights in understanding the changing nature of money supply process, provided the money multiplier framework takes cognizance of the various endogenous impacts from relative rates of return and other macroeconomic variables. Such an approach facilitates a better understanding of the money multiplier movements especially in the post-reforms period and also explains the movements in broad money. An examination of Indian monetary data over the decades of 1980s and 1990s has established this.

As regard the stability aspects of the money multipliers, over the full period of our analysis, in a residual based approach to testing of cointegration, we find that neither M_1 nor M_3 are cointegrated with reserve money. This indicates instability on the part of both narrow and broad money multipliers. However over the part period of 1980-90, we find these to be stable. The reasons for such a phenomenon could be the financial liberalisation witnessed in the economy in the 1990s.

Our analysis examined the narrow and broad money multipliers in a simultaneous equation SURE framework as well as VAR and found significant impacts on them from select opportunity costs as also measures of the yield curve and real income. Changing significance of determinants of alternative multipliers across periods could be contributing towards their greater variability and instability.

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Table 1: Money Supply Responses	
Changes in Variables	**Money Supply Responses**
(A) Fall in C/D ratio On account of 1. an increase in wealth and income 2. an increase in expected returns on deposits 3. a fall in riskiness of deposits 4. a fall in the information or anonymity value of cash	Expansion
(B) Rise in T/D ratio	Expansion
(C) Fall in R-D ratio	Expansion
(D) Fall in excess reserve holding of banks (ER) On account of 1. an increase in market interest rates 2. a fall in average level or variability of deposit outflows 3. an increase in market interest rates relative to discount rates	Expansion
Enhancement in cash reserve ratio (CRR)	Contraction
Rise in NBR (H*) On account of 1. Open market purchase	Expansion
Enhancement in Discretionary Finance	Expansion

Table 2 Statistical Profile of Monetary Indicators		
Item	1980s	1990s
Panel A: Monetary Aggregates		
1. Reserve Money (M_0)	16.8	13.9
2. Narrow Money (M_1)	15.1	15.6
3. Broad Money (M_3)	17.2	17.1
Panel B: Narrow Money Multiplier		
1. Maximum	1.2957	1.2702
2. Minimum	1.0205	1.0426
3. Mean	1.1614	1.1386
4. Standard Deviation	0.067325	0.053176
5. Coefficient of Variation	0.057968	0.46701
Panel C: Broad Money Multiplier		
1. Maximum	3.3740	4.1758
2. Minimum	2.8327	2.9346
3. Mean	3.1210	3.3672
4. Standard Deviation	0.11902	0.33399
5. Coefficient of Variation	0.038133	0.099189

Table 3: Unit Root Test Results				
	Constant and No Trend		**Constant and Trend**	
Variable	ADF (lag) Statistic	Critical Value	ADF (lag) Statistic	Critical Value
1. M_0				
Original Level	3.2186 (12)	-2.8743	-0.3893 (12)	-3.4307
First Difference	-2.5643 (11)	-2.8743	-4.6907 (11)	-3.4307
Log Level	-1.1682 (12)	-2.8743	-0.3877 (12)	-3.4307
First Difference	-3.5129 (12)	-2.8743	-3.6693 (12)	-3.4307
2. M_1				
Original Level	2.6911 (8)	-2.8743	0.53942 (8)	-3.4307
First Difference	-1.3510 (11)	-2.8743	-3.5694 (11)	-3.4307
Log Level	-0.1138 (12)	-2.8743	-2.6753 (12)	-3.4307
First Difference	-3.6935 (11)	-2.8743	-3.6841 (11)	-3.4307
3. M_3				
Original Level	6.9707 (8)	-2.8741	5.5070 (8)	-3.4303
First Difference	0.6871 (12)	-2.8741	-1.6710 (12)	-3.4303
Log Level	-1.1682 (12)	-2.8743	-3.9630 (12)	-3.4307
First Difference	-5.0577 (11)	-2.8743	-5.0669 (11)	-3.4307
4. IIP				
Original Level	3.0634 (12)	-2.8743	0.34524 (12)	-3.4307
Log Level	-0.3652 (12)	-2.8743	-1.7350 (12)	-3.4307
First Difference	-4.7448 (12)	-2.8744	-4.7349 (12)	-3.4307
5. z_1				
Original Level	-1.0667 (4)	-2.8743	-0.6174 (4)	-3.4307
First Difference	-3.6430	-2.8743	-4.1093	-3.4307
6. z_3				
Original Level	-0.4373 (2)	-2.8743	-1.3255 (2)	-3.4299
First Difference	-3.5778 (12)	-2.8743	-3.9415	-3.4299
7. nz_3				
Original Level	-1.1089 (12)	-2.8743	-0.0347 (12)	-3.4307
First Difference	-3.2587 (12)	-2.8744	-3.5163 (12)	-3.4308
8. ryc				
Original Level	-2.4460 (1)	-2.8738	-2.3490 (1)	-3.4299
First Difference	-4.5424 (12)	-2.8744	-4.6485 (12)	-3.4299
9. rs1				
Original Level	-1.7172 (1)	-2.8738	-1.0231 (1)	-3.4299
First Difference	-3.5778 (12)	-2.8743	-3.9415 (12)	-3.4299
9. rs3				
Original Level	-3.1994 (5)	-2.8740	-3.2220 (5)	-3.4302
First Difference	-9.2578 (5)	-2.8740	-9.2398 (5)	-3.4303

Note: 1. Parenthetic figures are the appropriate lag values based on the AIC/SBC criteria.
2. Variables other than M_0, M_1 and M_3 have been used in the subsequent sections.

Table 4: Stability Test Results (on the basis of OLS Engle-Granger Regression Results)	
Panel A: Full period (1980M4 – 2000M3) results	
Particular	Regression Result
1. Co-integration between broad money and reserve money in log-level form	$LM_3 = 0.5528 + 1.0566\ LM_0$ (10.23) (218.78) Adj. R^2 = 0.995, DW = 0.2719, ADF (2 lags) = -1.5409 (-3.3630).
2. Co-integration between narrow money and reserve money in log-level form	$LM_1 = 0.32041 + 0.9837\ LM_0$ (10.23) (218.78) Adj. R^2 = 0.9964, DW = 0.3013, ADF (4 lags) = -0.68405 (-3.3633).
Panel B: Part period (1980M4 – 1990M3) results	
3. Co-integration between broad money and reserve money in log-level form	$LM_3 = 1.0460 + 1.0566\ LM_0$ (13.076) (131.357) Adj. R^2 = 0.9932, DW = 0.9107, ADF (1 lag) = -4.1486 (-3.3889).
4. Co-integration between narrow money and reserve money in log-level form	$LM_1 = 1.3326 + 0.8862\ LM_0$ (22.8) (157.9) Adj. R^2 = 0.9964, DW = 0.3013, ADF (1 lag) = -3.8188 (-3.3889).

Note: Parenthetic figures for each regression refer to t-values of the coefficients, ADF lags decided on the basis of AIC/SBC criterion and critical values for the null of no co-integration respectively.

Table 5
Co-integration Results for z_1

1. Co-integration LR Test Based on Maximal Eigen value of the Stochastic Matrix (Order of VAR = 1)

List of variables included in the co-integrating vector:
z1 rs1 rs3 ryc liip
List of eigen values in descending order:
.21358 .10166 .034746 .022202 .017839 .0000

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	57.4221	34.4000	31.7300
r<= 1	r = 2	25.6231	28.2700	25.8000
r<= 2	r = 3	8.4519	22.0400	19.8600
r<= 3	r = 4	5.3660	15.8700	13.8100
r<= 4	r = 5	4.3019	9.1600	7.5300

2. Co-integration LR Test Based on Trace of the Stochastic Matrix

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	101.1650	75.9800	71.8100
r<= 1	r = 2	43.7429	53.4800	49.9500
r<= 2	r = 3	18.1198	34.8700	31.9300
r<= 3	r = 4	9.6679	20.1800	17.8800
r<= 4	r = 5	4.3019	9.1600	7.5300

3. Choice of the Number of Co-integrating Relations Using Model Selection Criteria

Rank	Maximised LL	AIC	SBC	HQC
r = 0	-114.3028	-114.3028	-114.3028	-114.3028
r= 1	-85.5917	-95.5917	-112.9740	-85.5917
r= 2	-72.7802	-90.7802	-122.0683	-103.3884
r= 3	-68.5542	-92.5542	-134.2718	-109.3652
r= 4	-65.8712	-93.8712	-142.5417	-113.4841
r = 5	-63.7203	-93.7203	-145.8672	-114.7340

Table 6
Co-integration Results for z_3

1. Co-integration LR Test Based on Maximal Eigen value of the Stochastic Matrix (Order of VAR = 1)

List of variables included in the co-integrating vector:
z3 rs1 rs3 ryc liip
List of eigen values in descending order:
.21070 .13837 .041640 .024545 .019217 0.00

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	56.5486	34.4000	31.7300
r<= 1	r = 2	35.5955	28.2700	25.8000
r<= 2	r = 3	10.1650	22.0400	19.8600
r<= 3	r = 4	5.9395	15.8700	13.8100
r<= 4	r = 5	4.6375	9.1600	7.5300

2. Co-integration LR Test Based on Trace of the Stochastic Matrix

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	112.8860	75.9800	71.8100
r<= 1	r = 2	56.3374	53.4800	49.9500
r<= 2	r = 3	20.7420	34.8700	31.9300
r<= 3	r = 4	10.5769	20.1800	17.8800
r<= 4	r = 5	4.6375	9.1600	7.5300

3. Choice of the Number of Co-integrating Relations Using Model Selection Criteria

Rank	Maximised LL	AIC	SBC	HQC
r = 0	-412.9459	-412.9459	-412.9459	-412.9459
r= 1	-384.6716	-394.6716	-412.0539	-401.6762
r= 2	-366.8739	-384.8739	-416.1620	-397.4821
r= 3	-361.7913	-385.7913	-427.5089	-402.6024
r= 4	-358.8216	-386.8216	-435.4921	-406.4345
r = 5	-356.5029	-386.5029	-438.6498	-407.5167

Table 7 Co-integration Results for nz3				
1. Co-integration LR Test Based on Maximal Eigen value of the Stochastic Matrix (Order of VAR = 1) List of variables included in the co-integrating vector: nz3 rs1 rs3 ryc liip List of eigen values in descending order: .20862 .15131 .040221 .025528 .017430 0.00				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	55.9220	34.4000	31.7300
r<= 1	r = 2	39.2106	28.2700	25.8000
r<= 2	r = 3	9.8116	22.0400	19.8600
r<= 3	r = 4	6.1804	15.8700	13.8100
r<= 4	r = 5	4.2025	9.1600	7.5300
2. Co-integration LR Test Based on Trace of the Stochastic Matrix				
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	115.3270	75.9800	71.8100
r<= 1	r = 2	59.4050	53.4800	49.9500
r<= 2	r = 3	20.1944	34.8700	31.9300
r<= 3	r = 4	10.3828	20.1800	17.8800
r<= 4	r = 5	4.2025	9.1600	7.5300
3. Choice of the Number of Co-integrating Relations Using Model Selection Criteria				
Rank	Maximised LL	AIC	SBC	HQC
r = 0	-350.8914	-350.8914	-350.8914	-350.8914
r= 1	-322.9304	-332.9304	-350.3128	-339.9350
r= 2	-303.3252	-321.3252	-352.6133	-333.9334
r= 3	-298.4194	-322.4194	-364.1369	-339.2304
r= 4	-295.3292	-323.3292	-371.9997	-342.9421
r = 5	-293.2280	-323.2280	-375.3749	-344.2417

Table 8: FGLS Estimates for the System of Equations (z_1 and nz_3 for overall period and sub-periods using Model 1 of the SURE Approach)				
Variable	Estimate	Std. Error	Z-	P-Value

			Statistic	
1. Overall Period (1980M4 – 2000M3): z_1 Equation				
constant	1.3124	0.75044E-01	17.488	0.00000
rs1	-0.55446E-01	0.43191E-02	-2.838	0.00000
rs3	-0.53485E-03	0.42352E-03	-1.263	0.20664
ryc	0.87634E-02	0.27656E-02	3.169	0.00153
logiip	0.24763E-01	0.33266E-01	0.744	0.45665
Adjusted R^2 = 0.83621 ; D-W statistic = 2.3731				
2. Overall Period (1980M4 – 2000M3): nz_3 Equation				
constant	0.41090	0.23011	1.786	0.07415
rs1	-0.83727E-01	0.13244E-01	-6.322	0.00000
rs3	-0.36680E-02	0.12987E-02	-2.825	0.00474
ryc	0.26179E-01	0.84800E-02	3.087	0.00202
logiip	0.86391	0.10200	8.469	0.00000
Adjusted R^2 = 0.91219 ; D-W statistic = 1.9858				
3. Part Period (1980M4 - 1990M3) : z_1 Equation				
constant	1.4446	0.78620E-01	18.374	0.00000
rs1	-0.12339	0.55993E-02	-2.037	0.00000
rs3	-0.15269E-02	0.95968E-03	-1.591	0.11160
ryc	0.28511E-01	0.31106E-02	9.166	0.00000
logiip	0.42638E-01	0.43798E-01	0.974	0.33030
Adjusted R^2 = 0.95231 ; D-W statistic = 1.9409				
4. Part Period (1980M4 - 1990M3) : nz_3 Equation				
constant	1.6514	0.34796	4.746	0.00000
rs1	-0.11758	0.25761E-01	-4.564	0.00001
rs3	-0.95397E-02	0.42628E-02	-2.238	0.02523
ryc	0.10365	0.15337E-01	6.758	0.00000
logiip	0.17593	0.19090	0.922	0.35675
Adjusted R^2 = 0.71203 ; D-W statistic = 1.8986				
5. Part Period (1990M4 - 2000M3) : z_1 Equation				
constant	0.22076	0.10953	2.016	0.04385
rs1	-0.11830E-01	0.31727E-02	-3.729	0.00019
rs3	0.19471E-03	0.40659E-03	0.479	0.63203
ryc	0.77569E-02	0.16882E-02	4.595	0.00000
logiip	0.38877	0.41189E-01	9.439	0.00000
Adjusted R^2 = 0.77252; D-W statistic = 1.7502				
6. Part Period (1990M4-2000M3) : nz_3 Equation				
constant	-0.38369	0.48980	-0.783	0.43341
rs1	-0.35313E-01	0.14408E-01	-2.451	0.01425
rs3	-0.19591E-02	0.12499E-02	-1.567	0.11701
ryc	0.15350E-01	0.83840E-02	1.831	0.06712
logiip	1.1289	0.18885	5.978	0.00000
Adjusted R^2 = 0.9280 ; D-W statistic = 1.5171				

Table 9: Impacts on Full Multipliers in Overall Period and Sub-periods Using Model 1 of the SURE Approach

Variable	Estimate	Std. Error	Z-Statistic	P-Value
Overall Period (1980M4 – 2000M3): z_1 Equation				
cons	1.2659	0.78474E-01	16.131	0.00000
rs1	-0.58436E-01	0.43434E-02	-13.454	0.00000
rs3	-0.59968E-03	0.41867E-03	-1.432	0.15205
ryc	0.10529E-01	0.27942E-02	3.768	0.00016
logiip	0.48071E-01	0.34499E-01	1.393	0.16350
Adjusted R^2 = 0.83766 ; D-W statistic = 2.4322				
Overall Period (1980M4 – 2000M3): z_3 Equation:				
Cons	1.3941	0.26629	5.235	0.00000
rs1	-0.14944	0.16062E-01	-9.304	0.00000
rs3	-0.46180E-02	0.16233E-02	-2.845	0.00444
ryc	0.40145E-01	0.10176E-01	3.945	0.00008
logiip	1.0450	0.11924	8.763	0.00000
Adjusted R^2 = 0.88301 ; D-W statistic = 2.1645				
Part Period (1980M4 -1990M3) : z_1 Equation				
cons	1.4469	0.78666E-01	18.393	0.00000
rs1	-0.12346	0.56070E-02	-22.020	0.00000
rs3	-0.15152E-02	0.96033E-03	-1.578	0.11462
ryc	0.28633E-01	0.31160E-02	9.189	0.00000
logiip	0.41414E-01	0.43820E-01	0.945	0.34461
Adjusted R^2 = 0.95233 ; D-W statistic = 1.9352				
Part Period (1980M4 -1990M3) : z_3 Equation				
cons	3.0959	0.41494	7.461	0.00000
rs1	-0.24426	0.30493E-01	-8.010	0.00000
rs3	-0.11013E-01	0.50821E-02	-2.167	0.03023
ryc	0.13409	0.17857E-01	7.509	0.00000
logiip	0.22084	0.22855	0.966	0.33390
Adjusted R^2 = 0.58861 ; D-W statistic = 1.9212				
Part Period (1990M4 - 2000M3) : z_1 Equation				
cons	0.23232	0.10702	2.171	0.02994
rs1	-0.11370E-01	0.31036E-02	-3.663	0.00025
rs3	0.20990E-03	0.39685E-03	0.529	0.59686
ryc	0.74206E-02	0.16573E-02	4.477	0.00001
logiip	0.38360	0.40300E-01	9.519	0.00000
Adjusted R^2 = 0.77039 ; D-W statistic = 1.7336				
Part Period (1990M4 - 2000M3) : z_3 Equation				
cons	-0.14148	0.58669	-0.241	0.80944
rs1	-0.58502E-01	0.17307E-01	-3.380	0.00072
rs3	-0.18425E-02	0.15717E-02	-1.172	0.24107
ryc	0.23158E-01	0.99497E-02	2.328	0.01994
logiip	1.5326	0.22531	6.802	0.00000
Adjusted R^2 = 0.91242 ; D-W statistic = 1.6379				

Table 10: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)	
Panel A: Co-integrating Vector for z1 for Full Period (1980M4 – 2000M3) Order of VAR = 1, chosen r =1. List of variables included in the co-integrating vector: z1 ryc rs1 rs3 liip List of imposed restriction(s) on co-integrating vectors: a1=1	
Variables	Vector 1
z_1	-0.4968 (-1.0000)
rs1	0.001998 (0.00402)
rs3	-0.013566 (-0.27309)
Ryc	-0.0037548 (-0.007559)
Liip	-0.3018 (-0.060753)
Intercept	0.80525 (1.6210)
Panel B: **LR Test of Restrictions**	
a1=0	CHSQ (1) = 4.0554 [0.044]
a2=0	CHSQ (1) = 0.02182 [0.883]
a3=0	CHSQ (1) = 30.7604 [0.000]
a4=0	CHSQ (1) = 0.37042 [0.543]
a5=0	CHSQ (1) = 1.2880 [0.256]

Table 11: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)

Panel A: Co-integrating Vector for z1 for Part Period (1980M4-1990M3)

Order of VAR = 1, chosen r =2.
List of variables included in the co-integrating vector:
z1 ryc rs1 rs3 liip

Variables	Vector 1	Vector 2
Z1	-4.7478 (-1.0000)	1.1174 (-1.0000)
Rs1	-0.51475 (-0.10842)	-0.13984 (0.12515)
Rs3	-.022806 (-0.0048036)	-.029295 (0.026217)
Ryc	0.035829 (0.0075464)	-0.012332 (0.011036)
Liip	0.59913 (0.12619)	1.0087 (-0.90276)
Intercept	4.5524 (0.95883)	-5.5095 (4.9306)

Panel B:
LR Test of Restrictions

a1=0	CHSQ (2) = 28.442 [0.000]
a2=0	CHSQ (2) = 24.9900 [0.000]
a3=0	CHSQ (2) = 11.7017 [0.003]
a4=0	CHSQ (2) = 1.8748 [0.392]
a5=0	CHSQ (2) = 26.1493 [0.000]

Table 12: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)		
Panel A: Co-integrating Vector for z1 for Part Period (1990M4-2000M3) Order of VAR = 1, chosen r =2. List of variables included in the co-integrating vector: Z1 ryc rs1 rs3 liip		
Variables	Vector 1	Vector 2
z1	3.0367 (-1.0000)	.82679 (-1.0000)
Rs1	0.015306 (-0.0050405)	0.0050319 (-0.0060861)
Rs3	-.0040112 (0.0013209)	0.014464 (-0.017494)
Ryc	-0.037953 (0.012498)	-.0012947 (0.0015660)
Liip	-.85151 (0.28041)	0.0070351 (-0.0085089)
Intercept	1.4130 (-0.46531)	-1.0746 (1.2997)
Panel B: **LR Test of Restrictions**		
A1=0	CHSQ (2) = 59.339 [0.000]	
A2=0	CHSQ (2) = 1.7080 [0.426]	
A3=0	CHSQ (2) = 29.019 [0.000]	
A4=0	CHSQ (2) = 27.111 [0.000]	
A5=0	CHSQ (2) = 57.051 [0.000]	

Table 13: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)		
Panel A: Co-integrating Vector for z3 for Full Period (1980M4 – 2000M3) Order of VAR = 1, chosen r =2. List of variables included in the co-integrating vector: z3 ryc rs1 rs3 liip		
Variables	Vector 1	Vector 2
z3	-0.13538 (-1.0000)	0.39589 (-1.0000)
rs1	-0.0084037 (-0.062075)	.085596 (-0.21621)
rs3	-0.014078 (-0.10399)	-0.4906E-3 (0.0012393)
Ryc	0.0047227 (0.034885)	-0.020897 (0.052785)
Liip	0.058873 (0.43487)	-0.30856 (0.77939)
Intercept	0.21923 (1.6194)	0.039955 (-0.10092)
Panel B: **LR Test of Restrictions**		
a1=0	CHSQ (2) = 27.348 [.000]	
a2=0	CHSQ (2) = 17.0823 [.000]	
a3=0	CHSQ (2) = 46.3510 [.000]	
a4=0	CHSQ (2) = 5.6523 [.000]	
a5=0	CHSQ (2) = 25.4097 [.000]	

Table 14: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)

Panel A: Co-integrating Vector for z3 for Part Period (1980M4 -1990M3)

Order of VAR = 1, chosen r =3.
List of variables included in the co-integrating vector:
z3 ryc rs1 rs3 liip

Variable	Vector 1	Vector 2	Vector 3
z3	0.48084 (-1.0000)	-0.76483 (-1.0000)	0.26049 (-1.0000)
Rs1	0.29229 (-0.60787)	0.027806 (0.036356)	0.12439 (-0.47751)
Rs3	0.038339 (-0.079733)	0.0015101 (0.0019745)	-0.011517 (0.044214)
Ryc	-0.018330 (0.038122)	0.027052 (0.035370)	-0.077017 (0.29566)
Liip	-1.1704 (2.4341)	-0.23750 (-0.31053)	0.14680 (-0.56354)
Intercept	3.0025 (-6.2443)	3.3155 (4.3350)	-1.7235 (6.6165)

Panel B:
LR Test of Restrictions

A1=0	CHSQ (3) = 25.5259 [0.000]
A2=0	CHSQ (3) = 26.4468 [0.000]
A3=0	CHSQ (3) = 14.4198 [0.002]
A4=0	CHSQ (3) = 3.5118 [0.319]
A5=0	CHSQ (3) = 35.7018 [0.000]

Table 15: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)	
Panel A: Co-integrating Vector for z3 for Part Period (1990M4 – 2000M3) Order of VAR = 1, chosen r =1. List of variables included in the co-integrating vector: z3 ryc rs1 rs3 liip	
Variables	Vector 1
z3	0.32924 (-1.0000)
Rs1	0.027073 (-0.082228)
Rs3	-0.010606 (0.032214)
Ryc	-0.032431 (0.098501)
Liip	-0.69538 (2.1121)
Intercept	2.8370 (-8.6167)
Panel B: **LR Test of Restrictions**	
A1=0	CHSQ (1) = 5.7299 [0.017]
A2=0	CHSQ (1) = 1.6135 [0.204]
A3=0	CHSQ (1) = 7.3419 [0.007]
A4=0	CHSQ (1) = 6.2616 [0.012]
A5=0	CHSQ (1) = 9.5502 [0.002]

Table 16: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)		
Panel A: Co-integrating Vector for nz3 for Full Period (1980M4 – 2000M3) Order of VAR = 1, chosen r =2. List of variables included in the co-integrating vector: nz3 ryc rs1 rs3 liip		
Variables	Vector 1	Vector 2
nz3	-0.11359 (-1.0000)	-0.47722 (-1.0000)
rs1	-0.9516E-3 (-0.0083776)	-0.085978 (-0.18016)
rs3	-0.014030 (-0.12351)	-0.7343E-3 (-0.0015387)
Ryc	0.0044556 (0.039226)	0.026714 (0 .055978)
Liip	0.040627 (0.35767)	0.35842 (0.75107)
Intercept	0.081276 (0.71554)	-0.60479 (-1.2673)
Panel B: **LR Test of Restrictions**		
a1=0	CHSQ (2) = 29.432 [0.000]	
a2=0	CHSQ (2) = 21.1021 [0.000]	
a3=0	CHSQ (2) = 46.0262 [0.000]	
a4=0	CHSQ (2) = 9.5759 [0.008]	
a5=0	CHSQ (2) = 29.1841 [0.000]	

Table 17: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)

Panel A: Co-integrating Vector for nz3 for Part Period (1980M4-1990M3)

Order of VAR = 1, chosen r =3.
List of variables included in the co-integrating vector:
nz3 ryc rs1 rs3 liip

Variable	Vector 1	Vector 2	Vector 3
Nz3	0.51486 (-1.0000)	0.95099 (-1.0000)	0.25549 (-1.0000)
Rs1	0.25443 (-0.49417)	-.074547 (0 .078389)	0.11672 (-0.45686)
Rs3	0.038213 (-.074221)	0.7670E-3 (-0.8065E-3)	-0.0095410 (0.037344)
Ryc	-0.015007 (0.029148)	-0.030960 (0 .032555)	-0.083060 (0.32510)
Liip	-1.1829 (2.2976)	0.18538 (-0.19493)	0.15190 (-0.59454)
Intercept	3.6925 (-7.1718)	-2.3492 (2.4703)	-1.3875 (5.4310)

Panel B:
LR Test of Restrictions

A1=0	CHSQ (3) = 22.7879 [0.000]
A2=0	CHSQ (3) = 26.4705 [0.000]
A3=0	CHSQ (3) = 14.2398 [0.003]
A4=0	CHSQ (3) = 4.0019 [0.261]
A5=0	CHSQ (3) = 35.8161 [0.000]

Table 18: Restricted Co-integrated Vectors in Johansen Estimation (Normalised in Brackets)	
Panel A: Co-integrating Vector for nz3 for Part Period (1990M4 – 2000M3) Order of VAR = 1, chosen r =1. List of variables included in the co-integrating vector: nz3 ryc rs1 rs3 liip	
Variables	Vector 1
nz3	0.25331 (-1.0000)
rs1	0.018493 (-0.073005)
rs3	-0.012620 (0.049820)
ryc	-0.024015 (0.094806)
liip	-0.54363 (2.1461)
Intercept	2.5511 (-10.0711)
Panel B: **LR Test of Restrictions**	
A1=0	CHSQ (1) = 3.0501 [0.081]
A2=0	CHSQ (1) = 0.6822 [0.409]
A3=0	CHSQ (1) = 10.914 [0.001]
A4=0	CHSQ (1) = 3.4997 [0.061]
A5=0	CHSQ (1) = 7.1091 [0.008]

Table 19
Period-wise Summary Results from SURE/VAR Exercises for Partial and Full Multipliers

Variable	1980-90	1990-00	1980-00
Panel A: **Full Multiplier z_1**			
rs1	-S (-S)	-S (-NS)	-S (+NS)
rs3	-NS (-S)	+NS (+S)	-NS (-S)
Ryc	+S (+NS)	+S (+S)	+S (-NS)
Real Y	+NS (+S)	+S (+S)	+NS (-NS)
Panel B: **Partial Multiplier nz3**			
rs1	-S (-S)	-S (-NS)	-S (-S)
rs3	-S (-S)	-NS (+S)	-S (-S)
Ryc	+S (+NS)	+S (+S)	+S (+S)
Real Y	+NS (+S)	+S (+S)	+S (+S)
Panel C: **Full Multiplier z_3**			
rs1	-S (-S)	-S (-NS)	-S (-S)
rs3	-S (-S)	-NS (-S)	-S (-S)
Ryc	+S (+NS)	+S (+S)	+S (+S)
Real Y	+NS (+S)	+S (+S)	+NS (+S)

Note: 1. -/+ Stand for negative/positive values respectively for the parameters. S and NS represent significance and non-significance of the variable in the related equations.
2. The parenthetic representations relate to the VAR results. S and NS represent significant and non-significant chi-square statistics.