India's trilemma: financial liberalization, exchange rates and monetary policy

Hutchison, Michael and Sengupta, Rajeswari and Singh, Nirvikar

University of California Santa Cruz

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Michael M. Hutchison
Department of Economics
University of California
Santa Cruz, CA 95064 USA

Rajeswari Sengupta
Department of Economics
University of California
Santa Cruz, CA 95064 USA

Nirvikar Singh
Department of Economics
University of California
Santa Cruz, CA 95064

Abstract

A key challenge for macroeconomic policy in open economies is how to simultaneously manage exchange rates, interest rates and capital account openness—the trilemma. This paper calculates a trilemma index for India and investigates its evolution over time. We find that financial integration has increased markedly after the mid-2000s, with corresponding limitations on monetary independence and exchange rate stability. This tradeoff has been mitigated, however, with the rise of international reserves as a partially independent instrument of macroeconomic policy. In addition, we confirm that the weighted sum of the three indexes adds up to a constant, validating the notion that a rise in one trilemma variable should be traded-off with a drop of the weighted sum of the other two. Finally, we consider the implications of changes in the trilemma index for macroeconomic outcomes. We find some evidence that greater financial integration and corresponding loss of monetary autonomy and exchange rate stability has influenced inflation and inflation volatility, though not in a consistent manner.

Keywords: Financial trilemma, Indian economy, International reserves, Foreign exchange intervention, Monetary policy, Capital account opening.

JEL Classification: E4, E5, F3, F4

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1. Introduction

A key challenge for macroeconomic policy in open economies is how to simultaneously manage exchange rates, interest rates and capital account openness—the open economy trilemma. The basic premise of the international policy trilemma principle is that a tradeoff exists between interest rate policy (monetary policy) independence, exchange rate stability, and financial integration and that changing one component is necessarily associated with a corresponding change in a combination of the other two components.

The trilemma principle has come into greater focus in recent decades as emerging markets aim at exchange rate and macroeconomic stability while becoming increasingly integrated into world financial markets.[1] The trend towards greater financial globalization in most emerging markets around the world is well documented and has imposed a new set of challenges for policymakers (Lane and Milesi-Ferretti; 2003, 2007). Today most emerging markets operate in the range of partial financial integration with regulations restricting the flow of funds and 'managed' floating regimes with central banks actively intervening in foreign currency markets (Aizenman, 2010).[2]

India also fits this general pattern, following a nuanced path of gradual capital account liberalization. Since the early 1990s, the macro-economic environment in India has changed substantially from being tightly controlled and regulated to one experiencing gradual deregulation and liberalization (Shah, 2008; Mohan and Kapur, 2009). These developments and structural changes have impacted the financial environment and external constraints facing Indian policymakers, and may have influenced operating procedures and effective policy tradeoffs between the trilemma choices. In particular, the trilemma principle predicts that India's experience with increasing financial integration would likely have been accompanied, *ceteris paribus*, by a loss of monetary

[1] Aizenman (2010) provides a detailed description of the trade-offs faced by countries in making policy choices in context of the trilemma. Aizenman, Chinn, Ito (2008, 2010) have investigated the trilemma empirically in a cross-section of a large number of countries.

[2] A few countries, notably China, have resisted this trend. China maintains strict controls on international capital flows which, together with a massive buildup in international reserves, allow maintenance of a rigid exchange rate and a large degree of monetary independence (Glick and Hutchison, 2009).

independence and/or loss of exchange rate stability. Evidence of increasing financial integration, for example, is closer linkage of short-term interest rates in India with those abroad (Hutchison, Kendall, Pasricha and Singh, 2010; Hutchison, Pasricha and Singh, 2010).

To what extent has financial integration imposed greater constraints on exchange rate and interest rates policies in India? What has been the cost of international financial liberalization in terms of macroeconomic policy? This paper addresses these questions by measuring the tradeoff between financial integration, exchange rate stability and monetary independence in India. We calculate a trilemma index for India and investigate its evolution over time using a methodology developed and employed for a cross-section of countries by Aizenman, Chinn and Ito (2008, 2009 and 2010). A novel aspect of their work is measuring the trilemma over a large cross section of countries while simultaneously taking into account the role of international reserves in macroeconomic management. We focus on India in our work, detail the evolution of the trilemma over time, associate changes in the macroeconomic policy tradeoff with financial liberalization and measure the extent to which international reserve management has played a role.

Previewing the results, our empirical measures confirm earlier research findings that financial integration has increased markedly after the mid-2000s. The rise in financial integration, in turn, has come with corresponding limitations on monetary independence and exchange rate stability. However, we also find that this tradeoff or constraint on policy has been mitigated with the rise of international reserves as a partially independent and actively employed instrument of macroeconomic policy. India has actively managed its exchange rate, building up a high level of international reserves by intervening heavily in the foreign exchange market, and has successfully limited exchange rate volatility (by international comparison) and maintained some control over monetary policy. Active intervention in foreign exchange markets and maintaining a degree of control over international capital flows has proved a potent combination of policy instruments in India.

Section 2 provides a narrative account of the process of financial integration in India, and describes how it was led both by explicit policy decisions and private market forces in India and abroad as part of a broader trend of financial globalization. Measuring

the evolution of the trilemma index in India is the subject of section 3. The extent to which financial integration has impacted the trilemma facing India monetary authorities is evaluated empirically in section 4. Section 5 discusses how changes in the external constraints, as represented by shifts in the trilemma indices, have influenced inflation and inflation volatility outcomes in India. The analysis also explores the role played by international reserves and changes in the level of reserves. Section 6 concludes the paper with a summary and discussion of future research directions.

2. The Trilemma, financial liberalization and international reserves in India

The Indian economy witnessed several structural changes during the past two decades. Following a balance of payments crisis in 1991, a deeper and more comprehensive series of liberalization and deregulation measures were implemented with regard to the banking sector and financial markets. Between 1992 and 1997, lending rates of commercial banks were deregulated, and the issue of ad hoc treasury bills was phased out (thereby eliminating automatic monetization of the budget deficit). In 1994, India switched over to a mainly market-determined exchange rate system and instituted current account convertibility. Over the 1990s, the exchange rate depreciated substantially against the US dollar, continuing a process that had begun in the 1980s.

Starting in 1998, the RBI undertook strong monetary policy measures (increasing interest rates and withdrawing liquidity) to deal with concerns about excessive liquidity and speculation in the foreign exchange market. The foreign exchange market was characterized by a high degree of volatility following the onset of the Asian financial crisis towards the end of 1997 and beginning of 1998. These emergency measures were gradually reversed once the threat had abated of the crisis spilling over to India.

During the subsequent period, through the mid-2000s, the RBI continued to refine its approach to macroeconomic management. With global and domestic inflation relatively low, the RBI set a band for target inflation of 4-5%, which was low by historical standards. Moreover while domestic fixed income markets continued to be thin (as opposed to vibrant stock exchanges), especially for corporate bonds, a market for government securities began developing in this period. Against this background, in the

next couple of subsections we analyze the role played by capital account liberalization and reserves management in altering the trilemma trade-offs faced by Indian policy-makers.

2.1 Financial integration and policy trade offs

Over the past 15 years or so the RBI continued to gradually ease capital controls, with implications for the functioning of domestic financial markets. Relaxations of capital controls included easing of requirements for and caps on foreign institutional investors (FIIs), streamlining of approval processes, and allowing FIIs to hedge exchange rate risk in currency forward markets. However, with regard to capital account liberalization, Indian policy-makers adopted a cautious stance from the very start (Hutchison, Kendall, Pasricha and Singh, 2010) as a result of which the process has been a continuous albeit a slow and gradual one. This perhaps was partly due to possible linkages between capital account and current account transactions such as capital outflows and trade mis-invoicing and partly owing to external events such as the Asian financial crisis, which reignited the debate on capital account openness for emerging markets.

Hence though the Indian economy has witnessed gradual financial liberalization over the past couple of decades but substantial controls on capital inflows continue to exist, as documented in Box 1. These restrictions can be best described as "complex, discretionary and fragmented" as in Hutchison, Pasricha and Singh (2010). Moreover, compared to other emerging market economies, India still has a relatively low degree of financial integration when measured as total external assets and liabilities as a percent of GDP (Figure 1). (The figure also shows that India has relatively low degree of exchange rate volatility).

The economy also started witnessing sharp increases in capital inflows over the last decade, especially in the years prior to the recent global financial crisis that started in 2007. Unlike the fast-growing East Asian economies, India has mostly run current account deficits, albeit modest, so there have been net capital inflows over most of its history. Earlier aid flows, however, have been displaced by private direct and portfolio investment from abroad (Hutchison, Pasricha, Singh, 2010). Large capital inflows in

some circumstances may increase the domestic money supply and put pressure on the exchange rate to appreciate. Moreover, given the relatively low exchange rate flexibility, the gradual process of capital account liberalization has the potential to cause distortions in the monetary policy. Thus, during this period, the RBI faced the traditional trilemma problem of maintaining an independent monetary policy in the face of international capital inflows and a desire to stabilize the exchange rate. The RBI also actively engaged in sterilization of inflows and began to accumulate foreign exchange reserves, detailed further in subsection 2.2.

Like most emerging market economies, India suffered from the spillover effects of the current global financial crisis. This recent episode again reflects the trilemma at work in Indian monetary policy making, in this instance where capital outflows and reserve losses (to limit exchange rate depreciation) presents a contractionary influence on domestic monetary policy. In particular, one of the main effects of the global financial crisis on the Indian financial markets, particularly following the collapse of Lehman Brothers in September 2008, was in the form of reduction in net capital inflows. The withdrawal of funds from the Indian equity markets, along with reduced access of Indian entities to funds from international markets put significant pressure on dollar liquidity in the domestic foreign exchange market. As described in the IMF country report for June 2009, while foreign direct investment (FDI) continued to remain strong, external commercial borrowings were less than half of their 2007-08 levels. Portfolio outflows amounted to US$9 billion in 2008Q2-Q4. This led to depreciation pressures and higher volatility in the foreign exchange market. In the event of such large capital outflows, the RBI undertook foreign exchange intervention measures to limit pressures on domestic liquidity, which in turn resulted in large losses in foreign exchange reserves.[3] Reserves fell by US$2.8 billion to US$248 billion by 2009Q1.

The picture however has changed dramatically over the last year as the global economy has begun to climb upwards from the trough of the recession, again switching the particular constraints associated with the trilemma. The Indian economy has been among the first to recover from the crisis. Improved growth prospects have been

[3] For more detail, see IMF (2009) and RBI(2009)

accompanied by large capital inflows. Investments of Foreign Institutional Investors (FIIs) have gone up by US $22.8 billion during 2009Q2-2009Q4, as against a net withdrawal of US $11.9 billion during the corresponding period of the previous financial year. Consequently, the Indian rupee appreciated by 11.24 percent against the US dollar as on January, 2010 compared to March, 2009. Inflation pressures have also been intensifying even as financial markets seem to have regained lost ground and growth seems to be approaching pre-crisis levels. Headline (WPI) inflation averaging at 10% or more, has fuelled debate as to whether the RBI should be tightening its monetary policy stance. In context of these international and domestic macro developments, the question of where India stands today with respect to the financial trilemma becomes even more significant and pertinent.

2.2 Foreign exchange reserve management and intervention

India has had an active foreign exchange management policy, with effective intervention in the foreign exchange market and very large growth in foreign exchange reserves. Foreign exchange reserves climbed from around USD $150 billion in mid-2005 to over USD $300 billion in mid-2010, a doubling in just five years and making India one of the largest reserve-holding countries in the world. The dramatic rise in reserves during this period indicates substantial and sustained USD purchases, and sales of the Indian currency, in the foreign exchange market by the authorities in order to limit rupee appreciation. This is shown in Figure 2. Since India had a current account deficit in the balance of payments during this period, so official purchases of foreign exchange were off-setting the substantial private capital inflows into India. These capital inflows are related in turn to partial relaxation of capital account restrictions, one part of the trilemma.

Another element of the trilemma tradeoff is the extent to which the accumulation of foreign exchange reserves has had a substantial impact on monetary policy. Figure 3, showing the rise of the monetary base and its two main components (net domestic credit and international reserves), suggests that it has had a substantial impact. The major asset of the Reserve Bank of India supporting the growth of central bank money (reserve money) is international reserve assets. These have accumulated so rapidly in recent years

that the central bank has been forced to sell off government securities (decline in net domestic assets) in order to maintain monetary control (IMF Country Report 10/73, Table 4; March 2010). The RBI is attempting to limit the impact of international reserves on the money supply, but to what extent has it been able to maintain monetary control in light of financial liberalization and large inflows of capital into India?

To shed some light on this issue we estimate a very simple sterilization equation whereby (the change in) net domestic assets series is regressed on (the change in) net foreign assets (NFA). We use data on net domestic assets and net foreign assets, both from the RBI database, available directly as quarterly series.

Results are shown in Table 1. A coefficient of minus one indicates that the RBI has been completely successful in insulating base money (RBI reserve money) from the accumulation of international reserves, i.e. a one rupee rise in international reserves is associated with a one rupee decline in net domestic assets. We also include a lagged dependent variable and lagged (four-quarter lag) industrial production (IP) to control for other factors influencing the growth of base money.

We split the (quarterly) sample into three equal parts (1996q2-2000q3, 2000q4-2005q1, and 2005q2-2009q3) to evaluate how sterilization and monetary control has changed over time in response to external financial liberalization, with the most recent period representing the period with the most open capital account. The sterilization coefficient equals -0.77, -0.87 and -0.44, respectively, for the three periods. This suggests that most of the rise in international reserves was offset by corresponding declines in the net domestic assets (up to 87%) from 1996-2004, but the control of money was comprised in the latter part of the decade as the RBI offset less than half (0.44). This suggests that monetary independence was partially lost in response to the relaxation of capital controls. We explore this issue more formally in the next two sections.

3. Data and Methodology

Our approach to analyzing India's response to the trilemma follows Aizenman, Chinn and Ito (2008, 2010). We first construct indices for each of the three policy objectives of the trilemma: monetary independence, exchange rate stability and capital account openness (or financial integration). We then estimate a linear model for the

trilemma configuration that is revealed by the data, by regressing a constant on the three indices. Next, we examine the role of international reserve accumulation in affecting policy outcomes, through the interaction of reserves with the trilemma configuration. Finally, we examine the impacts of reserve changes and sterilization efforts on the conduct and outcomes of India's monetary policy in the context of the trilemma.

We depart from Aizenman, Chinn and Ito in several respects. While they use cross-country data and time-averages of annual data, so that their major source of variation is across countries, we use data for a single country. Furthermore, the data is higher frequency, being quarterly, and subject therefore to substantial time variation. Indeed, we find that there is variation in the results across three equal sub-periods into which we divide our sample. We also use a different measure of capital account openness than the preceding authors. Finally, our exploration of the impacts of reserve changes and sterilization efforts also marks a departure from Aizenman, Chinn and Ito.

3.1 Data

The data extends from 1996Q2 to 2009Q3, covering 54 quarters.[4] For the trilemma indices, we have quarterly data on GDP, foreign investment inflows and foreign investment outflows, all from the Reserve Bank of India (RBI) website (Database on the Indian Economy). The exchange rate is a weekly series obtained from the Global Financial Database (www.globalfinancial data.com). We use the nominal Rupee-to-US dollar exchange rate. We use the weekly series to construct a quarterly index of exchange rate stability, as described in the next subsection. From the same source, we use weekly 90-day rates on government securities for the US and India. The correlations between these are used to create a quarterly index of monetary independence, again as described in the next subsection.

To examine the impact of international reserves, we again use data from the RBI. For most of the period, the data is weekly, while for some of the early part of the period, it is less frequent. We average reserves figures for each quarter to construct a quarterly

[4] These periods correspond to 1996-97: Q1 to 2009-10: Q2 according to the Indian fiscal year accounting.

series for international reserves. Since reserves are a stock, and GDP is a flow, when we calculate the reserves-to-GDP ratio using quarterly data, we annualize the GDP figure by multiplying it by four. We also use changes in reserves: these are taken directly from a quarterly series in the RBI database.

The policy outcomes we examine are inflation and inflation volatility. For both measures, we begin with the weekly Wholesale Price Index (WPI), from the RBI database. We then calculate weekly annual inflation figures. Averaging these for each quarter produces a quarterly inflation series. The standard deviation for each quarter yields our inflation volatility series.

3.2 Methodology and Estimation

The key constructs for examining the policy configuration with respect to the trilemma are indices of monetary independence (MI), exchange rate stability (ES) and capital account openness (KO). These indices are constructed as follows.

MI Index

We follow Aizenman, Chinn and Ito in measuring MI as the reciprocal of the correlation of interest rates in the home country (here India) and the base country (here the United States). Quarterly correlations are calculated using weekly interest rate data. The interest rates are on 90-day government securities. The precise formula is:

$$MI = 1 - \frac{corr(i_i, i_j) - (-1)}{1 - (-1)}$$

The scaling ensures that the index lies between 0 and 1, with the highest value indicating the greatest degree of monetary independence. The plot of the MI index is shown in Figure 4.

ES Index

Again we follow Aizenman, Chinn and Ito in constructing this index, adjusting for the differences in periodicity of the data. We calculate the quarterly standard deviations

of the change in the log of the Rupee-US dollar exchange rate, and the index is then constructed according to the formula:

$$ERS = \frac{0.01}{0.01 + stdev(\Delta(\log(exch\_rate))}$$

Again, the scaling ensures that the index lies between 0 and 1, with the highest value indicating the greatest degree of exchange rate stability. The evolution of this index for the sample period is shown in Figure 5.

KO Index

For construction of the KO index, we depart from Aizenman, Chinn and Ito, who use the Chinn-Ito index. For India, this index is essentially constant over the entire period, and may not capture well the changes that have been occurring in India's management of the capital account. Even other de jure measures such as that of Nayyar (2006) are not suitable, since they are only annual, and are not available for the latest part of our sample period. Therefore, we chose to go with a simple de facto measure of capital account openness, using the ratio of the sum of inward and outward foreign investment flows to GDP.

This measure also has drawbacks, since it is a function not only of the policy stance, but also of market sentiment. However, we believe it is a reasonable way of capturing changes in India's effective openness to international capital flows, and how those have changed over time. This index is easy to construct as a quarterly series. One other point should be noted: the KO index is not theoretically constrained to lie between 0 and 1 – the upper bound cannot be imposed. However, for the sample period, it is easily met. As we shall see in the next section, scaling issues are partly dealt with in the regression analysis for the trilemma policy configuration. The KO index for the sample period is shown in Figure 6.

4. Empirical Results: Policy Stance

In this section, we first examine the policy stance with respect to the trilemma, using the indices constructed in the previous section, and then relate the trilemma stance to the accumulation of foreign reserves, using the techniques introduced by Aizenman, Chinn and Ito.

4.1 Measuring the trilemma policy configuration

The central idea for measuring the trilemma policy configuration is that an increase in one of the indices must be balanced by a decrease in another, since there is an overall constraint on the three indices – all three cannot reach there maximum values simultaneously. At the same time, there is no reason for policymakers to not try for a combination of the three indices that is as high as possible, if all three objectives of monetary independence, exchange rate stability and capital openness (or financial integration) are desirable for some reason. However, the latter is an empirical question, and can be examined using the method of Aizenman, Chinn and Ito.

The approach used is to regress a constant (we use the value 2) on the three indices. Of course, the constant term is omitted on the right hand side of the estimation equation. Since, unlike ACI, we are using a time series for a single country to estimate the trilemma configuration, and the period under consideration was one of dramatic changes in external conditions as well as shifts in policy stances, we divide the entire sample period into three equal sub-periods of 18 quarters each. This allows one to see how differences in policy across different segments of this 13.5 year span have played out. The results are reported in Table 2A. The coefficients are not always estimated with great precision (particularly those for monetary independence), but the overall fit is extremely good, reflected in the very high R-squared numbers. This is consistent with the kind of results obtained by ACI, but it should be noted again that these results are obtained for a single country and a sample that incorporates short-run variability associated with quarterly data.

Table 2A also reports the means of the three indices for each of the three sub-periods. According to these measures, monetary independence is in an intermediate

range in all three sub-periods. It falls in the second period, then partially recovers. Exchange rate stability is quite high in the first two periods, then falls somewhat. Capital account openness increases a little from the first to the second period, then dramatically in the third period.

Following ACI, the key measure of the trilemma policy configuration is obtained by examining the contribution of each policy dimension to the total – here set to be 2. This can be calculated quarter-by-quarter, but we calculate and report the average contributions, by multiplying the coefficients by the means for each sub-period. The results are quite striking. Given the high goodness of fit, it is unsurprising that the contributions sum up to close to 2 in each sub-period. The contributions themselves are of great interest in terms of the trilemma policy configuration and how it changes over time.[5] The story they tell is as follows:

- Exchange rate stability receives high policy weight throughout the entire 13.5 year period.
- In the second sub-period, as capital openness or financial integration increases, monetary independence is completely lost, whereas there is an attempt to retain, or even strengthen, exchange rate stability.
- In the third sub-period, as capital openness continues to increase, some exchange rate stability is sacrificed to recover some monetary independence, though the final configuration involves less monetary independence and greater financial integration, as compared to the first sub-period.

The story that emerges from Table 2 is consistent with the broad outlines of what happened in India over this period. It is true that the variation in policy stances with respect to the trilemma may have not corresponded exactly to the three sub-periods we have chosen. However, that makes the results even more striking, in our view. Our results suggest that the ACI approach can be used effectively for single country time series, and not just for panels or cross-sections with time variation smoothed out.

[5] Here we can explain why there is some freedom from scaling issues with respect to the capital openness index not being constrained to a maximum of one, in the final analysis. Suppose that, for example, the KO index were multiplied by 2, so that average capital openness was doubled in the new measure. First, relative values over time would still have the same proportions. Second, the regression coefficient would be halved, so that the contribution would be unaffected by the rescaling.

4.2 Trilemma policy stance and reserve accumulation

An important part of the ACI analysis is their connection of reserve accumulation to the trilemma policy configuration. The broad idea is that reserve accumulation gives policymakers more flexibility in dealing with the short-run tradeoffs between monetary independence and exchange rate stability, where financial integration is a given. This is examined in the context of regressions that examine the role of reserves in achieving certain policy goals, and we present such results shortly. However, we first illustrate this fourth policy dimension with the diamond graph developed by ACI. Again, the difference here is that the graph represents a single country's experience, rather than any kind of average over a group of countries. The diamond graph, Figure 7, shows that India has increased its ratio of reserves to GDP along with its increase financial integration, as it has tried to balance monetary independence and exchange rate stability. The story in Figure 7 is that of Table 2, with the addition of the changing role of foreign reserves. Finally, Figure 8 shows the increase in international reserves over the time period under consideration.

5. Trilemma and Inflation: Impacts on macroeconomic outcomes

ACI examine the impact of the trilemma policy configuration and its interaction with the level of reserves on three policy outcomes: output volatility, inflation volatility and the level of inflation. Since output data is not available for sufficiently high frequencies to allow construction of a quarterly output volatility series, we focus on the latter two outcomes. Also, given the limited degrees of freedom in the subsamples, we do not include any other controls – in any case, most of the control variables used by ACI are relevant for cross-country estimations.

We first present results for the level of reserves, in section 5.1. Then, in section 5.2, we examine an alternative specification, with the reserves level replaced by the change in reserves. The latter specification allows us to compare two different ways of thinking about the impact of reserves and their interaction with the trilemma policy configuration, in affecting macroeconomic outcomes. Reserves level changes can

potentially tell us something about how reserves are being used in practice to soften the trilemma trade-off, particularly between exchange rate stability and monetary policy independence.

5.1 Trilemma indices and level of reserves

Results for inflation volatility and inflation are presented in Tables 3 and 4 respectively. Since the three trilemma indices are collinear, we estimate regressions using two indices at a time,[6] as in ACI. The R-squared for the regressions in Table 3 are in the range of about 0.16 to 0.46. Few of the coefficients are statistically significant in the various regressions. However, several patterns are discernible in the results in Table 3. First, exchange rate stability appears to dampen inflation volatility: the coefficient is always negative. Second, increased capital account openness seems to be weakly associated with higher inflation volatility. In both cases, the interaction terms of the trilemma indices with the reserves-GDP ratio are of the opposite signs, suggesting that the accumulation of reserves softens the impact of the trilemma policy stance. This is roughly consistent with the hypothesis of the work of ACI and other work by Aizenman (2010). The patterns with respect to monetary independence are less clear-cut, and the direct impact of reserve accumulation on inflation volatility is also somewhat mixed across the specifications and different sub-periods. Finally, it should be emphasized that the coefficients are not typically statistically significant, so the patterns should be taken as suggestive and requiring further investigation.

With respect to the level of inflation, the results are presented in Table 4. The patterns in these results display some striking differences from those for inflation volatility. Increased financial integration does not appear to increase the level of inflation – in fact, the coefficients are mostly negative. On the other hand, monetary independence does not seem to matter for the level of inflation.

The most interesting feature of the results in Table 4 involves exchange rate stability, the level of reserves, and their interaction. In the first sub-period, both these factors seem to increase the level of inflation, though these positive effects are muted by

[6] ACI also construct principal components of the trilemma indices and use those in the regressions. That possibility remains to be explored in this data set.

the interaction of the two variables. However, in the second sub-period, these impacts are exactly reversed. The first sub-period is the one that is inconsistent with the typical findings for different cross-country regressions in ACI. This sub-period is also the one in which exchange rate stability and reserves have the strongest negative impacts on inflation volatility (Table 3), suggesting a trade-off between the two objectives in this time frame. It is possible that the result is also related to the transition in the conduct of monetary policy that took place during this period of the late 1990s.

5.2 Trilemma indices and changes in reserves

In Tables 5 and 6 we present parallel results to those in Tables 3 and 4, but with the level of reserves replaced by the change in the level for that period. While the level of reserves provides information about the room for maneuver with respect to the trilemma policy configuration, changes in the level give an indication of how policy action is being taken. The goodness of fit of the regressions is again variable, but roughly in line with those for the regressions with the level of reserves.

In the case of inflation volatility (Table 5), none of the trilemma indices have statistically significant coefficients in any of the three sub-periods. The signs for the capital openness index are predominantly negative, which would imply that capital openness is associated with lower inflation volatility, though the relationship is not one can assert with confidence. Increases in reserves, on the other hand are mostly associated with increases in inflation volatility, though again the relationships are not statistically significant. However, the interaction of increased capital openness and reserve accumulation (positive changes in the level of reserves) is associated with reductions in inflation volatility, and this relationship is statistically significant in the first sub-period.

Turning to the level of inflation (Table 6), there is a strong negative relationship between monetary independence and the level of inflation in the first two sub-periods, though not in the third sub-period, which saw both the culmination of a boom and the bust that followed it. This is what might be termed an expected result, though it does not always obtain in the ACI cross-country estimations.

Increases in the level of reserves mostly have positive effects on the level of inflation, which would also be consistent with an increase in the monetary base. In a

couple of cases, the impact is statistically significant. However, in the first two sub-periods, the interaction term of the monetary independence index and changes in the level of reserves is negative (and significant in one case), suggesting that increases in reserves when combined with increased monetary autonomy tend to dampen inflation, amplifying the effect of monetary independence alone.

6. Conclusion

The "impossible trinity" or trilemma refers to the argument that an open economy cannot simultaneously maintain a fixed exchange rate, an independent monetary policy and an open capital account. It may choose any of these three policy goals at any given time, but not all of them together. This constitutes a primary challenge faced by most emerging market economies that have embraced capital account liberalization. India-one of the fastest growing small open economies in today's world is no exception, especially since the Indian economy has only a partially open capital account and a 'managed' floating exchange rate regime. In the context of the current global financial crisis of 2008-09 emerging market economies including India, have been experiencing capital inflow surges and face the dual policy challenge of maintaining a stable exchange rate and retaining monetary policy autonomy. Against such a background, the question as to where India stands today with respect to the financial trilemma, is a highly significant and pertinent one. In this paper we empirically explore this question and associated issues, such as accumulation of international reserves and sterilization by the RBI.

Using quarterly data from 1996 to 2009, we construct trilemma indices for each of the three policy objectives: monetary independence, exchange rate stability and capital account openness, for India following the methodology developed for a cross-section of economies by Aizenman, Chinn and Ito (2008). The results of our empirical analysis confirm earlier research findings that an increase in financial integration, especially after the mid 2000s, has changed the policy trade offs facing emerging market economies like India. The increase in capital account openness has come at the cost of reduction in monetary policy independence or of limitations on exchange rate stability. We also find that in some cases, greater financial integration and the corresponding loss of monetary

autonomy and exchange rate stability has influenced inflation and inflation volatility outcomes.

We also investigate the role played by international reserves in mitigating the severity of the trilemma faced by India, given that India is now one of the biggest hoarders of foreign exchange reserves. We find that indeed India has been able to actively manage the exchange rate and limit exchange rate volatility relative to other emerging market economies, by building up international reserves and intervening actively in the foreign exchange market. Such reserve management has also helped to some extent in regaining control over monetary policy even in the face of capital inflows.

Finally, we examine the impact of changes in reserve stock and sterilization efforts by the RBI, on the conduct of Indian monetary policy in context of the trilemma. We find that most of the increase in reserves during our sample period was offset by concomitant declines in net domestic assets, thereby suggesting that as a consequence of relaxation of capital controls, the Indian economy did partially lose monetary policy independence. However this issue warrants more detailed empirical investigation and is left as a future extension of this research.

References

Aizenman, J., 2010, "The Impossible Trinity (aka The Policy Trilemma)", forthcoming in Encyclopedia of Financial Globalization (May).

Aizenman, J., M. Chinn and H. Ito, 2008, Assessing the Emerging Global Financial Architecture: Measuring the Trilemma's Configurations over Time," NBER Working Paper No. 14533 (December).

Aizenman, J., M. Chinn and H. Ito, 2009,"The Emerging Global Financial Architecture: Tracing and Evaluating the New Patterns of the Trilemma's Configurations," (March), ADBI Working Paper.

Aizenman, J., M. Chinn and H. Ito, 2010, "Surfing the Waves of Globalization: Asian and Financial Globalization in the Context of the Trilemma," NBER Working Paper No. 15876 (April).

Glick and Hutchison, 2010. "The Illusive Quest: Do International Capital Controls Contribute to Exchange Rate Stability?"

Hutchison, M., J. Kendall, G. Pasricha and N. Singh, 2010, "Indian Capital Control Liberalization: Evidence from NDF Markets," UCSC Working Paper (March).

Hutchison, M., G. Pasricha and N. Singh, 2010, Some Market Measures of Capital Account Liberalization in India, forthcoming in ed., Y-W Cheung, *Financial Integration in Asia*

IMF, June 2009, "India: 2008 Article IV Consultation—Staff Report; Staff Statement; Public Information Notice on the Executive Board Discussion; and Statement by the Executive Director for India**,"** Country Report No. 09/187.

IMF, March 2010, "India: 2009 Article IV Consultation—Staff Report; Staff Statement; Public Information Notice on the Executive Board Discussion; and Statement by the Executive Director for India**,"** Country Report No. 10/73.

IMF (2008) "India: Selected Issues" (February) IMF country Report No. 08/52.

Lane, P.R., Milesi-Ferretti, G.M., 2005. "International Financial Integration". IMF Staff Papers 50, 82–113.

Lane, P.R., Milesi-Ferretti, G.M., 2007. The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities. Journal of International Economics 73 (2), 223–250.

Mohan and Kapur 2009, Managing the impossible trinity: volatile capital flows and Indian monetary policy-10th Annual Conference on Indian Economic Policy Reform at Stanford.

Reserve Bank of India, August 2009, Annual Report of RBI for the year ended June 2009

Shah, A., 2008, New issues in Indian macro policy. In T. N. Ninan, editor, *Business Standard India*. Business Standard Books, 2008

Box I: A Few Major Capital Account Restrictions in India

Portfolio Investment:

By the Foreign Exchange Management Act, FIIs, Non-Resident Indians (NRIs), and Persons of Indian Origin (PIOs) are allowed to invest in primary and secondary capital markets in India through the portfolio investment scheme (PIS). Under this scheme, FIIs and NRIs are permitted to acquire shares or debentures of Indian companies through Indian stock exchanges. The ceiling for overall investment for FIIs is 24% of the paid up capital of the Indian company and 10% for NRIs and PIOs. FII inflows into Indian equities have gone up steadily ever since the markets were opened in 1993. With the exception of 1999 and 2009, net flows have been positive. FIIs own 16% of equities (worth US$147bn) of India's biggest 500 companies and account for 10-15% of equity volumes.

In the wake of the global financial crisis of 2008-09 and heightened capital outflows, curbs on foreign issuance of equity derivatives (P-notes) imposed in October 2007 have been removed. Annual limits on FII holdings of corporate bonds and government bonds have also been raised from US$3 billion to US$15 billion and from US$3 billion to US$5 billion, respectively. Restrictions on FII allocations across equity and debt instruments have also been removed.

Foreign Direct Investment:

FDI in India is limited at 74% in private banks and telecoms, 51% in single-brand retailing, 26% in insurance, defense and oil refining and 20% in radio and it is prohibited in retail trading, atomic energy, real estate and agricultural businesses.

External Commercial Borrowing (ECB):

ECBs are being permitted by the Government of India for providing an additional source of funds to Indian corporates and public sector units. ECBs face a minimum average maturity of 3 years(up to US$20 million) and 5 years(US$ 20-500 million). The Reserve Bank of India (RBI) has eased the norms for raising funds through ECBs. With a view to liberalizing the ECB guidelines, RBI has decided that henceforth, Indian corporates can avail ECB of an additional amount of US$250 million with average maturity of more than 10 years, over and above the existing limit of USD 500 million, during a financial year.

Source: IMF Country Report (June, 2009); RBI Website.

Table 1: Effect of Net Foreign Assets (NFA) on Net Domestic Assets (NDA)

(Dependent variable: Change in NDA)

Variables	**1996Q2-2000Q3**	**2000Q4-2005Q1**	**2005Q2-2009Q3**
Change in NFA	-0.768385***	-0.867774***	-0.443428***
	(0.259622)	(0.260602)	(0.181335)
Lagged change in NDA	0.663150***	-0.214493	0.047067
	(0.199194)	(0.225896)	(0.249181)
Change in log of IP	-14803.59***	-18653.10*	-15150.19
	(4816.056)	(10987.70)	(38005.97)
Constant	4865.866***	7989.290	19861.67*
	(1578.655)	(5638.952)	(10865.56)
Adj R squared	0.463650	0.444902	0.275034

*, **, *** denote statistical significance at 10%, 5% and 1% levels respectively. Standard errors are denoted in parentheses.

Table 2A: Trilemma Indices for India, 1996 – 2010

		1996-97:Q1 to 2000-01:Q2	2000-01:Q3 to 2004-05:Q4	2005-06:Q1 to 2009-10:Q2
Means	MI	0.5348	0.4197	0.4828
	ES	0.7601	0.8107	0.5901
	KO	0.0385	0.0788	0.3140
Coefficients	MI	0.8107	-0.1793	0.4649
	ES	1.7075***	2.0412***	2.1369***
	KO	5.3987	5.2079***	1.4644*
R-squared		0.9697	0.9950	0.9727

Table 2B: Trilemma Contributions

		1996-97:Q1 to 2000-01:Q2	2000-01:Q3 to 2004-05:Q4	2005-06:Q1 to 2009-10:Q2
Contributions	MI	0.4335	-0.0752	0.2245
	ES	1.2978	1.6548	1.2611
	KO	0.2081	0.4105	0.4598
Sum of contributions		1.9395	1.9900	1.9454

Table 3: Inflation volatility, trilemma configuration and reserves

	1996-97:Q1 to 2000-01:Q2		2000-01:Q3 to 2004-05:Q4		2005-06:Q1 to 2009-10:Q2	
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0778	0.0329	0.0255	0.0438	0.0537	0.0838
MI	0.0331	0.0265	-0.0103	0.0130	0.0440	0.0728
ES	-0.1184**	0.0487	-0.0201	0.0551	-0.1454	0.1339
Res/GDP	-1.0215**	0.4448	-0.0626	0.2428	-0.1404	0.3600
MI*Res	-0.5574	0.3750	0.0453	0.0895	-0.2354	0.3413
ES*Res	1.7336**	0.6880	0.0573	0.3121	0.5809	0.5949
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0174	0.0463	-0.0075	0.0674	0.0731	0.0983
KO	0.3067	0.4271	0.3507	0.2931	0.0259	0.1522
ES	-0.0320	0.0478	-0.0135	0.0697	-0.1639	0.1432
Res/GDP	-0.2164	0.6183	0.1923	0.3691	-0.2263	0.4163
KO*Res	-3.7099	4.8670	-2.2180	1.6243	-0.1776	0.6685
ES*Res	0.4843	0.6597	-0.0383	0.3874	0.6636	0.6364
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	-0.0114	0.0190	-0.0079	0.0187	-0.0625	0.0519
MI	-0.0057	0.0258	-0.0054	0.0150	0.0343	0.0826
KO	0.5534	0.3775	0.2395	0.2609	0.0882	0.1629
Res/GDP	0.2053	0.2504	0.0792	0.1128	0.3359	0.2388
MI*Res	0.0510	0.3436	0.0027	0.1075	-0.1825	0.3851
KO*Res	-6.4208	4.3087	-1.2308	1.4355	-0.4131	0.7148

Table 4: Inflation, trilemma configuration and reserves

	1996-97:Q1 to 2000-01:Q2		2000-01:Q3 to 2004-05:Q4		2005-06:Q1 to 2009-10:Q2	
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	-0.3360	0.1749	0.5480	0.1678	-0.3762	0.5114
MI	0.0302	0.1406	-0.0872	0.0498	0.0022	0.4447
ES	0.4792*	0.2586	-0.5847**	0.2110	0.6269	0.8175
Res/GDP	5.3884**	2.3640	-2.4370**	0.9303	1.8456	2.1979
MI*Res	-0.5682	1.9927	0.3396	0.3429	-0.0242	2.0838
ES*Res	-6.6584*	3.6561	2.9826**	1.1959	-2.7331	3.6326
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	-0.2731	0.1910	0.8658	0.3516	-0.2068	0.5808
KO	-0.7058	1.7636	-1.4734	1.5296	-0.6762	0.8990
ES	0.4882**	0.1972	-0.9030**	0.3637	0.7300	0.8461
Res/GDP	4.4688	2.5533	-4.2087**	1.9261	1.0966	2.4591
KO*Res	12.0971	20.0985	7.9661	8.4759	3.0958	3.9492
ES*Res	-6.9536**	2.7242	4.7011**	2.0216	-3.3030	3.7596
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0874	0.0809	0.0799	0.0762	0.1575	0.2948
MI	0.1444	0.1099	-0.0603	0.0612	0.1098	0.4694
KO	-2.6536	1.6085	0.2136	1.0644	-0.7314	0.9250
Res/GDP	-0.3269	1.0668	-0.2947	0.4600	-0.4362	1.3564
MI*Res	-2.3020	1.4640	0.0329	0.4386	-0.5604	2.1875
KO*Res	33.8496*	18.3572	1.5995	5.8562	3.1858	4.0600

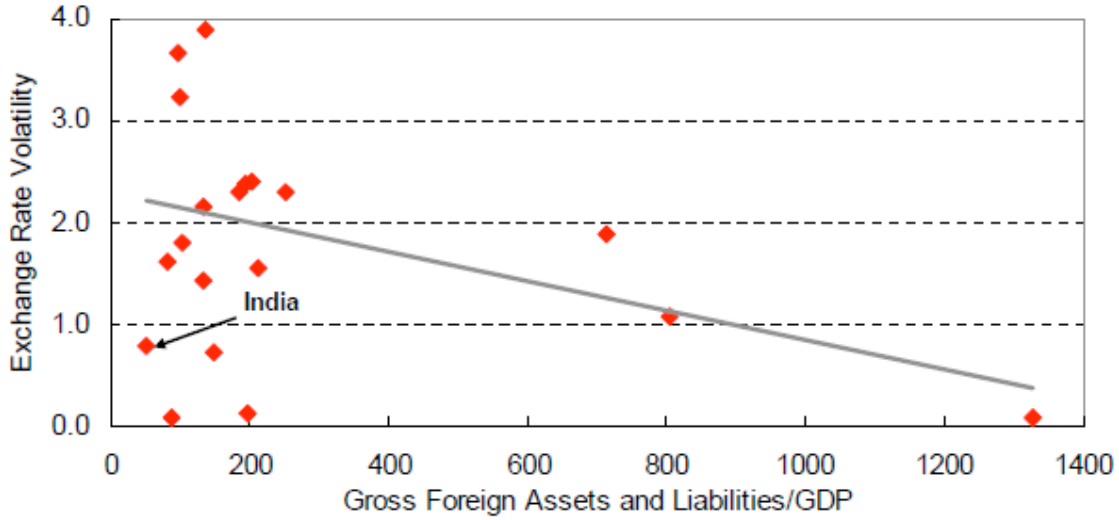
Table 5: Inflation volatility, trilemma configuration and changes in reserves

	1996-97:Q1 to 2000-01:Q2		2000-01:Q3 to 2004-05:Q4		2005-06:Q1 to 2009-10:Q2	
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0036	0.0039	-0.0041	0.0238	0.0139	0.0097
MI	-0.0023	0.0062	-0.0038	0.0075	0.0137	0.0134
ES	0.0033	0.0067	0.0134	0.0317	-0.0220	0.0121
ΔRes/GDP	0.1032	0.1972	-0.4435	0.5005	0.2083	0.1787
MI*ΔRes	-0.0346	0.3736	0.0335	0.1711	0.1983	0.2132
ES*ΔRes	-0.1029	0.2840	0.5292	0.6666	-0.4727	0.3609
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0030	0.0027	0.0100	0.0336	0.0212	0.0126
KO	-0.0170	0.0265	-0.0221	0.0835	-0.0059	0.0241
ES	0.0043	0.0041	-0.0036	0.0363	-0.0207	0.0141
ΔRes/GDP	0.1497	0.1244	-0.1781	0.6539	0.2261	0.1783
KO*ΔRes	-5.9355***	1.6765	-0.1921	1.5793	-0.3065	0.3245
ES*ΔRes	0.1140	0.1771	0.2455	0.7166	-0.1645	0.2983
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0052	0.0022	0.0095	0.0064	0.0018	0.0071
MI	0.0005	0.0037	0.0001	0.0063	0.0126	0.0121
KO	-0.0081	0.0261	-0.0466	0.0611	0.0072	0.0218
ΔRes/GDP	0.1558	0.1281	0.0948	0.1370	0.1315	0.1153
MI*ΔRes	0.0843	0.2238	0.2378	0.1646	0.1945	0.2125
KO*ΔRes	-5.6424***	1.6411	-2.1651	1.3795	-0.3952	0.3671

Table 6: Inflation, trilemma configuration and changes in reserves

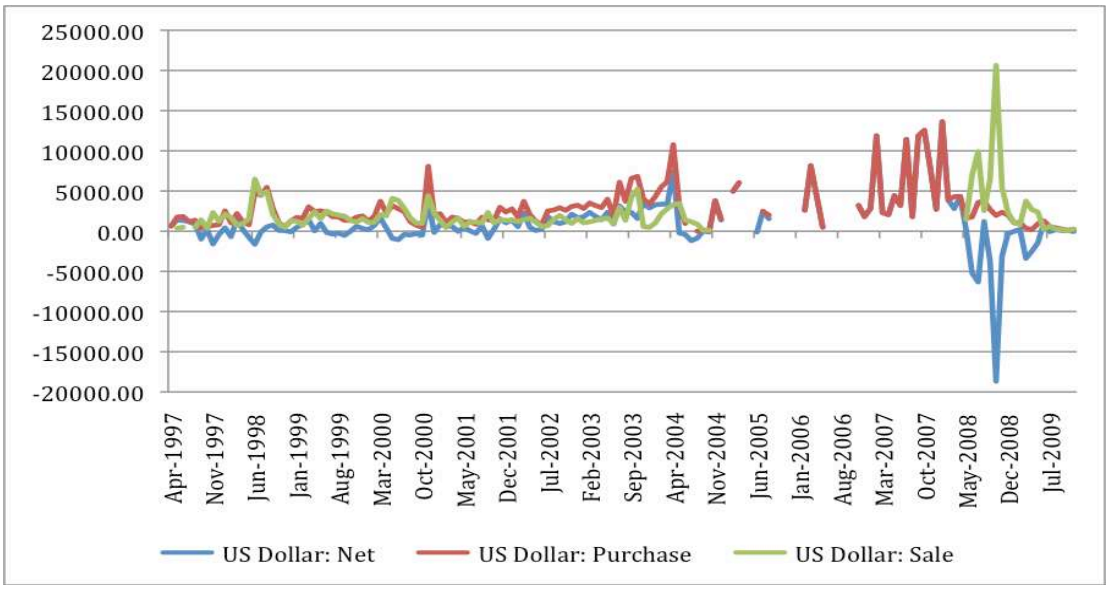
	1996-97:Q1 to 2000-01:Q2		2000-01:Q3 to 2004-05:Q4		2005-06:Q1 to 2009-10:Q2	
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0638	0.0193	0.1641	0.1029	0.0025	0.0522
MI	-0.0628*	0.0310	-0.0910**	0.0326	0.0825	0.0718
ES	0.0265	0.0334	-0.0864	0.1373	0.0173	0.0652
ΔRes/GDP	0.6824	0.9859	1.1375	2.1689	1.7255*	0.9602
MI*ΔRes	-2.4189	1.8682	-1.4862*	0.7415	0.9982	1.1455
ES*ΔRes	1.0092	1.4202	-0.4191	2.8888	-3.3214	1.9396
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0559	0.0203	0.2682	0.1724	-0.0566	0.0631
KO	0.1970	0.2006	0.0847	0.4290	0.2314*	0.1202
ES	-0.0261	0.0311	-0.2671	0.1864	0.0789	0.0707
ΔRes/GDP	-0.0348	0.9417	4.0739	3.3607	1.0757	0.8907
KO*ΔRes	15.9944	12.6942	-1.4020	8.1170	2.2183	1.6207
ES*ΔRes	-0.9507	1.3406	-4.6372	3.6829	-2.3226	1.4900
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	0.0680	0.0135	0.0905	0.0258	0.0159	0.0387
MI	-0.0547**	0.0230	-0.0807***	0.0255	0.0023	0.0658
KO	0.1899	0.1620	0.0569	0.2471	0.1473	0.1180
ΔRes/GDP	0.4455	0.7963	1.0890*	0.5540	-0.0607	0.6247
MI*ΔRes	-2.0319	1.3910	-0.6641	0.6658	-0.2259	1.1517
KO*ΔRes	16.2849	10.1976	-6.2057	5.5787	1.4725	1.9900

Figure 1: Financial Openness and Exchange Rate Volatility in India



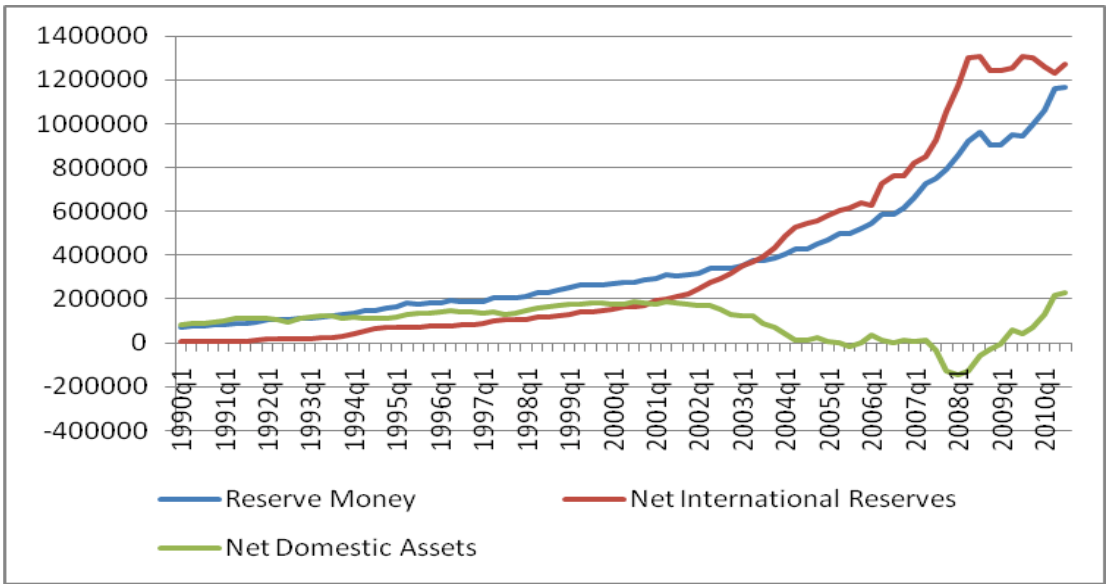
Source: Reproduced from IMF (2008) "India: Selected Issues" (February) IMF country Report No. 08/52. Underlying source for gross foreign assets and liabilities/gdp is Lane, P. and G. Milesi-Ferretti (2005).

Figure 2: Foreign Exchange Market Intervention



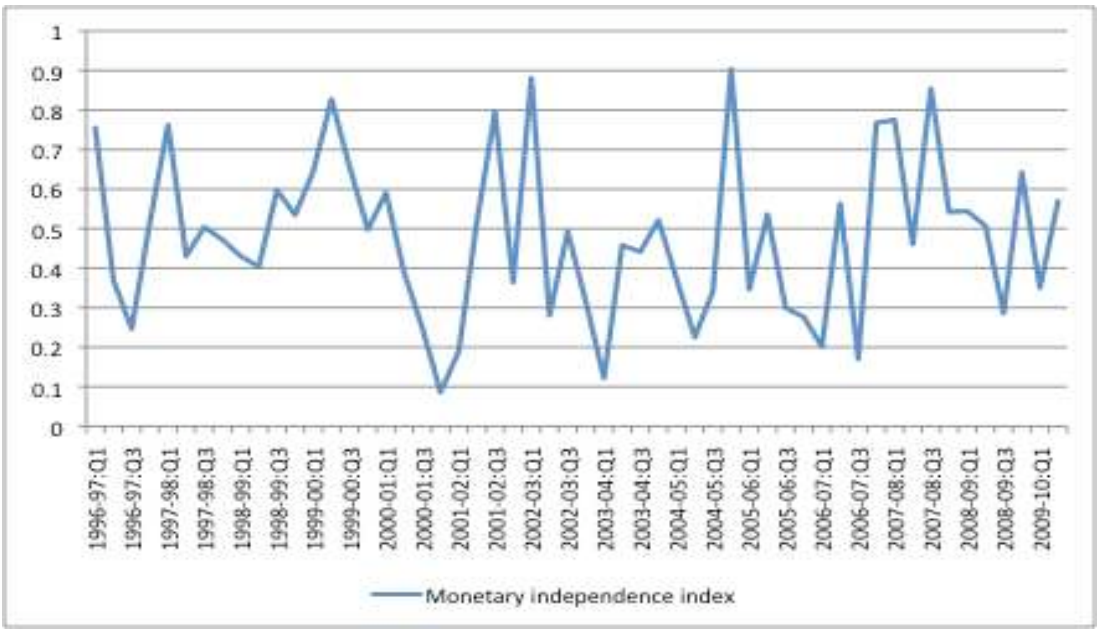
Source: CEIC Asia Database

Figure 3: Evolution of Monetary Base



Source: Reserve Bank of India.

Figure 4: Monetary Independence Index

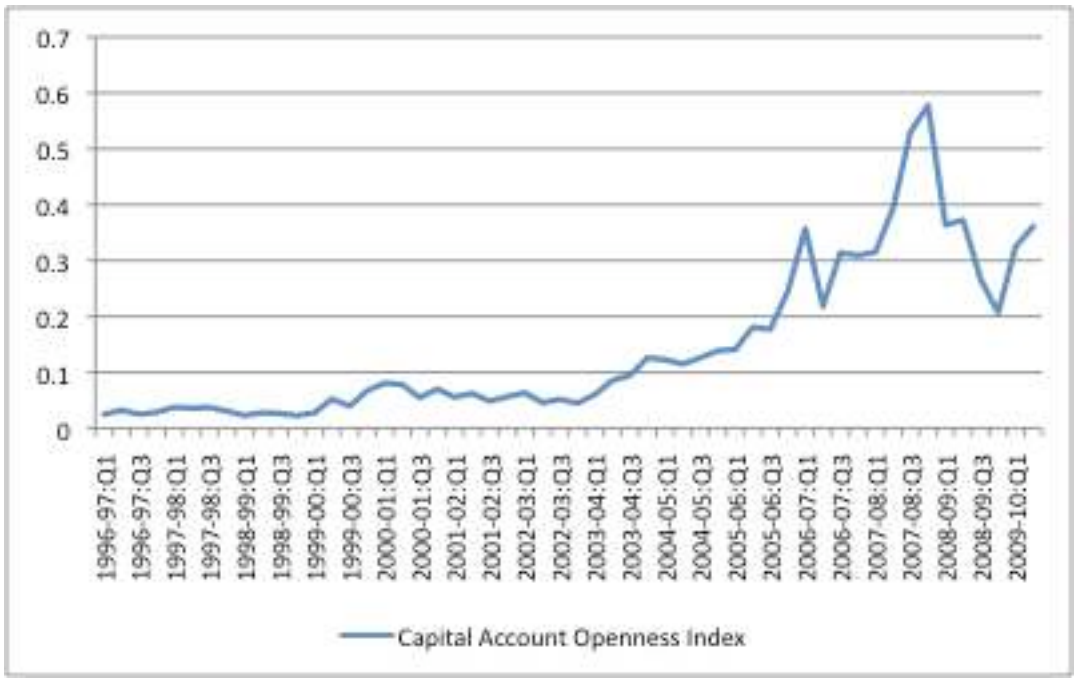


Source: Authors' calculations

Figure 5: Exchange Rate Stability Index

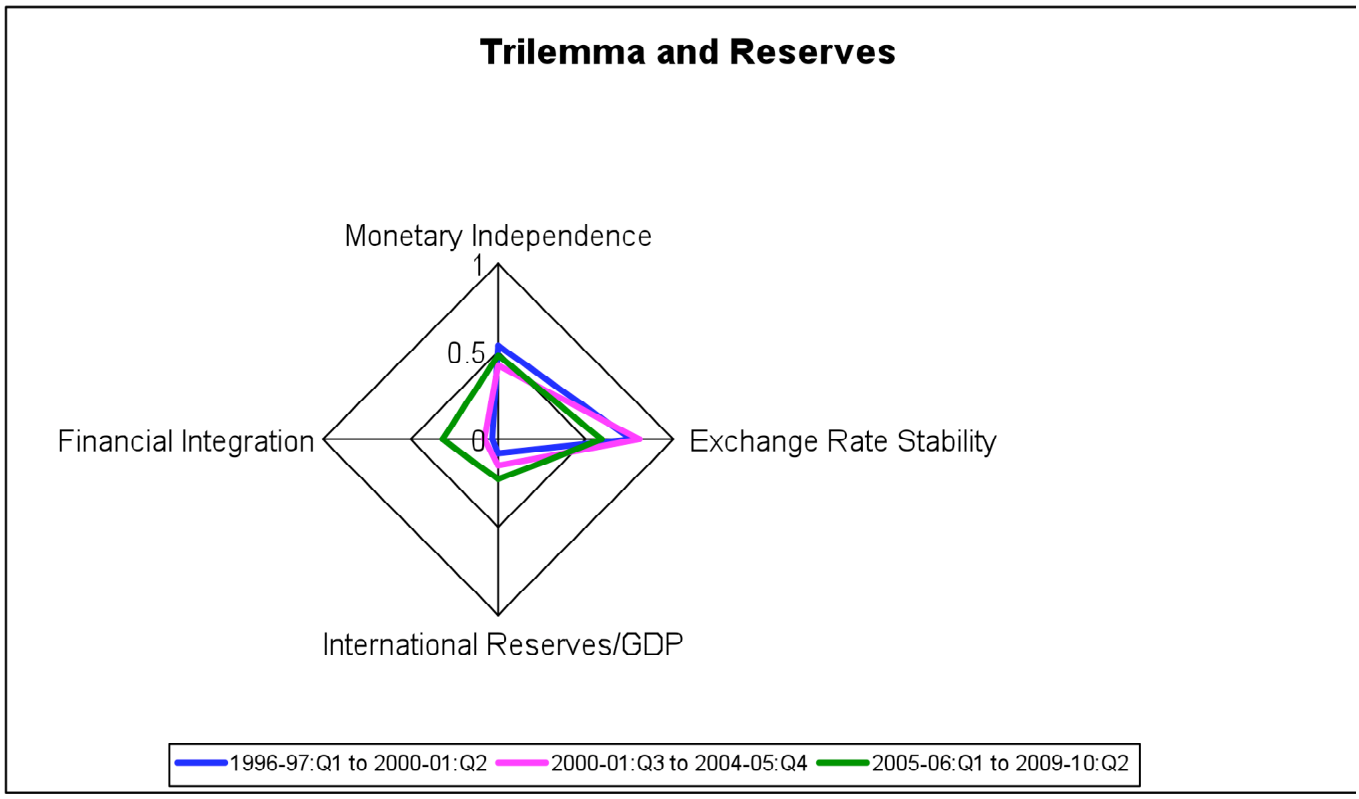
Source: Authors' calculations.

Figure 6: Capital Account Openness Index



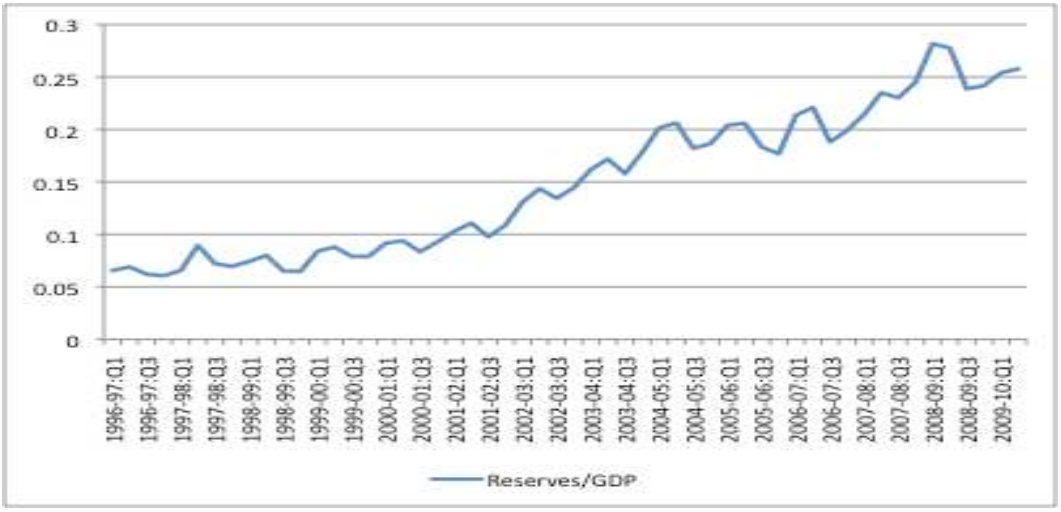
Source: Authors' calculations.

Figure 7: The Trilemma and Reserve Accumulation



Source: Authors' calculations; See section 4 in text for further detail.

Figure 8: Reserves-GDP Ratio



Source: Authors' calculations