# The Relationship between Interest Rate and Exchange Rate in India

**Pradyumna Dash***

## Introduction

The theoretical as well as empirical relationship between the interest rate and exchange rate has been a debatable issue among the economists. According to Mundell-Fleming model, an increase in interest rate is necessary to stabilize the exchange rate depreciation and to curb the inflationary pressure and thereby helps to avoid many adverse economic consequences. The high interest rate policy is considered important for several reasons. Firstly, it provides the information to the market about the authorities' resolve not to allow the sharp exchange rate movement that the market expects given the state of the economy and thereby reduce the inflationary expectations and prevent the vicious cycle of inflation and exchange rate depreciation. Secondly, it raises the attractiveness of domestic financial assets as a result of which capital inflow takes place and thereby limiting the exchange rate depreciation. Thirdly, it not only reduces the level of domestic aggregate demand but also improves the balance of payment position by reducing the level of imports. But the East Asian currency crisis and the failure of high interest rates policy to stabilize the exchange rate at its desirable level during 1997-1998 have challenged the credibility of raising interest rates to defend the exchange rate. Critics argue that the high interest rates imperil the ability of the domestic firms and banks to pay back the external debt and thereby reduce the probability of repayment. As a result, high interest rates lead to capital outflows and thereby depreciation of the currency.

The exchange rate regime in our country has undergone a significant change during 1990s. Until February 1992, exchange rate in India was fixed by the Reserve Bank of India. Thereafter a dual exchange rate system was adopted during March 1992 to

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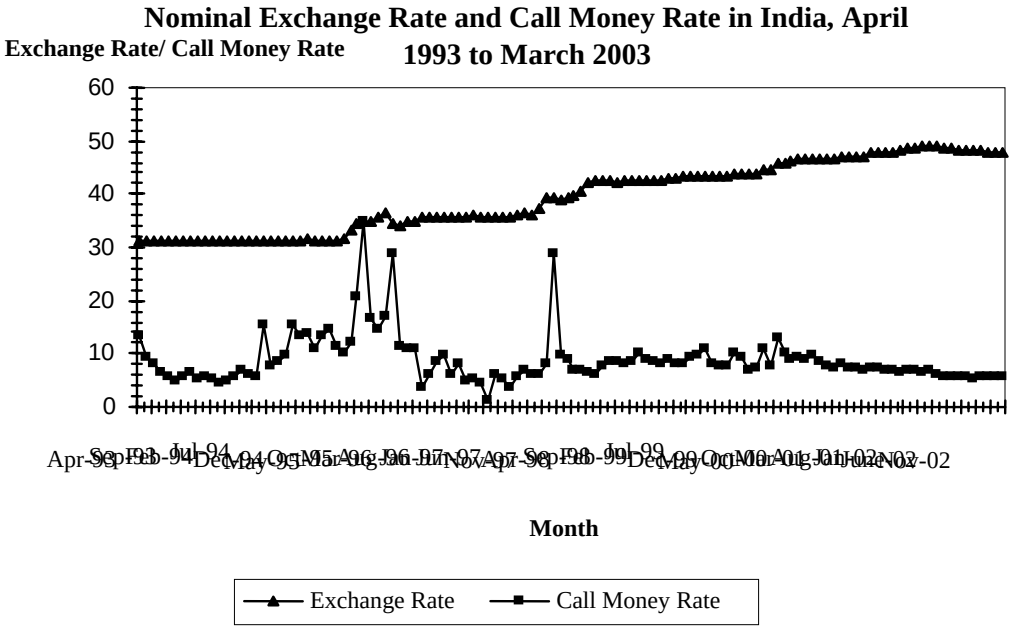
**Figure1:**




February 1993 which also came to an end and a unified market came into being in March 1993. The present exchange rate regime in India is popularly known as managed floating with no fixed target. It is said that because of this regime, India reaps the benefit of flexible exchange rate system on the one hand and less volatility in the foreign exchange market on the other. It has been observed that our economy witnessed nearly a constant exchange rate (around Rs 31.37 per USA $) during March 1993 to August 1995 (See Fig 1). However, after that the external value of the rupee was found to be under pressure for a few episodes because of various reasons like the East Asian and Russian currency crisis, border conflict, rise in oil prices, political instability etc. Besides the foreign exchange intervention in terms of purchasing and selling of foreign securities, the Reserve Bank of India has been using high interest rate policy to contain the excessive volatility of exchange rates in the foreign exchange market (See, Figure: 1). For example, the call money rate was allowed to increase to 34.83 percent in November 1995, 28.75 percent in March 1996, and again 28.75 percent in January 1998 to contain the excessive market pressure on rupee in the foreign exchange market. However, after restoration of

normal condition in the foreign exchange market the call money rate is brought back to its normal level.

However, it is unlikely to accept the changes in interest rate policy to be purely exogenous to stabilize the exchange rates because the monetary authorities in many countries resort to high interest rates policy when the currency is under pressure and low interest rates policy when the currency is in normalcy. In other words, declines in the value of the exchange rate may themselves prompt monetary authorities to raise domestic interest rates. For example, exchange rates depreciation in Thailand, Malaysia, Indonesia, Korea, and the Philippines during 1997-98 was associated with rising interest rates and vice versa. The monetary authorities in India might be using high interest rate policy whenever there is a pressure on rupee (See Fig 1). In other words, exchange rate depreciation may cause the rise in interest rate. Therefore, both the interest rate and exchange rate might be affecting each other.

Finally, the question is about the desirability of raising interest rates to stabilize the exchange rate. In other words, even if one identifies a set of policies and conditions under which raising interest rates successfully defend the value of rupee, but the costs of doing so in terms of output loss, financial system fragility, decline in investment, etc may outweigh the benefits of a more nominal appreciated exchange rate.

Therefore, there is a need to answer empirically the questions such as: what is the relationship between the interest rate and exchange rate in India? Whether and how far the exchange rate depreciates or appreciates due to an increase in interest rate? Can the exchange rate be stabilized during the downward pressure on rupee by raising the domestic interest rates in India? What is the causal relationship between interest rate and exchange rate? Is interest rate exogenously or endogenously determined in the context of stabilizing exchange rate? Can the opportunity cost of stabilizing nominal exchange rate through raising interest rate is too high?

In this context, the major objective of this paper is to examine whether and how far the high interest rate policy resulted in exchange rate stabilization in India during 1990s. The paper is structured as follows. Section I discusses review of literature on interest rate and exchange rate relationship. The methods and methodology are discussed in Section-II. Section-III discusses the empirical findings. Section-IV discusses the optimality and trade-offs in raising interest rates in India. The conclusions are presented in Section-V.

## Section-I

## Review of Literature on Interest rate and Exchange rate

Before discussing the economic literature on the relationship between interest rate and exchange rate elaborately, it would be useful to discuss briefly some of the important theories of exchange rate determination. There are many theories such as Purchasing Power Parity theory (PPP), Flexible Price Monetary Model (FPM), the Sticky Price Monetary Model (SPM), the Real Interest Rate Differential Model (RIRD), and the Portfolio Balance Theory (PBT) of exchange rate determination. The PPP maintains the equality between domestic and foreign prices measured in domestic currency term via commodity arbitrage. If the equilibrium condition is violated, the same commodity after adjusting exchange rate will be sold at different prices in different countries. As a result, commodity arbitrage or simultaneous buying of a commodity in the lower price country and selling it in the higher price country will bring back the exchange rate to its equilibrium level.

The FPM, SPM, and RIRD are known as the monetarists' model of exchange rate determination. The demand for and supply of money are the key determinants of exchange rates. They also assume that the domestic and foreign bonds are equally risky so that their expected returns would equalize, i.e., uncovered interest parity would prevail. Assuming wages in the labour market and commodity prices in the goods market to be perfectly flexible, PPP theory to hold continuously, and expected returns between the domestic and foreign bonds with similar risk and maturity are same, the FPM argues

that the relative money supplies, inflationary expectations, and economic growth as the major determinants of exchange rate in an economy. The SPM, which was first developed by Dornbusch (1976), argues that in the short-run prices and wages tend to be rigid, therefore, the desire of investors to equalize the expected returns across the countries is viewed as the major determinant of the short-run exchange rates, whereas goods market arbitrage is viewed as relevant to exchange rate determination in the medium and long-run**.** Frankel (1979) developed a model of exchange rate, which is known as 'real interest rate differential' model, which incorporates the role of inflationary expectations of the FPM and the sticky prices of the Dornbusch's model of exchange rate determination. According to the portfolio balance model, risk factors, current account, fiscal policy, authorities' intervention in the foreign exchange market are the major determinants of exchange rates (Branson, 1976; Kouri, 1976).

The uncovered interest parity theory which implies that domestic interest rate is the sum of world interest rate and expected depreciation of home currency is the basis of exchange rate determination. In other words, the interest rate differential between domestic country and world is equal to the expected change in the exchange change in the domestic exchange rate. According to the Mundell-Flemming model, higher interest differential would attract capital inflows and result in exchange rate appreciation. On the other hand, monetarists believe that higher interest rate reduces the demand for money which leads to depreciation of currency due to high inflation. But the nexus between the interest rates and exchange rate can be explained via the expected change in exchange rate. Assuming the world interest rate ($i^*$) to be exogenously determined, the relationship between domestic interest rate and exchange rate depends on how expected exchange rate responds to changes in interest rates. For example, in Dornbusch's over shooting model, expected exchange rate appreciates more than the spot rate that prevails before raising interest rates to equalize the return of domestic assets with the foreign assets. Therefore, there is a negative relationship between interest rate and exchange rate. i.e., a high interest rate policy is associated with exchange rate appreciation.

But the spot exchange rate might be affected positively by the high interest rate policy when the expected exchange rate becomes an increasing function of the domestic interest rates. According to Sargent and Wallace (1981) a high interest rate policy may lead to a reduction in demand for money and increase in price level because an increase in interest rate implies an increase in government debt which, in turn, would be financed by seinorage. As a result there will be exchange rate depreciation. Similarly an increase in interest rate may adversely affect the future export performance which would reduce the future flow of foreign exchange reserves and thereby, leads to depreciation of currency (Furman and Stiglitz, 1998).

Furman and Stiglitz (1998) argue that there are two important channels through which exchange rates are likely to be affected by the increase in interest rates. One of them is the risk of default and another one is the risk premium. Since the uncovered interest parity theory assumes no role for both these channels, the interest rate represents the promised return on domestic assets, i.e., actual interest receipts is equal to promised interest receipts. But in a post crisis situation, high interest rate policy may decrease the probability of repayment and increase the risk premium on domestic assets because of its adverse effect on domestic economic activity by reducing the profitability of domestic firms and increasing the borrowing costs. Therefore an increase in interest rate may lead to exchange rate depreciation. This could be stronger when the financial position of firms and banks is fragile.

Although the above-mentioned two views regarding the impact of interest rate on exchange rate contradicts to each other, the actual influence of interest rate on exchange rate depends on a few factors through which the transmission mechanism works. The uncovered interest parity theory on which the traditional theory of exchange rate determination is built assumes perfect capital mobility, risk neutrality, and rational expectations. Although these assumptions don't hold true in real life but the country specific high returns due to high interest rates may not prevail in the long-run because the exchange rate slowly depreciates to equalize the domestic returns with the foreign returns**.** But with the political stability and perfect information about economy's

fundamentals, a temporary increase in interest rate can bring exchange rate stability and low inflation through signaling because it will make investors to believe that there will be expected exchange rate appreciation, which, in turn, later lead to change in the appreciation of spot exchange rate even if the high interest rate policy is withdrawn later (Drazen, 2001). But according to Bensaid and Jeanne (1997), signaling channel of an increase in interest rate to defend the currency, when the domestic economy is weak and the government's political position is precarious, may have an adverse effect on exchange rate. However, over a period of time the cost of an interest rate defense may gets reflected in terms of financial fragility of banks and financial institutions, deteriotion of the fiscal position of the government, reduction in the share of export of national income and thereby, leads to the depreciation of currency. Therefore, even if the orthodox views on exchange rate appreciation is convincing, the adverse effect of high interest rates may outweigh the benefit of exchange rate appreciation. Therefore, the time and degree by which exchange rate responds to risk of defaults and risk premium determines the duration of the dominance of contrarians view over traditional view.

Keminsky and Schumulkler (1998) examined the time series correlation between daily exchange rates and interest rates for Indonesia, Korea, Malaysia, the Philippines, Thailand, and China by using daily data during the second half of 1997. They found that the signs of these correlations were very unstable and concluded that interest rates in those countries must not be an exogenous variable.

Goldfajn and Baig (1998) have studied the linkage between real interest rate and real exchange rate for the Asian countries during July 1997 to July 1998 by using Vector Autoregression (VAR) based on the impulse response function from the daily interest rates and exchange rates. They have not found any strong conclusion regarding the relationship between interest rate and exchange rate.

Some researchers have studied the nexus between the interest rate and exchange rate in a broader international crisis. In this context**,** Goldfajn and Gupta (1999) have examined 80 currency crisis episodes between 1980 and 1998. By using fixed effect

panel regression, they conclude that an increase in interest rate is associated with an appreciation of nominal exchange rates. They also found that the probability of choosing a high interest rate policy during the post-crisis period was low if the country was faced with a banking crisis.

Kraay (1998) has examined whether an increase in interest rate policy can defend the speculative attack by using monthly data for 75 developed and developing countries over the period 1060-99 and found that the high interest rates policy don't defend the currencies against speculative attacks. Therefore, he concludes that there is a striking lack of any systematic association between interest rates and the outcome of speculative attack.

Furman and Stiglitz (1998) have examined the effect of an increase in interest rate, inflation, and many non-monetary factors on exchange rate for 9 developing countries during 1992-98. They found that the high interest rate was associated with a subsequent depreciation of nominal exchange rate but the effect was more pronounced in low inflation country than in high inflation country.

The spot exchange rate not only depends on monetary variables but other factors (non-monetary variables) also. Some studies have attempted to control other factors' effect other than domestic monetary policy so that the independent effect of monetary policy on exchange rate can be isolated. Basurto and Ghosh (2000) conducted this test for Indonesia, the Republic of Korea, Thailand, and Mexico during 1990s. They have divided the determinants of exchange rate into two types: changes in the risk premium and everything else. Their object is to find out the influences of everything else on exchange rate and thereby, isolating the effect of changes in the risk premium, then to see the impact of real interest rate on risk premium. They found that tighter monetary policy was associated with an appreciation of exchange rate.

Gould and Kamin (2000) examined the interest rate and exchange rate relationship by studying the effect of interest rate, risk premium, and default probabilities

on the exchange rates for Indonesia, South Korea, Malaysia, the Philippines, Thailand, and Mexico. They found that the exchange rates in these countries were influenced by credit spreads and stock prices rather than interest rates. According them, their results neither support Mundell-Fleming's view nor monetarist's views.

There is hardly any empirical study on the relationship between interest rate and exchange rate in India. One study by Pattanaik and Mitra (2001) found that one standard deviation shock to the call rate leads to rupee appreciation in the second month. They also found that in response to one standard deviation shock the exchange rate appreciates by about 8 paise in the second month, but subsequently the exchange rate depreciates more than offsetting the initial impact of the hike in interest rates.

## Section-II

## The Model and Methodology

On the basis of a study of theoretical and empirical literature on the relationship between interest rate and exchange, we hypothesize exchange rate as a function of interest rate (or interest rate differential), inflation differential, and net intervention.

The rationale behind this hypothesis and a priori relationship between exchange rate and other factors including interest rates can be stated as follows: There are two views regarding the relationship between the interest rate and exchange rate. According to one view uncovered interest parity theory which implies that domestic interest rate is the sum of world interest rate and expected depreciation of home currency is the basis of exchange rate determination. In other words, the interest rate differential between domestic and world interest rate is equal to the expected change in the exchange change in the domestic exchange rate. Therefore, a higher interest differential would attract capital inflows and result in exchange rate appreciation. On the other hand, monetarists believe that higher interest rate reduces the demand for money which leads to depreciation of currency due to high inflation. The latter view has also been supported by Furman and Stiglitz(1998) who argue that the high interest rates imperil the ability of the domestic firms and banks to pay back the external debt and thereby reduces the

probability of repayment. As a result, high interest rates lead to capital outflows and thereby depreciation of the currency.

There is a direct relationship between domestic and world inflation differential and domestic exchange rate. In other words, a higher domestic inflation results in high domestic exchange rate depreciation. This is so because an increase in domestic inflation as compared to world inflation would increase the domestic demand for foreign commodities and lowers the foreign demand for domestic commodities, which, in turn, would lead depreciation of domestic currency to maintain the exchange rate as per the purchasing power theory. Similarly a decrease in domestic inflation as compared to world inflation causes appreciation of domestic currency. Therefore, the higher the inflation differential between domestic and foreign countries, the higher will be the depreciation of domestic currency and vive versa.

What could be the effect of net intervention, i.e., the difference between the purchases and sales of foreign currency assets by the monetary authorities on exchange rates? An increase in net purchases of foreign currency assets from the foreign exchange market by the Central Bank would reduce the supply of foreign currency in the foreign exchange market. As a result, domestic exchange rate would appreciate. In the same way, a decrease in net purchase of foreign currency assets would lead to depreciation of domestic currency in terms of foreign currency. Therefore, a negative relationship can be expected between the net intervention of the Central Bank and the exchange rate.

Based on the above-discussed rationale, the relationship between exchange rate and interest rate can be studied by the following exchange rate function:

$$ERt=C+\alpha_1 IR_t+ \alpha_2 INFDIFF_t+\alpha_3 INTER_t+U_t \quad \text{.....(1)}$$

Where ER= Exchange Rate, IR=Interest Rate, INFDIFF= Inflation differential between domestic and foreign countries, INTER= Net intervention by the Central Bank, C=constant, and t is time period.

The regression coefficients in the case of above equation are expected to have the following signs:

$\alpha_1 >$ or $< 0$, $\alpha_2 > 0$, $\alpha_3 < 0$

The relationship between interest rate and exchange rate in this Paper has been studied by using Co-integration, Error Correction, and Impulse Response Technique. Granger Causality between interest rate and exchange rate, Variance Decomposition, and Exogenity of interest rate have also been studied which is an improvement over the earlier Indian studies (Enders, 1995; Hamilton, 1994). All variables are expressed in level form. The required data for the purpose of estimation have been obtained from the various publications of Reserve Bank of India and the International Monetary Fund. The study uses monthly data for two time periods namely, from April 1993 to March 2003 and from June 1995 to March 2003 because of the unavailability of data for some variables in the former time period. The exchange rate is measured by the Indian rupee in terms of USA dollar. Interest rate is the monthly call money rate. Inflation differential is the monthly inflation difference between domestic inflation measured in terms of Wholesale Price Index (1980-81=100) and USA inflation measured in terms of Producer Price Index (1980-81=100). Net intervention is the monthly net purchases of foreign currency expressed in terms millions of USA dollar.

The first econometric step that has been used is to test the null hypothesis that the series are random walk or non-stationary by using Augmented Dickey-Fuller (1979) test. If the variables were found to be non-stationary, we have tested the possibility of one or more co-integrating relationships using the Johansen and Juselius (1990) methodology in the form of two test statistics namely, the trace test and the maximal eigen value during the above-mentioned two time periods. The impact of stationary exogenous variables on exchange rate and the short-run disequilibrium has been studied with the help of error correction model (ECM**)** (Sargan, 1984; Engle and Granger, 1987). The interrelationship between exchange rate and interest rate has been captured by the both vector autoregressive (VAR) model and co-integrating vector error correction model (VECM)

through Impulse Response Function Analysis which traces the response of exchange rate to one standard deviation change in interest rate. When the off diagonal elements of the correlation coefficient matrix of the error terms are found to be greater than 0.2, Cholesky Decomposition has been followed in the ordering of the variables to make the errors contemporaneously uncorrelated (Sims, 1980; Enders, 1995). Granger causality between interest rate and exchange rate and weak exogeniety of interest rate has also been studied.

# Section-III

# Empirical Results

Table 1 presents the ADF unit root test results for all variables. The variables like call money rate, interest rate differential, and exchange rate are found to be non-stationary, whereas the inflation rate differential and net interventions are found to be stationary in level form. But all variables are found to be stationary in their first difference form.

**Table 1: Augmented Dickey Fuller (ADF) Test Statistic**

| Variables | ADF | |
|---|---|---|
| | Levels | First Differences |
| Call Money Rate | -2.82 | -10.40* |
| Interest Rate Differential | -2.90 | -10.45* |
| Exchange Rate | -2.49 | -4.97* |
| Inflation Rate Differential | -9.60* | -7.50* |
| Net Intervention | -4.41* | -5.88* |
| **Critical Values (5% level)** | **-3.44** | **-2.88** |

Note: * indicates rejection of non-stationarity at 5% level.

The optimal lag length or order of the VAR was found to be 2 by the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), and Likelihood Ratio(LR) Test statistics. As far as the specification of the intercept and trend in the VAR is concerned, it has been found that the underlying VAR model does not contain deterministic trend but contains unrestricted intercept. The maximal eigen value and the trace statistics strongly rejected the null hypothesis that there is no co-integrating

relationship between the variables (i.e., r=0), and they showed that there is one co-integrating relationship between the variables (i.e., r=1) for both these time periods (see tables 2 and 3). The model selection criteria like AIC and SBC also suggested the existence of one co-integrating relationship between the variables (results have not been reported here). The normalized co-integrating vectors for the exchange rate have been represented in Table 4.

**Table: 2 Co-integration LR Test Based on Maximal Eigen value of the Stochastic Matrix for Nominal Interest Rates**

| H0: | H1: | Statistics | Critical Values | | Results |
|---|---|---|---|---|---|
| | | | 95% | 90% | |
| Model 1: Exchange Rate= f( Call Money Rate, Inflation Rate Differential) | | | | | |
| r = 0 | r = 1 | 26.09 | 14.88 | 12.98 | Reject Null Hypothesis |
| r ≤ 1 | r = 2 | 0.32 | 8.07 | 6.50 | Accept Null Hypothesis |
| Model 2: Exchange Rate= f( Call Money Rate, Inflation Rate Differential, Net Intervention) | | | | | |
| r = 0 | r = 1 | 20.60 | 14.88 | 12.98 | Reject Null Hypothesis |
| r ≤ 1 | r = 2 | 0.64 | 8.07 | 6.50 | Accept Null Hypothesis |

**Table: 3 Co-integration LR Test Based on Trace of the Stochastic Matrix for Nominal Interest Rates**

| H0: | H1: | Statistics | Critical Values | | Results |
|---|---|---|---|---|---|
| | | | 95% | 90% | |
| Model 1: Exchange Rate= f( Call Money Rate, Inflation Rate Differential) | | | | | |
| r = 0 | r ≥ 1 | 26.41 | 17.86 | 15.75 | Reject Null Hypothesis |
| r ≤ 1 | r ≥ 2 | 0.32 | 8.07 | 6.50 | Accept Null Hypothesis |
| Model 2: Exchange Rate= f( Call Money Rate, Inflation Rate Differential, Net Intervention) | | | | | |
| r = 0 | r ≥ 1 | 21.25 | 17.86 | 15.75 | Reject Null Hypothesis |
| r ≤ 1 | r ≥ 2 | 0.64 | 8.07 | 6.50 | Accept Null Hypothesis |

**Table: 4 Co-integrating Coefficients of Exchange Rate**

| Variables | April 1993 to March 2003 | June 1995 to March 2003 |
|---|---|---|
| Call Money Rate | -4.72**<br>(2.70) | -3.94*<br>(2.49) |
| Inflation Rate Differential$ | 0.019<br>(.0360) | 0.0425<br>(.0505) |
| Net Intervention$ | – | -0.0002***<br>(.00005) |

Note: (a) Figures in brackets are standard errors.
(b) ***, **, and * show the level of significance at 1%, 5%, and 10% respectively.
(c) $Coefficients have been obtained from the error correction model.

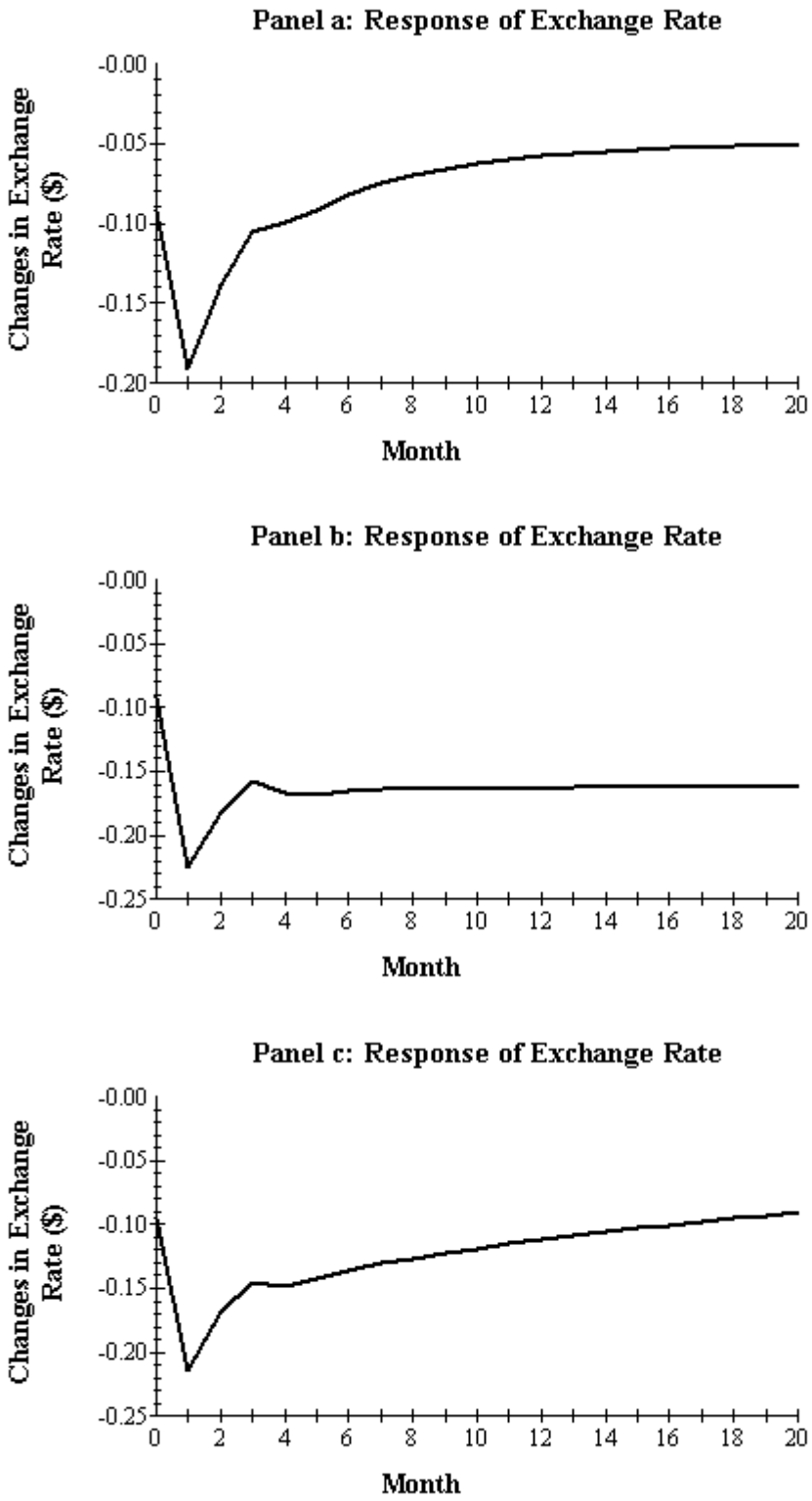
As expected, the coefficient of interest rate has negative sign in both the equations and it is highly significant. Interest rate differential between domestic and world interest rate as an alternative to interest rate has also been used and has correct (negative) sign (results have not been reported here). The same result has also been obtained by some other studies (Pattnaik and Mitra, 2001). The coefficient of stationary exogenous variables like inflation rate differential and net intervention has been obtained from the error correction model. The coefficient of inflation rate differential has expected sign (positive) but they are not significant in both the equations. So it shows the lack of expected inflation rate differential pass-through to the exchange rate. Similarly, the effect of net market intervention on exchange rate was found to be negative and highly significant.

The coefficients of error correction term of exchange rate in error correction model (ECM) had the correct sign (negative) but they were not statistically significant in both the equations (results are not reported here). The error correction term for exchange rate was expected to be negative because of the anticipated negative relationship between the actual and the long-run equilibrium values of the exchange rate. This was so because if the current exchange rate is higher than its long-run equilibrium value due to any shock, it should decline to its equilibrium value and vice versa.

**Impulse Responses:**

The dynamic interaction between the variables can be captured by the Impulse Response Function Analysis which traces the response of a variable to one standard deviation change in any other variable. Here, the impulse responses of exchange rate to interest rate have been studied in three ways in two time periods, i.e., by using co-integrating vector error correction model (VECM) during April 1993 to March 2003 (See Fig:2) and June 1995 to March 2003 (See Fig:3) and by using a theoretic unrestricted vector autoregression model (VAR) during June 1995 to March 2003 (See Fig:4). We have estimated a three variable VAR model by taking into account monthly call money rate, monthly exchange rate, and monthly net intervention by the Reserve Bank of India during the just mentioned time period. The optimal lag length was found to be 2 by using

**Figure 2: Impulse Response of Exchange Rate ($) due to one Standard Deviation Change in Interest Rate**



both AIC and SBC criterion. The estimated correlation coefficient matrices for both the VECM and VAR have been presented in Tables 5 and 6. Since the exchange rate is stabilized first by market intervention and then by increasing in interest rate, the same order has been followed to study the impulse responses in VAR.

It is found that a standard deviation change (around 3.18 percentage increase) in interest rate caused exchange rate appreciation by 19 paise in the first month itself. Despite modest subsequent depreciation, the overall impact over a period a time shows an appreciation of exchange rate about 5 paise (See Fig:2). Similarly, after considering the impact of net intervention during June 1995 to March 2003, a standard deviation change (around 3.30 percentage increase) in interest rate resulted in interest rate resulted in 22 paise appreciation of exchange rate in the first month and thereafter it started depreciating till the third month (See Fig:3). But the overall impact of change in interest rate on exchange rate is found to be 16 paise appreciation of exchange rate.

The impulse response generated from an unrestricted VAR model suggests that one standard deviation change (around 3.34 percentage increase) in interest rate leads the rupee depreciation by about 21 paise in the first month but subsequently the exchange rate depreciates gradually (See Fig:4). However, the overall impact over a period of time was shown an appreciation of rupee about 9 paise.

**Table 5: Correlation Matrix of the Estimated VECM Residuals**

| Time Period | Variables | Exchange Rate | **Interest Rate** |
|---|---|---|---|
| April 1993 to March 2003 | Exchange Rate | 1.00 | **-0.21** |
| | Interest Rate | -0.21 | **1.00** |
| June 1995 to March 2003 | Exchange Rate | 1.00 | **-0.22** |
| | Interest Rate | -0.22 | **1.00** |

**Table 6: Correlation Matrix of the Estimated VAR Residuals**

| | Exchange Rate | Interest Rate | Net Intervention |
|---|---|---|---|
| Exchange Rate | 1.00 | -0.25 | -0.40 |
| Interest Rate | -0.25 | 1.00 | 0.11 |
| Net Intervention | -0.40 | 0.11 | 1.00 |

**Table 7: Variance Decomposition of Interest Rate in VECM**

| Time Period / Month | April 1993 to March 2003 | | June 1995 to March 2003 | |
|---|---|---|---|---|
| | Interest Rate | Exchange Rate | Interest Rate | Exchange Rate |
| 1 | 0.72 | 0.28 | 0.72 | 0.28 |
| 10 | 0.61 | 0.39 | 0.66 | 0.34 |
| 20 | 0.61 | 0.39 | 0.66 | 0.34 |
| 50 | 0.59 | 0.41 | 0.65 | 0.35 |

**Table 8: Variance Decomposition of Interest Rate in VAR during June 1995 to March 2003**

| Month | Intervention | Interest Rate | Exchange Rate |
|---|---|---|---|
| 1 | 0.05 | 0.70 | 0.25 |
| 10 | 0.12 | 0.61 | 0.27 |
| 20 | 0.13 | 0.60 | 0.27 |
| 50 | 0.14 | 0.59 | 0.27 |

**Variance Decomposition Analysis:**

Another way of studying the dynamic behaviour between the variables in a model is variance decomposition analysis. This breaks down the variance of the forecast error for each variable into components that can be attributed to each of the endogenous variables. In other words, the variance decomposition of a variable tells us the proportionate change of that variable due its own changes verses changes to the other variables over a period of time. A variable is said to be purely endogenous (or exogenous) if any other variables explain a larger percentage of its variation (or do not explain its variation) over a forecast horizon. The variance decomposition for interest rate has been studied and reported in Tables 7 and 8. In a VECM, the variance decomposition indicates, at 50 month horizon, that changes in interest rate accounts for about 59 and 65 percent variation and exchange rate explains about 41 and 35 percent variation in interest rate during April 1993 to March 2003 and June 1995 to March 2003 respectively (See Table: 7). Similarly, in a VAR model, changes in interest rate and exchange rate explain about 59 and 27 percentage of variation of interest rate. The effect of net intervention is only 14 percent. This finding shows that changes in exchange rate accounts for the variation in interest rates in India.

**Granger Causality:**

Granger causality based on cointegrating vector error correction model , which was first introduced by Sargan (1984) and later popularized by Granger (1986), and Engle and Granger (1987), has been studied to find out the causal relationship between interest rate and exchange rate in India during April 1993 to March 2003 and June 1995 to March 2003. The error correction model states that a temporal causality between two variables X and Y exists in the Granger sense in at least one direction if these variables are cointegrated. We have tested the joint significance of the lagged variables of each variable along with the error correction term in the error correction model equation. According to this test, unidirectional causality between interest rate and exchange rate, i.e., interest rate Granger causes exchange rate but exchange rate does not cause interest rate can be established, when one could reject the hypothesis that interest rate does not Granger cause exchange rate and fails to reject the hypothesis that exchange rate does not Granger cause interest rate. The results in Table: 9 shows that both the null hypotheses, i.e., exchange rate is not Granger caused by interest rate and interest rate is not Granger caused by exchange rate are rejected during the above-mentioned time periods. Therefore, the Granger test indicates a bidirectional causality or feedbacks between interest rate and exchange rate in India.

**Table 9: Granger Causality Test**

| Null Hypothesis | Number of Lags | $\chi^2$( Calculated) | Conclusion |
|---|---|---|---|
| Model 1: Exchange Rate= f( Call Money Rate, Inflation Rate Differential) | | | |
| Interest Rate is not granger caused by Exchange Rate | 2 | 57.72 (0.000) | Reject the Null Hypothesis |
| Exchange Rate is not granger caused by Interest Rate | 2 | 10.56 (0.001) | Reject the Null Hypothesis |
| Model 2: Exchange Rate= f( Call Money Rate, Inflation Rate Differential, Net Intervention) | | | |
| Interest Rate is not granger caused by Exchange Rate | 2 | 52.22 (0.000) | Reject the Null Hypothesis |
| Exchange Rate is not granger caused by Interest Rate | 2 | 10.85 (0.001) | Reject the Null Hypothesis |

**Table 10: Weak Exogenity and Block Exogenity Tests for Interest Rate**

| Time Period | Weak Exogenity | Block Exogenity |
|---|---|---|
| April 1993 to March 2003 | $\chi^2(1)=27.78$ (0.000) | - |
| June 1995 to March 2003 | $\chi^2(1)=18.48$ (0.000) | - |
| June 1995 to March 2003 | - | $\chi^2(4)=13.389$(0.010) |

**Weak Exogenity and Block Exogenity:**

Exogenity of a variable can be studied with the help of causality and co-integration tests. A variable is said to be exogenous if it is determined outside the model and endogenous if it is determined inside the model. Hendry and Richard (1983) divided the term exogenity into three types namely, weak exogenity, strong, and super exogenity. Explaining all these concepts of exogenity is beyond the scope of this Paper. But a variable is said to be weakly exogenous if the coefficient of that variable in ECM is insignificant. For example, in our case, the interest rate can be said to be weakly exogenous if it is not affected by the behaviour of exchange rate. In other words, interest rate is said to be weakly exogenous if it is independent of the disequilibrium of the foreign exchange market. The results in Table 10 show that the interest rate turns out to be endogenous.

We have also tested the block exogenity of interest rate in an unconstrained VAR model. A variable is said to be block exogenous if the exclusion of that variable from the model does not lead to any loss of information. Interest rate was also found to be endogenous (See Table 10). Therefore, interest rate in India is endogenously determined during the managed floating exchange rate regime.

# Section IV

## Optimality and Trade-offs in Raising Interest Rates

In the previous section, it has been found that exchange rate in India can be stabilized or defended by raising interest rate. But even if the raising of interest rates lead to appreciation of exchange rate, the costs of raising interest rates in terms of large recession, decline in investment, corporate failures, financial system bankruptcies or fragility may outweigh the benefits of an appreciated exchange rates. In other words, the relative cost of raising interest rates to defend the currency to letting the exchange rate determined by the market forces may be higher. But an increase in interest rates in India can lead to exchange rate appreciation without causing any adverse effects. Let us examine how and why:

(1) A study by Athukorala concluded that in India, the high real interest rate promotes private sector capital formation by facilitating the accumulation of finance necessary for undertaking investment, that 1 percent increase in the real interest rate is associated with over 2 percent increase in private investment, and that the cumulative net impact of the real rate of interest on investment is positive because its effect operating through financial intermediation and complementarity outweighs its cost effect (1998, p.165). Similarly a study of interest elasticity of different components of fixed and inventory investments in the seventeen industries, the private corporate and public sectors, and the entire economy during the period 1950-51 to 1977-78 and its sub-periods have very well established that investment decisions in India have not been affected by interest rates in the theoretically expected manner i.e. interest rates have been mostly positively related to investment in the Indian economy (Bhole, 1985 a, and Bhole, 1985 b).

(2) It has been found that the gross savings rate was positively and statistically significantly influenced by the rates of interest during 1951-52 to 1979-80 (Bhole, 1985 b). Similarly, the Panel Data analysis of corporate savings for the period of 1966-67 to 2000-01 has shown that they are positively related to the rate of interest (Bhole and Mahakud). The annual average rate of growth of savings in India has declined from 16.1 percent in 1991-97 to 11.8 percent in 1998-2002.

(3) Table 11 presents percentage of interest payments to total borrowings, and sales income, respectively for 1981 to 2001 in the case of Public Limited Companies (PULCos), Private Limited Companies (PRLCos), and Foreign Companies (FCos) in India. Interest costs are not really as big a component of the sales income of the Indian corporate sector as it is made out to be; it has varied between hardly 3.19 percent to 6.16 percent in the case of all types of companies during 1981-82 to 2001-2002. In contrast, the interest cost to total income ratio in different countries like Belgium, Spain, France, Germany, Italy, Portugal, and UK varied between 13 to 69 percent in 1979, 24 to 52 percent in 1990, and 17 to 46 percent in 1995 (BOE, 1993 & 1997).

**Table 11: Percentage of Interest Payments to Total Borrowings and Sales Income of Three Types of Companies in India (Annual Averages).**

| Periods | Public Limited Companies | | Private Limited Companies | | Foreign Companies | |
|---|---|---|---|---|---|---|
| | IP/TB | IP/SAL | IP/TB | IP/SAL | IP/TB | IP/SAL |
| 1981-85 | 13.17 | 4.62 | 15.36 | 3.51 | 15.09 | 3.19 |
| 1986-90 | 13.04 | 5.61 | 13.78 | 4.11 | 15.44 | 3.78 |
| 1991-95 | 12.22 | 6.02 | 13.51 | 4.52 | 15.46 | 4.23 |
| 1996-2001 | 11.12 | 6.16 | 11.41 | 3.41 | 12.24 | 3.69 |

Notes: IP/TB= Interest Payments to Total Borrowings, IP/SAL= Interest Payments to Sales Income
Source: RBI, Company Finance, Statistics.

(4) If interest cost was really unaffordable or a constraining factor, the corporates would have depended on internal funds than on external borrowings much more than at present, and the recent lowering of interest rates would have led to an increase in non-food credit and corporate investment. But none of these things have occurred. The corporate capital structure "Pecking Order" in India has been different from the one in other countries. Unlike in other countries, internal funds do not hold the first rank in the sources of funds of the Indian corporates. The annual average of all internal funds as percentage of total sources of funds has declined in the case of PULCos (from 50.98 to 31.83 percent) and PRLCos (from 42.15 to 32.14 percent) during 1971-72 to 2001-02. On the other hand, the annual average of borrowings as percentage of total sources of funds

has increased in the case of PULCos (from 21.24 to 40.51 percent) and PRLCos (from 23.8 to 37.43 percent) during the same period (Bhole and Mahakud).

(5) The growth, stability, competition, and efficiency of Indian scheduled commercial banks in terms of various indicators, namely non-performing assets, income, profits, spread etc show that the performance of Indian banking system has improved to a great extent during 1990s (See Table 12 and Figure 3) and, in fact, has been far better than many Latin American, East Asian, and G3 countries (See Table 13).

**Table 12: Financial Indicators of Scheduled Commercial Bank in India**

| Financial Parameters | 1996-97 | 2001-02 |
|---|---|---|
| Operating Profit/Total Assets | 1.82 | 1.94 |
| Net Profit/Total Assets | 0.67 | 0.75 |
| Other Income/Total Assets | 1.45 | 1.57 |

Source: Reserve Bank of India, Report on Currency and Finance, 2001-02, Mumbai 2003.

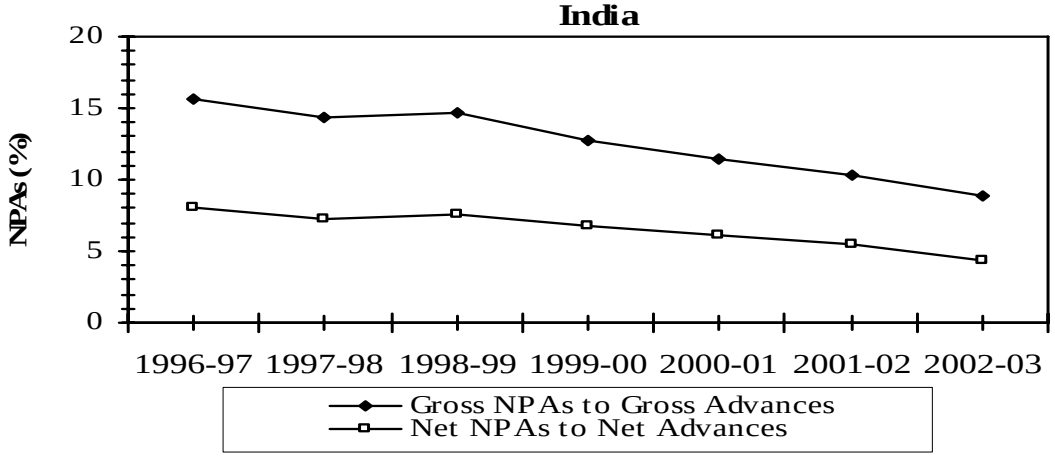
**Table 13: Banking Sector Performance**

| | India[1] | | East Asia[2] | | Latin America[3] | | G3[4] | |
|---|---|---|---|---|---|---|---|---|
| Year | 1992-97 | 1999 | 1992-97 | 1999 | 1992-97 | 1999 | 1992-97 | 1999 |
| Column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Spread | 2.9 | 2.8 | 2.6 | 2.2 | 5.2 | 5.4 | 2.0 | 2.0 |
| Other Income | 1.4 | 1.3 | 0.7 | 0.8 | 2.3 | 2.0 | 0.7 | 1.0 |
| Operating Cost | 2.7 | 2.7 | 1.6 | 2.3 | 5.5 | 5.7 | 1.7 | 1.8 |
| Gross Profit | 1.6 | 1.5 | 0.8 | -0.7 | 1.4 | 2.4 | 0.7 | 0.8 |

Note: 1. Scheduled Commercial Banks
2. Simple average of Indonesia, Korea, Malaysia, Philippines, Thailand
3. Simple average of Argentina, Brazil, Chile, Colombia, Mexico, and Peru.
4. Simple average of Germany, Japan, and USA.

Source: Same as in Table 12.

**Figure 3: NPAs of Scheduled Commercial Banks in India**




Source: Same as in Table 12.

(6) Expected growth rate of output by 8 percent, recent increase in inflation in terms of Wholesale Price Index (WPI) by 5.38 percent, and relatively higher inflation rate in terms of Consumer Price Index (CPI) also support a high interest rates policy in India.

**Table 14: Annual Average Growth Rates of Some Macroeconomic Aggregates (Percentages)**

| Year / Variables | 1991-92 to 1996-97 | 1997-98 to 2001-02 |
|---|---|---|
| Gross External Debt | 14.09 | 7.49 |
| Short-Term External Debt | 10.59 | -10.82 |
| Total Bank Credit | 15.9 | 16.2 |
| Net Capital Inflows | 43.9 | 6.4 |

(7) Table 14 presents the annual average growth rates of gross external debt, short-term external debt, total bank credit, and net capital inflows in India during 1991-92 to 1996-97 and 1997-98 to 2001-02 and shows that the performance of all variables has declined during the latter period.

From the above discussion it can be concluded that instead of letting the currency float freely in downward direction a high interest rates policy may be followed in India to

stabilize the exchange rate at its desirable level. It has been stated that "when market participants lose confidence in a currency and attach a high probability to further falls, it is difficult to induce them to hold the currency without higher interest rates…Moreover, halting a free fall of the currency takes an added importance when banks or corporations in the crisis country have large foreign currency obligations coming due in the short-run" (Goldstein, 1998).

## Section V
## Summary and Conclusions

The exchange rate regime in our country has undergone a significant change during 1990s. Until February 1992, exchange rate in India was fixed by the Reserve Bank of India. Thereafter a dual exchange rate system was adopted during March 1992 to February 1993 which also came to an end and a unified market came into being in March 1993. The present exchange rate system in our country is popularly known as 'managed floating exchange rate regime'. But the external value of the rupee was found to be under pressure for a few episodes because of various reasons like the East Asian and Russian currency crisis, border conflict, rise in oil prices, political instability etc. The Reserve Bank of India has been using high interest rate policy to contain the excessive volatility and to contain the excessive market pressure on rupee in the foreign exchange market.

In this context, the Paper has attempted to study the relationship between interest rate and exchange rate in India by using cointegration based on vector autoregression model during April 1993 to March 2003 and June 1995 to March 2003 and by using a theoretic vector autoregression model during June 1995 to March 2003. The variables like call money rate, exchange rate were found to be non-stationary, whereas the variables like net intervention and expected inflation rate differential between India and world were found to be stationary.

It was found that there has been a long-run relationship between the above mentioned variables. Both call money rate and net intervention have negatively and significantly influenced the exchange rate, where as the expected rate of inflation

differential between the India and world has not played significant role in the behaviour of exchange rate in India.

It has been found that the overall appreciation of exchange rate was found to be 5 paise and 16 paise due to one standard deviation change (around 3.18 and 3.30 percentage increase) in interest rate in a CVAR model during April 1993 to March 2003, and June 1995 to March 2003 respectively. Similarly, the over all appreciation of exchange rate was found to be 9 paise due to one standard deviation change (around 3.34 percentage increase) in interest rate in a VAR model.

Similarly, the variance decomposition, in a VECM at 50 month horizon, indicates that changes in exchange rate accounts for about 41 and 35 percent variation in interest rate during April 1993 to March 2003 and June 1995 to March 2003 respectively. Similarly, changes in exchange rate explain about 27 variation of interest rates in a VAR model during June 1995 to March 2003.

But, the changes in interest rate policy were found to be endogenous in stabilizing the exchange rate. In other words, declines in the value of the exchange rate have prompted monetary authorities to raise domestic interest rates. It is so because the Granger cause test indicates a bidirectional causality or feedback between interest rate and exchange rate in India during April 1993 to March 2003 and June 1995 to March 2003. Interest rate in India was also found to be endogenous by both weak and block exogenity tests. Therefore, both the interest rate and exchange rate were affecting each other.

Finally, there is a strong case for an increase in interest rates to stabilize the value of rupee during the downward pressure in India because the cost of doing so in terms of output loss, financial system fragility, decline in investment, etc may not outweigh the benefits of a more nominal appreciated exchange rate.

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