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MONETARY FUNDAMENTALS AND RUPEE-U.S.$ BEHAVIOUR: AN INDIAN EVIDENCE - PRE AND POST LIBERALISATION

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ABSTRACT

The paper examines different forms of money demand functions and derives reduced form equations relating exchange rate with monetary and real fundamentals of two economies the currencies of which are being related. The paper tries to determine Indian Rupee-U.S. dollar exchange rate for the period spanning 1971 to 2004.The study also analyses the models separately for pre liberalization and post liberalization periods using Ordinary Least Square (OLS) in simple linear and partial adjustment frameworks. The empirical findings support the partial adjustment model for both the periods. But after liberalization, the naïve static form of the models has been found to perform better so far as the sign and significance of the parameters is concerned. Structural break is indicated in the exchange rate movements the breaking point being the year of liberalization - 1991.

The adverse sign of relative real output is because of externalization and supports growth theory of exchange rate which states that, with rise in growth rate, the income has depreciating effect on currency. As a policy this can be matched with a choice of competitive technology which makes export of high value goods competitive so as to compensate for importisation of real output.

The relative money supply and interest rate differential are significant determinants in corresponding models, therefore, the study indicates that there should be monetary policy coordination between India and U.S. to stabilize the rupee-$ exchange rate. The significance of inflation rate differential implies that domestically inflation rate targeting may be adopted in conjunction with other policies. Recent rise in rupee value is because of intense capital flow to stock market which has put pressure on rupee.

I. INTRODUCTION

The idea of monetary approach to exchange rate determination has its roots in money market equilibrium. In this approach, the currency is looked as an asset. As per this approach, exchange rate is determined just as the price of common stock [Mussa (1979)]. In other words, the equilibrium exchange rate is determined at a level at which the market as a whole is willing to hold the given stock of asset dominated in different currencies i.e. when the market forces of their demand and supply are equal. This approach concentrates on the mechanism through which the exchange rate eliminates the incipient capital flows, including adjustment in real money balances through exchange rate induced price level variation and adjustment in nominal interest rate through changes in the expected rate of exchange rate depreciation.

The monetary approach assumes that: the demand for money is a stable function of limited number of economic aggregates, and in the absence of transportation cost and trade restrictions, the law of one price will hold instantaneously all the time (i.e. flexibility of prices assumed).

II. REVIEW OF LITERATURE AND EVOLUTION OF EXCHANGE RATE MODELS

The literature on flexi-price modeling has developed over last thirty five years. In literature, every study has used equilibrium of money market as the starting point and equates demand for money to supply of money. The monetary approach to exchange rate determination starts with the writings of Gustav Cassel in the period 1919-30. It was promoted by Robert Mundell (1968) and Johnson (1972). The monetary approach had a revival in the early and mid- 1970's as documented in the collection by Frenkel (1978). In this period, rational expectations were fully integrated into the theory. Before the mid- 1970's, the stock based monetary approach can be seen as a precursor to the more general portfolio approach. Monetary approach is a special case we get by assuming perfect capital mobility and an exogeneous money supply.

Frenkel's (1976) study consists of the doctorinal aspects as well as the empirical evidence of the monetary approach to the exchange rate and probably it is the best expository study in this area. He provided theoritical explanation for various determinants of exchange rate. Bilson (1978) examined the empirical validity of a simple asset market model for deutsche /pound exchange rate during 1970-1977 and found that the actual behaviour of the deutsche/ pound rate during the period since 1970 is broadly consistent with the predictions of the monetary model. He also argued that the monetary model may be useful in the analysis of short-run behaviour and as a guide to the intervention policy.

Woo (1985) studied monetary approach to exchange rate determination, ascertaining that a money demand function with a partial adjustment mechanism had more empirical support than a money demand function which assumed instantaneous stock adjustment. Boothe and Poloz (1988) conducted a study to investigate the importance of monetary model of exchange rate determination given by Frenkel (1979) by allowing the unrestricted dynamics and taking care of the shift in demand for money due to the financial innovations and developments. He tested for the Canada-U.S. exchange rate by using simulation technique and found a strong evidence in form of generalized model but found that the adjustment for shift in official money supply data has only minor implications.

Ahking (1987) re-investigated the monetary exchange rate model using the dollar/ pound exchange rate in the 1920's. He was motivated by the serious doubts arising in the findings of earlier studies. According to Ahking, the doubts arouse mainly because the implications of the monetary exchange rate model were not adequately tested in the existing work. Moreover, there is a presumption that the failure of the monetary exchange rate model in 1970's and 1980's was due to the special events such as real shocks that affected PPP and the instability of the U.S. money demand function. His findings raised serious doubts about the validity of the simple monetary model, even during 1920's. MacDonald and Taylor (1991) re-examined the monetary approach to exchange rate determination for the three key currencies of Germany, Japan and the U.K. with the flexible exchange rate regime. They used the multivariate cointegration technique and found that the unrestricted monetary model is a valid framework for analyzing the long run exchange rate. MacDonald and Taylor (1993) again re-examined the monetary approach to exchange rate determination, using monthly data on the deutsche-mark- U.S. dollar exchange rate and found that the monetary model is valid as a long run equilibrium condition. Choudhry and Lawler (1997) also examined the validity of the monetary model of exchange rate determination by applying the Johansen Juselius (1990) cointegration technique for the Canada-U.S. exchange rate over the period of Canadian float of 1950-62. They found the model as explaining the long run equilibrium relationship. They also used the error correction model and noted that in short run the exchange rate has a tendency to revert towards the long run equilibrium value determined by the long run model. Miyakoshi (2000) applied monetary models of exchange rate determination to Korean data and used Johenson Juselius (1992) procedure to find out cointegrating vector and asserts that the test indicated at least one cointegrating vector indicating that flexi-price model will have long run validity and said that the result were in contrast to the findings by Baillie and Selover (1987) and Meese (1987).

Moersch and Nautz (2001) in their study gave an alternative to the widely used reduced form test of monetary model of exchange rate determination. They showed that the reduced form approach to monetary model has some problems like, it rests on various parameter restrictions which can be easily avoided by estimating the long run money demand function separately. The resultant 'structural' forecast equation which they gave, allows an economic interpretation of the various elements affecting the exchange rate in the monetary model. Tawadros (2001) using Johansen Juselius (1992) cointegration methodology for Australian dollar vs. U.S. dollar found that an unrestricted dynamic monetary model outperforms the random walk model at all the forecasting horizons with the degree of improvement increasing as the forecasting horizon increases. Rapach and Wohar (2002) re-examined the monetary model for 14 industrialised countries using annual data from late nineteenth century to early twentieth century, with the help of OLS regression and Johansen (1988) multivariate maximum likelihood procedure. The authors found considerable support for simple form of monetary model in the long run. Seth and Panwar (2002) tested the empirical validity of reduced form monetary model and compared with random walk model for Indian rupee/US $ exchange rate during the period 1971:1 to 2000:4 and found that during the whole sample period, the dynamic monetary model works better whereas in the pre and post liberalization periods, the static form of the model works better on the basis of forecasting performance. Hwang (2003) estimated Dorbnusch-Frankel sticky price model for US $/Canadian dollar exchange rate during the period Jan. 1980 to Dec. 2000, using Johansen – Jusaelius (1990) cointegration method and compared the forecasting performance of the models on the basis of root mean square error (RMSE). He concluded that the random walk model forecasts are better than the structural model forecasts. Seth and Panwar (2003) tested restricted and unrestricted form of monetary model for Indian rupee/US $ exchange rate for the period 1971 to 1999, using OLS regression and found that the unrestricted from of monetary model is better than restricted from for forecasting exchange rate. Chang (2004) tested random walk model for five developed countries for the period 7th August 1974 to 30th Dec. 1998 and observed that the random walk hypothesis is rejected only for Japanese Yen and it might be because of intervention policy of Bank of Japan. Ehrmann and Fratzcher (2005) examined US $/Euro exchange rate for the period 1993 to 2003. the authors examined news effect on exchange rate using weighted least square procedure and found that the news about the fundamentals have a significant effect on exchange rate. Seth and Panwar (2006) tested four different forms of flexi-price monetary model for Indian rupee/US $ exchange rate for the period 1971 to 2004, using OLS and compared the models on the basis of sign, significance, variation explained and short run and logn run elasticities. They found that the partial adjustment models work better than the naïve models. Islam and Hasan (2006) tested the validity of monetary model of exchange rate determination for dollar-yen exchange rate by using Johansen and Juselius (1992) cointegration procedure. The study found a long run relationship between the exchange rate and the monetary variables. They also found that the forecasting performance of the monetary model based on error correction model outperforms the random walk model.

Already stated that the theory assumes stable demand functions in the two economies but different economists have given different demand functions for money under different assumptions therefore different researchers have used different specifications for the flexi-price exchange rate models. This paper examines two important theories of money market equilibrium for obtaining specifications for the determination of exchange rate.

(a) Neo-Classical Money Demand Function And Exchange Rate

There are two models based on this money demand function: (i) Current Account Model, and (ii) Capital Account Model. The models have been derived as follows:

(i) Current Account Model

The neo-classical demand function for money is given as:

$$\frac{M^d}{P} = AY^{\alpha}e^{-\beta r} \qquad (2.1)$$

i.e. real money demand is directly related to real output and inversely related to interest rate. Here, M = nominal domestic money supply, P = domestic price level, Y = domestic real income, α is the elasticity with respect to income, r is the domestic interest rate, β is the semi- elasticity of money demand with respect to interest rate. In equilibrium, we have

$M^d = M^s = M$, where M^s is assumed to be autonomous.

Taking log on both sides after replacing M^d with M, we can write equation (2.1) as:

$$m = p + \alpha y - \beta r + a \qquad (2.2)$$

where except 'r', the other small letters are the natural logarithm of the corresponding variables.

Similarly assuming same elasticities and semi-elasticities, the foreign money market equilibrium condition can be given as:

$$m^* = p^* + \alpha y^* - \beta r^* + a \qquad (2.3)$$

where the asterisks denotes the variables associated with the foreign economy.

Subtracting equation (2.3) from equation (2.2) and rearranging the terms, we get:

$s = (m-m^*) - \alpha(y-y^*) + \beta(r-r^*)$ [since PPP holds continuously, $s = (p - p^*)$]. (2.4)

The above equation is generally called the 'current account monetary model' or 'reduced form monetary model'. The model states that increase in relative money supply and interest rate differential depreciates the domestic currency and increase in relative real output appreciates domestic currency.

(ii)Capital Account Monetary Model

If expectations are realised in the foreign exchange market then uncovered interest rate parity gives us:

$\dot{s} = r - r^*$, where $\dot{s}$ is the rate of change of exchange rate per unit of time,so that

$$s = (m - m^*) - \alpha(y - y^*) + \beta \dot{s} \qquad (2.5)$$

From relative PPP, we have $\dot{s} = \pi - \pi^*$, where π is the expected inflation rate. Therefore, the above equation can be rewritten as:

$$s = (m - m^*) - \alpha(y - y^*) + \beta(\pi - \pi^*) \qquad (2.6)$$

This is the *capital account monetary model* of exchange rate determination. The current account model assumes that: PPP holds continuously in the short run and ignores the synchronizing effect of interest rate on exchange rate. The capital account model assumes that IRP holds in the short run and ignores the synchronizing impact of inflation rate on exchange rate. The above model states that the increase in relative money supply and interest rate differential depreciates domestic currency whereas the increase in relative real output appreciates domestic currency.

Quantity Theory of Money and Exchange Rate

Having all the usual assumptions of quantity theory of money, Fisher's quantity theory of money gives us another monetary model of exchange rate determination. The quantity theory of money states that

$$MV = PT \qquad (2.7)$$

where, V = income velocity of money, and T= total transactions and other variables have usual meaning. In the above equation the right hand side i.e. PT shows the total volume of transactions multiplied by the general price level i.e. it represents the transaction demand for money. The left hand side of the equation i.e. MV is the effective money supply. Here, M is the money stock and V is the velocity. Infact the model represents equilibrium between money demand and money supply.

From the above equation, we have

$$\frac{M}{P} = \frac{T}{V} \qquad (2.8)$$

Since T is the total transactions undertaken in the economy, it can be proxied by Y, the real income of the economy. Taking log on both sides of equation (2.8) and replacing T by Y, we have

$$p = m + v - y \qquad (2.9)$$

where the small letters indicate the natural logarithmic values of the corresponding variables.

Similarly for the foreign economy, we have

$$p^* = m^* + v^* - y^* \qquad (2.10)$$

Subtracting equation (2.10) from equation (2.9), we get

$$(p - p^*) = (m - m^*) + (v + v^*) - (y - y^*) \qquad (2.11)$$

Assuming holding of absolute PPP it becomes

$$s = (m - m^*) + \alpha(v + v^*) - \beta(y - y^*) \qquad (2.12)$$

This equation gives the model for determing exchange rate based on quantity theory of money.[Euri and Resnik(2004)]. The model implies that with the increase in relative money supply and velocity of circulation, the domestic currency depreciates and with the increase in relative real output, the domestic currency appreciates.

III. RESEARCH METHODOLGY

The above studies have used different methodologies which range from ordinary least square, autocorrelation function, multivariate cointegration using Granger's cointegration technique of Johansen Juselius procedure. In this study, we have used static and dynamic models to examine the exchange rate movement. Ordinary least square method has been used for estimation purpose.

All the three monetary models are tested for three different time horizons; first during the entire period i.e. 1971-2004, and then by breaking this time period into two parts, the breaking point being the year of liberalisation in the Indian economy i.e. during the pre-liberalisation period (1971-1990) and the post-liberalisation period (1991-2004). Further, the models have been estimated in two different frameworks; firstly in their naive static form and then following Woo (1985) and Somnath (1986), we estimated the models in their dynamic form i.e. the partial adjustment framework. In order to capture the effect of structural breaks, we have introduced dummies into the models. Dum 75 is introduced to capture the effect of oil shock and and Dum 90 to include the shift from implicit managed float to explicit managed float and the effect of liberalization process on the exchange rate behaviour over the decade.

The flexi-price models as given by equations (2.4), (2.6) and (2.12) are theoritical in nature. Their estimatable naive static forms are given as:

Current account model:

$$s = \alpha_1 + \beta_1 (m - m^*) - \gamma_1 (y - y^*) + \lambda_1 (r - r^*) + \text{Dum75} + \text{Dum90} + \mu_1 \qquad (2.13)$$

Capital account model using expected inflation:

$$s = \alpha_2 + \beta_2 (m - m^*) - \gamma_2 (y - y^*) + \lambda_2 (\pi - \pi^*) + \text{Dum75} + \text{Dum90} + \mu_2 \qquad (2.14)$$

Capital account model using long run interest rate as proxy for expected inflation:

$$s = \alpha_3 + \beta_3 (m - m^*) - \gamma_3 (y - y^*) + \lambda_3 (r_1 - r_1^*) + \text{Dum75} + \text{Dum90} + \mu_3 \qquad (2.15)$$

with $\mathbf{H}_0$: $\beta n = 1$ and $\mathbf{H}_1$: $\beta n \neq 1$, $n = 1,2,3$ for the models (2.13), (2.14) and (2.15)

Quantity theory of money model:

$$s = \alpha_5 + \beta_5 (m - m^*) - \gamma_5 (y - y^*) + \lambda_5 (v - v^*) + Dum75 + Dum90 + \mu_5 \quad (2.16)$$

with $\mathbf{H}_0$: $\beta_5 = \gamma_5 = \lambda_5 = 1$, and $\mathbf{H}_1$: $\beta_5 \neq 1$, $\gamma_5 \neq 1$, and $\lambda_5 \neq 1$.

In partial adjustment framework, if δ is the speed of adjustment, then the estimatable equations will be:

Current account model:

$$s = \alpha_1' + \beta_1'(m - m^*) - \gamma_1'(y - y^*) + \lambda_1'(r - r^*) + Dum75 + Dum90 + (1 - \delta_1)st\text{-}1 + \mu'_1 \quad (2.17)$$

Capital account model using expected inflation:

$$s = \alpha_2' + \beta_2'(m - m^*) - \gamma_2'(y - y^*) + \lambda_2'(\pi - \pi^*) + Dum75 + Dum90 + (1 - \delta_2)st\text{-}1 + \mu'_2 \quad (2.18)$$

Capital account model using long run interest rate as proxy for expected inflation:

$$s = \alpha_3' + \beta_3'(m - m^*) - \gamma_3'(y - y^*) + \lambda_3'(rl - r_l^*) + Dum75 + Dum90 + (1 - \delta_3)st\text{-}1 + \mu'_3 \quad (2.19)$$

Quantity theory of money model

$$s = \alpha_5' + \beta_5'(m - m^*) - \gamma_5'(y - y^*) + \lambda_5'(v - v^*) + Dum75 + Dum90 + (1 - \delta_5)st\text{-}1 + \mu'_5 \quad (2.20)$$

such that $\alpha i' = \alpha i \delta i$, $\beta i' = \beta i \delta i$, $\gamma i' = \gamma i \delta i$, and $\lambda i' = \lambda i \delta i$ where i= 1,2,3, and 5.

IV. DATA SOURCES AND PERIOD OF STUDY

In order to estimate the four different types of models i.e. the current account model, the capital account model and the quantity theory of money model as represented by equations (2.13), (2.14), (2.15) and (2.16) and the corresponding partial adjustment model (2.17), (2.18), (2.19) and (2.20), the required data on GDP, general price level (WPI for India and PPI for the US) and nominal interest rates (bank rate for Indian and discount rate for the US) for the two economies is obtained directly from International Financial Statistics (IFS) from the lines 99b, 63, and 60 respectively. For money supply, M1 definition of money supply is used. The data on M1 for U.S. is extracted from line 59ma of IFS. The data on money supply for India is collected from Handbook of Statistics on Indian Economy (a publication of RBI). Since RBI supplies all data to IMF, therefore, the M1 definition for India that RBI is using is consistent with definition of other variables used in the study. The study is conducted for the time period 1971-2004, using the annual data.

V. THE EMPIRIAL FINDING

In order to draw meaningful conclusion from any estimated regression equation, first of all, the order of integration of all the variables considered in the regression equations must be ascertained. The obtained regression results will be meaningful when the order of integration of the dependent variable is higher or equal to the order of integration of the independent variables [Charemza (1992)]. The following table 1 gives the order of integration of all the variables considered in the study for all the models on the basis of Dickey and Fuller (1979) and Phillip Perron (1989). Both the tests were necessary because the series of variables have structural breaks.

We see from the table that log of exchange rate is integrated of order one i.e. (1). This is the dependent variable in all the equations. None of the explanatory variables has order greater than one, therefore, the regression would not be spurious and provide us meaningful conclusions.

autocorrelation problem in estimated errors (see appendix Table A-1). Therefore, the naïve static form was estimated with AR1 process (Cochrane-Orcutt) and the model having lagged dependent variable

Table 1
Order of integration of the variables considered in the study

Variables	ADF Values (1971-2004)	PP Values (1971-2004)	ADF Values (1971-1990)	PP Values (1971-1990)	ADF Values (1991-2004)	PP Values (1991-2004)
s_t	-19.6957 I(1)	-19.6957 I(1)	-9.4153 I(1)	-9.4153 I(1)	-10.5256 I(1)	-10.5256 I(1)
(m – m*)	-19.1140 I(1)	-19.1140 I(1)	-14.4254 I(1)	-14.4254 I(1)	-6.8473 I(1)	-6.8473 I(1)
(y – y*)	-28.5623 I(1)	-28.5623 I(1)	-16.7230 I(1)	-16.7230 I(1)	-11.3579 I(1)	-11.3579 I(1)
(r – r*)	-5.0306 I(0)	-5.0306 I(0)	-4.4382 I(0)	-4.4382 I(0)	-11.6874 I(1)	-11.6874 I(1)
$(\pi^e - \pi^e)$	-19.2156 I(0)	-18.5673 I(0)	-13.3103 I(0)	-13.3103 I(0)	-7.2944 I(0)	-7.2944 I(0)
$(r_L - r_L^*)$	-26.7509 I(1)	-26.7509 I(1)	-12.3192 I(1)	-12.3192 I(1)	-8.3644 I(0)	-8.3644 I(0)
(vl – vl*)	-23.1338 I(1)	-23.1338 I(1)	-15.0596 I(1)	-15.0596 I(1)	-8.8109 I(1)	-8.8109 I(1)

*Critical values for the ADF test
For Lags= 0, and no trend, ADF value at 1% level of significance is –2.65
* these critical values are given by Kerry Patterson(2000).

For current account monetary model and quantity theory of money monetary model, we have one table each. For the capital account model, we have two tables. The first of the tables give estimates using expected inflation and the second by using long run interest rate as a proxy for expected inflation. The regression estimates of the different models considered in the study are given below.

Current Account Monetary Model
The reduced form current account monetary model for the three spans of period was estimated and was found to be having was estimated with maximum likelihood estimation procedure.

The estimated reduced form current account monetary model is given in table 2. If we look at table 2, the signs of coefficients of relative money supply and of interest rate differential are proper and the coefficients are significant at 5% level of significance except for the period 1991-2004 (partial adjustment framework). The coefficients of relative real income have adverse sign except for the period 1971-90 (partial adjustment framework) and 1991-2004 (the naive static model). However, the coefficients are insignificant at 5% level of significance. Dum 90 is significant at 5% level of significance indicating a structural break during 1991 i.e. the year of liberalisation. Dum 75 is significant during 1971-90 indicating the impact of oil shock on exchange rate.

The analysis indicates that the monetary model explains the exchange rate movements for the whole period 1971-2004 and for 1971-90. Although the reduced form monetary modeling expresses the sign of the coefficient of relative real income to be negative; however the growth theory and the balance of payment theory of exchange rate determination assert the positive sign of the relative real income. It is well known that the growth rate of Indian national income is positively associated with imports (correlation = 0.98). The pressure of imports induces depreciation of the domestic currency and therefore, the coefficients have obtained positive signs. The monetary reduced form model during the period 1991-2002 does not work as well as in the other segment.

Table 2
Regression Results of Current Account Monetary Model (Final Estimates)
Dependent Variable : s_t

Independent Variable	**(1971-2004)**		**(1971-1990)**		**(1991-2004)**	
	Naïve Static Framework	**Partial Adjustment Framework**	**Naive Static Framework**	**Partial Adjustment Framework**	**Naive Static Framework**	**Partial Adjustment Framework**
constant	-0.3217 (-0.9091)	0.1991 (0.9652)	-0.8093 (-1.6659)	-0.7359 (-1.4818)	0.3079 (0.3267)	0.6461 (0.9748)
(m-m*)	0.6427 (6.6001)*	0.1909 (2.0576)*	0.7717 (5.9494)*	0.4977 (2.6954)*	0.6415 (2.3639)*	0.2178 (0.8029)
(y-y*)	0.3521 (1.1313)	0.4141 (2.4779)*	0.1125 (0.4274)	-0.0871 (-0.3010)	-0.3497 (-0.2696)	0.2130 (0.2417)
(r-r*)	0.0227 (3.4485)*	0.0179 (4.7274)*	0.0184 (3.2036)*	0.0148 (2.9919)*	0.0100 (0.5140)	0.0084 (0.6454)
s_{t-1}	-	0.5578 (5.8916)*	-	0.4679 (3.3023)*	-	0.4666 (1.4831)
Dum75	-	-	-	-	-	-
Dum90	0.1692 (2.3769)*	0.1101 (2.6038)*	-	-	-	-
R^2	0.9943	0.9969	0.9843	0.9861	0.9199	0.9586
$\bar{R}^2$	0.9931	0.9964	0.9798	0.9821	0.8899	0.9312
DW/h-statistic	1.4441	1.6955	1.8632	1.4916	1.2979	2.2846
$H_0 : \beta = 1$ $H_1 : \beta \neq 1$	**F-Value=** 13.4656 (0.0012 significance level)	**F-Value=** 70.0565 (0.0000 level of significance)	**F-Value=** 3.0995 (0.1001 level of significance)	**F-Value=** 7.4005 (0.0166 level of significance)	**F-Value=** 1.7456 (0.2229 level of significance)	**F-Value=** 8.3133 (0.0279 level of significance)
Rho coefficient	0.5889 (3.4755)	0.1582 (0.6873)	0.6324 (3.4476)	0.3129 (1.0556)	0.3017 (1.0602)	-0.4672 (-0.8702)

* significant at 5% level of significance
values in the parentheses represent t-values

Capital account reduced form monetary model using expected inflation

The initial estimates of capital account reduced form monetary model using expected inflation showed autocorrelation problem in the error term (see Table A-2), therefore, the models were estimated through AR1 process (Cochrane-Orcutt) when it was naïve static form and with the help of maximum likelihood method when it was in the partial adjustment framework. The estimated regressions are given in table 3.

Table 3 indicates that the naïve static framework does not works well over the period 1971-2002, as the coefficients of all the explanatory variables are insignificant except for Dum90. In the partial adjustment framework, the coefficients of relative real income, lagged dependent variable and the Dum 90 are significant. The signs of coefficients of real relative income are adverse in both types of model. The material change that has occured after removing autocorrelation is that the coefficient of relative inflation rate became insignificant in both the estimates. When the autocorrelation

Table 3
Regression Results of Capital Account Monetary Model Using Expected Inflation (Final Estimates)
Dependent Variable : s_t

Independent Variable	(1971-2004)		(1971-1990)		(1991-2004)	
	Naive Static Framework	Partial Adjustment Framework	Naive static Framework	Partial Adjustment Framework	Naive Static Framework	Partial Adjustment Framework
constant	16.5301 (2.1931)*	0.4555 (1.4932)	-2.6191 (-3.9932)*	-1.0173 (-1.6868)	0.7193 (1.3308)	0.7057 (1.1656)
(m-m*)	0.1735 (0.8931)	0.0994 (0.8049)	1.2719 (7.0368)*	0.4865 (2.1016)*	0.6102 (3.5931)*	0.5684 (1.2944)
(y-y*)	0.0923 (0.2579)	0.5755 (2.0397)*	-0.8991 (-2.1327)*	-0.2107 (-0.6235)	-0.7399 (-0.8598)	-0.6582 (-0.5385)
(π- π *)	0.0002 (0.1007)	0.0031 (1.3267)	0.0026 (0.8488)	0.0032 (1.5079)	0.0060 (0.9011)	0.0061 (0.8251)
s_{t-1}		0.6021 (4.8466)*	-	0.6251 (4.0320)*	-	0.0546 (0.1050)
Dum75	-	-	-	-	-	-
Dum90	0.2043 (3.1463)*	0.1901 (3.1893)*	-	-	-	-
R^2	0.9929	0.9951	0.9572	0.9809	0.9481	0.9482
$\overline{R}^2$	0.9914	0.9938	0.9480	0.9751	0.9222	0.9068
DW/h-statistic	1.5258	2.1669	1.4953	1.6964	1.7926	1.7864
$H_0 : \beta = 1$ $H_1 : \beta \neq 1$	F-Value= 18.0928 (0.0003 level of significance)	F-Value= 53.2087 (0.0000 level of significance)	F-Value= 2.2630 (0.1547 level of significance)	F-Value= 4.9218 (0.0449 level of significance)	F-Value= 5.2689 (0.0615 level of significance)	F-Value= 0.9659 (0.3708 level of significance)
Rho-coefficient	0.9972 (1.3865)	0.3498 (1.3213)	0.2213 (0.9381)	0.4115 (0.8808)	0.2541 (0.5657)	-0.1017 (-0.1439)

* significant at 5% level of significance
values in the parentheses represent t-values

in the naive static equation was removed, the only change that occured was that the significance of coefficient of relative income improved.

Capital Account Monetary Model Using Long Run Interest Rate as a Proxy for Expected Inflation

When inflation was proxied by long run interest rate, the estimated error of regression equations suffered from autocorrelation problem (see appendix Table A-3). The naïve static form was re-estimated by AR1 process (Cochrane-Orcutt) and the partial adjustment model was estimated with the help of maximum likelihood estimation procedure.

In table 4, we observe that coefficients of relative money supply have obtained correct signs and are significant at 5% level of significance in all the models except partial adjustment model for the period 1991-2004. The coefficient in this case is significant at 20% level of significance. The sign of coefficients of relative real income is adverse in both the regressions during 1971-2004 and during 1971-1990 in the naïve static form but the coefficients of relative real income is insignificant in all the models. The coefficients of long run interest

Table 4
Regression Results of Capital Account Monetary Model Using Long Run Interest Rate As a Proxy for Expected Inflation (Final Estimates)
Dependent Variable : s_t

Independent Variable	(1971-2004)		(1971-1990)		(1991-2004)	
	Naive Static Framework	**Partial Adjustment Framework**	**Naive Static Framework**	**Partial Adjustment Framework**	**Naive Static Framework**	**Partial Adjustment Framework**
constant	0.1615 (0.5796)	0.3683 (1.3673)	-0.6783 (-1.3232)	-1.0511 (-1.7536)	-0.0325 (-0.0612)	0.4826 (0.8917)
(m-m*)	0.5383 (6.9672)*	0.3070 (2.5085)*	0.7549 (5.5481)*	0.5122 (2.0489)*	0.7451 (4.1741)*	0.3821 (1.4119)
(y-y*)	0.3599 (1.4340)	0.4372 (1.7462)	0.0630 (0.2296)	-0.1351 (-0.3915)	-1.0481 (-1.1532)	-0.3121 (-0.3629)
$(r_L - r_L^*)$	0.0315 (5.5874)*	0.0219 (3.2249)*	0.0209 (3.2915)*	0.0006 (0.0463)	0.0403 (3.1545)*	0.0211 (1.4920)
s_{t-1}	-	0.3019 (2.2192)*	-	0.6169 (1.7358)	-	0.3241 (1.1041)
Dum75	-	-	-	-0.0633 (-1.6841)	-	-
Dum90	0.2367 (4.6335)*	0.2098 (4.2256)*	-	-	-	-
R^2	0.9961	0.9966	0.9839	0.9827	0.9632	0.9677
$\overline{R}^2$	0.9953	0.9957	0.9793	0.9760	0.9494	0.9462
DW/h-statistic	1.6556	1.8433	1.8703	1.7371	1.5154	1.9165
$H_0 : \beta = 1$ $H_1 : \beta \neq 1$	**F-Value=** 35.6989 (0.0000 level of significance)	**F-Value=** 32.0545 (0.0000 level of significance)	**F-Value=** 3.2429 (0.0933 level of significance)	**F-Value=** 3.8074 (0.0729 level of significance)	**F-Value=** 2.0383 (0.1912 level of significance)	**F-Value=** 5.2151 (0.0625 level of significance)
Rho-coefficient	0.5305 (2.5509)	0.4729 (1.8712)	0.5565 (1.3885)	0.3000 (0.7276)	2.1109 (0.6392)	-0.4086 (-0.8102)

*significant at 5% level of significance
values in the parentheses represent t-values

rate differential have obtained the correct signs and are significant during 1971-2004 and in the naïve static regression during the two segments but the coefficients in partial adjustment framework were insignificant.

We see that all the regression equations explain more than 94% variations in the dependent variable. If we compare the capital account models, the models with long run interest rate as proxy of expected inflation (the regressions using proxy) perform better in terms of significance of the variables and the explanatory power of the equations.

Quantity Theory of Money Model

In case of quantity theory of money model also, the initial equations suffered from autocorrelation problem in the error term (see appendix Table A-4). Therefore, the naïve static form was estimated through AR1 process (Cochrane-Orcutt) and the equations containing lagged dependent variable were estimated with the maximum likelihood estimates. The estimated equations are given below in table 5.

In the final models, the signs of all the variables are as expected by theory, except the sign of real relative income during the entire period. Insignificance of real relative income has already been explained. In the post- liberalization, the model is supporting the theory very well as all variables are having expected signs.

Table 5
Regression Results of Quantity Theory of Money Model (Final Estimates)
Dependent Variable : s_t

Independent Variable	(1971-2004)		(1971-1990)		(1991-2004)	
	Naive Static Framework	**Partial Adjustment Framework**	**Naive Static Framework**	**Partial Adjustment Framework**	**Naive Static Framework**	**Partial Adjustment Framework**
constant	-0.1797 (-0.5863)	0.3072 (1.1637)	-1.1296 (-2.2244)*	-1.0004 (-1.8526)	-0.2944 (-0.4348)	1.1700 (2.5188)*
(m-m*)	0.8269 (7.9732)*	0.3424 (1.8669)	1.0773 (8.3602)*	0.7117 (3.0499)*	0.9794 (3.8444)*	-
(y-y*)	0.4649 (4.6229)*	0.6345 (3.2658)*	-0.0218 (-0.0630)	-0.1018 (-0.3120)	-0.7037 (-0.6912)	0.4281 (0.6755)
(v_L - v_L *)	0.1403 (4.6229)*	0.0826 (2.5222)*	0.1354 (2.5222)*	0.0695 (2.1113)*	0.1312 (2.3925)*	-0.0320 (-0.7959)
s_{t-1}	-	0.4661 (2.9257)*	-	0.4090 (2.1888)*	-	0.5632 (2.6857)*
Dum75	-	-	-		-	-
Dum90	0.1677 (2.5818)*	0.1158 (2.1961)*	-	-	-	-
R^2	0.9949	0.9954	0.9750	0.9827	0.9518	0.9566
$\overline{R}^2$	0.9938	0.9945	0.9703	0.9778	0.9338	0.9380
DW/h-statistic	1.7532	1.5413	1.2208	1.5494	1.8852	2.4974
$H_0 : \beta = 1$ $H_1 : \beta \neq 1$	**F-Value=** 2.7820 (0.1078 level of significance)	**F-Value=** 12.8598 (0.0014 level of significance)	**F-Value=** 0.3601 (0.5568 level of significance)	**F-Value=** 1.5258 (0.2371 level of significance)	**F-Value=** 0.0065 (0.9377 level of significance)	**F-Value=** 4.2361 (0.3894 level of significance)
Rho-coefficient	0.4417 (2.0093)*	0.3526 (1.2871)	0.4082 (1.1470)	0.2658 (0.6086)	0.2074 (0.5916)	-0.5377 (-1.4169)

* significant at 5% level of significance
values in the parentheses represent t-values

Comparing the models

If we look at the performance of the models in terms of signs and significance of the variables and the explanatory power of the regression, it is observed that over the whole period the partial adjustment models perform better than naive static form in all the models. Similar behaviour is also observed in the case of 1971-1990 also. However, during the segment 1991-2004, the naïve static form is performing better than the partial adjustment framework.

When we look at the Appendix Table A-5, in the short run none of the models show unit elasticity of relative money supply. The maximum elasticity in the short run was 0.71 during 1971-1990 in the quantity theory of money model. Maximum short run elasticity with respect to relative real income is 0.65 in the capital account model during 1991-2004. The responsiveness of other variables such as interest rate differential, inflation rate differential, long run interest rate differential and relative income velocities is low. In the long run, the maximum elasticity has been shown during the period 1971-1990 which equals 1.3369 when capital account model was applied on the data with long run interest rate as proxy for inflation. In the capital account model, the elasticity of spot exchange rate with respect to relative real income is highest during 1971-2004 which is 1.44 when expected inflation was proxied through rational expectations and 1.34 when expected inflation was proxied by long run interest rate.

The long run elasticity with respect to relative income among the four models has been highest with the capital account model in the long run using expected inflation. It is 1.45 during 1971-2004 followed by quantity theory of money model (1.19) again followed by current account model (0.94). It has been observed that elasticities with respect to interest rate differential, inflation rate differential have been very low but with respect to relative income and velocity of circulation, it is unity

During the period 1971-1990, the exchange rate has been responsive to relative money supply. While the responsiveness with respect to interest rate differential and the inflation rate differential has been low.

VI. CONCLUSION

The study indicates that adding the time series component increases the variation explained [Somnath (1986)]. In all the models, the variation explained in the dependent variable is more than 94%. The year of 1991 represents the year of structural break. Various models have indicated that relative money supply, relative real income, interest rate differential, inflation rate differential as proxied by long run interest rate differential, and relative velocity of circulation are the significant determinants of exchange rate movements over the whole periods. During 1971-1990, the behaviour of relative money supply and relative real income has remained the same whereas during 1991-2004, relative money supply has been a significant determinant of exchange rate. However, naive static form of capital account model with expected inflation rate differential as proxied by long run interest rate differential was the only model which worked well. It is also observed that over the whole period, the models work well in terms of sign and significance of the variables. During 1991-2004, there is no clear cut indication of other variables being significant other than relative money supply. However, during 1971-1990, some of the models have worked well of which capital account model with inflation rate differential proxied by long run interest rate differential and current account model in naïve static form are the important ones.

VII. POLICY IMPLICATIONS

The estimation of the models has revealed the relevant variables affecting exchange rate. The coefficients of these variables are the elasticities and partial elasticities of exchange rate with respect to variables included in the models. The short and long run elasticities (Appendix – 6) indicate the dimensions to which the change in exchange rate would occur if the variables included in the models are affected by policy instruments to the extent of a percent. This information can be used to select the policy instruments for stabilizing exchange rate. The relative money supply usually has low response as against the relative real income in both the short and the long run and the relative real income variable has positive sign indicating depreciating behaviour instead of appreciating beheviour of exchange rate as given in the theory. It is due to the externalization of the growth process. If the externalization is reduced, the relative GDP will tend to appreciate rupee and therefore the policy choice remains between externalization or internalization of the growth process. To contain excessive externalization, we need to adopt policies which promote exports of high value goods and for that India needs to develop competitive technology against countries such as China, Korea, Indonesia, Thialand etc.

Significance of relative money supply variable in all the models indicate that we need to have monetary policy coordination with U.S. so as to stabilize the Rupee-U.S.$ exchange rate. The models also indicate that inflation rate differential is an important determinant and needs to be targeted through policy. In India, in a recent statement, the governor of reserve bank has already expressed this need. Although, inflation at present is below 5%, the monetary policy is targeted to an inflation rate below this level. The interest rate differential is also an important determinant in the current account model over the whole period. This shows that a special watch on U.S. interest rate is required and a corresponding effect-mitigating policy is required to be adopted.

Notes:

1. $s^* = f[(m - m^*), (y - y^*), (r - r^*)]$

s^* is the equilibrium exchange rate

$(s_t - s_t\text{-}1) = - \lambda (s^*_t - s_t - 1)$

$s_t = \lambda (f) + (1 - \lambda) s_t\text{-}1$ i.e. the actual exchange rate moves partially towards its equilibrium value.

2. expected inflation rate differential is generated through rational expectation model

$Y_t = \alpha Y_t\text{-}1 + t_i$

$\mathbf{H}_0: \alpha = 1, \mathbf{H}_1: \alpha \neq 1$ i.e. restricting $\alpha = 1$.

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APPENDIX

Table A-1
Regression Results of Current Account Monetary Model (Initial Estimates)
Dependent Variable : s_t

Independent Variable	(1971-2002) No. of Observations = 32		(1971-1990) No. of Observations = 20		(1991-2002) No. of Observations = 12	
	Naive Static Form	Partial Adjustment Framework	**Naive Static Form**	**Partial Adjustment Framework**	Naive Static Form	**Partial Adjustment Framework**
constant	-0.1762 (-0.5691)	0.3090 (1.3829)	-1.0309 (-1.9007)	-0.7544 (-1.6999)	0.3079 (0.3267)	0.6461 (0.9748)
(m-m*)	0.6109 (7.2407) *	0.1649 (1.7486)	0.8492 (5.6304) *	0.5179 (3.1344) *	0.6415 (2.3639)*	0.2178 (0.8029)
(y-y*)	0.3799 (1.2571)	0.5533 (0.2013)	-0.0408 (-0.1172)	0.0229 (0.0871)	-0.3497 (-0.2696)	0.2130 (0.2417)
(r-r*)	0.0284 (5.6479) *	0.0176 (0.0038)	0.0233 (4.1423) *	0.0134 (2.9802) *	0.0100 (0.5140)	0.0084 (0.6454)
s_{t-1}	-	0.5584 (5.9551) *	-	0.4526 (3.5689) *	-	0.4666 (1.4831)
Dum75	-0.0472 (-1.0689)	-0.0370 (-1.2152)	-0.0719 (-2.0285)*	-0.0529 (-2.1302)*	-	-
Dum90	0.2191 (3.8035)*	0.1039 (2.4645)*	-	-	-	-
R^2	0.9931	0.9972	0.9759	0.9897	0.9199	0.9586
$\bar{R}^2$	0.9918	0.9964	0.9696	0.9857	0.8899	0.9312
DW/h-statistic	1.2375	1.8924	1.1877	2.1757	1.2979	2.2846
$H_0 : \beta = 1$ $H_1 : \beta \neq 1$	**F-Value=** 21.2636 (0.0001 level of significance)	**F-Value=** 78.3323 (0.0000 level of significance)	**F-Value=** 0.9999 (0.3332 level of significance)	**F-Value=** 8.5091 (0.1201 level of significance)	**F-Value=** 1.7456 (0.2229 level of significance)	**F-Value=** 8.3133 (0.0279 level of significance)
Rho coefficient	0.5896 (3.2301)	0.0609 (0.2482)	0.6409 (3.0579)	-0.1893 (-0.5538)	0.3017 (1.0602)	-0.4672 (-0.8702)

* significant at 5% level of significance
values in the parentheses represent t-values

Table A-2
Regression Results of Capital Account Monetary Model Using Expected Inflation (Initial Estimates)
Dependent Variable : s_t

Independent Variable	(1971-2002)		(1971-1990)		(1991-2002)	
	Naive Static Framework	Partial Adjustment Framework	**Naive Static Framework**	**Partial Adjustment Framework**	Naive Static Framework	**Partial Adjustment Framework**
constant	-0.0637 (-0.1449)	0.5063 (1.7717)	-2.6227 (-4.0338)*	-1.0733 (-1.7951)	0.7193 (1.3308)	0.7057 (1.1656)
(m-m*)	0.5669 (4.8172)*	0.0274 (0.2443)	1.2822 (7.1468)*	0.5200 (2.2552)*	0.6102 (3.5931)*	0.5684 (1.2944)
(y-y*)	0.4551 (1.0572)	0.6275 (2.3484)*	-0.7806 (-1.8105)	-0.1492 (-0.4412)	-0.7399 (-0.8598)	-0.6582 (-0.5385)
(π- π *)	0.0098 (2.5463)*	0.0055 (2.1999)*	0.0004 (0.1249)	0.0016 (0.6605)	0.0060 (0.9011)	0.0061 (0.8251)
s_{t-1}	-	0.7016 (6.3205)*		0.6042 (3.9166)*	-	0.0546 (0.1050)
Dum75	0.0318 (0.4435)	-0.0046 (-0.1026)	-0.0624 (-1.1170)	-0.0444 (-1.1462)	-	-
Dum90	0.3320 (4.7393)*	0.1354 (2.5413)*	-	-	-	-
R^2	0.9871	0.9953	0.9609	0.9829	0.9481	0.9482
$\overline{R}^2$	0.9844	0.9941	0.9489	0.9757	0.9221	0.9068
DW/h-statistic	1.1027	1.9325	1.6236	1.8685	1.7926	1.7864
$H_0 : \beta = 1$ $H_1 : \beta \neq 1$	**F-Value=** 13.5349 (0.0012 level of significance)	**F-Value=** 75.2544 (0.0000 level of significance)	**F-Value=** 2.4745 (0.1397 level of significance)	**F-Value=** 4.3319 (0.0595 level of significance)	**F-Value=** 5.2689 (0.0615 level of significance)	**F-Value=** 0.9659 (0.3708 level of significance)
Rho-coefficient	0.9974 (29.5215)	0.4379 (1.7139)	0.7575 (4.0333)	0.1008 (0.2190)	0.2541 (0.5657)	-0.1017 (-0.1439)

* significant at 5% level of significance
values in the parentheses represent t-values

Table A-3
Regression Results of Capital Account Monetary Model Using Long Run Interest Rate As a Proxy for Expected inflation (Initial Estimates)
Dependent Variable : s_t

Independent Variable	(1971-2002) Naive Static Framework	(1971-2002) Partial Adjustment Framework	(1971-1990) Naive Static Framework	(1971-1990) Partial Adjustment Framework	(1991-2002) Naive Static Framework	(1991-2002) Partial Adjustment Framework
constant	0.3895 (1.5794)	0.5984 (2.4719)*	-0.5699 (-0.9798)	-1.0511 (-1.7536)	-0.0325 (-0.0612)	0.4826 (0.8917)
(m-m*)	0.4763 (7.0381)*	0.1811 (1.4292)	0.7389 (4.6344)*	0.5122 (2.0489)*	0.7451 (4.1741)*	0.3821 (1.4119)
(y-y*)	0.4742 (1.8886)	0.6264 (2.6453)*	0.0826 (0.2377)	-0.1351 (-0.3915)	-1.0481 (-1.1532)	-0.3121 (-0.3629)
$(r_L - r_L^*)$	0.0337 (7.4108)*	0.0199 (3.0189)*	0.0253 (4.3867)*	0.0006 (0.0463)	0.0403 (3.1545)*	0.0211 (1.4920)
s_{t-1}	-	0.4126 (2.6932)*		0.6169 (1.7358)	-	0.3241 (1.1041)
Dum75	0.0027 (0.0711)	-0.0141 (-0.3785)	-0.0405 (-1.0984)	-0.0633 (-1.6841)	-	-
Dum90	0.2682 (6.0105)*	0.1856 (3.6541)*				
R^2	0.9951	0.9961	0.9774	0.9827	0.9632	0.9677
$\bar{R}^2$	0.9941	0.9951	0.9714	0.9760	0.9494	0.9462
DW/h-statistic	1.0484	1.2473	1.0595	1.7371	1.5954	1.9165
$H_0 : \beta = 1$ $H_1 : \beta \neq 1$	F-Value= 59.8661 (0.0000 level of significance)	F-Value= 41.7346 (0.0000 level of significance)	F-Value= 2.6807 (0.1224 level of significance)	F-Value= 3.8074 (0.0729 level of significance)	F-Value= 2.0383 (0.1912 level of significance)	F-Value= 5.2151 (0.0625 level of significance)
Rho-coefficient	0.5337 (2.5124)*	0.4805 (1.8851)	0.5702 (1.3525)	0.4873 (1.0573)	0.2111 (0.6392)	-0.5181 (-1.1962)

* significant at 5% level of significance
values in the parentheses represent t-values

Table A-4
Regression Results of Quantity Theory of Money Model (Initial Estimates)
Dependent Variable : s_t

Independent Variable	(1971-2002)		(1971-1990)		(1991-2002)	
	Naive Static Framework	Partial Adjustment Framework	**Naïve Static Framework**	**Partial Adjustment Framework**	Naive Static Framework	**Partial Adjustment Framework**
constant	-0.3397 (-1.2171)	0.2113 (0.5807)	-1.0348 (-1.8855)	-1.0239 (-1.8591)	-0.2944 (-0.4348)	1.1707 (1.2746)
(m-m*)	0.9111 (9.4965)*	0.4018 (1.6687)	1.0691 (8.0555)*	0.6272 (2.3617)*	0.9794 (3.8444)*	-0.0005 (-0.0008)
(y-y*)	0.3198 (1.1959)	0.5602 (2.0418)*	-0.0066 (-0.0184)	-0.0979 (-0.2948)	-0.7037 (-0.6912)	0.4287 (0.4047)
$(v_L - v_L^*)$	0.1736 (6.9555)*	0.0927 (2.2000)*	0.1492 (4.0618)*	0.0398 (0.7435)	0.1312 (2.3925)*	-0.0321 (-0.3449)
s_{t-1}	-	0.4299 (2.3023)*	-	0.4989 (2.1854)*	-	0.5635 (1.3103)
Dum75	0.0666 (1.5442)	0.0189 (0.3907)	0.0259 (0.5357)	-0.0354 (-0.7122)	-	-
Dum90	0.1347 (2.3745)*	0.1150 (2.1421)*	-	-	-	-
R^2	0.9946	0.9955	0.9755	0.9834	0.9518	0.9566
$\bar{R}^2$	0.9936	0.9943	0.9689	0.9769	0.9338	0.9277
DW/h-statistic	1.3086	1.5109	1.2356	1.6720	1.8852	2.4973
$H_0 : \beta = 1$ $H_1 : \beta \neq 1$	**F-Value=** 0.8567 (0.3632 level of significance)	**F-Value=** 6.1701 (0.0204 level of significance)	**F-Value=** 0.2713 (0.6101 level of significance)	**F-Value=** 1.9704 (0.1838 level of significance)	**F-Value=** 0.0065 (0.9377 level of significance)	**F-Value=** 3.0058 (0.1337 level of significance)
Rho-coefficient	0.3821 (1.5234)	0.3550 (1.2636)	0.4266 (1.0149)	0.2226 (0.5039)	0.2074 (0.5916)	-0.5121 (-1.0510)

* significant at 5% level of significance

values in the parentheses represent t-values

Table A-5

Correlation Matrix (1971- 2004)

	s_t	(m-m*)	(v_L - v_L *)	(y-y*)	(r-r*)	(r_L - r_L *)	(π- π *)
s_t	1.0	0.9805	-0.5543	0.9491	0.7315	0.7259	0.4952
(m-m*)	0.9805	1.0	-0.689	0.9731	0.6165	0.6097	0.4189
(v_L - v_L *)	-0.5543	-0.689	1.0	-0.7258	-0.005	0.0002	-0.0120
(y-y*)	0.9491	0.9731	-0.7258	1.0	0.6023	0.5958	0.4047
(r-r*)	0.7315	0.6165	-0.005	0.6023	1.0	0.9998	0.5446
(r_L - r_L *)	0.7259	0.6097	0.0002	0.5958	0.9998	1.0	0.5547
(π- π *)	0.4952	0.4189	-0.0120	0.4047	0.5446	0.5546	1.0

Correlation Matrix (1971- 1990)

	s_t	(m-m*)	(v_L - v_L *)	(y-y*)	(r-r*)	(r_L - r_L *)	(π- π *)
s_t	1.0	0.8872	-0.5439	0.7104	0.4956	-0.068	0.2295
(m-m*)	0.8872	1.0	-0.8479	0.9029	0.1541	-0.456	0.1302
(v_L - v_L *)	-0.5439	-0.8479	1.0	-0.8965	0.2954	0.7521	0.0147
(y-y*)	0.7104	0.9029	-0.8965	1.0	-0.0206	-0.6126	0.081
(r-r*)	0.4956	0.1541	0.2954	-0.0206	1.0	0.5198	0.1507
(r_L - r_L *)	-0.068	-0.456	0.7521	-0.6126	0.5198	1.0	-0.1994
(π- π *)	0.2295	0.1302	0.0147	0.081	0.1507	-0.1994	1.0

Correlation Matrix (1991- 2004)

	s_t	(m-m*)	(v_L - v_L *)	(y-y*)	(r-r*)	(r_L - r_L *)	(π- π *)
s_t	1.0	0.9574	-0.8534	0.9288	-0.7851	0.0742	0.3792
(m-m*)	0.9574	1.0	-0.9499	0.9758	-0.8479	-0.1303	0.3953
(v_L - v_L *)	-0.8534	-0.9499	1.0	-0.9163	0.8747	0.2308	0.0152
(y-y*)	0.9288	0.9758	-0.9163	1.0	-0.823	-0.0724	-0.3504
(r-r*)	-0.7851	-0.8479	0.8747	-0.823	1.0	-0.0965	0.3524
(r_L - r_L *)	0.0742	-0.1303	0.2308	-0.0724	-0.0965	1.0	-0.0983
(π- π *)	0.3792	0.3953	0.0152	-0.3504	0.3524	-0.0983	1.0