Capital Mobility in India : Does Sterilization Matter ?

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Abstract

This paper examined a linkage between capital flows, floating but managed exchange rate, and conduct of monetary policy in India. The sporadic surge in capital inflows have caused a great deal of fluctuations on the domestic exchange rate. Considering this, we analyzed different channels through which the RBI intervened in the foreign exchange market to provide greater leeway in conduct of the monetary policy. The study found that after the global financial crisis, RBI has proactively been engaged into selling of foreign currency concurrently with buying of dollars in the forex market so that the Indian rupee can be stabilized, and currency volatility can be diminished. However, prior to the crisis in the aftermath of unprecedented capital inflows, foreign reserves were accumulated to stabilize the exchange rate. We investigated the extent of sterilization of capital inflows by deploying a sample of quarterly data over the period from 2002 - 2015 and found that reserve money was sterilized to a significantly higher degree during the pre-crisis period (2002-2007) than the post-crisis period (2008-2015). The impact of direct intervention by the central bank was found largely effective in the post-crisis period. Further, this study highlighted various challenges emanating from sterilization to the economy in terms of burden of interest payment on the government securities and less availability of funds as needed for developmental expenditures. Full sterilization of reserve money may reduce exchange rate volatility and can provide much control over domestic monetary conditions; however, the risks of financial instability remain present.

Keywords: **capital flows, sterilization, reserve money**

JEL Classification : E58, F21, F31

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The Indian economy has gone through economic reforms starting from the early 1990s and has gradually moved from financial repression to financial openness. This broadly includes deregulation of administered interest rates, progressive deepening of the financial sector, and more importantly, liberalization of the external sector. India adopted the policy of flexible exchange rate in March 1993, and thereafter, current account became convertible in 1994. The external liberalization has been expedited by volatile capital inflows and outflows beginning in 1993 - 94, which gained momentum since 2003 - 04 and witnessed an unprecedented growth just before the onset of the global financial crisis. The foreign investment inflows constituting of foreign direct investment (FDI) and foreign institutional investment (FII) jumped from $21.45 billion in 2005-06 to $62.12 billion in 2007-08 and drastically fell down to $23.98 billion in 2008-09 in the wake of the global financial crisis. Only in the recent times these inflows crossed the pre-crisis level and increased to $67.9 billion in 2016 -17.

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Large capital inflows are often seen as both boon and bane for an economy, especially when a country persistently runs sizeable trade deficits and current account imbalances. Alternatively, they may cause booms and busts in the stock market, rise in inflationary expectations, and spike in exchange rate volatility may raise financial stability concerns (Ju & Wei, 2006 ; Mohan & Kapur, 2009 ; Prasad, Rajan, & Subramanian, 2007). India, too, has received substantial as well as volatile and reversible capital flows after opening of the capital account of the balance of payment account. The sporadic surge in capital inflows has caused a great deal of fluctuations on the domestic exchange rate (Aizenman, Jinjarak, & Park, 2011; Chawla & Sharma, 2014). However, the objective of India's exchange rate policy is to maintain a stable exchange rate without mentioning any specific target. Since India does not follow a fully flexible exchange rate, the exchange rate did not fully adjust to eliminate the mismatch between demand and supply in the foreign exchange market. Therefore, the burden of adjustment falls on the foreign exchange reserves. The central bank intervenes in the forex market to manage exchange rate as appreciating exchange rate hurts domestic exports' competitiveness and depreciating exchange rate raises concerns regarding climbing of import bill (Committee on the Global Financial System (CGFS), Bank for International Settlements, 2009 ; Reserve Bank of India, 2013).

However, this direct intervention by the central bank leads to an increase in reserve money and consequently, increases in the money supply. Such monetary expansion could fuel in inflationary pressures in the economy (Ray, 2013). However, to insulate the economy from inflationary pressures, countries often indulge into sterilization of capital flows so that the domestic monetary base remains unaffected. Despite the fact that sterilization has its own benefits, it incurs certain costs as well. In this way, capital flows can be a mixed blessing - if not managed wisely, they can have strong repercussions on monetary policy in terms of loss of monetary control or decrease in monetary independence (Kapur & Mohan, 2014 ; Sikdar, 2013).

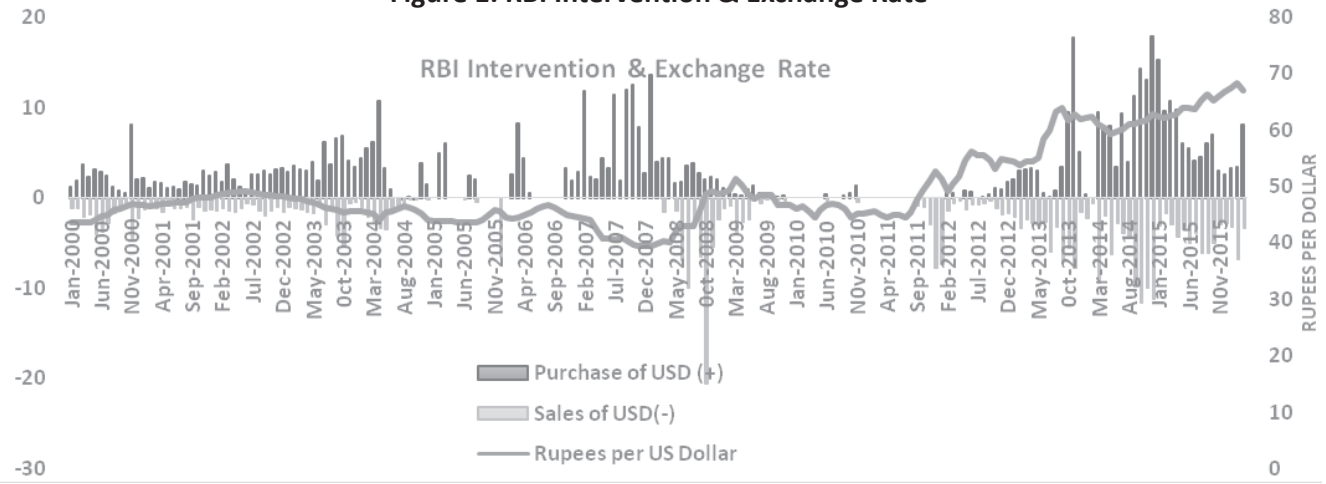
Considering the growing capital inflows in the pre-crisis period and sharp reversal of inflows during the crisis followed by subdued growth in the post-crisis period, the paper aims to analyze the direct intervention of the RBI in the foreign exchange market from 2000 to 2015. It intends to examine the nature of intervention, whether it led to net buying of foreign exchange or net selling of it. Following this, the paper investigates the role of sterilization and instruments used by the Reserve Bank of India from time-to-time to provide greater leeway in conduct of the monetary policy. We have restricted the time period of our study till 2015 as the data indicates a structural break in 2016 and 2017, which might have affected the robustness of the results.

In this backdrop, this study attempts to address the existing gaps in the literature by analyzing different channels through which the RBI intervened in the foreign exchange market in order to provide greater leeway in conduct of the monetary policy. Further, we measured the degree of sterilization with a longish time-series encompassing both the peak and trough of capital flows into the Indian economy. As per our knowledge, none of the studies have been extended to the post-crisis period when capital flows to India plummeted. In this way, we contribute to the existing literature.

Capital Flows, Exchange Rate, and RBI Intervention in the Forex Market

Exchange rate management in India is guided by the various considerations such as avoidance of excessive volatility, high trade deficits, volatile capital flows, and build-up of adequate foreign exchange reserves (Mohan & Kapur, 2009 ; Singh & Kaur, 2015). During the 1990s, the exchange rate was relatively stable, despite the fact that there were some large discrete changes in the exchange rate ; however, since the 2000s, exchange rate has been experiencing greater volatility on a day-to-day basis. In the aftermath of large capital flows into the Indian economy, the rupee - dollar exchange rate appreciated by 17% from ₹ 47 per U.S. dollar in August 2006 to ₹ 39 per U.S. dollar in November 2007. After the eruption of the sub-prime crisis in August 2007, capital inflows to India

Figure 1. RBI Intervention & Exchange Rate



Source : Compiled from Reserve Bank of India. (2006). *Report of the committee on fuller capital account convertibility.* Retrieved from https://rbidocs.rbi.org.in/rdocs/PublicationReport/Pdfs/72250.pdf

jumped as Fed started its rate cut in order to provide additional liquidity in the economy. RBI intervened in the foreign exchange market, and its net purchases of forex were $48.5 billion during the 5-month period from September 2007 to January 2008 (see Figure 1). However, large volume of drop in portfolio capital was witnessed on account of a rise in oil prices and collapse of Lehman Brothers in September 2008; demand for Indian rupee vis a vis US dollar went down and consequently, exchange rate depreciated by 18% from ₹ 43 per U.S. dollar in June 2008 to ₹ 51 in May 2009. To stabilize the exchange rate, RBI continuously intervened in the forex market and net sales of $43.3 billion were observed over this period, with the majority of them taking place in October 2008 just after the collapse of Lehman brothers (Kapur & Mohan, 2014).

Despite the global financial crisis, the Indian economy registered resilient growth largely attributing to strong economic fundamentals and timely fiscal & monetary stimulus packages (Gupta & Siddiqui, 2014). However, the growth trajectory was derailed with the onset of Sovereign Debt Crisis in 2010 and spreading it to European economies such as Greece, Ireland, Portugal, Spain, etc., putting the peripheral countries of the European Union to the brink of default on their public debt. This infused greater volatility in the foreign exchange markets and stock markets across the globe (Singh & Kaur, 2015). Since Europe constitutes a major share in India's exports, its slowdown resulted in fall in demand for Indian goods, which adversely affected India's industrial growth and resulted in surge in current account deficit (CAD) to 4.2% of GDP in 2011-12, which widened to record high of 4.8% of GDP in 2012-13. Financial turbulence led to substantial rise in portfolio outflows from India. All these put pressure on the Indian rupee which sharply depreciated by over 24% between August 2011 (₹ 45 per U.S. dollar) and August 2012 (₹ 56 per U.S. dollar). Net sales of $22 billion were observed during this period, with the majority of them taking place in December 2011 and January 2012.

The third major shock experienced by the Indian economy was when the Fed announced phased withdrawal of bond purchased programme in USA. This statement created unrest in the world economy, and the U.S. investors started taking out their money from the overseas market. This led to increase in demand for dollar so the prices of other currencies weakened. Rupee had already weakened by mounting current account deficits, and it further got worsened when FIIs started withdrawing money from the Indian markets in order to park their funds in U.S. securities considered as safe haven (Peddada, 2017). Huge outflows from FII debt and equity market were witnessed. Rupee declined to ₹ 58 per U.S. dollar in June 2013 and further plummeted to an all-time low to ₹ 64 per

U.S. dollar in September 2013. During this 4 - month period, net sales of US dollars by RBI to stabilize rupee were around $14 billion. Subsequently, rupee was stabilized, up to some extent, in a response to measures taken by RBI and returning back of foreign investors since the Fed continued with their quantitative easing policy and withheld their prior announcement (Jain, 2013 ; Singh & Yadav, 2010).

In June 2014, crude oil prices crashed and plunged by 60% between June 2014 and January 2015. A combination of low demand due to weak global economic activity and increase in supply led to a sharp decline in oil prices. This oil crisis acted as a boon in the revival of the Indian economy. Pressure on balance of payments eased as oil imports, which constitute a significant proportion in total imports, declined. Furthermore, net foreign institutional investments revived and rose to $42.2 billion in 2014-15 against a meager $4.8 billion in 2013-14, which was a crisis year. Consequently, rupee was stabilized and RBI did not have to significantly intervene in the foreign exchange market.

Change in Foreign Exchange Reserves and Sterilization

In this section, we will analyze the extent to which Reserve Bank of India has been able to shield growth in reserve money from the change in liquidity associated with significant change in foreign exchange reserves during pre - and post - global financial crisis periods. We exhibit the estimates of India's marginal propensity to sterilize/neutralize the effects of foreign exchange reserves on the reserve money over the said period of time in the following section.

We observed in the previous section that sudden jumps and falls in capital flows, owing to various shocks, affect the exchange rate. Since India does not follow fully the flexible exchange rate, the exchange rate did not fully adjust to eliminate the mismatch between demand and supply in the foreign exchange market. Therefore, the burden of adjustment falls on its foreign reserves. Prior to the sub-prime crisis, the unprecedented capital inflows led to net purchases of U.S. dollars (i.e accretion to the foreign reserves) that caused a rise in monetary base[1] (or reserve money) and consequently, money supply. Usually, central banks do not want the domestic money supply to change as a result of their transactions in foreign exchange in order to prevent a possible inflationary effect. Therefore, central banks have to undertake an offsetting transaction to neutralize the effect of net purchases of dollars on reserve money, which is possible by decrease in net domestic assets. In other words, open market sale of bonds or other assets is required to neutralize the impact of net purchases of dollars in order to prevent the exchange rate from falling (rupee appreciation). This phenomenon is known as sterilized foreign exchange intervention. However, sterilization could be in full or partial.

Before sterilization of foreign exchange has been analyzed in a quantitative manner, a stylized version of the balance sheet of central bank of India has been exhibited. As shown in the Table 1, the assets side comprises of foreign assets (largely dominated by official reserves) and domestic assets (principally, government bonds). On the liabilities side, a central bank holds monetary and non - monetary liabilities. The former includes currency with public comprising notes in circulation, rupee and small coins less cash with banks, and reserve deposits that are maintained by commercial banks as part of their cash reserve requirements. Non - monetary liabilities include all the liabilities, which do not create any money such as capital, various RBI reserves, etc. Reserve money is derived from the balance sheet. A change in the balance sheet minus the non - monetary liabilities is nothing but change in reserve money. Since central banks create reserve money, it not only forms the basis for money supply in an economy, but also gives so much power to central banks. Reserve money is known by different names such as high powered money, monetary base, base money, and narrow money.

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[1] *Reserve = Net foreign assets (NFA) + Net domestic assets (NDA) + Government's Currency Liabilities to the Public (rupee coins and small coins, also included in currency in circulation) – Non-monetary liabilities of RBI.*

Table 1. Stylized Balance Sheet of RBI

Assets	Liabilities
Net Foreign Assets *(NFA)*	**Monetary Liabilities**
• Gold	• Currency in circulation
• Foreign currency assets	• Reserve Deposits
Net Domestic Assets *(NDA)*	**Non-monetary Liabilities**
• Net RBI credit to government	• Currency and Gold Revaluation Account
• RBI credit to banks & commercial sector	• Paid-up Capital and Reserve Fund
	• Others - Contingency Reserves, etc.

Furthermore, theory on reserve money suggests that it can be explained in two ways : one is by various types of reserve money or its components which are nothing but the liabilities of RBI. Illustratively, items like currency in circulation or banks' deposits with RBI are types of reserve money. Secondly, by sources, that is, RBI needs to engage in some operations in order to generate reserve money. Thus, RBI purchases foreign assets, gold, domestic bonds, etc. All these represent assets of RBI.

Thus, if reserve money changes, then it must be mirrored in changes in NDA or NFA. Therefore, we can write the following identity, adopted from Lavigne (2008):

$$\Delta Currency + \Delta Reserve\ Deposits = \Delta NDA + \Delta NFA$$

After analyzing the Reserve Bank of India's balance sheet as presented in Table 2, it has been found that year-to-year growth in reserve money was not greater than 15% during March 2002 - March 2007 despite the fact that the period witnessed huge capital inflows. In fact, all this expansion was led by an increase in net foreign assets of Reserve Bank of India, which was ₹ 4156 billion, accompanied by negative changes in domestic assets (NDA), implying that capital flows were being sterilized. Since the reserve money expanded by ₹ 1858 billion between FY 2002 and FY 2005, this indicates that RBI sterilized on average around 57% of its net foreign exchange purchases, leading to partial seepage of foreign reserves (or NFA) into reserve money. Likewise, RBI sterilized about 41% of its net foreign exchange purchases between March 2007 and March 2008. The pace of accumulation in foreign exchange reserves came to a halt when the crisis hit the Indian economy.

In contrast, when there was capital outflow following the global financial crisis, RBI expanded its balance sheet: net domestic assets (loans and advances given to government, commercial sector, and banks) sharply rose by ₹ 1925.9 billion during March 2008 to 2009 in comparison to fall in NDA by ₹ 1184 billion in the previous fiscal. Rise in NDA in the crisis years clearly indicated a sharp rise in net credit to the government, especially from 2009 to 2013, reflecting large borrowings by the government in order to stimulate investment and output (see Table 2). Contrary to this, NFA either declined or registered slow increase in response to weak revival of capital flows and constrained exports (mounting current account deficit), especially prior to the plunge in crude oil prices. This was also reflected in parallel selling of dollars in foreign exchange market to prevent the exchange rate from further depreciation (Figure 1). In the aftermath of the second and third economic shocks witnessed by the Indian economy (or post-global financial crisis), RBI was proactively engaged into selling of dollars concurrently with buying of dollars in the forex market so that rupee exchange rate can be stabilized which has never been observed prior to the global financial crisis except at the time of crisis. Between September 2011 and September 2013, total sales of forex was $37 billion - more than the total purchases - signaling heavy intervention by RBI in the foreign exchange market in order to provide the much needed stability to the Indian rupee.

Table 2. Reserve Bank of India's Balance Sheet (₹ Billion)

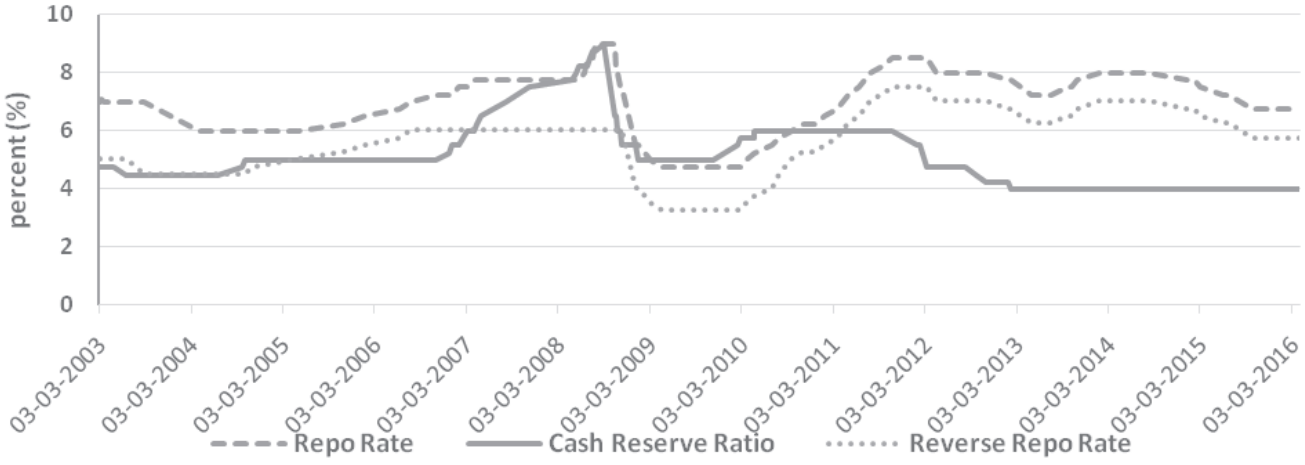
	31-03-00	31-03-01	22-02-02	31-03-03	31-03-04	31-03-05	31-03-06	31-03-07	31-03-08	31-03-09	31-03-10	31-03-11	31-03-12	31-05-13	31-03-14	31-03-15
Net Domestic Assets (NDA)	1803.2	1801.3	1709.6	1308.9	523.9	-113.3	137.8	116.0	-1068.3	857.6	2140.8	4038.8	5445.5	6644.4	7562.0	5670.3
Net RBI credit to the Government	1482.6	1538.8	1513.5	1206.8	449.1	-179.8	66.0	24.2	-1132.1	615.8	2115.9	3965.6	5357.4	6456.1	6987.1	3645.2
RBI's Claims on Banks	109.0	63.7	55.2	13.7	12.3	13.3	28.0	76.4	45.9	103.6	11.7	51.6	48.5	164.2	486.5	1876.6
RBI's Credit to Commercial Sector	211.5	198.9	140.9	88.4	62.6	53.2	43.9	15.4	17.9	138.2	13.3	21.6	39.6	24.1	88.4	148.5
Net Foreign Assets (NFA)	1658.8	1971.8	2456.1	3582.4	4844.1	6128.0	6729.9	8661.5	12361.3	12801.1	12319.4	13285.7	14722.0	15949.5	18025.3	21272.8
Reserve Money	2805.5	3033.1	3202.5	3690.6	4365.1	4891.1	5719.3	7088.6	9282.8	9879.6	11556.5	13768.2	14263.4	15402.3	17327.4	19284.6
Growth Rates																
Reserve Money Growth	8.2	8.1	5.6	15.2	18.3	12.0	16.9	23.9	31.0	6.4	17.0	19.1	3.6	8.0	12.5	11.3
Money Supply Growth	14.6	16.8	14.1	14.7	16.7	12.0	21.1	21.7	21.4	19.3	16.9	16.1	13.5	13.6	13.4	10.9
Change over Previous Period in Billion of Rupees																
NDA	22.9	-1.9	-91.7	-400.7	-785.0	-637.2	251.1	-21.9	-1184.3	1925.9	1283.3	1898.0	1406.7	1199.0	917.5	-1891.7
Net RBI Credit to the Government	-42.8	56.1	-25.3	-306.7	-757.7	-628.8	245.7	-41.8	-1156.3	1747.9	1500.1	1849.7	1391.8	1098.7	531.0	-3341.8
RBI's Claims on Banks	32.9	-45.4	-8.5	-41.5	-1.4	1.1	14.7	48.4	-30.5	57.7	-91.9	39.9	-3.1	115.7	322.3	1390.1
RBI's Credit to Commercial Sector	32.8	-12.7	-57.9	-52.5	-25.9	-9.4	-9.3	-28.5	2.5	120.3	-124.9	8.4	18.0	-15.5	64.3	60.1
NFA	279.3	312.9	484.4	1126.3	1261.7	1283.8	601.9	1931.7	3699.8	439.8	-481.6	966.3	1436.3	1227.6	2075.7	3247.5
Reserve Money	212.7	227.6	169.4	488.1	674.5	526.0	828.2	1369.3	2194.1	596.9	1676.9	2211.7	495.2	1138.8	1925.1	1957.2

Reserves and Money Aggregates : Other Instruments of Sterilization Used by RBI

In the face of excess foreign exchange flows and to neutralize their impact over fluctuating exchange rate and thus to maintain the competitiveness of domestic exports, the RBI intervenes in the foreign exchange market at regular intervals by a combination of instruments. As explained above, one is selling of domestic assets, which is known as open market operations (OMO) and other instruments primarily include cash reserve ratio (CRR), liquidity adjustment facility (LAF), and market stabilization scheme (MSS). These market - based approaches involve monetary transactions between the central bank and the market leading to injection or absorption of liquidity in the market. The RBI has been sterilizing capital flows since 1993 onwards via a slew of instruments such as conducting open market operations in government securities and changing reserve requirements of the commercial banks for almost a decade. However, faced with large scale capital inflows since 2003-04 and declining stock of government securities, the market- based sterilization activities led to run out of government securities to sell with the RBI. Market Stabilization Scheme (MSS), a new unique instrument for sterilization, has been introduced since April 2004 wherein RBI has been empowered to issue Government Treasury Bills and medium duration dated securities bonds to offset the expansionary impact of capital flows. MSS securities are just like any government securities to the lenders. However, the scheme works by holding the MSS proceeds in a separate account with the RBI, and these can be used only for the purpose of redemption and/or buy-back of the Treasury bills (Chandrasekhar & Ghosh, 2007). It is important to note that the use of MSS as a sterilization tool has immensely helped in smooth conduct of monetary policy. Moreover, it has contributed to greater independence of the central bank in monetary policy operations as it does not depend on the government for its recapitalization in the event of making losses (Subbarao, 2011).

Along with the MSS, the RBI raises the CRR time - to - time to absorb some excess liquidity that emanates from the massive capital inflows. During 2003 and 2007, RBI has predominantly used MSS to sterilize the foreign inflows, thus there was no noticeable change in CRR, and so it hovered within an average band of 4.75% - 5%. Later on, it was raised to 6% in March 2007, and thereafter it has kept on rising sharply in response to large scale

Figure 2. Monetary Policy Rate and Reserve Requirements – LAF (Repo & Reverse Repo) and Cash Reserve Ratio (CRR)



capital flows and attained a peak of 9% in August 2008, just prior to the bankruptcy of Lehman Brothers. As capital flows reversed in the wake of the sub-prime crisis, the CRR was drastically slashed from 9% in August 2008 to 5% in January 2009 to inject the much - needed liquidity into the market. The liquidity adjustment facilities (LAF), other option of sterilization represented through repo rate, were also sharply pruned down to facilitate greater money supply in the economy. As the situation improved, foreign inflows turned back to the economy, CRR also revised and increased in the range of 5% - 6% prior to the onset of the sovereign debt crisis of Eurozone. Thereafter, it was declined to pump in additional liquidity in the economy and hovered in the range of 5% to 4% and since then, it continued to stabilize at around 4% (Figure 2).

Model Specification of Sterilization of Capital Inflows

To further investigate this issue, we have attempted to quantitatively estimate the extent of sterilization of foreign exchange with the objective of analyzing sterilization activity in the pre-crisis period (2000Q2 to 2007Q4) and post - crisis period (2008Q1 to 2015Q1). Changes in degree of sterilization have been estimated by an OLS multivariate regression wherein RBI's change in net domestic assets are regressed over on the change in net foreign assets, using the quarterly data, over the 2000 Q2 - 2015 Q1 period. Data on all the variables were extracted from Reserve Bank of India's *Handbook of Statistics on the Indian Economy*. To estimate the degree of sterilization between the two time periods, we deploy interaction regressor $\Delta NFA\ D$ where dummy D is 0 for pre-crisis period and is 1 for post-crisis period as its inclusion has provided greater degrees of freedom rather than doing this by employing two regressions for two time periods. We also included quarterly growth rate of real GDP on the right hand side to control for other explanatory variables that might influence the demand for money. The methodology that we use was adopted from Cumby and Obstfeld (1981) and its variants were used in many other studies (Glick & Hutchison, 2009, Kohli, 2011 ; Lavigne, 2008 ; Mohanty & Turner, 2006). Thus, this takes the form :

$$\Delta NDA_t = £ + \alpha \Delta NFA_t + \beta \Delta NFA_t * D_t + \mu\ GDP_t$$

The above regression equation assumes that the central bank neutralizes or sterilizes the monetary impact of foreign capital inflows (i.e change in foreign assets ΔNFA_t) by change in its domestic assets (i.e $\Delta\ NDA$). We estimate the sterilization coefficient, α for pre-crisis period, and $\alpha + \beta$ for post crisis period, with values ranging from -1 to 0. A unitary coefficient, that is, $\alpha = -1$ represents full monetary sterilization of reserve changes, so is true for $\alpha + \beta$. On the other hand, $\alpha = 0$ or its lower values would infer no or less sterilization. Hence, full sterilization signifies that the central bank allows domestic credit to accommodate fully higher demand for money as a result of growth in GDP, but at the same time, prevents any domestic credit expansion due to accumulating foreign exchange reserves. In other words, it represents that the central bank fully sterilizes the increase in reserve money due to increase in its net foreign assets by reducing its net domestic assets in the times of surge in capital inflows.

After fitting the data in the above regression equation, we get the following results. We have also conducted unit root test for all the variables such as *NDA, NFA*, and real growth *(GDP)* so that there is no scope for spurious results. All the variables were found to be stationary after first difference. The details are set out in the Appendix.

$$\Delta NDA_t = \underset{}{180.9} - \underset{(0.04)}{0.70}\ \Delta NFA_t + \underset{(0.00)}{0.54}\ \Delta NFA_t * D_t + \underset{(0.02)}{2.6}\ GDP_t \qquad (0.03)$$

Below the regression equation, p -values of t - statistic are indicated in parentheses.
F- statistic = 3.73; Prob (F - statistic) = 0.016 ; DW = 1.9

The above results denote that all the coefficients of interest are statistically significant at the 5% significance level. The central bank of India sterilized 70% of the increase in reserve money due to surge in capital inflows through reduction of its domestic assets over the pre - crisis period (2000Q2 to 2007Q4). In common parlance, monetary base merely expanded by one - third when there was two - thirds of sterilization of capital inflows and amount of increase in liquidity can be derived by multiplying the rise in reserve money to the existing money multiplier. In the post-crisis period (2008Q1 to 2015Q1), which coincided with capital outflows in the beginning and later on with slow growth in capital flows and sharp rise in net credit to the government, the sterilization coefficient is - 0.16 (i.e 0.54 - 0.7). This implies lower neutralization of foreign capital inflows in the post-crisis period. This reduced degree of sterilization might indicate that the central bank did not sterilize a major part of the capital inflows. This seems quite plausible as the post-crisis period witnessed a slower growth in net foreign reserves, and at the same time, there was an increase in borrowings by the government to provide fiscal and monetary stimulus packages in order to revive the economy. The control variable, growth rate, is found to be positive, indicating that the demand for money increases as income of a country rises. Moreover, rising domestic output growth reflects demand for credit by banks and commercial sector rises.

The empirical results from available literature (say Kohli, 2011) suggest that RBI neutralized around 64% increase in reserve money due to capital inflows by direct reduction of its domestic assets over January 2003 to June 2006 using the monthly data. As per Lavigne (2008), changes in net domestic assets offset 60% of changes in net foreign assets in India during 2000 - 2006. Likewise, a cross - country study by Mohanty and Turner (2006) found that during the period from January 2000 to May 2006, changes in net domestic credit sterilized around 85% - 95% of the changes in net foreign assets in India, Korea, Malaysia, Singapore, and Taiwan (China). Thus, our regression results have been consistent with the available literature for the first period.

However, it is worthwhile to note that, none of the studies as per our knowledge have been extended to a later time period, that is, the post-crisis period. This is our contribution to the literature. Moreover, we did a detailed study investigating the extent of sterilization from the golden years of the Indian economy till the recession and recovery years and also deployed a better methodology by using interactive dummy in order to have greater degrees of freedom.

Domestic Consequences of Sterilization

(1) Cost of Sterilization : How long a country can pursue sustained sterilized intervention ? As there is no specified answer to this, it largely depends upon the stock of foreign exchange reserves and extent to which domestic currencies are prevented to appreciate/depreciate. Well, there are certain external and internal costs associated with the instruments of sterilization along with the benefits. As regards to the costs, there are distortionary effects associated with maintaining an undervalued exchange rate, which includes implicit subsidization of the export sector and the imposition of capital controls, factors that increase the threat of retaliatory protectionist measures.

According to Dani Rodrik, domestic costs include fiscal costs of sterilization, which arise from the difference between the rates that the government must pay on the domestic bonds they issue and what they receive in return by investing in foreign exchange assets, which are primarily the low yielding U.S. government securities. The historic trends suggest that the difference is largely positive in emerging economies, including India, as domestic securities usually yield higher than the most common reserve asset, that is, U.S. Treasury bills. A simple estimate of fiscal costs borne by the Indian government in the process of sterilization is depicted in the Table 3. Its column 5 shows difference between nominal yields on domestic bonds, including treasury bills of 91-day, 182-day, and 364-day and U.S.'s money market instruments, including treasury bills.

The Table 3 specifies an approximation to fiscal costs. The yield differential is positive for all the years from

Table 3. Costs of Sterilization

1	2	3	4	5	6	7
	India	U.S.				
	Money Market Rate/ Call Money Rate (Weighted Average)	Money Market Rate	Treasury Bill Rate	Interest Rate Differentia (2-3)	Nominal Appreciation / lDepreciation of Rupee against USD (-/+) or Capital Loss/Gain	Net Loss/ Gain (-/+)of interest
2007	15.29	5.02	4.41	10.27	-8.74	-19.01
2008	11.55	1.93	1.46	9.62	5.22	-4.40
2009	4.49	0.16	0.16	4.33	11.26	6.93
2010	6.51	0.18	0.13	6.34	-5.53	-11.87
2011	8.80	0.10	0.06	8.69	2.07	-6.63
2012	9.34	0.14	0.09	9.20	14.50	5.30
2013	8.58	0.11	0.06	8.48	9.66	1.18
2014	8.64	0.09	0.04	8.55	4.15	-4.40
2015	8.47	0.12	0.03	8.35	5.12	-3.23

Note. Spreads are calculated as difference between nominal yields on domestic bonds up to one year and yield on weighted average of U.S.'s major money market instruments including treasury bills.

Source: International Financial Statistics, Reserve Bank of India and authors' calculations.

2007 to 2015, meaning that short-term interest rate in India was higher than the interest rate in the U.S. Further, we observe that spread was over 10% in the pre-crisis years when there were huge inbound inflows while it dropped to 4% in the wake of the crisis. However, it revived back to around 8%, but could not match the pre-crisis level due to contractionary monetary stance in India. However, these significant fiscal costs or costs of sterilization will get further aggravated when effects of exchange rates are taken into account so that value of foreign reserves can be obtained at mark-to-market prices. Appreciation of domestic currency against dollar erodes the value of dollar denominated reserves and vice-versa also holds true. In 2007, when rupee appreciated by 8.7%, net loss on yield differential was much higher and amounted to 19%. Thanks to continuous depreciation, the Indian currency did not only narrow down the spread, but contributed to positive returns on foreign assets, say, 5.3% and 1.18% for the years 2012 and 2013, respectively, as denoted in the last column of Table 3.

(2) Market Distortions : Apart from the difference between the yield on government securities and return on foreign exchange assets, which is fiscal cost to the RBI, a tax on banks is also imposed. To be precise, this is in the context of the higher reserve requirements (CRR) where direct costs are borne by the banking sector since the day interest is not being paid over the CRR balances maintained with RBI. This increases their transaction costs, making the banking sector less profitable and less attractive for borrowers and depositors. Banks may opt to finance riskier loans or low-quality loans. This may lead to rise in share of non-performing assets in proportion to total bank assets as is the case witnessed in China (Lavigne, 2008). In case of India, bad loans of banks and corporates are at their peak, amounting to 10% of gross loans of the banking sector. This might raise concerns towards financial sector stability.

Imposition of capital controls on inflows and outflows generally make sterilized intervention effective, but can bring in market distortions in the economy as regulations on capital inflows limit the avenues for domestic investment. Likewise, controls on outflows restrict the investment opportunities of the residents and shield the

domestic financial sector from foreign competition. However, capital regulations insulate the economy from reversible and speculative capital flows, so it is not at all imprudent to impose capital controls (Ghosh, Ostry, & Qureshi, 2017).

Conclusion

The present study shows that large inflows and outflows have implications on exchange rate and monetary policy. Our empirical results exhibit that capital flows in India accelerated during 2003 - 2007, indicating that the sterilized intervention by RBI has increased at an accelerating pace, creating room in conduct of the monetary policy. However, in the post - crisis period, when capital flows dwindled in the wake of a series of economic shocks, the pace of reserve accumulation slowed down. We find that RBI has proactively been engaged into selling of foreign currency, concurrently with buying of dollars in the forex market so that Indian rupee can be stabilized and currency volatility can be diminished, which has never been observed prior to the global financial crisis, and this is the contribution of our paper. This resulted into tightening of reserve money up to some extent and also denoted a smaller degree of sterilization during the post-crisis period (2008 - 2015) as per our empirical results.

Implications, Limitations of the Study, and Scope for Further Research

From this study, the implications of sterilization of foreign exchange reserves could be viewed as challenges emanating from its sterilization. Large burden of interest payment on the government securities and usage of non-market friendly sterilization methods, which are essentially considered as a tax on banks, are likely to cause disintermediation of finance. This may cause less availability of funds as needed for widespread developmental requirements of the Indian economy. Further, the fact is that full sterilization of reserve money may reduce exchange rate volatility and provide much control over domestic monetary conditions, however, the risks of financial instability may remain present, given the volatile nature of non-FDI inflows.

This paper has attempted to assess how India has sought to insulate its monetary base from the effects of capital inflows by sterilizing through issuance of central bank liabilities. However, this study limits its discussion to reserve money; it is not extended to finding a relationship between reserve money and money supply in the economy. In this regard, a linkage between reserve money to money supply (liquidity), real GDP, and price level can be further explored to understand the inflationary expectations of different policy scenarios. This would provide direct implications for monetary policy, especially in the regime of flexible inflation targeting (FIT), which India adopted in January 2016.

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Appendix

Econometricians have suggested examining whether the data series is stationary or not as the presence of unit roots may lead to spurious results. If data series are found to be non-stationary, then in the next step, the order of integration is estimated. For robustness, in this study, we have applied the unit root tests such as Augmented Dickey-Fuller (ADF) test and Phillips - Perron (PP) using Eviews software. This test assumes the presence of unit root at level and rejection of null suggests that the data series are stationary. Furthermore, it is usually recommended by experts that non-stationary series be transformed into stationary series by appropriate differencing before any empirical testing.

Appendix Table 1A. Unit Root Test Results

TEST	*NDA*		*NFA*		Real Growth Rate *(GDP)*	
	Level	FD	Level	FD	Level	FD
ADF-FC	-1.21	-6.26	-2.12	-7.9	-3.01	-7.9
	(0.89)	(0.00)	(0.5)	(0.00)	(0.13)	(0.00)
PP-FC	-1.26	-6.29	-2.12	-7.99	-3.11	-7.94
	(0.88)	(0.00)	(0.5)	(0.00)	(0.12)	(0.00)

Note. *p* - values are mentioned in the parentheses. Probability 0.00 implies that probability tends to zero.

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