ILA PATNAIK[1]
National Council of Applied Economic Research

India's Experience with a Pegged Exchange Rate

According to the Reserve Bank of India (RBI), the exchange rate of the Indian rupee is "market determined," in the sense that it is set in a currency market and is not administratively determined. However, the RBI actively trades in the foreign exchange market with the stated goal of "containing volatility" and influencing the market price. Recent research on the Bank's interventions has demonstrated that the rupee is effectively pegged to the U.S. dollar. That link to the dollar, combined with the easing of restrictions on India's current account and capital account during the 1990s, suggests a potential conflict with Bank efforts to conduct an autonomous monetary policy directed toward stabilizing the domestic economy.

A key insight of open economy macroeconomics, newly prominent in recent decades, is the idea of the "impossible trinity."[2] The theory is that no country can simultaneously have an open capital account, a fixed exchange rate, and a monetary policy targeted on the domestic economy. Specifically, once the capital account is open and the exchange rate is fixed, monetary policy is driven solely by the need to uphold the fixed exchange rate.

To review the logic of the impossible trinity, suppose a central bank begins to tighten monetary policy in the presence of an open capital account and a fixed exchange rate. Tight monetary policy raises interest rates, which attract capital inflows. The central bank must therefore buy foreign currency to prevent a currency appreciation. Financing the purchases requires an increase in the monetary base, reversing the earlier effort to tighten monetary policy. As an alternative, the bank might seek to finance the purchase of foreign currency by offsetting sales of other domestic assets, such as its holding of government debt (a process known as

1. This paper grew out of conversations with Ajay Shah. The views in this paper are my own. I would like to thank Rajnish Mehra, Indira Rajaraman, Shankar Acharya, Arvind Virmani, Suman Bery and Barry Bosworth for many improvements to the paper. I am grateful to CMIE and Golak Nath of NSE for help on data.

2. Mundell (1961).

sterilization); but those actions will exacerbate the rise in interest rates, attracting further inflows.

Few countries today adhere to the extreme position of having a fixed exchange rate. But many countries that try to "manage" a "market determined exchange rate" face similar conflicts. And the more the central bank focuses on currency policy, the more it loses monetary policy autonomy.

In the years after World War II, many countries chose to have autonomy in both currency policy and monetary policy and did so successfully by closing the capital account. With a closed capital account, even if economic agents have speculative views about future fluctuations of the currency, they cannot express these views by taking positions in the foreign exchange market. With a more open capital account, however, when economic agents have speculative views about the future, they are able to move capital across borders and vary their net currency positions. For example, an importer who expects a rupee appreciation may choose to delay payments in order to convert into U.S. dollars at a more attractive exchange rate. The steady increase in openness on the capital account in recent decades is forcing many countries now to grapple with the trade-off between having a currency policy and having monetary policy.

Until the past decade, India had a system of strong capital controls. In the spirit of the impossible trinity, these controls made it possible for India's central bank to operate a fixed exchange rate regime and have monetary policy autonomy. During the 1990s, however, restrictions on the current account and the capital account were substantially, though not completely, eased. (A later section of this paper describes capital mobility in India in more detail.)

As the conceptual framework of the impossible trinity implies, India's liberalization of the current account and the capital account should have steadily tied monetary policy to the need to maintain the currency regime.[3] Although currency flexibility in India appears to have been unchanged in the past twenty-five years, the monetary policy consequences of upholding this currency policy are likely to have changed substantially.

It is important to emphasize that India has neither a completely open capital account nor a completely fixed exchange rate. The current policy framework comprises partial controls on capital, a pegged (but not fixed) exchange rate with extremely low volatility, and an effort at monetary policy autonomy. The policy framework in India today is hence an interesting gray area, one not well illuminated by theory.

3. Joshi (2003).

This paper seeks to shed some light on the extent to which India's choice of a pegged currency regime has attenuated monetary policy. It addresses four questions. First, where does India stand in terms of opening the capital account? Second, what has the RBI's stance of sterilization been? Third, is it possible to isolate episodes of large-scale currency trading by the central bank? And finally, what were the monetary consequences of currency trading?

The following sections provide a brief summary of recent research on India's currency regime, an overview of the implications of capital controls for the operation of the currency forward market, and an examination of the extent to which the RBI has sought to sterilize the domestic monetary implications of its exchange market interventions. These discussions provide the context for the analysis of two episodes of large-scale RBI intervention in currency markets, one in 1993–94 and the other after June of 2001. In both episodes the RBI accumulated foreign currency reserves in an effort to resist an exchange rate appreciation. The analysis highlights the growing conflict for India between implementing a pegged exchange rate and operating an autonomous monetary policy.

Recent Research on India's Currency Regime

Several recent research papers have focused on the question of how to characterize a country's *de facto* currency regime, as opposed to the regime that the central bank claims is in operation. G. A. Calvo and C. M. Reinhart propose a metric of currency flexibility that combines volatility of the exchange rate, volatility of foreign exchange reserves, and interest rate volatility.[4] Within this context, they find that the Indian exchange rate exhibits extremely low flexibility and that the degree of flexibility did not change during 1979–99.

Reinhart and K. S. Rogoff propose a data-driven algorithm for identifying the *de facto* currency regime.[5] First, they examine the monthly absolute percentage change in the exchange rate. If the change is equal to zero for four consecutive months or more, they classify that episode (however long it lasts) as a *de facto* peg if no dual or multiple exchange rates are in place. This approach allows them to identify relatively short-lived *de facto* pegs as well as longer-lasting pegs. Second, they compute the probability that the monthly exchange rate change remains within a 1 percent band over a

4. Calvo and Reinhart (2002).
5. Reinhart and Rogoff (2002).

rolling five-year period. If the probability is 80 percent or higher, they classify the regime as a *de facto* peg or crawling peg over the entire five-year period. If the exchange rate has no drift, they classify it as a fixed parity; if it has a positive drift, they label it a crawling peg. If it goes through periods of both appreciation and depreciation, it is a moving peg. Based on these methods, Reinhart and Rogoff classify the current currency regime in India as a "peg to the US dollar" (in various forms) since August 1979.

In a working paper last year I examined in more detail the question of how to characterize India's currency regime.[6] In summary, I found that India's enormous reserves buildup after mid-2002 cannot be explained as a quest for reserves as insurance. In addition, extending Calvo and Reinhart's metric of currency flexibility beyond 1999 shows no change over 1979–2003. A variety of tests betray symptoms of pegging the rupee to the U.S. dollar. The volatility of the rupee-dollar exchange rate, for example, is extremely low while that of the exchange rate of rupee and the euro or the yen is high. Tests based on a methodology devised by J. Frenkel and S.-J. Wei show that the dollar is overwhelmingly the dominant currency in explaining fluctuations of the Indian currency.[7]

India's Openness on the Capital Account

It is widely believed that India opened up to capital inflows beginning in 1991. But as table 1 shows, total inflows dropped from 11.6 percent of GDP in 1991–92 to 9.7 percent of GDP in 2002–03. Nonofficial flows stagnated at roughly 9 percent. How can this picture be reconciled with India's substantial capital account liberalization during the 1990s?

Understanding the Elements of Openness

One explanation for this seeming contradiction lies in the way capital flows are measured. They can be measured in terms of gross inflows, or net inflows, or gross flows (inflows plus outflows), just as trade openness can be measured in terms of the trade balance, or exports, or exports plus imports. In the case of trade, or the current account, the most meaningful measure, which is universally used, is exports plus imports as percentage of GDP. Similarly, I will use capital account inflows plus outflows as percentage of GDP to measure the extent of capital account openness.

6. Patnaik (2003).
7. Frenkel and Wei (1994).

TABLE 1. Capital Inflows into India, 1991–92, 1995–96, 2002–03

Percent of GDP		
Year	*Total*	*Nonofficial*
1991–92	11.59	8.81
1995–96	7.22	6.34
2002–03	9.75	9.19

Source: Reserve Bank of India, *Monthly Bulletin,* various issues.

The second explanation involves thinking carefully about the nature of capital controls in India today. It proves useful to think in terms of a hierarchy of openness of the different channels through which capital now flows both inward and outward. The following discussion touches briefly on the channels in this hierarchy, running from the most open to the most controlled.

CURRENT ACCOUNT. Since India's current account was sharply liberalized during the 1990s, trade in both goods and services has grown enormously. As table 2 shows, trade, as a share of GDP, grew from 21.3 percent to 36.8 percent from 1991–92 to 2002–03.

The current account is one of the most open channels for cross-border capital movements because government inspectors are unable to measure accurately the value of goods and services, such as shipments of diamonds or email attachments containing software. The current account is also a well-known channel for evading capital controls. During the 1990s, for example, trade misinvoicing on the current account was a significant route for capital flows.[8] Hence the growth of the current account should be interpreted as an effective easing of capital controls. Since 1991, RBI regulations on the current account have not been used to implement currency policy.

INVESTMENT FLOWS. Investment flows involve some capital controls. India has steadily eased restrictions on foreign direct investment, foreign institutional investors engaging in portfolio investment, and outward flows by Indian firms seeking to build international operations, so that investment flows are a relatively open channel for cross-border capital flows. Nevertheless, for example, government regulations for foreign direct investment involve restrictions in certain industries—such as that foreign investors cannot own more than 24 percent of an insurance company. And rules for foreign institutional investors have caps for the ownership of any one stock and ceilings for the total ownership by all such

8. Patnaik and Vasudevan (2000).

TABLE 2. Growth of India's Current Account, 1991–92 to 2002–03

Trade account category	1991–92 (Billions of U.S. dollars)	2002–03 (Billions of U.S. dollars)	1991–92 (Percent of GDP)	2002–03 (Percent of GDP)
Merchandise				
Exports	18.3	53.0	6.9	10.4
Imports	21.0	65.5	7.9	12.8
Invisibles				
Exports	9.5	43.0	3.6	8.4
Imports	7.9	26.9	2.9	5.2
Total	56.7	188.3	21.3	36.8

Source: Author's calculations based on data from Reserve Bank of India, *Monthly Bulletin,* various issues, and Centre for Monitoring Indian Economy.

investors in a stock. Foreign investors are essentially prohibited from buying government bonds.

At the same time, these channels constitute effective capital account convertibility for these classes of investors, who are free to move capital in and out of India and who are permitted access to the currency forward market. As with the current account, tactical changes in these rules have not been used by the government or RBI as an instrument of implementing currency policy.

OTHER CAPITAL FLOWS. Balance of payments statistics show an entry for "other capital flows," which consist of delayed export receipts, advance payments against imports and loans to non-residents by residents. These offer a channel for capital flows that are not restricted by official controls.

LOANS. Although Indian firms can borrow from overseas, the borrowing involves significant restrictions, and the Ministry of Finance and RBI have attempted to use changes in these capital controls as a way to implement currency policy.

BANKING FLOWS. Capital flows through the banking system are influenced by a very detailed set of regulatory restrictions operated by RBI. As both the central bank and the banking regulator, RBI uses banking regulation to implement capital controls. For example, RBI sets the interest rate at which banks borrow from foreigners (labeled "nonresident Indians"). Hence it is useful to think of all capital flows through the banking system as being highly controlled.

OFFICIAL FLOWS. These flows are, by definition, not available to private economic agents and are excluded from consideration.

As table 3 shows, the least-controlled capital flow channel, investment flows, increased from less than 1 percent of GDP to 3.9 percent of GDP

TABLE 3. Private Capital Flows as Percent of GDP, India, 1991–92, 1995–96, 2002–03

Percent of GDP	*1991–92*	*1995–96*	*2002–03*
Investment flows	0.08	1.99	3.91
Other capital flows	2.43	1.20	1.82
Loans	4.19	4.62	4.41
Banking flows	10.07	3.63	5.52
Total	16.76	11.43	15.36

Source: Author's calculations based on data from Reserve Bank of India, *Monthly Bulletin,* various issues, and Centre for Monitoring Indian Economy.

over a decade. The most-controlled channel, banking flows, dropped from 10 percent of GDP to 5.5 percent of GDP. Overall, private capital flows saw no trend increase.

With the current and capital account combined, India's total private external transactions rose from roughly 35 percent of GDP to more than 50 percent of GDP from 1991–92 to 2002–03. Over this decade, both the foreign exchange market and private participation in it increased considerably.

Restrictions on the Currency Forward Market

One element of the capital controls now in place is barriers to arbitrage on the currency forward market. In a conventional forward market, arbitrage defines the forward rate. Even if strong speculative views and positions on the market exist, in a normal forward market no interesting interpretation can be attached to the level of the forward premium because the premium is determined purely by covered interest parity. When violations of market efficiency arise, near-infinite capital comes into play in arbitrage. Through this process, arbitrageurs restore the forward price to its fair value.

In India, RBI rules sharply restrict the ability of banks to engage in covered interest parity arbitrage, thus breaking the link between the spot market price and the price of the derivative.[9] In addition, although the RBI trades extensively to manipulate the spot market, the observed forward price tends to be a market-determined rate.

Interestingly, the RBI rules that inhibit covered interest parity arbitrage combine with the relatively undistorted forward market to generate a

9. Currency derivatives can either trade OTC or on exchange. At present, currency derivatives are only traded OTC; there is no exchange. Hence, my treatment is limited to currency forwards and does not use data from a currency futures market.

remarkable information source. When arbitrage does not determine prices, information from the forward market conveys expectations about the future. If economic agents expect the rupee to depreciate, they grow more interested in selling rupees forward. Exporters stay unhedged, and importers are likely to hedge. Conversely, if economic agents expect the rupee to appreciate, they grow more interested in buying rupees forward.

The arithmetic of forward pricing, as noted, is based on covered interest parity, which involves comparing two routes for riskless dollar investment. An investor could convert \$1 into $(1 + r_u)^T$ through r_u, which is obtained from the U.S. zero coupon yield curve for T years. Or the investor could convert into rupee at the spot price (S), invest in the Government of India (GOI) zero coupon yield of comparable maturity, and obtain a locked-in cash flow of $S(1 + r_i)^T/F$ by converting back into dollars at the exchange rate F at date T. Under no-arbitrage, these two investment strategies have to yield an identical return, through which the fair value for F can be computed. Once we know the fair value, we can measure the error when compared with the observed market price.

If RBI rules did not restrict arbitrage, the forward premium would not be informative. Under the existing policy framework, however, it is a uniquely useful market-based measure of future expectations, one that is not available in most countries where regulators do not inhibit arbitrage.

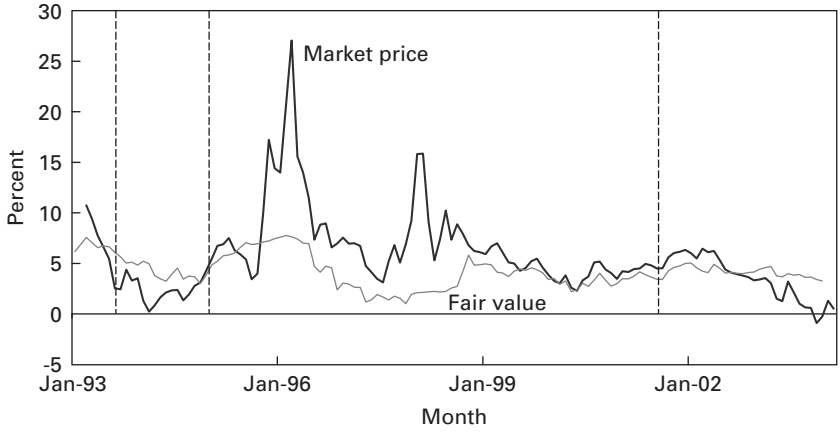
Internationally, empirical research related to currency expectations uses data based on surveys.[10] Market participants, central bankers, multinational companies, and economics departments of banks are interviewed on a weekly or monthly frequency. Survey data such as the *Currency Forecasters' Digest*, now known as the *Financial Times Currency Forecast*, form the basis of empirical research on currency expectations.[11]

Although no such data are available for India, the daily data from the forward market on the deviation of the forward-market rate from covered interest parity are a unique high-frequency source of information about currency expectations. As shown in figure 1, in the rupee-dollar forward market, deviations from the covered parity conditions have tended to persist over many years. In an open market, arbitrage would have wiped out such deviations almost instantly.

Apart from conveying expectations of the market, the error between the observed forward premium and its fair value also shows the arbitrage opportunity available to those who are allowed to participate in the forward market.

10. Frankel and Okongwu (1996).
11. Chinn and Frankel (1994).

FIGURE 1. Rupee-Dollar Forward Premium: Market Price and Fair Value, January 1993 to February 2004



Source: Author's calculations based on data from Federal Reserve Board, National Stock Exchange, Telerate and ABN Amro. Fair value is the interest rate on 91-day treasury bill in India minus that on the 3 month treasury bill in the US.

Full Period: Vertical lines are placed at "06/01/93" and "11/01/94" and "08/01/01"

Extent of Sterilization

A central bank has several options in responding to variations in the volume of net capital inflows. One is simply to allow the market for foreign exchange to clear through changes in its price. But if the central bank is committed to a specific exchange rate, it can finance its purchases of foreign exchange either by expanding the monetary base or by selling other domestic assets, normally government debt. Concern that large expansions of the monetary base could worsen inflation pressures often leads to efforts to "sterilize," or offset, the monetary implications through the sale of other assets in the bank's portfolio. The extent of sterilization by the central bank can differ, depending on both the need to sterilize and the ability to do so. It is also possible to distinguish between "narrow" sterilization, involving the sale of other domestic assets, and "broad" sterilization, involving levers like changes in reserve requirements.

In what follows I estimate an offset coefficient that measures the extent to which the addition to net foreign exchange assets (NFA) is sterilized by the central bank. The central bank offsets the change in NFA by changes in net domestic assets (NDA), where NDA is a policy variable. My work

is based on a monetary model, which includes a simple money demand function and a money supply function. The reduced form expression assumes that NDA is responsive to demand conditions in the economy, determined by output growth. Changes in NDA take into account the changes in the monetary base due to changes in NFA or to changes in reserve requirements.[12] When the central bank fully offsets changes in NFA, in the limit, the offset coefficient is –1. Partial sterilization generates values of the coefficient between 0 and –1.

The model is estimated for the period April 1993 to December 2003 using monthly data. Net domestic assets of the RBI are adjusted to reflect net non-monetary liabilities. For comparability, the index of industrial production (IIP) is re-expressed in nominal terms using the wholesale price index. This yields a time-series of the nominal IIP (IIPn), which is used as a proxy for nominal output. The cash reserve ratio (CRR) is used to measure bank reserve requirements.

The series NDA, NFA, and IIPn are non-stationary. Unit root tests indicate that they are I(1). Further, both the Johansen cointegration tests and standard tests for stationarity suggest that the series are cointegrated. Consequently, the model for estimating the offset coefficient is set up as an error-correction model. The first stage is specified in levels, and the second stage in first differences with the lagged residual term as an additional variable and with monthly dummies:

$$\text{NDA} = \alpha_0 + \alpha_1 \text{NFA} + \alpha_2 \text{IIPn} + \alpha_3 \text{CRR} + \varepsilon_t \tag{1}$$

$$\Delta\text{NDA} = \beta_0 + \beta_1 \varepsilon_{t-1} + \beta_2 \Delta\text{NFA} + \beta_3 \Delta\text{IIPn} + \gamma_t \tag{2}$$

The empirical results are

$$\underset{(30.7)}{\text{NDA} = -0.822\ \text{NFA}} + \underset{(17.7)}{841.6\ \text{IIPn}} + \underset{(0.4)}{360.4\ \text{CRR}}, \quad R^2 = 0.93 \tag{3}$$

and with error correction,

$$\underset{(4.5)}{\Delta\text{NDA} = -0.271\ \varepsilon_{t-1}} - \underset{(5.4)}{0.602\ \Delta\text{NFA}} + \underset{(5.8)}{375.2\ \Delta\text{IIPn}}, \quad R^2 = 0.38 \tag{4}$$

The results suggest that RBI directly sterilized its currency intervention by a reduction in net domestic assets. However, though the extent of sterilization

12. Schadler and others (1993) estimate an offset coefficient that measures the degree to which capital inflows offset the changes in net domestic assets in a fixed exchange rate regime. My model is similar to the one used by them, but is motivated by a different question.

was large, it was not complete. The offset coefficient is estimated to be –0.8 in levels and 0.6 in the error-correction estimate.

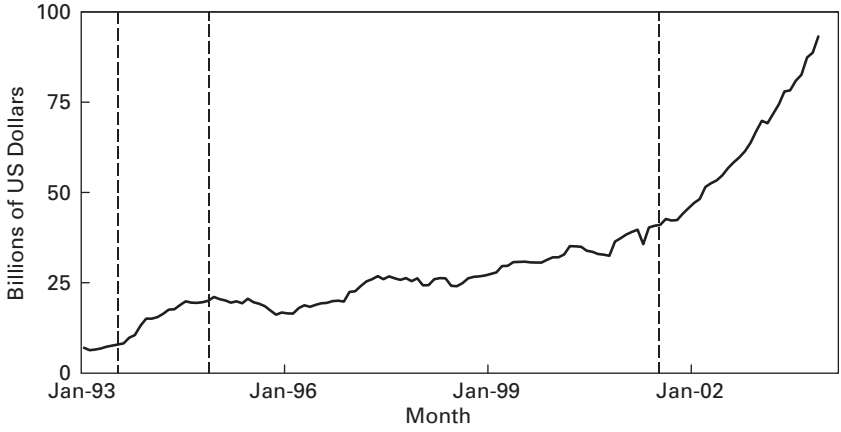
The relationship with output growth was found to be positive and highly significant. In other words, growth in net domestic assets was higher when output growth was faster. The coefficient of CRR was found to be insignificant and is excluded in the error-correction estimate.

Analyzing Major Episodes of RBI Currency Trading

To understand the consequences of the impossible trinity, as well as issues in the implementation of the rupee-dollar peg, it is interesting to focus on the periods when the RBI has engaged heavily in currency trading. Figure 2 shows the time-series of India's foreign currency reserves from January 1993 to November 2003. Based on the rate of reserve accumulation, two episodes merit attention. Episode I runs from June 1993 to November 1994 (eighteen months). Episode II runs from August 2001 onward. Both episodes happen to involve a sharp increase in reserves. There is no comparable episode of a sharp drop in reserves.

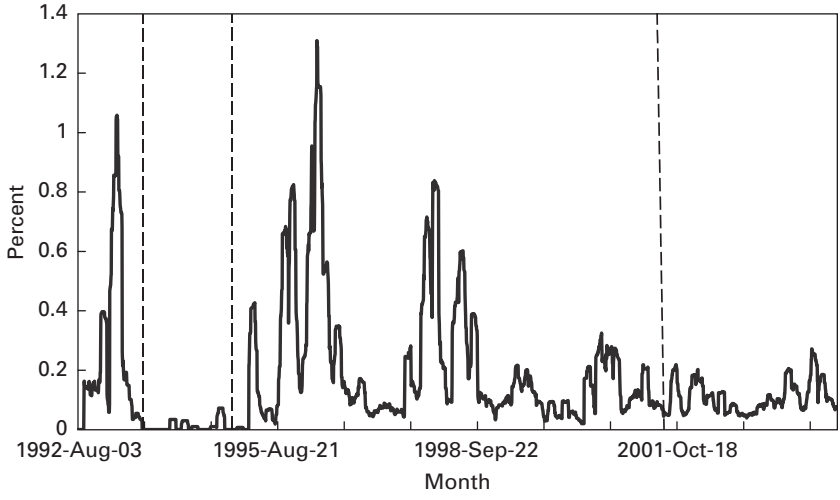
Reserves increased because the central bank was purchasing dollars to prevent an appreciation of the rupee. Figure 3 shows the time-series of daily volatility of the rupee-dollar exchange rate during the period in question.

FIGURE 2. Foreign Exchange Assets of the Reserve Bank of India, 1993–2003



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Full Period: Vertical lines are placed at "06/01/93" and "11/01/94" and "08/01/01"

FIGURE 3. Rolling Window Estimates of Rupee-Dollar Daily Volatility, 1993–2003



Source: Author's calculations based on data from Centre for Monitoring Indian Economy.
Full Period: Vertical lines are placed at "06/01/93" and "11/01/94" and "08/01/01"

In both Episodes I and II, the standard deviation of daily returns attains low values like 0.1 percent.

I propose to understand both these episodes using the following framework. First, how did the episode commence? Second, what were the fluctuations of the currency in the episode? How tightly did RBI peg the currency? Third, what was the currency forward market thinking? Fourth, how large was RBI's currency trading, compared with reserve money? Fifth, how did RBI offset the monetary implications of currency trading? Sixth, what was the trajectory of money supply and interest rates in the episode?

Episode I

In 1993–94, India began liberalizing portfolio inflows. From near-zero levels, portfolio inflows rose sharply to $307 million in the second quarter of 1993–94, to $935 million in the third quarter, to $2283 million in the fourth quarter. The shift marked the beginning of a capital surge into the country.

TABLE 4. Balance of Payments in Episode I

Billions of U.S. dollars

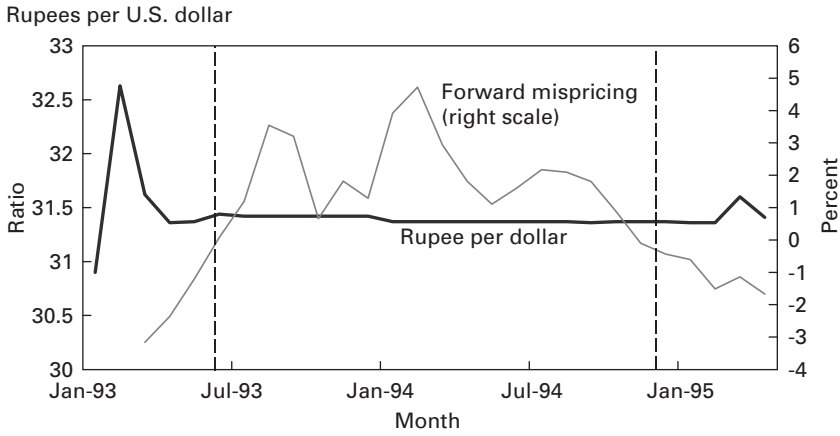
Year	*Current account balance*	*Net capital inflows*	*Change in net foreign assets*
1991–92	–9.6	3.7	5.71
1992–93	–1.2	2.9	–1.25
1993–94	–1.2	9.6	7.45
1994–95	–3.4	9.1	7.10
1995–96	–5.9	4.7	–0.19
1996–97	–4.6	11.5	4.78

Source: Reserve Bank of India, *Monthly Bulletin,* various issues.

Table 4 shows the evolution of balance of payments around Episode I. The current account was unchanged from 1992–93 to 1993–94. Net capital inflows, however, rose sharply from $2.9 billion to $9.6 billion. My dating of Episode I, from June 1993 to November 1994, is squarely in this period of high capital inflows.

Faced with a capital surge, RBI chose to prevent the rupee from appreciating. The rupee-dollar rate was kept largely fixed, as shown in figure 4. Between July 1993 and December 1993, the dollar was fixed at Rs 31.42. In January 1994, it moved to Rs 31.37.

FIGURE 4. Expectations of Rupee Appreciation, Episode I



Source: Author's calculations based on data from Reserve Bank of India and Centre for Monitoring Indian Economy.

Episode I: Vertical lines are placed at "06/01/93" and "11/01/94"

As noted earlier, covered interest parity violations on the currency forward market are a source of information about the speculative views of private market participants. In a longer time-series beginning from 1993, the errors are typically negative, reflecting expectations of rupee depreciation.[13]

As figure 4 shows, the speculative views of the market swung into positive terrain at the start of Episode I. That is, private market participants appear to have believed that the rupee was a "market determined exchange rate," so the capital surge would lead to a rupee appreciation.

With the benefit of hindsight, we know that these expectations were incorrect. Nevertheless, this information about expectations shaped contemporaneous investment decisions of economic agents and thus the capital flows.

Figure 5 shows the time-series of RBI purchases of foreign currency during Episode I. Because the exchange rate was fixed, the data on currency intervention serve as a proxy for the capital inflow into the economy, for which monthly data are not available.

The similarity between the fluctuations of RBI purchases of foreign currency and the mispricings on the currency forward market is striking. This is consistent with my argument that such mispricings reflect the then-prevalent currency views of private market participants, which would have shaped their decisions on short-term capital flows.

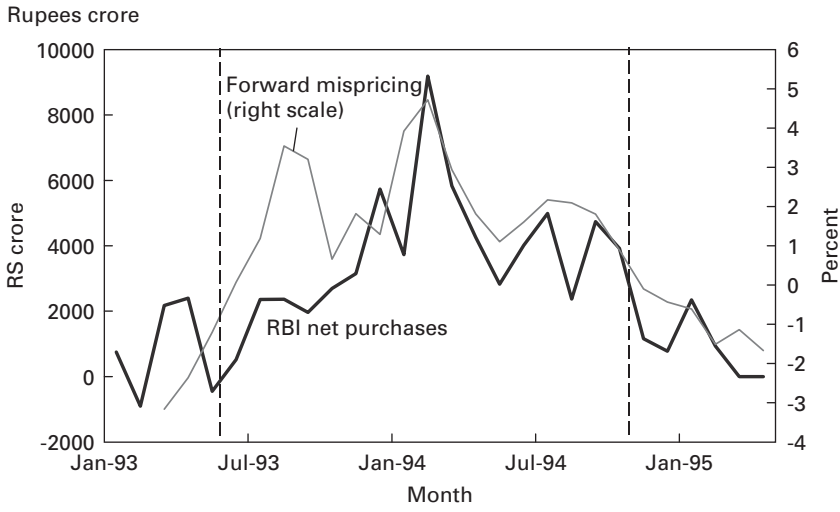
When a central bank engages in currency trading, the trading affects reserve money. If the capital account is highly open, the scale of currency trading required to distort the price on the currency market is larger. In the case of Episode I, the purchases of foreign assets by RBI led to a rise in net foreign assets from 20 percent of reserve money to 45 percent of reserve money.

As noted, the central bank has several options in sterilizing this impact. One would be the sale of government bonds that are part of reserve money. Data for open market operations in this period have not been released, but at the time of Episode I the bond market was highly illiquid, which may have placed constraints on the RBI's use of open market operations in sterilization. Another option would have been the weaker lever of not replacing maturing government bonds.

Figure 6 shows the growth of net foreign assets and net domestic assets in Episode I. Net foreign assets rose sharply, reflecting currency trading.

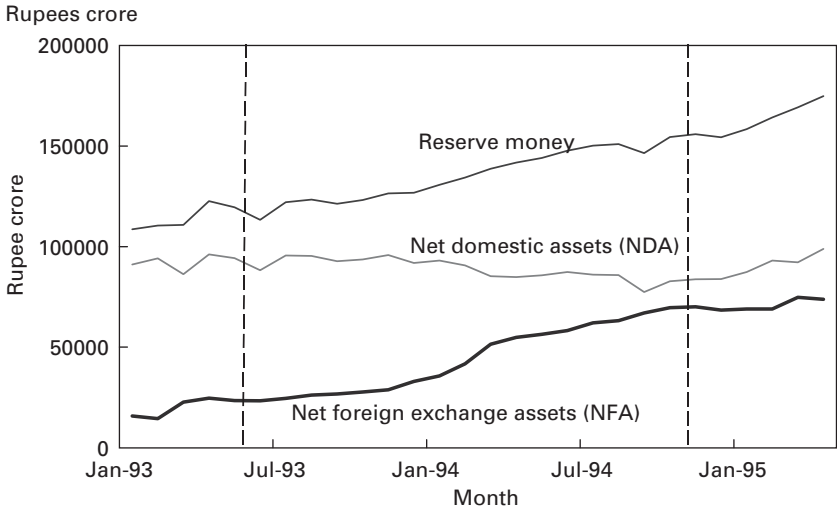
13. The "typical" configuration in India has been one where domestic inflation is higher than worldwide inflation, and the rupee has steadily depreciated.

FIGURE 5. RBI Net Purchases of Foreign Currency, Episode I



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Note: 1 crore is 10 million

FIGURE 6. Central Bank Assets and Reserve Money, Episode I



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Note: 1 crore is 10 million

TABLE 5. RBI Use of Reserve Requirements for Sterilization in Episode I

Date	*Action*
June 11, 1994	Cash reserve ratio raised from 14% to 14.5%.
July 9, 1994	CRR raised to 14.75%.
Aug. 6, 1994	CRR raised to 15%.
Oct. 29, 1994	CRR for Foreign Currency Non-Resident Accounts raised from 0% to 7.5%.
Jan. 21, 1995	CRR for Non-Resident accounts raised from 0% to 7.5%; CRR for FCNR accounts raised to 15%.
July 17,1995	Conditions for overdraft facility to stock brokers to draw money from banks made more stringent.

Source: Reserve Bank of India, *Monthly Bulletin,* various issues.

Sterilization is "partial," in that NDA fell But the drop in NDA was not as large as the rise in NFA.

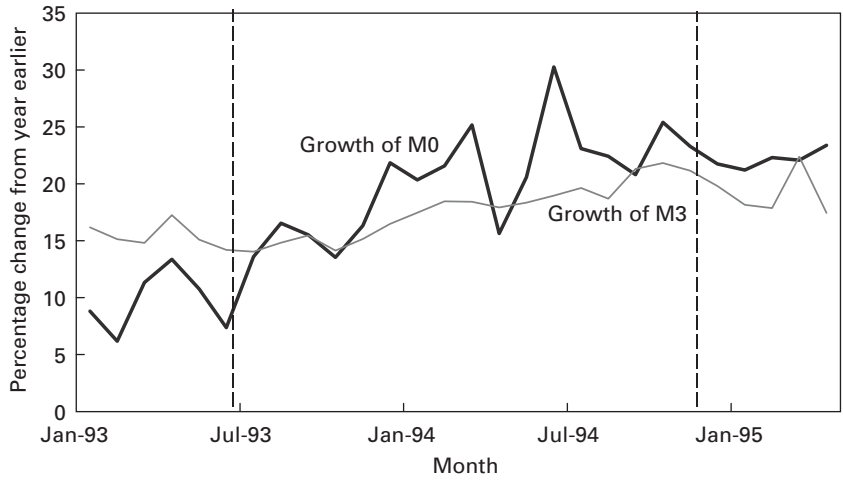
By my dating, Episode I started in June 1993. One year into the episode, the growth of reserve money, M_0, had touched 30 percent. Beginning on June 11, 1994, RBI embarked on monetary tightening by using reserve requirements (see table 5). These policy decisions marked a reversal of RBI's earlier policy of phasing out the cash reserve ratio (CRR), which was seen as a component of financial repression and a tax on banking. The use of reserve requirements as a tool for currency policy has been observed to affect interest rates in many developing countries.[14]

Figure 7 summarizes the monetary consequences of the pegged exchange rate regime in Episode I. Reserve money grew at rates as high as 30 percent annualized. The RBI muted the impact of reserve money growth on M_3 growth through the use of reserve requirements. Interest rates during the period of the capital surge declined slightly, as may be expected if sterilization is incomplete. The decline can be attributed to the higher growth of money supply. Toward the end of the period, when reserve requirements were raised and as output growth in the economy picked up, short-term interest rates rose (figure 8).

To summarize, Episode I began as a surge in capital inflows. Although the exchange rate was fixed, the market expected the rupee to appreciate against the dollar. The months when the market expected rupee appreciation saw a sharp inflow of dollars. To prevent the appreciation, the RBI actively purchased dollars, pushing net foreign assets as a share of reserve money up from 20 percent to 45 percent. Because the bond market was relatively illiquid, the opportunity for doing open market operations was limited. Although net domestic assets growth slowed, the shift did not offset the sharp growth

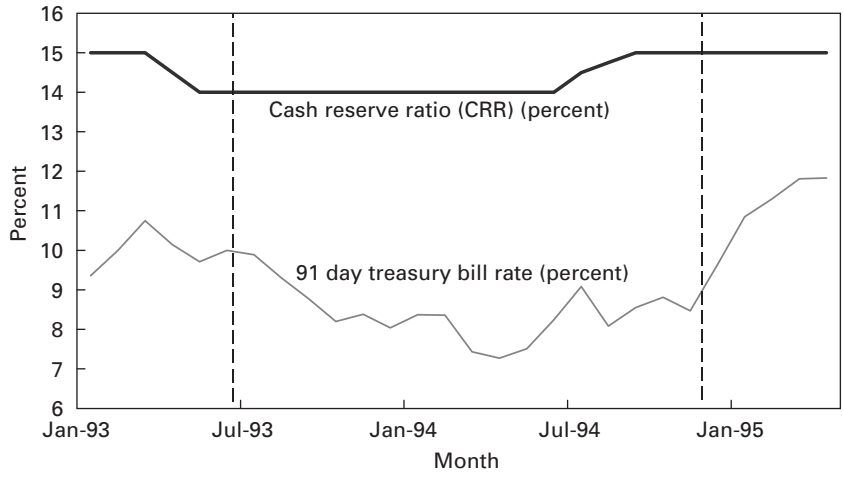
14. Reinhart and Reinhart (1999).

FIGURE 7. Growth of Reserve Money and M_3, Episode I



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Note: M_3 includes currency, demand deposits and saving accounts.

FIGURE 8. The 91-day Treasury Bill Rate and the Cash Reserve Ratio, Episode I



Source: Reserve Bank of India, *Monthly Bulletin,* various issues.
Episode I: Vertical lines are placed at "06/01/93" and "11/01/94"

in NFA, and reserve money grew at rates as high as 30 percent. Short-term interest rates fell for roughly a year, reflecting only partial sterilization. After that, reserve requirements were tightened, and interest rates rose. At the same time, M_3 growth accelerated.

In Episode I, the near-fixed exchange rate during a period of large dollar inflows necessitated massive RBI currency trading, which led to rapid growth of reserve money and to a temporary reversal of the phase-out of CRR. Although RBI raised reserve requirements, M_3 growth accelerated significantly. The monetary tightening, which began in month twelve of this eighteen-month episode, led to a period of rising interest rates. Episode I was, hence, India's first experience with the loss of monetary policy autonomy.

The experience was particularly striking given that during Episode I, openness on the capital account was limited and the external sector was small relative to the Indian economy. Nevertheless, the logic of the impossible trinity was powerful enough that the pursuit of currency pegging led to an economically significant attenuation of monetary policy.

Episode II

Unlike Episode I, Episode II did not begin with a capital surge. In 2000–01 and 2001–02, India's capital account (table 6) was remarkably stable. From 1999–2000 to 2001–02, net capital inflows into India were roughly $10 billion a year. Instead, Episode II began with a dramatic shift in the current account—from a deficit of $4.7 billion (1999–2000) to a surplus of $1.4 billion (2001–02)—that affected the currency market.

Figure 9 underlines this difference between Episode I and Episode II. Early in Episode II, the current account turned from a deficit into a surplus; later, large capital inflows began.

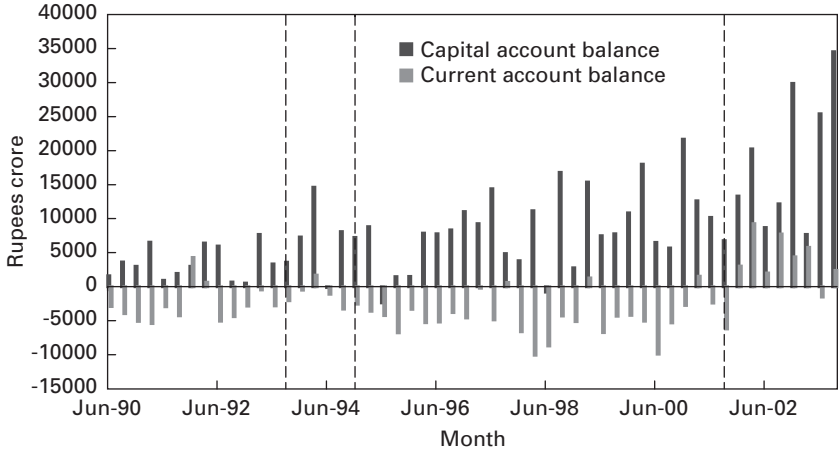
TABLE 6. Balance of Payments in Episode II

Billions of U.S. dollars

Year	*Current account balance*	*Net capital inflows*	*Change in net foreign assets*
1999–2000	–4.7	10.2	2.26
2000–01	–2.6	9.0	6.14
2001–02	1.4	9.5	12.32
2002–03	3.7	13.3	17.50
2003–04	N.A.	N.A.	37.38

Source: Reserve Bank of India, *Monthly Bulletin,* various issues.

FIGURE 9. Current Account Surplus and Capital Inflows in Episode II



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Note: 1 crore is 10 million
Full Period: Vertical lines are placed at "06/01/93" and "11/01/94" and "08/01/01"

Currency Spot and Forward Markets

In Episode II, the central bank at first prevented the rupee from appreciating. In June 2002, however, with foreign exchange reserves exceeding $55 billion, the rupee was allowed to appreciate.

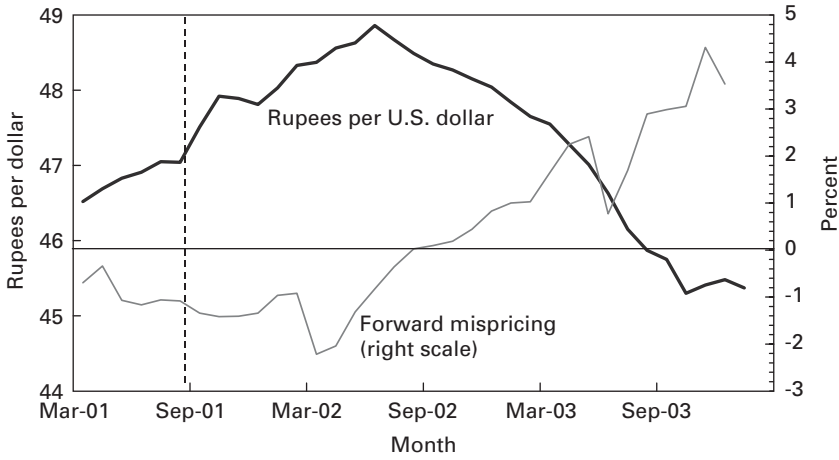
Figure 10 shows that currency expectations had starting turning around even before the rupee began appreciating. After June, when the rupee was allowed to start appreciating, private forecasts of the rupee changed sharply.[15] After July, the observed forward premium was lower than the fair value, reflecting expectations of a currency appreciation.

Currency Expectations and Capital Flows

Foreign exchange reserves with the RBI started growing sharply in 2001–02, that is, before the increase in capital inflows in the following year. The implementation of the pegged exchange rate, coupled with the strengthening current account, led to a sharp increase in currency trading by RBI (figure 11).

15. There was a sharp decline in the forward premium during Episode II, from March 2003 onward. This partly merely reflected a change in the fair value (that is, changes in the 90-day rate in India and in the United States). However, there was also a widening of the gap between the two series, which is shown in figure 10, which shows the mispricing on the forward market.

FIGURE 10. Expectations of Rupee Appreciation, Episode II



Source: Author's calculations based on data from Reserve Bank of India and Centre for Monitoring Indian Economy.
Episode II: The vertical line is placed at "08/01/01"

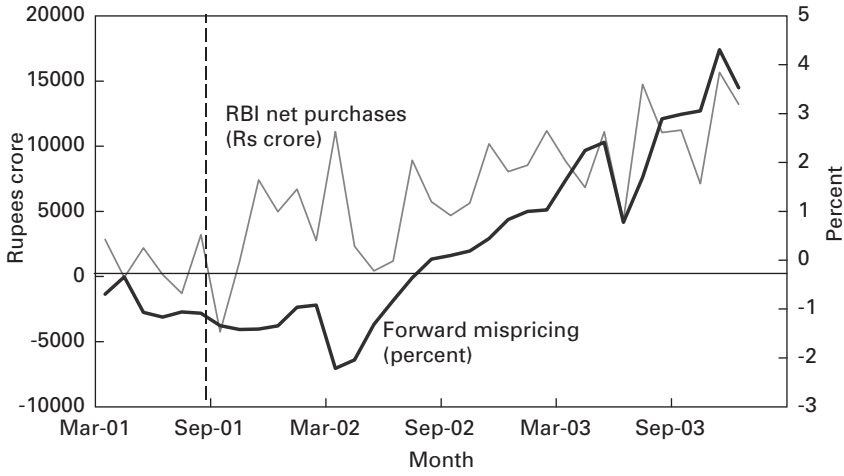
As noted earlier, apart from conveying expectations of the market, the error between the observed forward premium and its fair value also shows the arbitrage opportunity available to foreign investors. In December 2003, the error between the observed forward premium and its fair value exceeded 350 basis points.[16] A foreigner who bought GOI bonds and had a locked-in repatriation into U.S. dollars at a future date using the forward market was thus earning a return of over 350 basis points. Not surprisingly, the period after July 2002 witnessed a sharp inflow of dollars, both on the current and capital account (figure 9). The capital surge thus began in 2002–03.

Tools for Sterilization

In terms of sterilization, Episode II also differed from Episode I. This time, the institutional infrastructure for conducting open market operations was in place. By 2000–01, the turnover ratio in the bond market had risen to 100 percent, making the market sufficiently liquid for the

16. Strictly, the observed forward premium should be slightly higher than that computed from covered interest parity, owing to the country credit risk premium required for India exposure. However, the failure probability of a GOI bond on a 90-day horizon is likely to have been negligible through this period. Hence, this is unlikely to be an important issue in my analysis.

FIGURE 11. Currency Trading of the Reserve Bank of India, Episode II



Episode II: The vertical line is placed at "08/01/01"

government to be able to conduct substantial open market operations (figure 12).[17]

Figure 13 shows that the increase in net foreign exchange assets was sterilized by open market operations. In a striking and inverse relationship, The months with high purchases of U.S. dollars were months with substantial sale of GOI bonds.

Table 7 shows that the stock of government bonds with the RBI was reduced to barely Rs 274 billion, or about $6 billion by March 2004. That same month, a new category of bonds, Market Stabilization Bonds, was designed to be used solely as an instrument of sterilization. The cash reserve ratio stood at 4.5 percent in March 2004. The existing legal framework prevents the CRR from being cut below 3 percent.

Money Growth

Because of sterilization, reserve money did not grow despite the increase in net foreign assets. Instead, the share of net foreign assets in reserve money increased sharply from 65 percent in 2001 to 78 percent in 2002 to more than 100 percent in January 2004. Figure 14 shows the sharp decline in the

17. While data are not available for the first episode, there is a consensus that the bond market was even more illiquid in the preceding years.

FIGURE 12. Turnover Ratio of Government Bonds, January 1993–February 2004

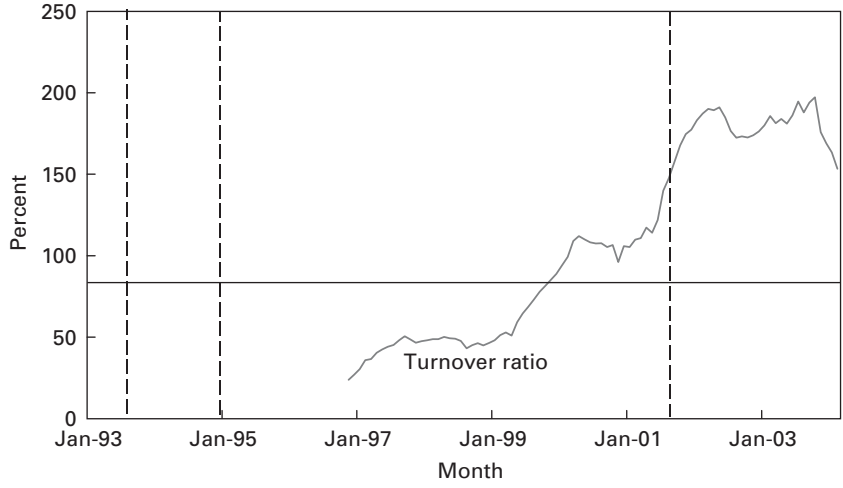
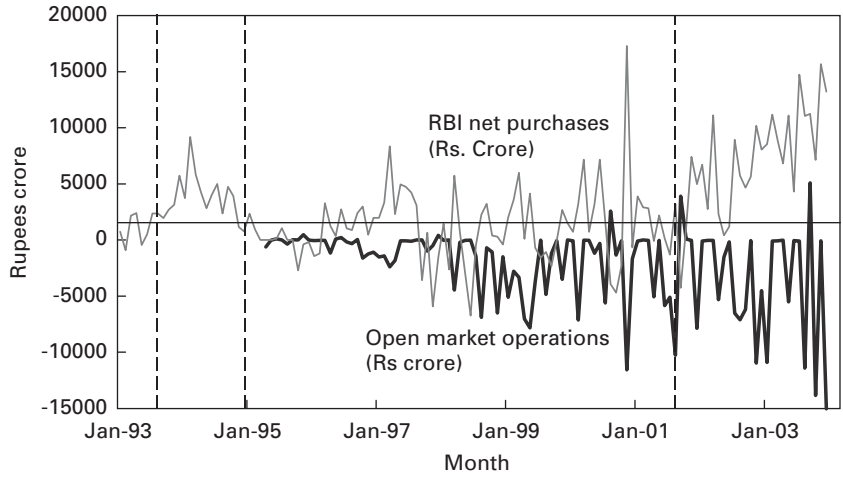


FIGURE 13. Currency Trading and Open Market Operations, 1993–2003



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Full Period: Vertical lines are placed at "06/01/93" and "11/01/94" and "08/01/01"

TABLE 7. Sources of Reserve Money, March 19, 2004

Source	*Billions of rupees*
Net RBI credit to government	274.83
RBI credit to banks	39.17
Net foreign exchange assets of RBI	4974.02
Government's currency liabilities to the public	72.40
Net non-monetary liabilities of RBI	1277.73
Reserve Money	4082.70

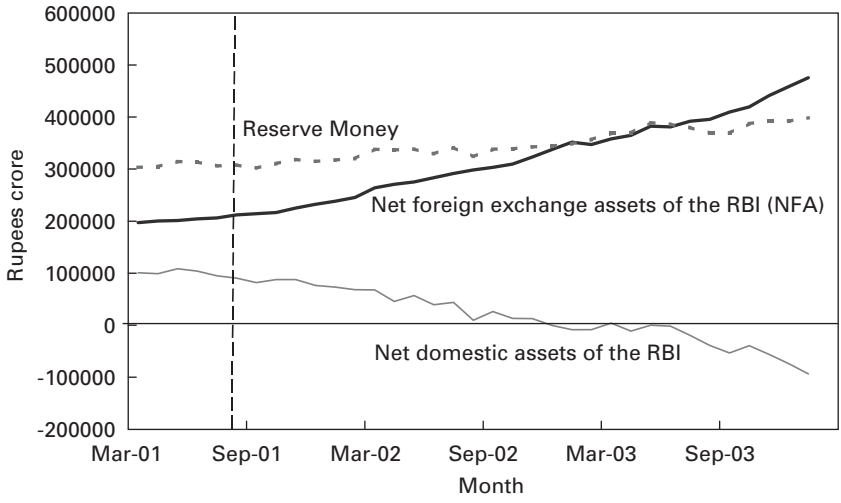
Source: Reserve Bank of India, *Weekly Statistical Supplement,* March 27, 2004.

share of RBI credit to the government in reserve money. As a consequence, growth of reserve money remained under control.

Because sterilization was possible through the simplest route, open market operations, it was not necessary for the RBI to reduce money supply through changes in reserve requirements, as in the first episode. On the contrary, CRR was steadily reduced.

As a consequence, the money multiplier increased in value during this period. Despite that, as a result of the large scale of sterilization and the low

FIGURE 14. Net Foreign Assets, Net Domestic Assets, and Reserve Money of the Reserve Bank of India, Episode II



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Episode II: The vertical line is placed at "08/01/01"

growth of reserve money, the growth of money supply remained under control (figure 15).

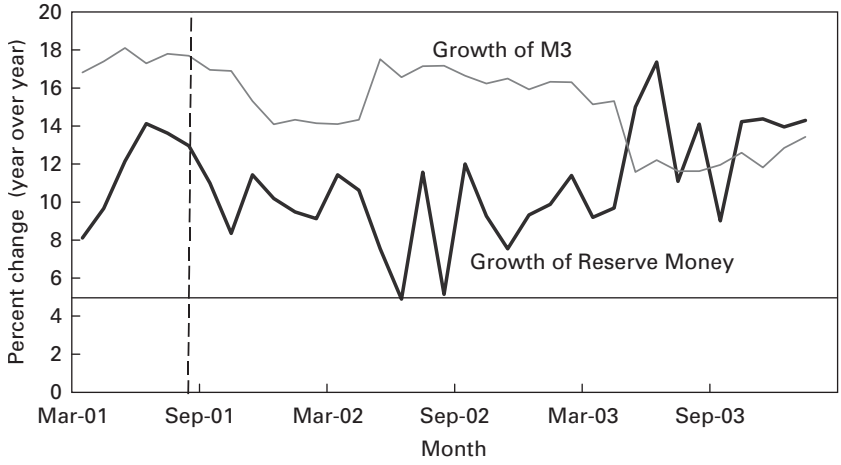
Stance of Monetary Policy

The unprecedented drop in interest rates that India experienced in Episode II reflects a combination of developments. The first was the partial sterilization of capital inflows, which open economy macroeconomics expects to lower domestic interest rates. The second was the steady pace of CRR reductions. And the third was slow output growth during this period, which led to slow growth in demand for capital.

Summary

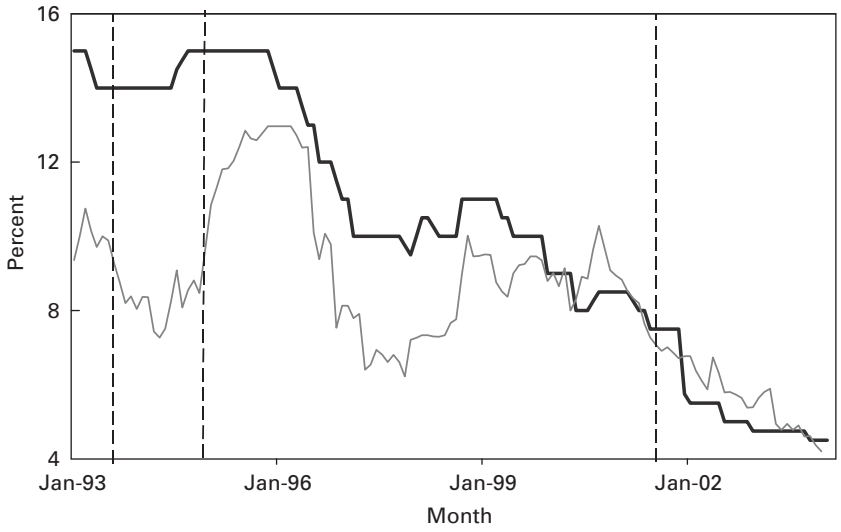
To summarize, Episode II began as a surge in the current account. Capital account openness in this episode was greater than it was in the first episode. After June 2002, the rupee began to appreciate, the forward market forecasted further appreciation, and a capital surge began. Net foreign assets as a share of reserve money went up from an already high 70 percent to 120 percent. The RBI actively used the bond market for open market operations. The program for phasing out the cash reserve ratio stayed on course;

FIGURE 15. Growth of Reserve Money and the Money Supply, Episode II



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Note: M3 is the sum of currency, demand deposits, and savings accounts.
Episode II: The vertical line is placed at "08/01/01"

FIGURE 16. The 91-day Treasury Bill Rate and the Cash Reserve Ratio, 1993–2003



Source: Reserve Bank of India, Monthly Bulletin, various issues.
Full Period: Vertical lines are placed at "06/01/93" and "11/01/94" and "08/01/01"

the money multiplier kept rising. M_3 and M_0 growth did not accelerate. The CRR was steadily cut. Interest rates declined sharply through a combination of partial sterilization of capital inflows and a steady pace of CRR reduction.

In contrast with Episode I, when the rupee was kept largely fixed, Episode II saw a slow appreciation of the rupee. The daily volatility of the rupee-dollar exchange rate remained very low, at around 0.1 percent, and the rupee-dollar rate was not a random walk. Once the rupee started appreciating, currency expectations turned around, followed by a sharp inflow of capital, which may have been motivated by either covered interest parity arbitrage or currency speculation.

Comparing the Two Episodes

Did the stance of direct sterilization change in Episode I or Episode II? To address this question, I introduce slope dummies d_1 and d_2 for the two episodes. The model may now be expressed as follows:

$$\text{NDA} = \alpha_0 + \alpha_1 \text{NFA} + \alpha_2 d_1 * \text{NFA} + \alpha_3 d_2 * \text{NFA} + \alpha_4 \text{IIPn} + \alpha_5 \text{CRR} + \varepsilon_t \quad (5)$$

Three α coefficients are of interest: α_1, the "normal" level of sterilization; α_2, which tests for a change in stance in Episode I; and α_3, which tests for a change in stance in Episode II.

The estimated equation when slope dummies for the each of the episodes are introduced is

$$\begin{aligned} \text{NDA} = & -0.67\ \text{NFA} + 0.039\ d_1 * \text{NFA} - 0\ 072\ d_2\ * \text{NFA} \\ & (11.3)\ \ (0.6) \qquad\quad (3.4) \\ & +701.9\text{IIPn} + -517.7\ \text{CRR} \\ & (10.8)\ \ (0.5) \qquad\quad R^2 = 0.93 \end{aligned} \quad (6)$$

The coefficient of NFA is estimated to be –0.67, suggesting that, in general, the RBI sterilizes roughly two-thirds of its trading in the foreign exchange market. This result is broadly consistent with previous RBI study results on sterilization by Sitikantha Pattanaik and Satyananda Sahoo that RBI undertook large scale but not full sterilization.[18]

The coefficient for the dummy for Episode II is negative and significant showing a change in the stance of the RBI. The coefficient for Episode I is not found to be significant.

Table 8 summarizes the differences between the two episodes. In some senses, the outcomes in Episode II were more benign than those in Episode I. Given access to a more liquid bond market, RBI was able to sterilize to keep the monetary base under control. It could continue to cut the cash reserve ratio steadily and prevent interest rates from rising. In Episode I the central bank's inability to use open market operations led to a sharp rise in the monetary base that was followed by a rise in the CRR and interest rates. So far Episode II has been spared these developments.

Both episodes featured a tightly pegged exchange rate and partial sterilization of capital inflows. Hence, the surge in capital inflows was expansionary and helped to generate a drop in interest rates.

All through Episode I, a current account deficit offset capital inflows. In contrast, in Episode II, the current account has turned positive.

The most important difference is that Episode I ended in 1.25 years, while Episode II had been under way 2.5 years as of the time of writing.

18. Pattanaik and Sahoo (2001).

TABLE 8. Comparing Features of Episodes I and II

Feature	*Episode I*	*Episode II (thus far)*
Initiation	Capital account	Current account
Exchange rate	Mostly fixed	Slight appreciation
Forward market	Expected appreciation	Expected appreciation
Net foreign assets as share of reserve money	21% → 45%	70% → 120%
Cash reserve ratio phase-out	Reversed	Unaffected
Bond market	Weak	Much improved
Use of open market operations	Data not disclosed	Strongly visible
M_0 and M_3 growth	Accelerated	Unaffected

Source: Summarized from the text.

How Episode II unfolds further is one of the most interesting questions in Indian macroeconomics today.

Conclusion

The reforms of the 1990s in India saw a significant opening of the current and capital accounts and created new challenges for the implementation of the pegged exchange rate regime.

Faced with a surge of capital inflows soon after the rupee had been made "market determined," the RBI followed a policy of a fixed exchange rate, which implied large-scale trading in the currency market. That trading led to an acceleration in reserve accumulation that was partly sterilized and that partly spilled over into an expansionary monetary policy. Despite the small capital account, pegging to the U.S. dollar led to an attenuation of monetary policy autonomy.

The second major episode of currency trading took place in 2000–01 with a surplus on the current account. Faced with pressure on the rupee to appreciate, the RBI traded extensively on the currency market. This time, the rupee-dollar exchange rate was not fixed. From June 2002 onward, RBI permitted some appreciation.

This appreciation might have been motivated by the RBI's desire to reduce the extent of trading required to implement the peg. However, as soon as the rupee started appreciating, currency expectations changed: instead of depreciating, the rupee was expected to appreciate. The full impact of a more open capital account, with a smaller set of capital controls, led to a surge of inflows on both the current and capital account. The fol-

lowing twenty months have been spent trying to curb the inflows, maintain the currency peg, and cling to monetary policy autonomy.

In conclusion, Episode I and II both highlight the extent to which implementing a pegged exchange rate comes at the cost of autonomy in monetary policy. As India continues on the path of eliminating currency controls, it appears that implementing the pegged regime will increasingly crowd out monetary policy autonomy.

References

Calvo, Guillermo A., and Carmen M. Reinhart. 2002. "Fear of Floating." *Quarterly Journal of Economics* 117(2): 379–408.

Chinn, Menzie D., and Jeffery A. Frankel. 1994. "More Survey Data on Exchange Rate Expectations: More Currencies, More Horizons, More Tests." Technical Report 312, University of California, Santa Cruz.

Frankel, Jeffery A., and Chudozie Okongwu. 1996. "Liberalised Portfolio Capital Inflows in Emerging Markets: Sterilisation, Expectations, and the Incompleteness of Interest Rate Convergence." *International Journal of Finance and Economics* 1(1): 1–23.

Frankel, Jeffery A., & Shang-Jin Wei. 1994. "Yen Bloc or Dollar Bloc? Exchange Rate Policies of the East Asian Countries." In *Macroeconomic Linkage: Savings, Exchange Rates and Capital Flows*, edited by T. Ito and A. Krueger. University of Chicago Press.

Joshi, Vijay. 2003. "India and the Impossible Trinity." *The World Economy* 26(4): 555–83.

Mundell, Robert. 1961. "The International Disequilibrium System." *Kyklos* 14: 154–72.

Patnaik, Ila. 2003. "India's Policy Stance on Reserves and the Currency." Technical report, ICRIER Working Paper No 108.

Patnaik, Ila, and Deepa Vasudevan. 2000. "Trade Misinvoicing and Capital Flight from India." *Journal of International Economic Studies* 14: 99–108.

Pattanaik, Sitikantha, and Satyananda Sahoo. 2001. "The Effectiveness of Intervention in India: An Empirical Assessment." *Reserve Bank of India Occasional Papers* 22(1–3): 1–24.

Reinhart, Carmen M., & Kenneth S. Rogoff. 2002. "The Modern History of Exchange Rate Arrangements: A Reinterpretation." Technical Report 8963, National Bureau of Economic Research.

Reinhart, Carmen, and Vincent R. Reinhart. 1999. "On the Use of Reserve Requirements to Deal with the Capital Flow Problem." *International Journal of Finance and Economics* 4(1): 27–54.

Schadler, Susan, Maria Carkovic, Adam Bennett, and Robert Kahn. 1993. "Recent Experiences with Surges in Capital Inflows." *IMF Occasional Papers* 108.