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Exchange Rate Trends and Management in India

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1 Introduction

This chapter evaluates developments in India's nominal and real exchange rates over the past two decades, describing longer term trends as well as short-term movements and volatility. Exchange rate movements are influenced by a host of real and nominal determinants, including government policy, especially foreign exchange market intervention, capital controls, and monetary policy. We explore how these policies in India responded to exchange rate movements and how they have, in turn, influenced the exchange rate.

India has been developing its foreign exchange market and the average *daily* turnover in the onshore market, sum of spot, and forward transactions, increased tenfold in about 15 years—from 2.7 billion USD in March 1999 to about 30 billion USD in March 2015.[1] Rapid growth in the foreign exchange market reflects India's rise in international trade, especially in services, the broadening and deepening of the financial sector, and increasing globalization of the economy.

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[1]Source: Reserve Bank of India, Database on the India economy. The numbers cited are the sum of merchant and interbank purchases and monthly averages of daily data.

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Maintaining orderly conditions in the foreign exchange markets is an official objective of the Reserve Bank of India (RBI).[2] RBI is the manager of the Foreign Exchange Regulation Act (FEMA, 2004), which also gives it the power to impose capital controls.[3] In practice, this objective has meant very active management of controls on international capital movements and frequent foreign exchange market intervention operations, as well as at least one episode of interest rate defense of the exchange rate in 2013.[4] These considerations make understanding the linkages between monetary policy, capital controls, and foreign exchange market intervention operations central to a study of exchange rates in India.

We begin in Sect. 2 with a statistical representation and analysis of the Rupee exchange rate, comparing the bilateral rate against US dollar (USD) with the trade-weighted multilateral nominal and real exchange rates. The bilateral exchange rate against the USD is the rate that the RBI monitors most closely and attempts to stabilize, through its interventions in the spot and forward markets. However, the multilateral rate is probably the most important, measured in real terms, for the Indian economy. Overall, the bilateral and multilateral measures point to large cumulative nominal depreciation of the rupee over January 1998–December 2014. Trend inflation in India over this period was much higher than inflation in the U.S., however, resulting in substantial real (price-adjusted) appreciation of the rupee against USD. By contrast, nominal trend depreciation of the rupee currency on a multilateral basis largely offset moderate inflation differentials between India and a broad index of its trading partners, leading to a fairly stable real multilateral real exchange rate—formal tests of long-term purchasing power parity (PPP) cannot be rejected. Exchange rates by either measure have not moved uniformly since 1998, leading us to identify several distinct "regimes" during which exchange rate trends and volatilities exhibited quite different patterns. Exchange rate volatility rose markedly in the mid-2000s, especially since the Global Financial Crisis (GFC).

Section three considers the policy levers that affect exchange rates—exchange rate management—and in particular whether foreign exchange market intervention and changes in the intensity of capital controls are consistent with, and directed toward, an exchange rate objective. This section also considers how intervention and capital controls interact with monetary policy in navigating a balance between external and internal policy objectives. Section four concludes. We argue that the

[2]See for example, Khan (2011) which notes "Excessive volatility in exchange rate is a potential source of macroeconomic instability, and accordingly, the RBI aims at containing volatility to ensure a stable macroeconomic environment.".

[3]Quotation from RBI website: https://www.rbi.org.in/scripts/FS_Overview.aspx?fn=5.

[4]That is to say that the exchange rate enters into the RBI's policymaking not only due to its impact on inflation but also its potential impact on economic growth directly and on financial stability. In countries where central bank targets inflation (since 2015 for the RBI) and the central bank credibility is high, exchange rate pass-through to inflation is typically low. Many advanced economies have seen the exchange rate pass-through decline over time (BIS, 2005), and central banks worry about exchange rate movements mainly to the extent that they affect current or expected inflation.

gradual rise in financial openness in India has pushed the RBI to accept more instability in the exchange rate in favor of greater monetary independence. Monetary independence since the GFC has primarily focused on stimulating output growth and employment, and not controlling inflation.

2 Nominal and Real Exchange Rates: Bilateral and Trade-Weighted Baskets

2.1 Trends

Chart 1 shows the development of two *nominal* exchange rate measures for the Indian rupee (INR) from January 1998 through December 2014: the U.S. Dollar/INR exchange rate and the INR against a trade-weighted basket of 36 trading partners.[5] The base for each index is set as 100 for January 1998, and a decline in the index represents a fall in the value of the rupee. Monthly data is shown.

Cumulative nominal depreciation in the USD/INR rate over January 1998–-December 2014 was about 40 %, while declining on a broad trade-weighted basis by almost 30 %. However, three phases in the nominal exchange rate are identifiable from Chart 1, consistent across the two INR measures and denoted by vertical lines: (a) a period of moderate fluctuations during 1998–2007, initially characterized by gradual nominal depreciation until 2006, followed by robust appreciation; the result was quite similar exchange rate values in 1998 and early 2008; (b) a period of sharp depreciation and very high volatility from mid-2008 to mid-2013; (c) a period of relative stability since October 2013.

Measures of the *real* exchange rate, by contrast, reveal quite different *longer-term* patterns. Chart 2 shows the corresponding real USD/INR exchange rate and the 36-country trade-weighted real multilateral exchange rate. The base is set to 100 in January 2001 (sample is limited by data availability on relative prices). A rise in each index implies a real exchange rate appreciation. We again distinguish the three nominal exchange rate episodes by vertical lines, contrasting nominal with real exchange rate developments. As is apparent, real exchange rate developments are more difficult to classify than nominal exchanges into distinct phases and show substantial medium-term swings.

The indices demonstrate substantial cumulative real exchange rate appreciation against the U.S. Dollar over the 15-year period (more than 40 %). But against a broad basket of 36 currencies the INR has appreciated relatively little (9 %) and was at virtually the same real value in September 2013 as early 2001. Strong real appreciation in 2014 pushed the real value of the 36-country weighted exchange rate again above its stable "Purchasing Power Parity" (PPP) value. Despite the larger movements in real bilateral than trade-weighted index, the two series are

[5]See appendix A for data sources and descriptions.

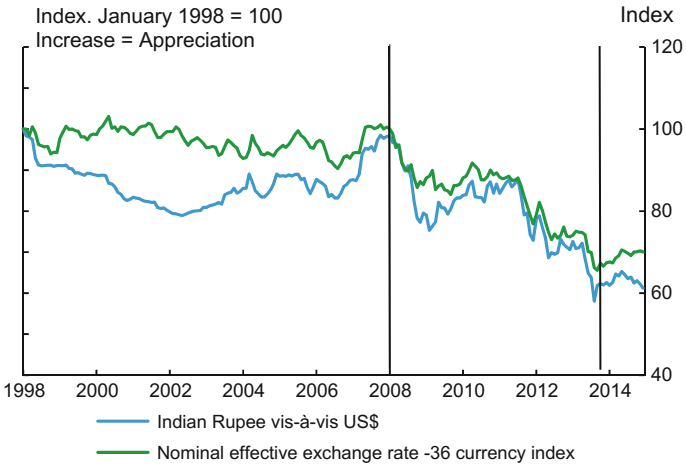

Chart 1 Nominal exchange rate movements *Sources* U.S. Federal Reserve, Reserve Bank of India, and Bank of Canada calculations

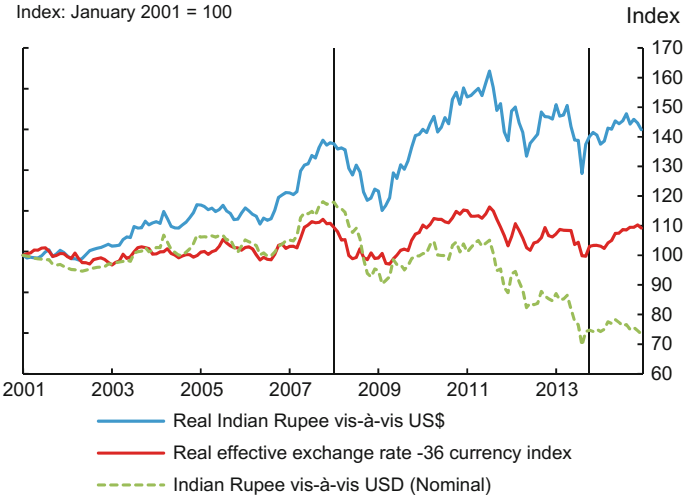

Chart 2 Real exchange rate movements *Sources* Bloomberg, Reserve Bank of India, and Bank of Canada calculations

highly correlated, with a correlation coefficient of 0.83 over the period January 2001–December 2014. The nominal series, by contrast, have a correlation coefficient of only 0.23 over the same period.

The divergent trends in nominal and real exchange rates are explained, of course, by relative price developments in India vis-à-vis the U.S. and vis-à-vis India's counterparts in the currency baskets. Chart 3 shows two series—the relative Indian

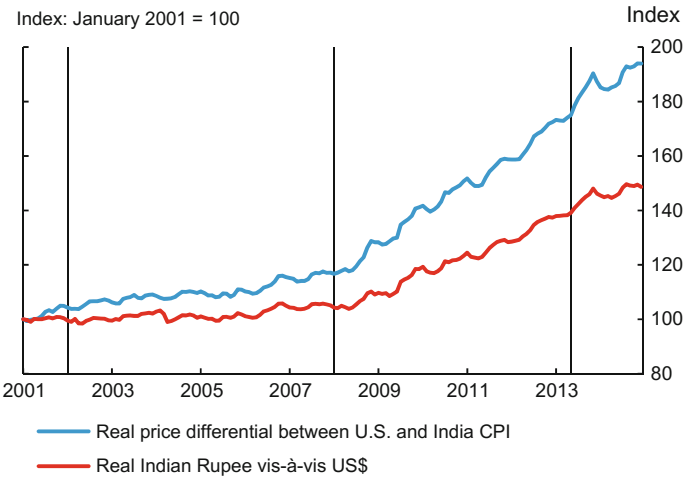

Chart 3 Relative price movements *Sources* U.S. Bureau of Labor Statistics, India Ministry of Statistics and Programme Implementation, Reserve Bank of India, and Bank of Canada calculations

price level against the U.S. and the relative Indian price level against a trade-weighted average of 36 countries. The chart shows that, since 2001, the relative Indian price level climbed more than 90 % compared to the U.S. price level and almost 50 % against a broad price index of trading partners. The comparatively rapid rise in the Indian price level explains why the USD/INR exchange rate appreciated by 42 % in real terms over this period despite an almost 30 % depreciation in the nominal exchange rate. By contrast, the modest 11 % real appreciation of the INR against the broad currency basket during 2001–2015 reflects the effect of a 25 % nominal deprecation largely offsetting the larger rise in the Indian price level relative to its trading partners.

A few other noteworthy observations emerge during the subsamples. First, trend real appreciation against the USD is evident in the second phase (mainly during 2009–2012). This contrasts markedly with the relatively steady nominal exchange rate values during this period. Second, the substantial instability and volatility in the real exchange rate with alternating bouts of depreciation followed by rebounds is particularly noteworthy in the second phase. Movements in the real USD/INR rate were greatest, with a real value index of 138 in December 2007, falling to a low of 115 in February 2009 and then sharply appreciating to 162 by July 2011. Substantial depreciation again followed, reaching 128 by August 2013. The real trade-weighted index followed a similar pattern, but with less extreme movements, ending this episode (August 2013) with about a 10 % cumulative real depreciation against the broad (36 country) multilateral index. Third, the final episode in our sample, August 2013 through January 2015, showed substantial real appreciation.

2.2 Volatility

Chart 4 shows that high volatility and turbulence in the INR during 2008–2013 is quite distinct compared with the relative stability of the two other periods. Generally, month-to-month fluctuations in the INR/USD rate over most of the sample have been within a ±2.5 % band. The exchange rate volatility increased post-2004, but the volatility of the Global Financial Crisis and its aftermath—characterized by a higher frequency of days exceeding the 2.5 % ± band—is clearly distinct from the other periods. The volatility of the nominal trade-weighted index also increased between 2008 and 2013, but the shift is not as dramatic as for the INR/USD spot rate.

Though volatility of the INR/USD was relatively high compared to the broad trade-weighted index, it was comparatively low compared to the two other most actively traded and heavily weighted (in the broad currency basket) international currencies in the index—the British pound (GBP) and the euro. This reflects the RBI's focus on mitigating volatility in the INR/USD rate over much of the period. Chart 5 plots the annualized volatility of the INR spot exchange rate against the USD, the GBP, and the euro. These are computed as the annualized volatility of the daily percentage spot exchange rate changes in the month, and smoothed by taking the lagged 6-month moving average. The chart shows that, through the end of 2006, volatility of the INR/USD pair was much lower than that of INR against these two other major international currencies. Although other factors were at work, this pattern is consistent with central bank actions attempting to mitigate INR/USD volatility. However, post-2007, and particularly between 2008 and 2013, volatility

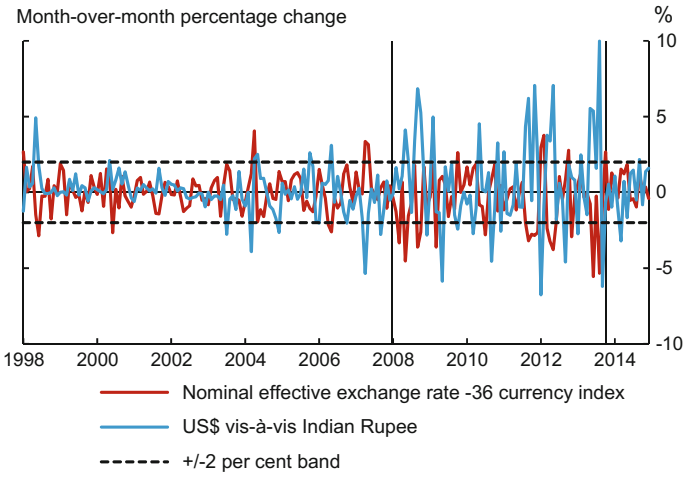

Chart 4 Monthly percentage change in nominal exchange rates *Sources* Bloomberg and authors' calculations

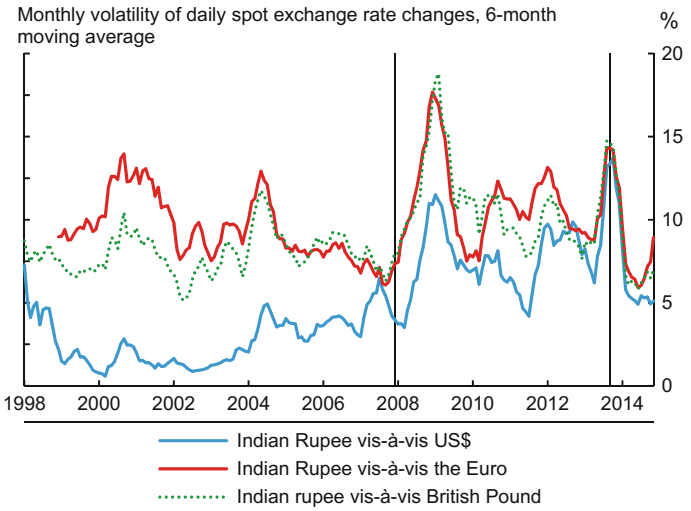

Chart 5 Annualized Volatility of Rupee spot exchange rates *Sources* Datastream, Reserve Bank of India, and Bank of Canada calculations

in the INR/USD was closer to the volatility of INR against the GBP and the euro, suggesting limited intervention (or limited effectiveness of such intervention).

In terms of real exchange volatility, shown in Chart 6, both bilateral and multilateral indices show substantial fluctuations over the sample period, frequently exceeding the ±2.5 % band. There are two similarities between the nominal

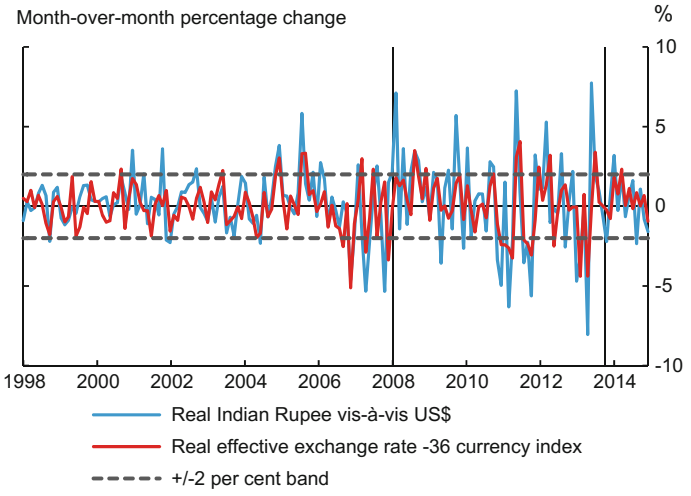

Chart 6 Monthly percentage change in real exchange rates *Sources* Bloomberg, Reserve Bank of India, and Bank of Canada calculations

exchange rate volatilities (Chart 4) and real exchange rate volatilities (Chart 6). As with nominal exchange rates, volatility was greatest for real exchange rate during the GFC and its aftermath (2008–2013). Nominal and real exchange rate volatility against USD has also been larger than that against the trade-weighted basket of currencies. The main difference between the nominal and real exchange rate volatilities is that real exchange rate volatility was relatively higher even in the pre-2006 period, with frequent deviations outside the ±2.5 % band.

2.3 *Long-Term Linkages Between Prices and Exchange Rates: PPP and Cointegration Tests*

The descriptive analysis indicates the Indian real exchange rate against the USD has shown a much larger trend appreciation, and greater volatility, than against a broad basket of currencies. These observations are borne out by formal cointegration tests where we investigate whether purchasing power parity (PPP) holds in the longer term. This procedure amounts to testing for a long-term linkage (cointegration) between the (log) nominal exchange rate and (log) relative prices. Formal PPP would indicate a 1:1 long-term (negative) linkage between the nominal exchange rate and relative prices. However, we postulate a weaker relationship, testing whether a cointegrating vector exists between the nominal exchange rate and relative price, allowing for a linear trend as a deterministic variable. We consider both the Granger–Engle and the Phillips–Ouliaris (residual) tests of cointegration and report both the tau-statistic and the Z-statistic. The null is that the nominal exchange rate and relative prices are not cointegrated, hence rejecting the null indicates a long-run relationship between the two series.

Table 1 reports the results of the cointegration tests for the USD/INR exchange rate and the Indian/US relative CPI price. Table 2 reports the results between the

Table 1 Cointegration between nominal INR/USD exchange rate and relative CPI

Variable	Coefficient	Standard error	t-Statistic	Probability
Constant	0.073	0.021	3.523	0.001
Log(RPRICE_IND_US)	−0.416	0.063	−6.582	0.000
R^2	54.9			
Adjusted R^2	54.6			
Null hypothesis: series are not cointegrated				
	Value	Probability[a]		
Engle–Granger tau-statistic	0.549	0.694		
Engle–Granger Z-statistic	0.546	0.660		
Phillips–Ouliaris tau-statistic	0.078	0.670		
Phillips–Ouliaris Z-statistic	0.028	0.634		

[a]MacKinnon (1996) p-values

Table 2 Cointegration between nominal rupee trade-weighted (36 countries) exchange rate and relative prices

Variable	Coefficient	Standard error	t-Statistic	Probability
Constant	4.621	0.006	822.186	0.000
Log(RPRICE36)	−0.828	0.038	−21.818	0.000
R^2	88.5			
Adjusted R^2	88.5			
Null hypothesis: series are not cointegrated				
	Value	Probability[a]		
Engle–Granger tau-statistic	−3.371	0.058		
Engle–Granger Z-statistic	−21.911	0.043		
Phillips–Ouliaris tau-statistic	−3.528	0.039		
Phillips–Ouliaris Z-statistic	−23.991	0.027		

[a]MacKinnon (1996) p-values

broad multilateral exchange rate index and the Indian price level vis-à-vis the foreign country weighted price index. The first part of each table reports the point estimates of the long-run relationship (using fully modified least squares), including a constant term and linear trend, and the second part reports the formal cointegration tests on the residual series.

Comparing the point estimates across the two series, it is evident that the linkage of relative Indian price level bilaterally against the USD is much weaker than against the multilateral basket of currencies, i.e., the point estimate of the former is −0.42 (USDINR rate depreciates only 0.42 % in response to a 1 % rise in relative price level in India relative to U.S.) and the point estimate of the latter is −0.82 (trade-weighted nominal exchange rate depreciates 0.82 % in response to a 1 % rise in relative price level in India relative to group of trading partners). However, the strict PPP restriction of −1.0 as a cointegrating term is decisively rejected for both equations at the 1 % level of significance. In line with observations of volatility, the long-run variance estimate against the USD is much larger than against the basket of currencies.

Not surprisingly, the weaker test of cointegration (any stable longer-term link, not necessarily 1:1) is strongly rejected between exchange rates and prices in India and the U.S. by both the Granger–Engle and Phillips–Ouliaris tests (Table 1). Trend movements in the USD/INR exchange rate simply do not reflect longer term movements in relative prices between the two countries.

Cointegration is not rejected, however, between relative prices and the multilateral exchange rate (Table 2). Three of the test statistics reject the "no cointegration" null at the 5 % level of significance, and the fourth rejects at the 6 % level. This is strong descriptive and statistical evidence that longer term trends in the Indian nominal exchange rate, measured as a weighted average of a large group of trading partners, reflects relative movements in price levels. It appears that a weak form of PPP holds, meaning that the real exchange rate for a broad basket of currencies shows large fluctuations over the short- and medium-term horizons but

reverts to a stable trend over longer periods—the nominal exchange rate largely adjusts (about 82 % of the movement) to offset relative price movements over longer periods.

3 Exchange Rate Policy: Intervention, Capital Controls, and Monetary Policy

Although long-term movements in the INR exchange rate may largely reflect relative price trends between India and its trading partners, as well as real factors such as relative productivity developments and other "real" shocks, short-and medium-term fluctuations are influenced by a host of factors including government policy, especially foreign exchange market intervention, capital controls and monetary policy.

The objectives of an exchange policy are typically multifaceted, but generally focus on mitigating exchange rate volatility and turbulence as well as influencing the medium-term path of the exchange rate. However, the mix of policies is also constrained by the "trilemma" which suggests limits to independent policies across three dimensions: exchange rates, external capital controls (financial openness), and monetary policy. We explore how different dimensions of policy in India may have influenced the exchange rate. In what follows, we discuss intervention, capital controls, and monetary policy as they relate to capital inflows and exchange rates.

Mitigating exchange rate volatility has been an explicit objective of the Reserve Bank of India (RBI) for decades, long acknowledged in official documents and speeches.[6] RBI is also the manager under the Foreign Exchange Management Act (FEMA) 1999, which gives it the objective of "promoting the orderly development and maintenance of foreign exchange market in India" and the powers to restrict transactions in foreign currency.[7] In consultation with the government, the RBI may specify the class of capital account transactions that are permissible and the limit up to which foreign exchange can be made available for these transactions. Further, the RBI has broad powers to issue regulations to prohibit, restrict, and regulate transactions between residents and nonresidents in securities, lending, immovable

[6]For example, page 15 of RBI's (2014) Annual report states that RBI's response to the developments following the US Fed's indication that it would taper its large-scale asset purchase program "aimed at containing exchange rate volatility, compressing the current account deficit (CAD) and rebuilding buffers.".

[7]FEMA 1999 was passed to replace the Foreign exchange Regulation Act, (FERA) 1973 (later amended as FERA 1993). FERA 1973 was a draconian law that made violation of foreign exchange regulations a criminal offense and presumed guilty until proven innocent. In addition to reversing these provisions of the FERA and other liberalizations, the FEMA 1999 also made the rupee convertible on the current account. However, the RBI and the Government of India continued to have the power to regulate transactions on both current and capital account and the market for foreign exchange. The full text of the act is available here: http://finmin.nic.in/the_ministry/dept_eco_affairs/capital_market_div/FEMA_act_1999.pdf.

property, deposits, and currency notes. The RBI used capital controls as well as foreign exchange intervention to stabilize the exchange rate or to lean against the wind, to give some room to monetary policy responsive to domestic conditions. However, the constraints of the trilemma seemed to bind to some degree for the entire sample period, limiting monetary policy autonomy.

3.1 Exchange Rate Policy and Intervention

The policy shifts between maintaining exchange rate parities and allowing flexibility are evident throughout our sample period, with the RBI choosing different configurations over time. Considerably more exchange rate variation is evident in recent years, caused partly by the nature of the domestic and external environment (i.e., larger and more variance in external shocks) and partly by gradually opening of the external financial flows and willingness of the authorities to allow greater exchange rate flexibility as a "shock absorber" to external shocks.

Greater financial openness and flexibility in exchange rates has also been encouraged by the IMF. For example, the 2013 IMF Article IV Consultation Report lauds the virtues of exchange rate flexibility and states that: "The floating Rupee is an important shock absorber. Rupee flexibility has offset inflation differentials and prevented exchange rate misalignment. Such flexibility would be particularly important in case of renewed global financial stresses." (IMF 2013, p. 20).[8] Policymakers allowing greater flexibility in recent years are consistent with the evidence in the Sect. 2 on how exchange rate depreciation is offsetting high inflation rates in India compared with its trading partners, Similarly, even in the face of quite high exchange rate volatility following the GFC and its aftermath, the 2015 IMF Article IV Report states: "Given India's increased and adequate reserve buffers, greater exchange rate flexibility would be welcome and thereby encourage private sector entities to limit excessive risk taking. Foreign exchange intervention should be limited to preventing disruptive movements in the exchange rate. If global financial market volatility resurfaces, exchange rate flexibility should be an important shock absorber." (IMF 2015, p. 21).

Although the Indian authorities may accept greater exchange rate flexibility, the authorities have nonetheless continued to engage in extensive interventions in the foreign exchange market. Chart 7 shows the accumulation of foreign exchange reserves in India from the RBI database and measured in (monthly) flows in billions of USD. This is a measure of foreign exchange intervention, with increases representing purchases of USD in the foreign exchange market and decreases representing sales of USD in the foreign exchange market. Generally, purchases of dollars (sales of INR) by the RBI in the foreign exchange market are designed to

[8]The reports are not always consistent in the views expressed about the merits of exchange rate flexibility, however.

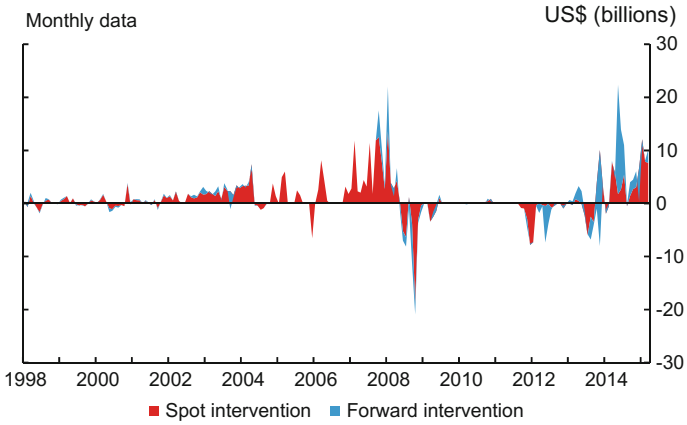

Chart 7 Foreign exchange reserve accumulation *Source* Reserve Bank of India

limit INR appreciation and are one measure of how the RBI is attempting to influence the exchange rate through intervention operations. Sales of dollars (purchases of INR) are designed to limit INR depreciation.

There is a sharp asymmetry in the use of official reserves policy to manage nominal exchange rate. During periods of nominal exchange rate appreciation pressures, particularly from January 2002 to May 2008, reserves accumulation was actively used to "lean against the wind." India's international reserves (excluding gold) climbed more than sixfold during this period, from 47 billion USD to 305 billion USD. However, during periods of depreciation, there was a reluctance to sell off reserves. The total intervention (spot and forward) during the global financial crisis period of June 2008–May 2009, amounted to only 19 % of India's total foreign exchange reserves (excluding gold) of 305 billion USD—spot sales of the USD during June 2008–May 2009 totalled 43 billion USD—and the exchange rate depreciated significantly. Similarly, the level of USD purchases during the tapering episode of May–September 2013 did not match the rate of reserves accumulation in the pre-2008 period or the rate of accumulation during 2014 when Rupee appreciation pressure reemerged. Overall, the RBI accumulated reserves rapidly during periods of exchange rate appreciation pressures, but resisted using reserves to limited nominal depreciations. This strategy reflected a "fear of losing reserves" as India is largely a current account deficit country, and has been outlined in RBI documents.[9]

It appears that much of foreign exchange purchase operations, involving large-scale sales of the Rupee, were sterilized so as not to allow an expansion of the monetary base. For example, when the RBI ran out of government bills/bonds to sell to sterilize foreign exchange reserves purchases, on February 23, 2004, it

[9]See Reserve Bank of India (2013).

announced the launch of a market stabilization scheme to issue additional government bills/bonds explicitly as sterilization instruments.[10] At the peak, reserve purchases (both spot and forward) were about 22 billion USD a month in 2007. However, during the 2008 global financial crisis, foreign exchange reserves were not used to stabilize a depreciating exchange rate, with sales being negligible. During 2009, the reserves accumulation resumed in periods of appreciation pressures, but compared to the pre-2008 period, the extent of accumulation remained subdued, until picking up again in 2014.

In summary, intervention policy in India has been mainly one-sided, directed toward limiting exchange rate appreciation, during which times dollar purchases were generally large, and *not* directed toward limiting depreciation. The general trend in exchange rate depreciation in nominal terms over our sample period was facilitated by intervention policy. This policy may have allowed relative stability in the real exchange rate, hence maintaining India export competitiveness, as the exchange rate depreciated over longer periods to offset relative high inflation in India. Intervention policy and exchange rate depreciation also allowed greater monetary autonomy, especially during a period associated with increased financial liberalization of the international capital account. Moreover, reserve accumulation —through USD purchases on the foreign exchange market—is a desirable objective to the extent that it provides a stock of precautionary reserves in the event of a balance of payments/currency crisis or sudden stop in private capital inflows that generally finance persistent current account deficits in India. On the other hand, the exchange rate did not play the role of a "nominal anchor" of monetary policy and high inflation in India as a consequence has been a recurring problem.

3.2 Capital Controls and Exchange Rates

Control of international financial capital movements is another policy instrument that has been frequently employed to influence financial flows in and out of India and the exchange rate. Although the overall trend was toward financial liberalization of the capital account, capital control actions (i.e., tightening and easing of restrictions on capital flows) have been actively used as an instrument to "lean against the wind" of exchange rate pressures in both directions.

A measure of cumulative changes in the capital account is shown in Chart 8. These data are from Pasricha et al. (2015). Each of the capital account openness indices is the cumulative sum of the number of weighted capital control easings less tightenings per quarter. The changes are weighted by the share of the country's international balance sheet that the measures are designed to impact (The weights

[10]See RBI announcement at: https://www.rbi.org.in/scripts/BS_PressReleaseDisplay.aspx?prid=9788.

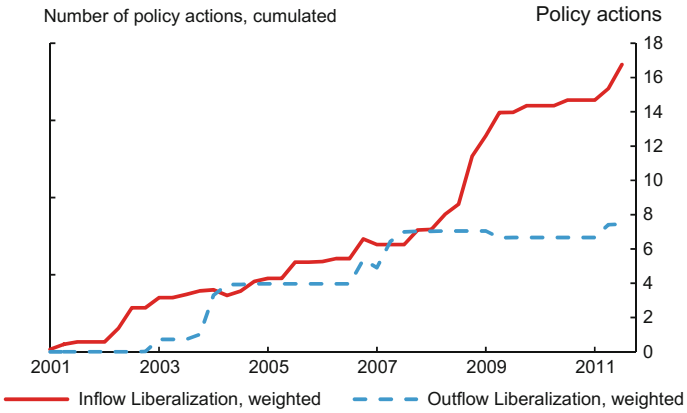

Chart 8 Capital control liberalization in India *Notes* Each of the capital account openness indices is the cumulative sum of number of (unweighted or weighted) capital control easings less tightenings per quarter. The changes are weighted by the share of the country's international balance sheet the measures are designed to impact. The weights are from Lane and Milesi-Ferretti (2007), as in Pasricha et al. (2015). *Source* Pasricha et al. (2015)

are from Lane and Milesi-Ferretti). Four indices are shown: cumulative changes for easings less tightenings for total capital inflows (outflows) and the total less FDI.

Chart 8 shows that both inflow and outflow restrictions have been gradually liberalized. However, there were some reversals in the inflow liberalization process, and the timing of the actions on both inflow and outflow sides appear to be associated with the major changes in nominal exchange rate trends:

- There are two periods during which inflow liberalization trend was temporarily reversed through a net tightening of inflow controls—2003–2004 and 2006–2008.[11] Both these were periods of appreciating nominal INR/USD exchange rate. These periods also saw several net liberalizations of outflow controls, as authorities attempted to reduce exchange rate appreciation pressure associated with surging net capital inflows.
- There was significant net liberalization of inflow controls after 2008, particularly during 2008, 2011, and 2013, the years that saw sharp depreciations of the Rupee. The year 2013 also saw tightening of outflow controls in response to the net capital outflow pressures, as authorities responded to the taper tantrum.

[11]The de-jure liberalization resulted in de facto liberalization, as measured by deviations from covered interest parity. Hutchison et al. (2012b) use a self-Exciting Threshold Auto-Regressive (SETAR) model to the interest differentials between the onshore interbank rate and offshore-NDF implied (covered) yield over the period 1998–2011 and find that prior to 2008, capital control tightenings were able to create a wedge between the offshore and onshore interest rates, but only in periods in which the controls were actively tightened (March 2003–August 2005 and August 2006–October 2008). They also find that post-2008, the no-arbitrage band for the differentials fell to close to zero.

The issue of whether changes in capital inflow controls in India systematically responded to exchange rate pressures is addressed directly using an event study methodology by Pandey et al. (2015). A figure from their work is shown as in Chart. 9. This study finds that the 68 episodes of net capital inflow easing are systematically associated with periods of INR exchange rate depreciation (rising INR/USD four weeks prior to changes in controls) and the 8 episodes of net capital

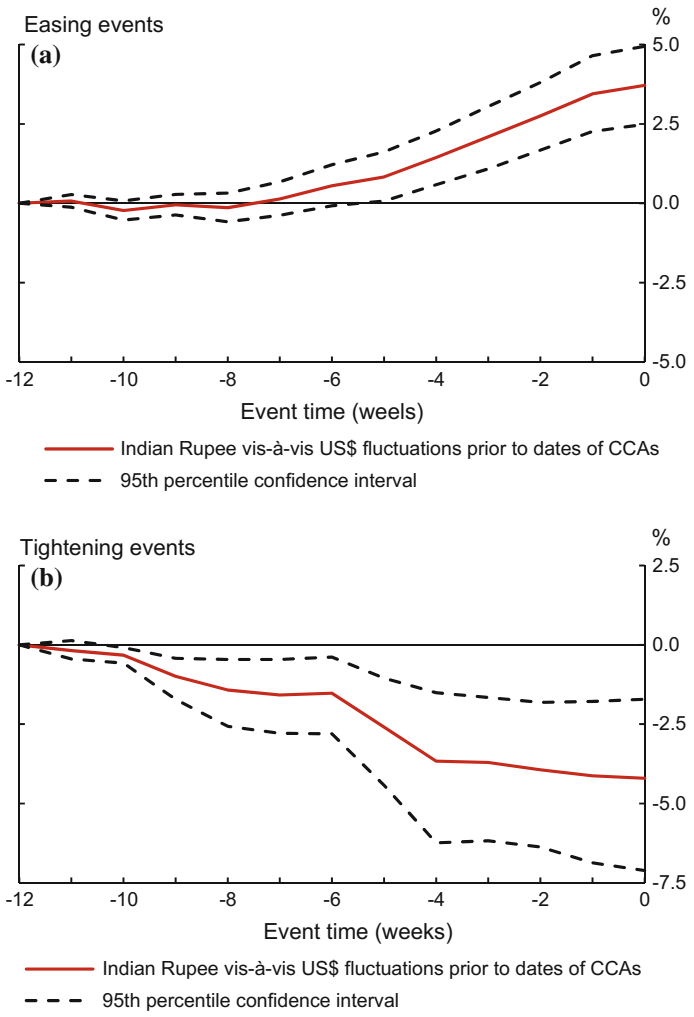

Chart 9 **a** Capital controls responded to exchange rate pressures *Note* Sample includes 68 easing events. *Source* Pandey et al. (2015), **b** Capital controls responded to exchange rate pressures *Note* Sample includes 8 tightening events. *Source* Pandey et al. (2015)

inflow tightening are associated with periods of INR appreciation (fall INR/USD ten weeks prior to changes in controls). This suggests that the timing of changes in capital controls was influenced by the movements in exchange rate.

While capital controls on both inflows and outflows were used to respond to nominal exchange rate pressures, it is not clear that these measures delivered on reversing the exchange rate trend or even stabilizing it. Pandey et al. (2015) also address this issue. They employ a propensity score matching methodology to assess the causal impact of changes in a certain type of inflow controls (those on foreign borrowing by Indian residents) for the period from January 2004 to September 2013. The propensity score matching methodology controls address selection bias that would arise in a simple event study or regression if policymakers use capital controls for exchange rate management purposes. The weeks in which capital control actions (CCAs) were implemented will differ in identifiable ways, from weeks in which CCAs were not implemented.

The propensity score matching (PSM) methodology is a way of building the counterfactual of what would have happened if the controls had not been employed. Instead of trying to model the outcome variables, the methodology shifts focus to modeling the policy variable (the use of a CCA) and estimating the conditional probabilities for the use of CCAs. These conditional probabilities, called propensity scores, are used to identify time periods that had similar characteristics to those prior to the date of the CCA but where no CCA was employed (control group). The behavior of the outcome variables for the control group gives a counterfactual for how each of these variables would have behaved had the CCA not been employed. Outcomes of the weeks after the CCA are compared between the treatment and control groups.

Chart 10, which is an updated version of the one in Pandey et al. (2015), plots the difference between nominal INR-USD spot exchange rate between treatment and control weeks for easing of capital controls on foreign borrowing. It shows no significant difference between the outcomes after easing CCAs and the outcomes in control periods. This result also held for other outcome variables. Therefore, they conclude that these controls did not significantly impact either nominal or real exchange rate movements.

Pandey et al. consider a longer sample, but one interesting episode is the period of "taper tantrum," May–September 2013. The taper tantrum began after Bernanke's testimony to the US congress on May 22, 2013 that the Federal Reserve "could take a step down in our pace of purchase" of assets under the QE program, conditional on improving economic conditions.[12] These events led to considerable market volatility and a global retrenchment from risk taking, with market

[12]The FOMC press conference in June further reiterated that the asset purchases could slow in the fall of 2013, conditional on the economic recovery continuing to take hold.

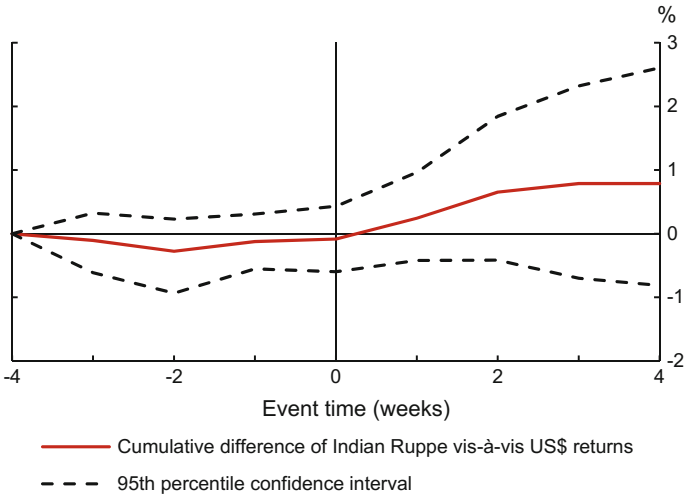

Chart 10 Causal impact of capital controls on nominal INR-USD exchange rate *Source* Pandey et al. (2015)

participants interpreting the statements to suggest that the Federal Reserve may start normalizing policy earlier than markets had so far expected.

This retrenchment from risk-taking hit India particularly hard, as at that time the economic fundamentals appeared to be weak, with slowing growth, high inflation, high fiscal deficit, and political uncertainty due to the upcoming 2014 general elections. The Indian policy response consisted of tightening of monetary policy, curbs on gold imports and currency trading, and liberalization of inflow controls. However, the Rupee depreciation continued unabated (Chart 11, Panel-a). The Rupee's value hit the lowest among the other emerging markets that formed the "fragile five," i.e., Brazil, Indonesia, South Africa, and Turkey (Chart 11, Panel-b). All the fragile five countries responded by raising interest rates, while Indonesia, Brazil, and Turkey also intervened in the currency markets. Sahay et al. (2014) assessed the domestic policy responses in an event study specification and found that EME policies during the taper tantrum did have a dampening effect on the pace of depreciation. However, the taper tantrum was officially over—and all the fragile five currencies stabilized—only when the Federal Reserve did not reduce its monthly purchases under QE in its September 18 monetary policy announcement.

The upshot of this analysis is that a general trend of international capital market liberalization has occurred in India, particularly on the liberalization of capital inflows. Moreover, the intensity of liberalizations coincided with bouts of exchange rate pressure, such as the taper tantrum episode, with changes in capital controls

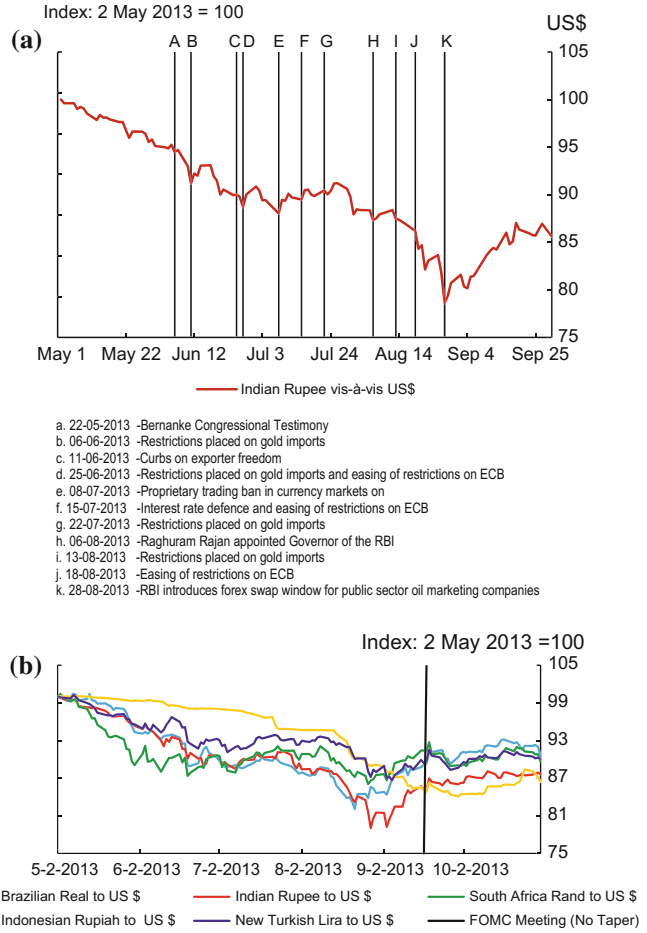

Chart 11 **a** Capital controls and INR-USD exchange rate during "taper tantrum" *a* 05-22-2013—Bernanke Congressional Testimony, *b* 06-06-2013—Restrictions placed on gold imports, *c* 06-11-2013—Curbs on exporter freedom, *d* 06-25-2013—Restrictions placed on gold imports and easing of restrictions on ECB, *e* 07-08-2013—Proprietary trading ban in currency markets on, *f* 07-15-2013—Interest rate defense and easing of restrictions on ECB, *g* 07-22-2013—Restrictions placed on gold imports, *h* 08-06-2013—Raghuram Rajan appointed Governor of the RBI, *i* 08-13-2013—Restrictions placed on gold imports, *j* 08-18-2013—Easing of restrictions on ECB, *k* 08-28-2013—RBI introduces forex swap window for public sector oil marketing companies *Source* Reserve Bank of India and Bank of Canada calculations, **b** Fragile 5 currencies during the "taper tantrum" *Source* Datastream

attempting to moderate exchange rate movements. However, it is not clear from the empirical evidence that capital control changes had much impact on exchange rate movements.

3.3 *Monetary Policy, the Trilemma, and Exchange Rate Management*

Monetary policy in India, especially the use of policy interest rates, has occasionally been influenced by external developments as well as directed toward moderating exchange rate movements (Hutchison et al. 2012, 2013). The trade-offs between an independent interest rate (monetary) policy, exchange rate stability, and financial openness (deregulation of capital controls)—the well-known trilemma constraint—is clearly evident in India. The trilemma configuration is an important part of an analysis of factors determining exchange rates in India as exchange rate stability is compromised (given a particular external environment) when authorities pursue greater capital market openness (financial liberalization) or follow an interest rate policy that diverges from the rest-of-the-world (monetary independence).

Policy constraints between these three policy instruments were operating in India over the past decade, as shown in Chart 12. The chart shows the evolution of interest rate policy independence (monetary policy autonomy, MPA), international capital account openness (KO), and exchange rate stability (ES). The monetary policy autonomy index (MPA) is computed as in Aizenman et al. (2008). This index measures the inverse of the correlation between nominal money market interest rates in India and the US, and varies between 0 and 1, with higher values indicating greater monetary policy autonomy.[13] The exchange rate stability index is also computed as in Aizenman et al. (2008), as the normalized annual standard deviation of the monthly percentage changes in nominal INR/USD spot exchange rate. To measure capital account openness (KO), we compute the index as the sum of total financial assets and liabilities as percentage of GDP.[14]

The MPA index suggests very low monetary policy autonomy during 1999–2006, taking values below 0.3 for the entire period. The MPA index is declining from 1999 to 2004, a period when the volatility of exchange rate against the USD was lowest, as seen in Chart 2.[15] This period is also characterized by heavy foreign exchange market purchases of USD, leading to large reserves accumulation. Up to 2003, RBI sterilized the reserves purchases using open market

[13]We use IFS data on money market interest rates, where available, and monthly average of interest rates. For the US, this series is the federal funds rate. For India, the IFS series on money market rates is missing between June 1998 and April 2006. For this period, we use the MIBOR data from Haver's EMERGE database.

[14]Exchange rate data is the monthly average nominal spot exchange rate against the USD series from IMF IFS. International investment position data is also from IMF IIP statistics.

[15]The monetary policy autonomy index is based on money market interest rates, rather than actual policy rates. The RBI was reducing interest rate and cash reserve ratios over the period 1999–2004. However, sterilized intervention increased the supply of domestic bonds held by the public, which may have prevented full transmission to market interest rates. Real rates also did not decline in this period as inflation was low (fiscal policy was contractionary, with declining fiscal deficit). The index therefore seems to capture well the declining monetary policy autonomy over the period of sterilized intervention.

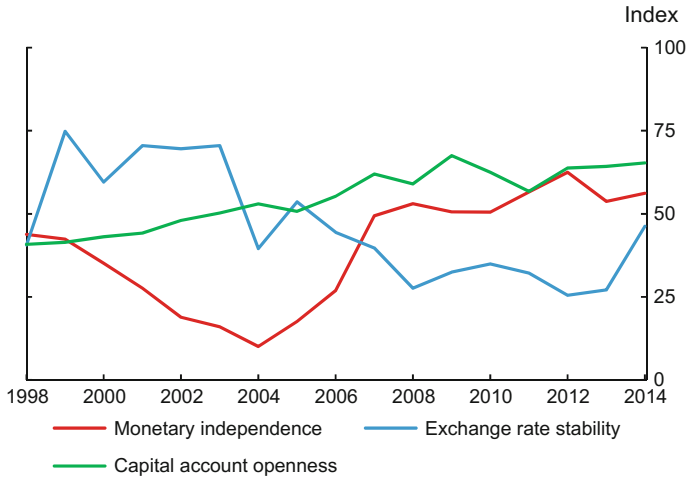

Chart 12 Trilemma indices for India *Source* Haver (IMF IFS and EMERGE databases) and the authors' calculations

operations. In 2003, RBI ran out of government bonds with which to sterilize and the government of India issued special market stabilization scheme bonds to sterilize intervention. As the fiscal cost of sterilization became more apparent under the MSS, this may have led to a slowdown in the rate of sterilization. The year 2004 also marks the lowest point in the MPA index, after which it started increasing, as RBI shifted the focus from sterilized intervention to using more capital controls (tightening of controls on foreign borrowing and easing of outflow controls), as well as gradually allowing (or accepting) more exchange rate volatility.

The year 2008 marked a shift in nominal exchange rate volatility, seen in Chart 2 and measured by lower values of the exchange rate stability index of Chart 12. This allowed the authorities to maintain a high degree of monetary policy autonomy despite increasing capital account openness. The MPA index was fairly stable at around 0.5 in 2007–2010, climbing somewhat from in 2011–2012. The exchange rate stability index continued to fall continuously from the mid- to late-2000s and, by 2012, reached a level below that observed in late 1990s. A small decline in monetary policy autonomy is evident in 2013, as the RBI reacted to taper tantrum by an interest rate defense, intervention in spot, and forward markets as well as capital controls.

To provide a sense of how the three policies: monetary, capital controls, and intervention were used to manage the exchange rate, Table 3 puts together the three policies and the trends in nominal exchange rate of the rupee against the USD for our sample period January 1, 1998–December 31, 2014. We divide the sample period into 6 subperiods, based on the direction of monetary and capital controls policies. Specifically, we use capital control regime change dates identified by Hutchison et al. (2012a) and update these beyond 2011, together with our judgement of the monetary policy cycle turning points (based on information on the

Table 3 Policy regime description

Begin	End	Exchange rate trend	Regime	Description		
				Capital controls	Monetary policy	Total intervention (Spot + Forward)
January 1, 1998	July 7, 2003	Depreciation up to Jan 02, then appreciation	MP: Easing CC: Some NKI increasing measures Intervention: Yes, purchases	Slow and tentative liberalization of inflows but few changes	Easing, on all 4 policy rates	USD 42 billions
July 8, 2003	October 10, 2008	Appreciation — moderate up to April 2006, then rapid	MP: Neutral/Tight CC: NKI reducing measures Intervention: Yes, purchases	Outflow liberalizations and net tightening of restrictions on inflows, particularly between 2006 and 2008	Tightening, starting in August 2004 with CRR and October 2005 in repo rate	USD 149 billions
October 11, 2008	November 20, 2009	Depreciation	MP: Easing CC: NKI increasing measures Intervention: Yes, sales	Inflow liberalizations, no change in outflow controls	Easing	(Sales) USD 30 billion

(continued)

Table 3 (continued)

Begin	End	Exchange rate trend	Regime	Description		
				Capital controls	Monetary policy	Total intervention (Spot + Forward)
November 21, 2009	October 25, 2011	Appreciation, till Apr 2011	MP: Tightening CC: NKI increasing measures Intervention: **No**	Inflow liberalizations, no change in outflow controls	Tightening	None (Sales of USD 1 billion)
October 26, 2011	May 9, 2013	Depreciation	MP: Easing CC: NKI increasing measures Intervention: Yes, Sales	Inflow liberalizations, some outflow tightening	Easing	(Sales) USD 29 billion
May 10, 2013	Dec 31, 2014	Sharp depreciation till September 2013, then stabilization or appreciation	MP: Tightening CC: NKI increasing measures Intervention: Yes, Sales and purchases	Inflow easing, outflow tightening	Tightening	Sales during taper tantrum (USD 27 billion between June and Nov 2013), heavy purchases since (USD 77 billion between Dec 2013 and Dec 2014)

RBI's key policy rates). The capital control regimes are characterized as NKI increasing measures regime (i.e., when most measures taken during the time period were either inflow easing or outflow tightening measures, both of which would tend to increase net capital inflows) or NKI reducing measures regime (where most measures taken were either inflow tightening or outflow easing measures). Monetary policy regimes are described as easing or tightening cycles. We divide the full sample period into 6 regimes. It turns out that most of these subperiods also fit well with the changes in exchange rate trends.

For the three regimes—July 2003–September 2008, October 2008–November 21, 2009, as well as between November 2011 and April 2013—capital control changes (and reserves accumulation) seem to be neutralizing the expected impact of monetary policy changes on the exchange rate. Easing of monetary policy is associated with NKI increasing measures, both simulative measures for the domestic economy but with opposing impacts on net capital inflows and therefore the exchange rate. Reserves sales are used to stem depreciation pressures. Tightening of monetary policy in these periods is associated with NKI reducing measures, both of which would have countered overheating of the economy, but also to reduce exchange rate appreciation pressure from capital flow response to interest rates. Intervention response to appreciation was also strong.[16] These policy responses are consistent with what one would expect, if monetary policy was used to respond to domestic conditions, but capital controls and intervention were used to neutralize the expected impact of monetary policy on the exchange rate.

In contrast, there are two periods where the direction of capital controls and monetary policies reinforced each other in terms of their impact of the exchange rate: the first period is November 21, 2009–October 2011 and the second period is May 2013–May 2014. Both these periods saw monetary policy tightening being conducted at the same time as NKI increasing measures (which may counteract the effect of monetary tightening on domestic liquidity conditions). Both periods seem to suggest some policy response to the value of the currency, although only the second period involved a full interest rate defense of the currency, as we discuss below.

In the period November 21, 2009–October 2011, monetary policy tightening (starting from February 2010) was a response to high prevailing inflation (and high output growth).[17] The inflow increasing measures undertaken at this time were mostly easing of controls on foreign borrowing for infrastructure investment or on FDI in infrastructure, which could be thought of as measures that could ease future supply bottlenecks, and are consistent with RBI's understanding of the inflation problem at this time as being one of supply bottlenecks (Khan 2011).[18] Foreign exchange intervention was not used in this period.

[16]Whether the focus on exchange rate made monetary policy is less effective is a question we do not address here.

[17]Note that real interest rates (measured ex-post using CPI inflation) remained negative throughout this period.

[18]RBI was also concerned during this period with exchange rate pass-through to inflation, as the exchange rate had started depreciating in 2011.

On the other hand, in the May–November 2013 period, all the three policies—capital controls, intervention and monetary tightening—were used in defense of the currency. Monetary policy in this period was clearly reacting to outflows of capital. The RBI acknowledged as much in its 2014 annual report in stating that monetary policy between July and September 2013, characterized as a "post-taper tantrum," was geared toward stemming capital outflows by increasing interest rates.

For India, this period which coincided was one of slowing growth, high inflation, and a sharp decline in exchange rate. These episodes contrast sharply with the 2004 cycle of monetary tightening which occurred as controls on outflows were reduced (while controls on inflows were little changed). Both monetary and capital control policies in 2004 were therefore leaning against the wind, limiting exchange rate changes, and slowing an overheated economy.

In summary, monetary independence in India rose sharply in the mid-2000s against a background of increased financial openness and rising volatility of the exchange rate. By our measure, monetary independence was at a low point in 2004, and climbed sharply until 2007. Monetary independence remained at a high level by historical standards, with some minor fluctuations, through 2014. This is an especially important development since capital account openness rose almost continuously during this period. The natural constraints on monetary independence associated with greater financial openness were therefore facilitated by allowing greater exchange rate flexibility. Greater monetary independence may have allowed the RBI in principle to choose its domestic priorities. But this was against a background of an economy buffeted by the GFC. Annual consumer price inflation jumped from an average of less than 5 % during 2002–2007 to 10 % during 2008–2013, declining sharply in 2014. The domestic priority of the RBI from 2008 to 2013 appeared to output and employment growth at the cost of higher inflation in the aftermath of the GFC.

4 Conclusion

This chapter surveys nominal and real exchange rate developments in India since the late 1990s, both in terms of trend movements and volatility, and investigates the roles of Indian international economic policy—primary foreign exchange market intervention, opening of the capital account and discretionary capital controls, and monetary policy—in influencing the path and volatility of the Rupee exchange rate.

In considering longer term exchange rate trends in India, we find a strong linkage between a broad-based nominal currency index and relative price movements between India and its trading partners. Cointegration between the exchange rate and relative prices cannot be rejected, implying that the exchange rate adjusts to reflect relative inflation differentials over longer periods of time. As a consequence, the nominal exchange rate—against a background of relatively high inflation—has

maintained international competiveness between India and its trading partners. Relatively high inflation rates in India are the main factor underlying long-term trend nominal depreciation of the Rupee—the external value of the currency is clearly influenced by domestic price and monetary policy developments over longer periods of time.

While the long-term trend in the *nominal* value of the Rupee since the 1990s has been one of depreciation, the Rupee has not generally been a "weak" currency in *real* terms, with a relatively stable trend value against a broad basket of currencies and substantial appreciation bilaterally against the USD. Beyond long-term trends, the Rupee exchange rate has evolved through several distinct episodes during our sample. Most importantly, exchange rate volatility has increased markedly since the mid-2000s, especially since the Global Financial Crisis and its aftermath (standard deviation of month-to-month percentage changes more than doubled).

Higher exchange rate volatility in India is influenced by greater volatility in the external environment and recognition among policymakers that exchange rate flexibility may be a necessary short-term trade-off to facilitate both a more open capital account and greater monetary policy independence. The IMF, in consultations with the Indian government, has also lauded the benefits of greater exchange rate flexibility as a "shock absorber" to economic disturbances.

We have argued that trend depreciation of the Rupee is necessary to maintain international competitiveness when inflation in India is higher on average than its trading partners. This has been facilitated by official intervention operations in the foreign exchange market. The India government has attempted to moderate exchange rate appreciation of the Rupee by foreign exchange purchases, substantially increasing the stock of international reserves. This may have had some limited effect on reducing upward pressure on the Rupee during periods of large financial capital inflows. By contrast, little attempt to use intervention operations to limit currency depreciation is evident. Tightening of restrictions on net capital inflows has also been a policy instrument attempting to limit currency appreciation, although evidence suggests that this policy has limited effectiveness.

The long-standing policy of gradual international capital market liberalization would normally be expected to place severe constraints on monetary policy. However, greater exchange rate exchange rate variability in India has largely offset the constraints on monetary policy independence implied by the deregulation of capital controls. In fact, we find that monetary autonomy increased significantly in line with greater exchange rate volatility and the backdrop of gradual liberalization of capital controls. Greater monetary autonomy was not associated with lower inflation rates in India, however, at least not through 2013. The main concerns of the RBI during the turmoil of the GFC and post-GFC period appear to have been maintaining output and employment. Relaxation of the external (exchange rate) constraint may have allowed the RBI to focus more on domestic policy objectives, but concerns about the rise in inflation were apparently dominated by output and employment objectives until quite recently.

Appendix: Data Sources

Series	Source	Notes
Indian Rupee vis-à-vis US$	Bloomberg	Spot exchange rate
Nominal effective exchange rate—36-currency index (NEER36)	Reserve Bank of India	Index: 2004–2005 (April–March) = 100; Trade-based weights. Current series begins. Data prior to July 2005 spliced from the discontinued NEER series with earlier base year
Real Indian Rupee vis-à-vis US$	Bloomberg	Index: January 2001 = 100; spot exchange rate normalized by the authors to an index
Real effective exchange rate—36-currency index (REER36)	Reserve Bank of India	Index: 2004–2005 (April–March) = 100; Trade-based weights. Current series begins. Data prior to April 2004 spliced from the discontinued NEER series with earlier base year
Real price differential between India and trade-weighted 36 index (RP36)	Construction by authors	Index: January 2001 = 100. RP36 = NEER36/REER36
Real price differential between India and US$	Construction by the authors	India CPI/US CPI
Spot intervention	Reserve Bank of India	
Forward intervention	Reserve Bank of India	Forward intervention series is a net amount outstanding. We take month-over-month level change to show intervention
Capital control liberalization indices (inflow and outflow liberalizations, including and excluding FDI)	Pasricha et al. (2015)	Weighted number of capital control actions, cumulated over time. Noncumulated, weighted data from source
Monetary independence Index	IMF IFS and Haver	Constructed by the authors using methodology in Aizenman et al. (2008). This measures the correlations between nominal short-term money market interest rates in India and the USA. Higher numbers indicate lower correlations, i.e., higher monetary policy autonomy. IFS data is used except for India between June 1998 and April 2006 (when the IFS series is missing). For this period, MIBOR data from Haver is used

(continued)

(continued)

Series	Source	Notes
Exchange rate stability Index	IMF IFS	Constructed by the authors using methodology in Aizenman et al. (2008). This measure is the normalized annual standard deviation of the monthly percentage changes in nominal INR/USD spot exchange rate
Capital account openness Index	Lane and Milesi-Ferretti (2007)	Total foreign assets and liabilities, as percentage of nominal GDP. Both measured in US Dollars

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