The Indian Foreign Exchange Market and the Equilibrium Real Exchange Rate of the Rupee

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1. Introduction

An economy is linked to the world economy through two broad channels: trade and finance. India's economic policy reforms of 1991 sought to globalize the hitherto relatively closed Indian economy by opening up both these channels. The changes in both trade and the financial sector have been slow giving the economy time to adjust. Despite restrictions, the trade channel between India and the rest of the world was far more open than financial markets. Not only was the financial sector closed to international agents, the price of capital (interest rate) or of the domestic currency (exchange rate) was not market determined. The nineties saw a twin development in financial markets - prices were allowed to be determined by the market, and the domestic financial market was integrating with international financial markets.

At the same time, India moved from a fixed to a floating exchange rate. However, the economy continued to have features of the closed economy and fixed exchange rate regime that had prevailed for a long period, even after rates were supposed to be market determined. Capital controls continue. While current account convertibility for both inflows and outflows by residents and non-residents was established as early as August 1994, controls continue on the ability of resident individuals and corporates to send capital abroad.

The objective of this paper is to analyze the structural changes that took place on the Indian foreign exchange market and to examine the extent to which authorities during that period managed to keep real exchange rates in line with long-run fundamentals. The analysis is based on an econometric analysis of the determinants of the Rupee exchange rate [Patnaik and Pauly (2000)]. Empirically, the challenge here lies in modelling the exchange rate for a time during which there were significant changes in the foreign exchange regime as the transition from a fully fixed to a largely market determined rate took place. Between 1991 and 1993 there existed a system when only a proportion of export earnings could be converted into the domestic currency at the market determined exchange rate. After January 1993 the exchange rate became fully 'market determined'. However, it was kept constant for a long period by the central bank intervention in the foreign exchange market.

India's exchange rate was fixed by the central bank until the recent policy changes and there is little historical experience in modlling exchange rates for the Indian Rupee with a floating exchange rate. To explain the determination of the exchange rate of the rupee in Patnaik and Pauly (2000) we sought to identify the underlying economic forces that are submerged under an interventionist market structure. This identifies the long run equilibrium properties this exchange rate should have if it were completely determined by output markets.

Details of the econometric work are reported in Patnaik and Pauly (2000). In this paper, we focus primarily on an analysis of the market developments during the period of marketization and liberalization and on the policy implications of our suggested determinants of the equilibrium rupee exchange rate. In section 2, we provide an overview over the developments of the 1990s.Section 3 contains a short description,and empirical results are reported in section 4. Section 5 focuses on an analysis of the role of domestic factors in determining the equilibrium rupee rate, and we conclude with a short summary.

2. India: Exchange rate regime and recent trends

The movement towards market determined exchange rates in India began with the official devaluation of the rupee in July 1991. In March 1992 a dual exchange rate system was introduced in the form of the Liberalized Exchange Rate Management System (LERMS). Under this system all foreign exchange receipts on current account transactions were required to be submitted to the Authorized dealers of foreign exchange in full, who in turn would surrender to RBI 40% of their purchases of foreign currencies at the official exchange rate announced by RBI. The balance 60% could be retained for sale in the free market. As the exchange rate aligned itself with market forces, the Re/$ rate depreciated steadily from 25.83 in March 1992 to 32.65 in February 1993. The LERMS as a system in transition performed well in terms of creating the conditions for transferring an augmented volume of foreign exchange transactions onto the market. Consequently, in March 1993, India moved from the earlier dual exchange rate regime to a single, market determined exchange rate system.

The deepening of the foreign exchange market has been aided by the implementation of some of the recommendations of the Sodhani Committee on Foreign Exchange Markets (1995) and the Tarapore Committee on Capital Account Convertibility (1997). The Sodhani Committee (1995) made recommendations to develop, deepen and widen the forex market. A number of its recommendations regarding introduction of various products and removal of restrictions in foreign exchange markets to improve efficiency and increase integration of domestic foreign exchange markets with foreign markets have been implemented. Liberalisation measures undertaken on the capital account relate to foreign direct investment, portfolio investment, investment in joint ventures/wholly owned subsidiaries abroad, project exports, opening of Indian corporate offices abroad, and raising of Exchange Earners Foreign Currency entitlement.

Box 1

Development of the Foreign Exchange Market

The Sodhani Committee (1995) made recommendations to develop, deepen and widen the forex market. It suggested introduction of various products and removal of restrictions to improve efficiency.

Recommendations implemented by RBI include:

For Banks freedom to

- Fix overnight position or gap limit
- Initiate trading position in overseas markets
- Borrow or invest funds in the overseas markets (within limits)
- Determine interest rates and maturity period of FCNR deposits
- Use derivative products for asset liability management
- Exemption of inter-bank borrowings from statutory requirements

For corporates

- Permission to hedge anticipated exposures
- Freedom to cancel and rebook forward contracts
- Some freedom in managing exposures and access to lower cost option strategies

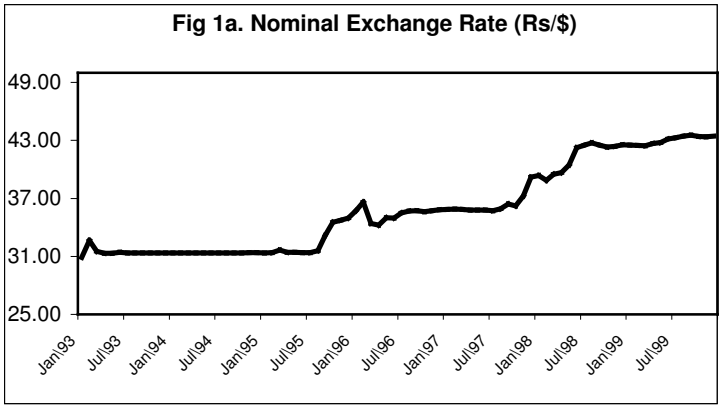
For improvements in internal controls

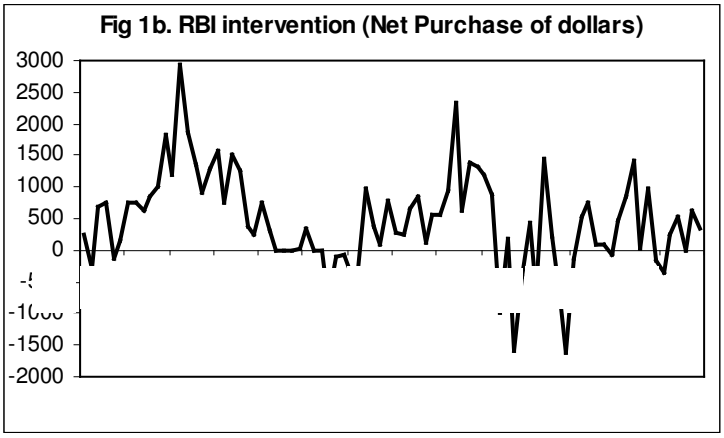
- Framing risk management guidelines for banks
- Adopting Basle committee norms or computing foreign exchange position limits

Among recommendations not implemented are:

- Inducting Development Financial Institutions as full fledged Authorised Dealers
- Setting up a forex clearing house
- Permitting corporates to undertake margin trading
- Setting up off-shore banking units in Mumbai

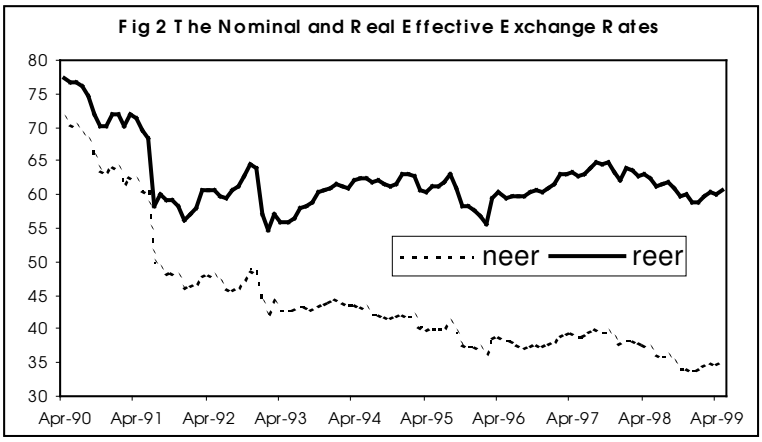
While trade flows and foreign investment have had a role to play in the determination of the exchange rate, another important development that has led to the capital movements has been the reform that has taken place in other segments of financial markets in India. This has led to increasing integration of broad segments of the market such as the money market, government securities, capital market and the foreign exchange market. Market participants and move from one market to the other leading to inter-linking of these markets. The link between the forex and domestic market has increased due to the freedom given to banks to maintain foreign currency assets and liabilities that can be swapped into rupees and vice versa. On the liabilities side there are foreign currency borrowings from overseas offices, borrowings for lending to exporters, foreign currency non-resident deposits (FCNR-B) deposits and Exchange Earners Foreign Currency deposits of corporates. Banks are permitted to use these funds either for raising rupee resources through swaps or for lending in foreign currency. Banks have been allowed to lend in foreign currency to companies in India for any productive purpose without linking to exports or import financing. Corporates can substitute rupee credit for foreign credit as they now have the choice to borrow either in foreign currency or rupees depending on the cost, taking both interest cost and exchange risk into account (Reddy, 1999). Evidence suggests that the nineties have seen growing inter-linkages between money, foreign exchange and government securities markets.



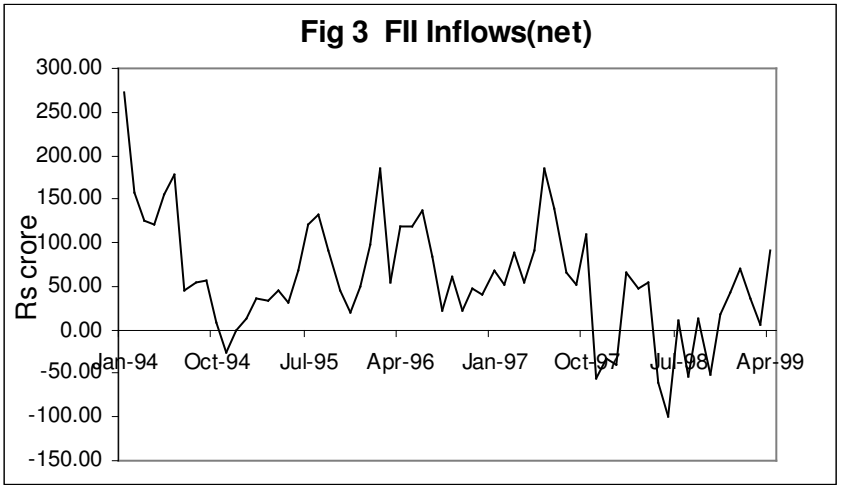


During 1994-95 there was upward pressure on the rupee because of foreign portfolio capital inflow that was now allowed to enter India. However, the rupee was not allowed to appreciate but was kept constant by the RBI (fig 1a and 1b). This was due to the conflict between the objectives of export promotion and the free movement of the rupee. The market was not freely allowed to determine the exchange rate of the rupee. If it had, the rupee would have appreciated. The RBI intervened to maintain the nominal value of the rupee at a constant level of Rs/$ 31.4 for a period of sixteen months from March 1993 to July 1995. In real terms the rupee appreciated as inflation levels in India were higher than in the partner countries (fig 2).

As figure 3 indicates, in 1995 the initial surge was over and buying pressure from FIIs reduced. As the rupee continued to be overvalued the current account deficit started mounting (Fig 4). There was downward pressure on the rupee. A depreciation in the

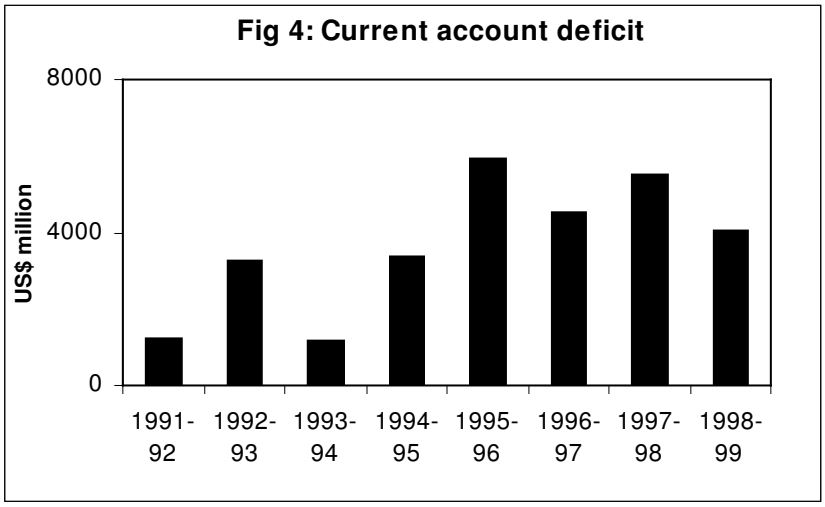


Re/$ was welcome as the appreciation in the real exchange rate had made exports uncompetitive. The nominal rate fell to Rs/$ 35.65, recording a fall of 13.6% over the rate of Rs/$ 31.37 that had been maintained for about two years . In the following year, the appreciation of the US dollar against other major currencies put upward pressure on the rupee. The policy of stabilizing the exchange rate of the rupee against the dollar ensured that the rupee traded in the range of Rs.34-Rs.35 to a dollar. In 1997-88 and 1998-99 the RBI allowed the rupee to be more or less determined in the market. In this period there



has been little pressure on the nominal rate to appreciate and whenever political, economic or other reasons have introduced volatility in the foreign exchange market the RBI has intervened. The stated objective of the RBI's exchange rate policy is to reduce volatility and speculation in the foreign exchange market and to keep the rate in line with economic fundaments.

As figure 1 b clearly shows, the number of episodes of the net purchase of dollars by RBI in the foreign exchange market far out number those when it was negative. Thus RBI followed a policy to prevent appreciation, even for prolonged periods of time. Episodes when it stepped in to sell dollars were short and few and usually associated with a crisis



that might have caused excess volatility. To keep the exchange rate 'in line with economic fundamentals' the rupee should have been continuously depreciating in nominal terms to prevent a real appreciation. Thus, if for any short-term reasons such as capital flows, there was excess demand for the rupee leading to a pressure on the rupee to appreciate, the RBI purchased dollars to push up their demand for dollars and prevent the appreciation.

Any analysis of exchange rates must consider that there may be cross-currency movements in exchange rates that may not be adequately captured by a bilateral exchange rate. Therefore, effective exchange rates may be more meaningful indicators of external competitiveness. Effective exchange rates are expressed as indices. The nominal effective exchange rate (NEER) is a weighted average of bilateral nominal exchange rates. The weights reflect the relative importance of each currency in the home country's external transactions. In India, the NEER is expressed as an index using bilateral export weights or bilateral total trade (exports plus imports) weights. For instance, if arithmetic averages are used to compute NEER, it would be calculated as follows:

$$EER = 100 * \sum w_i \left(E_{it} / E_{i0}\right)$$

where the w_i's are trade weights, E_{it} and E_{io} are current and base period exchange rates of the rupee against currency i, the exchange rates being measured in terms of the price of the foreign currency in terms of the rupee. The NEER is constructed as a 5-country, 10-country and 36-country based index on a monthly as well as annual basis. The 36-country NEER is the most comprehensive, representing 65-70% of total exports/trade during 1975 and 1991 (Source: RBI bulletin July 1993). In constructing the NEER, the exchange rates of the currencies are expressed as the number of units of numeraire per unit of currency. Special Drawing Rights (SDRs) were chosen as the numeraire as the exchange value of the SDR is determined by a weighted average of a basket of currencies which could offset fluctuations in individual currencies. That is,

$$NEER = \prod_{i=1}^{n} \left(\frac{e}{ei}\right)^{wi}$$

where

$$wi = \frac{Xi}{\sum_{i=1}^{n} Xi}$$

and

$$\sum_{i=1}^{n} Wi = 1$$

e: exchange rate of the rupee against SDRs in indexed form (1985=100)

ei: exchange rate of currency I against SDRs in indexed form (1985=100)

e/ei: exchange rate of the rupee against currency I in indexed form (1985=100)

Wi: Weight attached to country/currency i in index

Xi: India's merchandise exports to/trade with country i

n: number of countries/currencies in the index other than India.

In terms of the real effects of exchange rate movements the appropriate indicator to examine will be the real exchange rate which measures the relative purchasing power of two currencies in the goods market. It is obtained by deflating the nominal rate by an

index of relative prices between home and abroad. The bilateral US- India real exchange rate, for instance, may be measured by the nominal rate multiplied by the ratio of the US producer price index (PPI) to India's wholesale price index (WPI). The real effective exchange rate (REER) is the weighted average of bilateral price-deflated nominal rates. In other words, it is the weighted average of NEER adjusted by domestic to foreign relative local-currency prices. REER is also measured monthly and annually on the basis of 5, 10 and 36 country trade and export weights. The 36-country REER is measured as follows.

$$REER = \prod_{i=1}^{n} \left[\left(\frac{e}{ei}\right)\left(\frac{P}{Pi}\right) \right]^{wi}$$

where

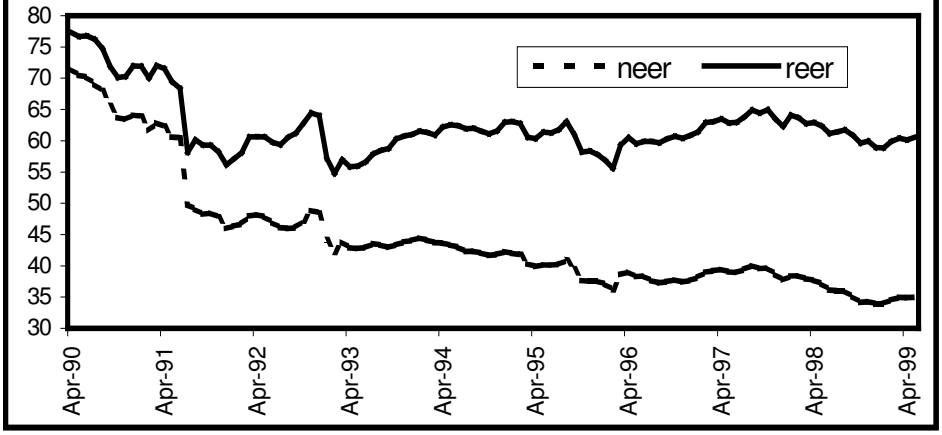
P: India's wholesale price index (1985 = 100)

Pi: Consumer price index of country i (1985 = 100)

Depending on whether price levels are measured in consumer prices, wholesale prices, GDP deflators or trade prices, the REER becomes the relative price of domestic to foreign consumption, production or tradeables. Therefore, a decline in the REER reflects a reduction in the cost of producing domestic goods and an increase in export competitiveness.

We now examine the different assessments that emerge by focusing on nominal and real measures of the effective Rupee rate. Large inflows of foreign portfolio investment in 1993 and 1994 and the consequent appreciation pressure on the rupee were not visible in the nominal exchange rate, which remained steady at about Rs/$ 31.4 from March 1993 to July 1995 as a result of RBI intervention in the foreign exchange market. The effective

Figure 4. 5 Nominal and Real Effective Exchange Rate (Indices)



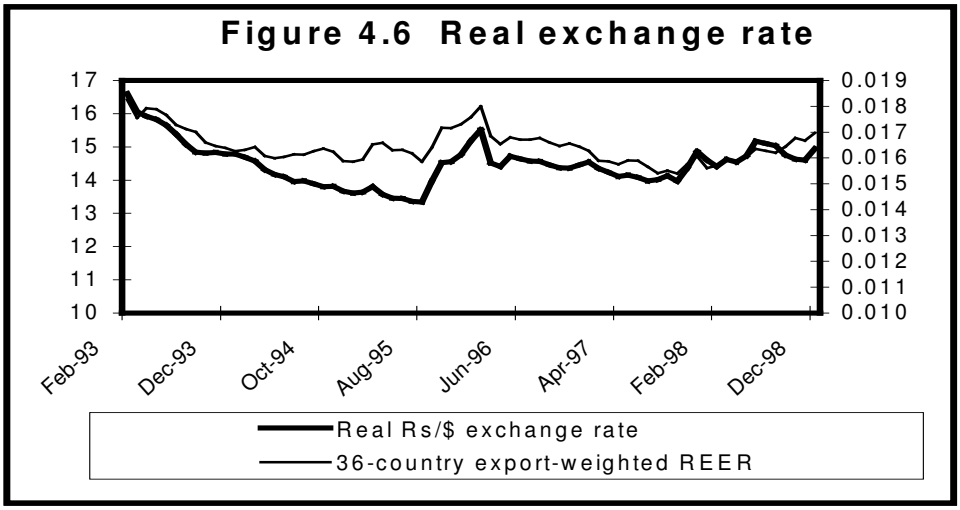
exchange rate indices, however, reflected the cross-currency movements between the dollar and other international currencies. Despite the steady nominal rate, the 36-country NEER had depreciated by 0.2% at the end of FY1993-94 over its level in the previous fiscal, reflecting a strengthening of the currencies of some of India's major trading partners other than the U.S (Fig.4.5).

A rising US-Japan current account deficit and the perceived economic stability of Germany put additional pressure on the dollar vis-à-vis the Yen and DM in the first quarter of 1994-95. The rupee mirrored the weakness of the intervention currency and the NEER depreciated by a steep 7.8% by March 1995. The nominal depreciation of the rupee was strong enough to offset the adverse inflation differentials between India and its trading partners. Consequently, the REER, which had appreciated by over 5% in March 1994 as a result of higher inflation in India, fell from 60.89 to 60.65 in March 1995.

An evaluation of the effective exchange rates during 1991-99 reveals that the rupee has undergone sharp depreciation in nominal terms. The NEER has depreciated by about 23% between January 1993 and January 1999, largely as a consequence of the movement towards market determined exchange rates from artificially suppressed 'managed' rates. In contrast, the REER appreciated by about 2.8%, although there were periods of when significant depreciation of the REER was observed. Visually, the REER appears to be stationary over this period, suggesting that there may have been only marginal gain in overall export competitiveness.

Finally, it appears that the bilateral Rupee/$ rate is a fairly good approximation to the effective real exchange rate for most of the period. In the structural model underlying this study the model is based on a two-country model for real exchange rate. It requires data such as the nominal exchange rate and prices of traded and non-traded goods in each of the two countries. The model developed was a bilateral (rather than a multilateral) model with the US and India as the two countries. Fig. 6 compares the bilateral dollar rate with the 36 country export weighted REER. The RBI publishes data for 5-country,

10-country, 36-country REER and NEER. Each of these indices is available on a trade-weighted or export-weighted basis, and with different base years. The same methodology can be used for any of these series.



Not only is a large component of our trade and capital flows dollar denominated, the dollar is the intervention currency of the RBI. This has clearly been demonstrated not only in the 1993-95 episode when the value of the rupee was kept constant against the dollar for 16 months, but also later whenever there was a pressure on the rupee dollar rate, the RBI intervened to prevent appreciation of the rupee. The other rates in the market are determined broadly by the movement of the dollar against various currencies. Since it is the dollar and not the rupee that is a major currency in international markets, arbitrage ensures that the value of the rupee expressed in yen cannot be significantly different from what the dollar-rupee-yen rate would set it at (apart from some transaction costs). Consequently it was decided that a dollar-centric model would be more appropriate than a model that separately tries to forecast the rupee- yen, rupee-pound, rupee-mark, rupee-franc, rupee-lira etc. rates, since these rates cannot diverge from the rate set by international markets for dollar versus other currencies.

3.The Model

In Patnaik and Pauly (2000) it is assumed that the analysis of exchange rate behaviour can be dichotomized into the modeling of short-run fluctuations and a determination of the long-run equilibrium exchange rate (see the models in MacDonald ( ) and Taylor ( )). Good surveys can be found in Isard (1995) and Frankel and Rose (1995). It is the behaviour of the long-run equilibrium rate that is the focus of this paper.

In the short run it is assumed that a variant of uncovered interest parity holds which allows for systematic deviations from simple UIP. Deviations from the basic parity condition arise due to a number of factors. The most important among these may be risk. The above analysis assumes that the foreign exchange market is in equilibrium only when expected returns on domestic and foreign currency bonds are the same. This assumption is known as perfect asset substitutability. Two assets are perfect substitutes when it does not matter to investors how their portfolios are divided between them, provided both yield the same expected rate of return. However, if two assets differ in terms of the risk associated with them, they are not perfectly substitutable. Differences in degrees of risk associated with different assets leads to imperfect asset substitutability. If assets denominated in different currencies have different degrees of risk, investors may be willing to earn lower expected returns on assets that are less risky. A very risky asset may be held only if the return on it is expected to be very high. Hence, when domestic and foreign assets are not perfect substitutes, equilibrium in the foreign exchange market requires that the domestic interest rate equal the expected domestic currency return on foreign assets plus a vector of variables that lead to deviations from UIP such as risk premium, Ω, that reflects the difference between the riskiness of domestic and foreign bonds due to inflation risk or country risk and other factors such as central bank intervention (Π).

Following some elementary manipulation, this assumptions leads to a model in which the current real exchange rate is determined by real interest differentials, the risk premium, intervention in the foreign exchange market by the monetary authorities and

the expected exchange rate. The expected exchange rate is a function of the lagged exchange rate and an equilibrium exchange rate so that

$$q_t = ((1-\beta)\bar{q}_t + \beta q_{t-1}) - (r_t - r_t^*) + \Omega_t + \Pi_t + \varepsilon_t$$

For details, see Patnaik and Pauly (2000). The equilibrium exchange rate is the focus of this paper, and we now examine how the equilibrium exchange rate is determined.

The purchasing power parity (PPP) hypothesis remains the most important theoretical construct in seeking to explain the long run behaviour of exchange rates. Though evidence has been conflicting and PPP has often been rejected as a predictive theory in the empirical literature, it still remains the most powerful tool to understand the. Changes in output markets such as productivity growth or demand shifts lead to changes in price ratios of traded and behaviour of the movement of exchange rates of different currencies.

However, systematic deviations from the PPP occur due to the fact that not all goods are tradable and hence their prices do not equalize Changes in output markets such as productivity growth of demand shifts lead to changes in price ratios of traded and nontraded goods that determine the exchange rate [see Balassa (1964), Samuelson (1964) and earlier Harrod (1933)]. The Harrod-Samuelson-Balassa effect is a tendency for countries with higher productivity in tradables compared with non-tradables to have higher price levels. More precisely, it can be shown that if a country's productivity growth advantage in tradables exceeds its productivity growth advantage in non-tradables it will experience a rise in its relative price level or in other words a real appreciation of the exchange rate.

Further, changes in demand lead to changes in the real exchange rate. For instance, a shift in demand in one country away from tradables and towards nontradables raises the relative price of tradables and change in the price ratio leads to change in the exchange rate.

We therefore identify the long run equilibrium real exchange rate to be determined by the following definition

$$\lambda = E * P^*/P$$

where $P = (P^{NT})^{\alpha}(P^{T})^{1-\alpha}$ and $P^* = (P^{NT^*})^{\alpha^*}(P^{T^*})^{1-\alpha^*}$

and $P^T = E * P^{T^*}$

Expressing in logs and substituting in the equation for the real exchange rate it can be shown that

$$\text{og } \lambda = \alpha^* (\log P^{NT} * - \log P^{T}*) - \alpha (\log P^{NT} - \log P^{T})$$

The equilibrium exchange rate may therefore be expressed as a function of the price ratios of non-traded to traded goods in both the home and the foreign country.

4. Empirical Results

The model specified above is estimated for the bilateral Rupee/US-$ rate over the period January 1993 to December 1998.

As indicated above, not only is a large component of our trade and capital flows dollar denominated, the dollar is the intervention currency of the RBI. This has clearly been demonstrated not only in the 1993-95 episode when the value of the rupee was kept constant against the dollar for 16 months, but also later whenever there was a pressure on the rupee dollar rate, the RBI intervened to prevent appreciation of the rupee. The other rates in the market are determined broadly by the movement of the dollar against various currencies. Since it is the dollar and not the rupee that is a major currency in international markets, arbitrage ensures that the value of the rupee expressed in yen cannot be significantly different from what the dollar-rupee-yen rate would set it at (apart from some transaction costs). Consequently, a dollar-centric analysis is preferred.

Since the expected future value of the exchange rate is unobserved, actual lead data is used to measure expected future values assuming that expectations are rational. As the prices of nontraded and traded goods are not published as such, most research in this area proxies these by the consumer and producer price indices. In the same tradition the prices of nontraded and traded goods in India are proxied by the consumer price index for industrial workers (CPI_IW) and the WPI respectively. Similarly, prices for the US are measured by the consumer price index (CPI) and the PPI. Liquidity is measured by reserve bank lending to the central government. Intervention by the central bank (Π) is measured by the net purchase of dollars by RBI in the foreign exchange market. Here we are missing out the component of intervention in the foreign exchange market that the State Bank of India undertakes on behalf of the RBI. No suitable measure for this variable is available as one cannot separate purchase of dollars for normal bank activity from that for the sole purpose of sale and purchase of dollars to influence the rupee.

The nominal interest rate in India is measured by the return on 364-day treasury bills. The foreign interest rate is measured by the one year LIBOR on US dollar deposits. Inflation is measured in terms of the percentage increase in the WPI or PPI for India and the US respectively.

The risk premium is measured by the import cover or the foreign exchange reserves with the Reserve Bank of India scaled by the relevant year's monthly average imports. The source of the data is various monthly bulletins of the Reserve Bank of India (RBI), International Financial Statistics (IMF), the website of the Bureau of Labour Statistics of the US and the Handbook of Statistics published by the Ministry of Industry, Government of India.

Within this framework Patnaik and Pauly (2000) arrive at the following two-equation system ::

Expected Exchange Rate

$$q^{e}_{t+1|t} = -0.14 + (1-0.72)(0.5 * Log(P^{NT*}/P^{T*}) - 0.5 * Log(P^{NT}/P^{T}) + 0.72 q_{t-1} + 0.07 * D_t + \varepsilon_t$$

(–0.6) (11.9) (11.9) (3.4)

Current Exchange Rate

$$q_t = 0.56 + 0.8 q_{t+1} - 0.0008\ (r - r^*) - 0.006\ \Omega + 0.000001\ (\Pi) + \rho_t$$

(2.8) (11.45) (-1.25) (-2.9) (0.47)

where

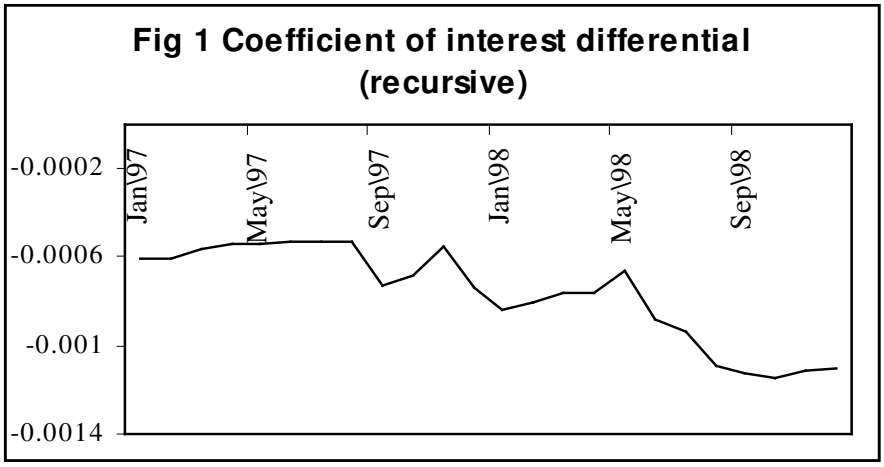
Ω = Foreign currency assets / Average monthly imports

Π = net purchase of dollars by the RBI in the foreign exchange market

The estimation results for the expected exchange rate equation show that when the domestic price of non-traded goods increases, the domestic currency is expected to appreciate. Similarly, when the foreign price ratio of nontradables to tradables increases, the domestic currency is expected to depreciate. t. Liquidity in the system is measured by reserve bank credit to the central government. As liquidity in the home country increases, the currency is expected to depreciate.

The correlation between expected returns on foreign markets and the domestic interest rate has increased due to financial reform in India that has led to greater integration of different segments of financial markets such as money and forex markets. If we estimate the equation recursively we find evidence of this increasing integration. The

Fig 1 Coefficient of interest differential (recursive)



absolute value of the coefficient increases (note that the coefficient is negative) indicating the increasing importance of capital flows. Figure 1 shows the coefficient of the real interest differential when the equation is estimated recursively. It is first estimated from January 1993 to December 1996 and then the sample is extended month by month to include the period till December 1998.

The import cover proxies the country risk associated with the home country. Foreign exchange reserves with the central bank represent the country's capacity to import and honor its debt. International creditors such as banks and foreign portfolio investors often monitor the level of foreign exchange reserves available with developing countries to assess the risk of default on foreign debt. The foreign exchange crisis of 1991 in India, when India was on the brink of default reached its peak when reserves fell to only two weeks worth of imports. A comfortable level of reserves that allow a country a few months of import cover, and the capability to service debt represent reduced risk and hence increase confidence in its assets. A fall in reserves would be associated with increase in risk leading to an outflow of short-term capital and eventually a depreciation of the currency. Thus, if the import cover serves as a good proxy for the measure of risk and has a significant impact on the movement of capital and therefore on the short-term equilibrium exchange rate, the sign of the coefficient of import cover should be negative.

Our results suggest that when risk is measured by foreign currency reserves scaled by the average monthly value of imports for that year, the sign of the coefficient is both negative and significant. Thus, if there is a fall in reserves, confidence in the currency reduces, foreign capital, especially short term and portfolio investment, moves out and the rupee depreciates.

Central bank intervention in the foreign exchange market is expected to be yet another source of deviation of the exchange rate from its long run level. The government's objective, for instance, of trying to prevent loss of investor confidence in the currency may lead to attempts to prevent it from depreciating. As long as the pressure is not extreme, a central bank, by direct sale and purchase in the foreign exchange market can, in the short run, determine how the currency moves. In the period after January

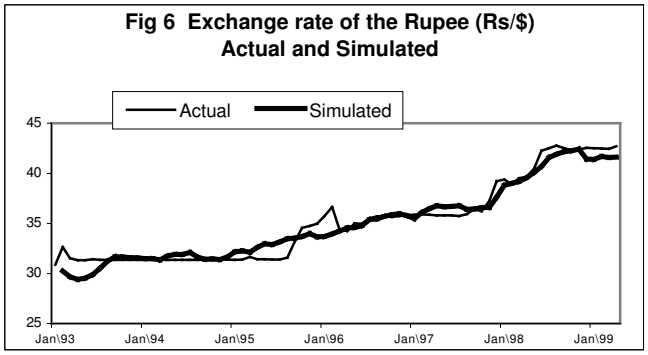
1994 when foreign institutional investors were allowed to enter the Indian stock market, the increase in capital inflows put a sharp upward pressure on the rupee. Active intervention in the shape of purchase of dollars, however, kept the value of the rupee constant for sixteen months. Purchase of dollars is expected to increase the value of the dollar by raising its demand. We find a positive correlation between intervention (measured by net purchase of foreign currency) and a movement of the exchange rate, but the data do not provide strong support for an effect of active intervention..

4. The Role of the Domestic Policies

Simulations of the model suggest that during most of 1994-95 the exchange rate was overvalued in comparison to its long run level (Figure 6). To be in line with the long run equilibrium it should have depreciated. However, because of foreign portfolio capital inflow there was an upward pressure on the rupee. In this period the rupee was kept constant by the RBI. In 1995 the demand for rupees from FIIs reduced. But since the rupee was overvalued, trade deficit rose and put pressure on the rupee. Between May 1995 and May 1996 there was little intervention by the RBI since this time the pressure was downward rather than upward. When the rupee depreciated sharply, there was an overcorrection. For a few months it can be seen that the rupee was undervalued in terms of the long run equilibrium rate. The nominal value of the rupee soon adjusted and it became equal to the equilibrium rate. After this for a few months the rupee moved very little and did not depreciate at a rate that would have kept it at the level that would have ensured equilibrium in the output market. This was followed by another episode of overadjustment after the Pokhran nuclear test in May 1998. The economic sanctions imposed by certain industrial countries, suspension of fresh multilateral lending,

downgrading by some international credit rating agencies and reduction in net foreign institutional investment led to a sharp depreciation of the rupee. The foreign exchange market again came under pressure in August 1998, reflecting the adverse sentiment with the deepening of financial crisis in Russia and the fear of devaluation of the Chinese renminbi. Both events were followed by measures by the RBI to stabilise the rupee. The Resurgent India Bonds (RIB) scheme was also launched in August 1998. The RIB scheme was designed to offset the disruption of normal capital flows to India and to counteract the possible adverse sentiments in the international markets due to downgrading of India's sovereign rating. This led to a pressure to appreciate and in contrast to cumulative sales by the Reserve Bank amounting to US $ 2,502 million during May-July 1998 to defend the rupee, the subsequent period from August 1998 to March 1999 witnessed cumulative purchases of US $ 4,143 million. Following that the exchange rate remained until now, by and large, fairly stable.

As the Figure 6 shows the model captures the behaviour of the exchange rate rather well. The rate generated by the model appears to be the underlying rate that determines the movement of the rupee as there is a tendency for the observed exchange rate to return to the path it follows. As expected the market does not move instantly to the output market equilibrium rate as adjustment in the output market is slow. Current account deficit can mount, financed by a draw down of reserves and capital flows.



Another aspect of the model is the implied response of the exchange rate to changes in fundamentals. A number of factors which characterize domestic policy making and/or economic conditions are exogenous in the model. The model can be used for the purpose of examining the movement of exchange rate that would occur due to a change in these exogenous variables. It is therefore worthwhile to evaluate the response characteristics of the model. The following graphs show the percentage change in the exchange rate due to changes in the exogenous variables.

Figure 7 shows the impact on the exchange rate of the rupee that a 10 per cent increase in the domestic price of non-tradables would have. As expected the increase in the domestic price of non-tradables raises the domestic price ratio of non-traded to traded goods and leads to an appreciation. The exchange rate takes about a year to adjust and stabilises at a new level where the percentage change is just below 3 percent.

Figure 9 shows the impact of a 2 percent increase in real interest differential on the real and nominal interest rates. As the graph suggests, an increase in the interest differential leads to an appreciation of the rupee. Similarly Figures 10, 11 and 12 show the percentage change in the value of the rupee due to a change in liquidity, central bank intervention and country risk. It is assumed that RBI credit to the central government increases by 10 percent. Figure 10 shows the resulting depreciation in the Re/dollar rate. Fig 11 shows that the impact of net purchase of dollars by the central bank by an

additional $10 billion. Fig 12 shows that the depreciation due to a fall in foreign exchange reserves worth 5 months worth of imports.

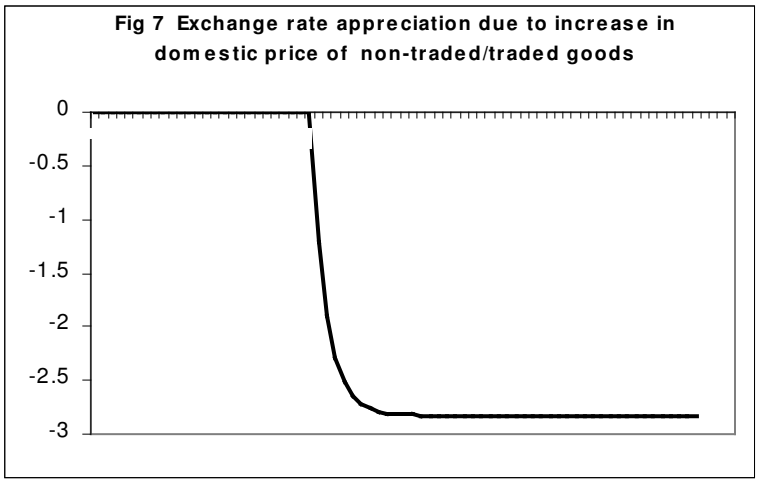


Fig 7 Exchange rate appreciation due to increase in domestic price of non-traded/traded goods
0
-0.5
-1
-1.5
-2
-2.5
-3

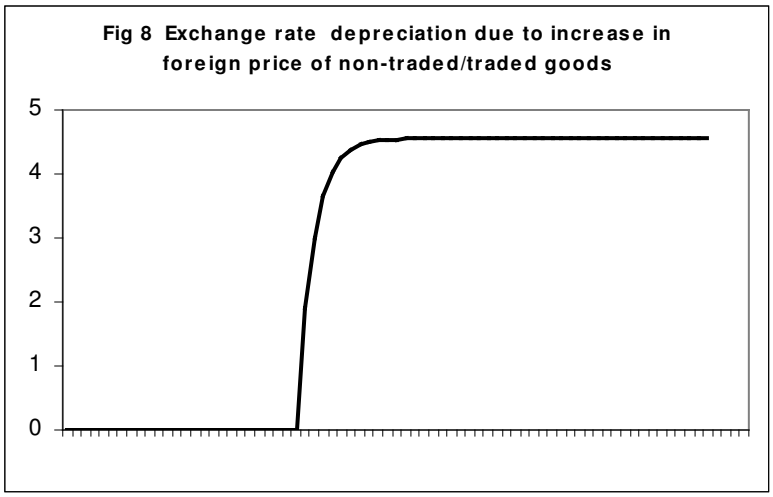


Fig 8 Exchange rate depreciation due to increase in foreign price of non-traded/traded goods
5
4
3
2
1
0

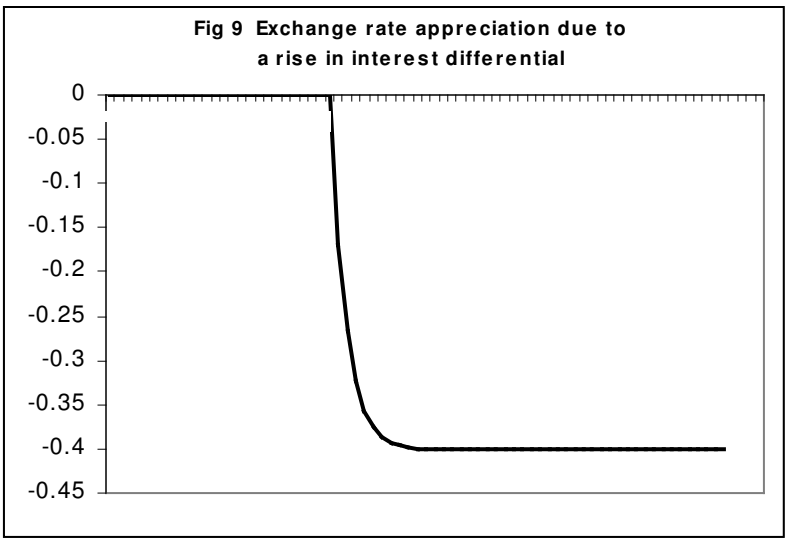


Fig 9 Exchange rate appreciation due to a rise in interest differential
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
-0.45

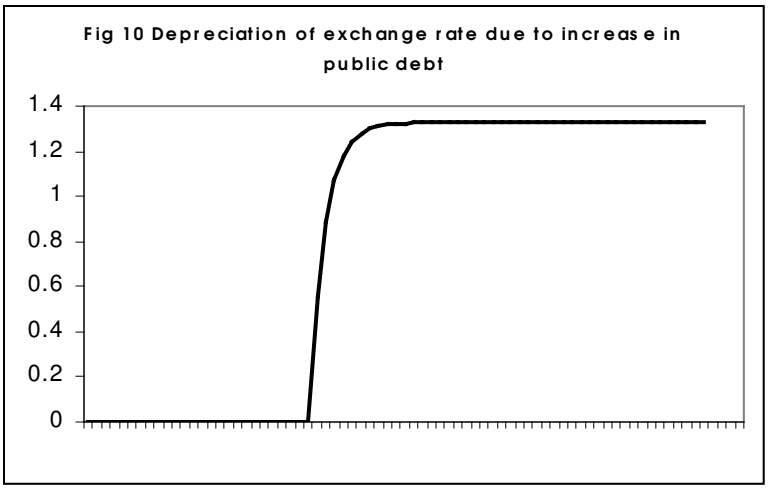


Fig 10 Depreciation of exchange rate due to increase in public debt
1.4
1.2
1
0.8
0.6
0.4
0.2
0

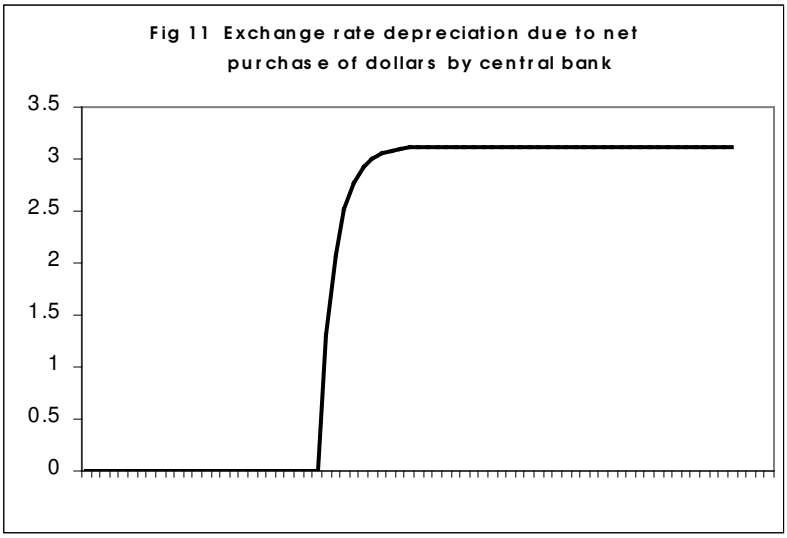


Fig 11 Exchange rate depreciation due to net purchase of dollars by central bank
3.5
3
2.5
2
1.5
1
0.5
0

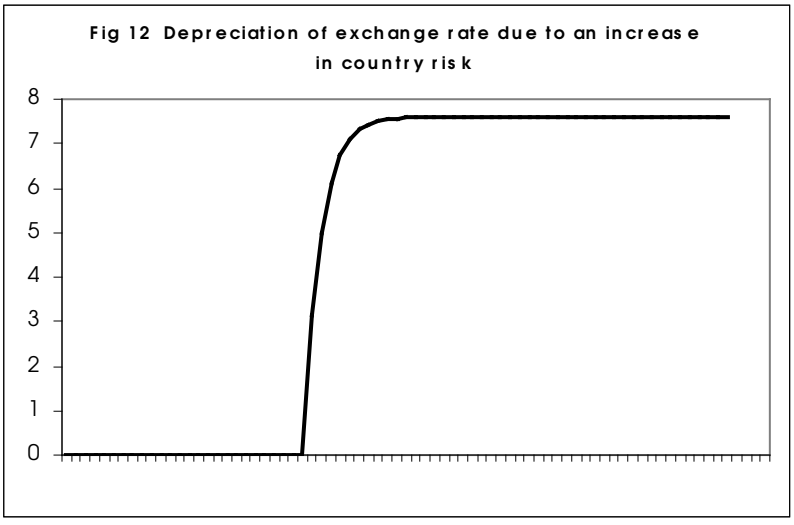


Fig 12 Depreciation of exchange rate due to an increase in country risk
8
7
6
5
4
3
2
1
0

5.Concluding Remarks

As markets are liberalised the rupee's value is increasingly determined by economic forces. Our results suggest that in the nineties the rupee was essentially determined by equilibrium in the output market. However, due to slow adjustments in this market, the exchange rate was not always at the equilibrium rate. Deviations from the output equilibrium rate were common. But despite periods when the rupee was overvalued or undervalued compared to the long run rate, usually in response to forces in financial markets, there appeared to be a clear tendency to revert to the output equilibrium level. Whenever the rupee became overvalued in response to capital inflows it did not take long for a mounting current account deficit to put pressure on it to depreciate.

Sometimes there was an overcorrection and the foreign exchange market witnessed a short spell when the rupee was undervalued. Usually this was short lived because even if this was followed by a period when the nominal exchange rate did not move as India's normally higher inflation rate vis-à-vis the US ensured that the real value of the rupee soon returned to the equilibrium path.

Financial reform has led to increased integration of domestic markets with international money markets. This is revealed by the increasing importance of interest differentials in the determination of the exchange rate. As the reforms proceed this variable is expected to become more important. This process has important policy implications as it leads to loss of monetary policy independence. As the vast theoretical and empirical literature on the European experience under the ERM shows pursuing a policy of managing the exchange rate within a band reducing the options available for monetary policy when the capital account is open. Conflicts may often arise between what are perceived to be the needs of the domestic economy and those arising from exchange rate considerations. Our results show that in India both liquidity conditions and interest differentials play a role in determination of the exchange rate. A recent example of the use of these instruments of monetary policy is the increase in the cash reserve ratio and bank rate in January 1998 to curb volatility in the forex markets despite the danger that

tightening liquidity could hurt the real sector that was already facing recessionary conditions. With greater globalisation of financial markets there are likely to be more such conflicts in future.

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