Chapter 5
Summary of Findings, Policy Suggestions and Scope for Further Research

5.1 Introduction

The notable change during the last two decades that significantly affected the attitudes of policy makers in matters relating to exchange rate management seems to be the sharp rise in the cross-border capital flows in response to financial liberalization all over the world. The liberalized capital flows across political frontiers has contributed to crises with varied intensity and frequency. There are sudden stops or reversal of capital flows that affected the exchange rate stability. More importantly, there is a significant rise in the precautionary demand for reserves in response to increased frequency and intensity of banking and financial crises experienced by emerging countries in the 1990s. There is a general consensus on the view that the unprecedented accumulation of reserves in some emerging countries reflects significant rise in precautionary demand for reserves in response to increased frequency and intensity of banking and financial crises. Some of the recent empirical studies on reserve demand provide evidence in favour of this claim.

Nevertheless, it is intriguing to note that large reserve holding Asian countries such as China, Taiwan, South Korea, etc are still maintaining several restrictions on capital flows as it would limit the external vulnerability. In fact, the emerging Asian countries maintain administrative controls to restrict capital flight while providing incentives to encourage durable capital inflows. Such asymmetric capital controls has been an integral part of exchange rate management policy of emerging countries. Under this arrangement, capital inflows tend to be durable; hence, there will be persistent pressure on domestic currency to appreciate.
Therefore, the available option for authorities which have concern for export growth is to buy foreign exchange to prevent real appreciation of domestic currency.

In India, the unprecedented accumulation of reserves appears to be an eventual outcome of a shift in policies regarding reserve and exchange rate management in view of growing transactions on the capital account. Most of the transactions on capital account are still administered and capital outflows are not as free as capital inflows. Such an asymmetric control over capital flows aimed at preventing sudden withdrawal of capital; hence, it is less probable that the country will face currency crises or speculative attacks. If so, why should the RBI build up huge volume of reserves?

The authority builds up reserves for several reasons. Firstly, a country needs reserves to pay for its import and to service external debt if there is a temporary shortfall in export earnings or access for foreign exchange is temporarily closed. Secondly, reserves are built up as insurance against sudden stops or reversal of foreign capital. Thirdly, the authority may accumulate reserves to prevent real appreciation of domestic currency as it would help sustaining export growth. The first motive reflects the transaction demand while the second motive reflects the precautionary demand for reserves. The third motive describes the mercantilist view that reserve accumulation is triggered by concerns over export competitiveness.

Although larger reserve holding strengthens the credibility of the country in the international market and creates more access for external funds at relatively cheaper rate, it incurs an opportunity cost. Having realized the existence such cost, authorities have designed some indicators to determine the adequacy of reserves. There are number of criteria adopted to determine the adequacy of reserves. The reserve adequacy is often determined by simple rule of thumb that the stock of reserve should be equivalent to the imports of a few months Triffin
Conventionally, reserves equivalent to three months of import considered to be adequate. This was widely accepted when the cross-border capital flows were insignificant. The amount of reserves so held largely serves as precautionary balance to absorb shocks in external payment. Such shocks arise when there is an unforeseen mismatch between external receipts and payments. However, the recent surge in the accumulation of official reserves especially by the emerging countries cannot be explained by the conventional reserve adequacy indicator.

The significant rise in the cross-border capital flows which are highly volatile has brought in a renewed thinking in matters relating to reserve adequacy. Apart from trade based adequacy measures, there are efforts to link reserve adequacy with external debt position. For instance, the Guidotti (1999) and Greenspan (1999) suggested that the level of reserves should be equivalent to short-term external debt due to next twelve months, average maturity of external debt should be three years and above and countries must maintain liquidity at risk. Alternative measures of reserve adequacy which are incorporated in the Report of Committee on Capital Account Convertibility by S.S.Tarapore (2006) suggest trade-based, money-based and debt-based indicators.

While there are number of adequacy indicators emerged in response to growing intensity and frequency of financial crises all over the world, there is rich theoretical literature which deals with determining the optimal level of reserves. The most popular approach stems from the buffer stock model of Frenkel and Jovanovic (1981). If a country holds inadequate amount of reserves, the authority will have to opt for stringent policy measures to build the reserves which might result in output loss. The cost attached with such reserve restocking is called the macroeconomic adjustment cost. Such adjustment cost tends to decline as reserve holding increases. On the contrary, reserve accumulation increases the income foregone in other investments; hence, there is a rise in the opportunity cost with increase in reserve holdings.
The optimal level of reserves is determined at a point where the expected sum adjustment cost and opportunity cost is minimized.

However, official intervention in the foreign exchange market gives rise to number of questions which need to be addressed. The crucial among them are: (i) what are the motives behind reserve holdings? (ii) what is the optimal level of reserves to be maintained by the authority? and (iii) does intervention serve the purpose to which it is being tuned? Addressing these issues is not just of research interest. A thorough investigation of these issues would be highly useful exercise in the context of framing policy measures with regard to exchange rate management. Against these backdrops, the present study intends to address three important questions: (i) what lies behind accumulation official reserves? (ii) do the factors responsible reserve accumulation varies over times? and (iii) is intervention successful in minimizing the volatility of exchange rate?

To investigate the above mentioned issues, the study uses weekly data for the sample period from 20th December 1996 to 25th March 2011. The data on all the variables used in the empirical exercises are collected from various issues of Handbook of Statistics on Indian Economy, Reserve Bank India (RBI) and various sources of Bombay Stock of Exchange. To identify the reason behind stockpile of foreign exchange reserves the study has used the buffer stock model of Frankel and Jovanovic (1981). The long run relationship among the variables that figure in the buffer stock model is examined using the ARDL approach of Pesaran et. al. (1996) and Pesaran and Shin (1998), which allows us to test for cointegration and to obtain the long run elasticities of the model. Moreover, the model is estimated for various sub-samples as the reserve accretion took place at difference pace during the sample period.
We define a policy reaction function exclusively for official intervention and estimate the reaction function using the Flexible Least Square method of Kalaba and Tesfatsion (1988); Tesfatsion and Veitch (1990). This approach provides time varying reaction of the RBI with respect to changes in the foreign exchange market. The autoregressive conditional heteroskedasticity (ARCH) models of Engle (1982) and generalized autoregressive conditional heteroskedasticity models of Bollerslev (GARCH) and asymmetric power autoregressive conditional heteroskedasticity APGARCH Ding, Granger and Engle (1993) are deployed to examine the impact of intervention on exchange rate volatility and appropriate dummies are used to investigate structural break in the model and asymmetry in exchange rate intervention.

5.2 Major Findings

Chapter 2 is devoted to investigate the first objective of the thesis that what are the factors contributed to the accumulation of reserves. The long run elasticity of reserve demand equations are obtained from the ARDL approach using weekly data. The estimates of reserve demand equations are obtained for three sets of sample period which are determined based on the rate at which reserve accretion took place in India during the market based exchange rate system. The major inference drawn from the empirical results are:

- The estimates of buffer stock model obtained from autoregressive distributive lag model revealed that the coefficient on incremental reserve volatility is upwardly biased when volatility is measured as rolling average of standard deviation of past reserve increment.
- The volatility constructs from an appropriate GARCH model that provides bias free elasticity estimates.
It is interesting to note that the estimated volatility coefficient is much lower than theoretical prediction; hence, growing precaution is not the dominant source of reserve accumulation.

The negative coefficient with respect to change in log of nominal Re/S exchange rate indicate that the RBI leans against wind; hence, the exchange rate intervention during an era of persistent net capital inflows seems to have contributed to the large stockpile of reserve.

More than fifty percent of current reserves holdings, which were accumulated during a short span of around thirty months, reflect the absorption of speculative capital that were flowing into the stock market.

Chapter 3 is devoted to investigate whether there is any change in the behaviour of exchange rate intervention in response to changes that have occurred in the foreign exchange market. The empirical examination of this issue is conducted using flexible least square method. Four different variants of the reaction function are estimated. The percentage change in foreign currency asset is used as measure of official intervention while percentage change in exchange rate, conditional volatility of incremental reserves and stock return are used as explanatory variables. Taking into account the evidence obtained from the previous chapter and from other empirical studies, we incorporate exchange rate return as two variables – positive and negative – to capture the asymmetric intervention in response to appreciating and depreciating rupee. The empirical investigation has been carried out using weekly data for the sample period considered in the previous chapter. The major inferences drawn from this chapter are:

First, we examined the time varying nature of the parameters in the model. In this regard, the plots of residual efficiency frontier indicated that the efficiency frontier for all four specifications are fairly steeply sloped; hence, allowing some degree of time variation in coefficients results in larger reduction in measurement error. These
evidences confirmed the fact that some of the coefficients in intervention reaction function are changing through time.

- Second, time variation in each coefficient is examined using the estimates of mean, standard deviation and coefficient of variation of each parameter in the reaction functions for alternative values of $\delta$. The estimates of coefficient means, standard deviation for alternative values of $\delta$ for all the variants of reaction function were found to exhibit shift even for a small change in $\delta$. The standard error corresponding to each coefficient was found to increase with fall in $\delta$ and to stabilize in the extreme. These evidences have confirmed that the OLS optimization would have produced biased parameters estimates of the reaction function.

- The coefficients exhibited substantial variations over the sample period. There is also strong evidence of asymmetry in the exchange rate intervention policy and such asymmetry was found to be very strong during excessive capital inflows.

- The RBI has been penalizing rupee appreciation more severely and defending rupee value only in times of excessive pressure on rupee to depreciate.

- Inclusion of return on stock index as an additional variable in the reaction function did significantly alter the results. In sum, the time varying nature of intervention policy indicate that reserve accumulation seems to have been to a larger extent on account of asymmetric exchange rate intervention which might have been driven by concern over export competitiveness.

Since the Reserve Bank of India has been focusing only on minimizing undue fluctuations in exchange rate through exchange rate intervention, this chapter 4 is devoted to examine whether such official intervention during the sample has been successful in containing volatility of exchange rate. To this end, we estimated exchange rate equation using ARCH type models wherein the absolute amount of intervention is incorporated as an explanatory variable in the variance equation. In addition, instead of using the usual GARCH models in
which the power of variables in the variance equation is determined a priori, we adopted the approach of Ding et al. (1993) which is popularly known as asymmetric power autoregressive conditional heteroscedastic model and allows the data to determine the power of explanatory variables in the variance equation. The major findings of this chapter are as follows

- The evidence from a simple GARCH model and A-PARCH model indicated that the RBI intervention triggers volatility and selling bring relatively larger volatility in exchange market.
- The evidence derived from the APGARCH model further indicated that the impact of intervention seemed to have been asymmetric in the sense that official selling of foreign exchange has larger impact on volatility as compared to what buying operations had.

### 5.3 Policy Suggestions

- The conventional measures of volatility obtained as coefficient of variation or rolling standard deviation are biased estimates; hence, any decision based on such biased estimates might be misleading. Instead, one must use volatility constructs from an appropriate ARCH/GARCH models
- Although the elasticity estimates from the reserve demand equation is not very large and the current level of reserve seems to be on higher side, the recent trend in some of the reserve adequacy indicators suggest that the RBI needs to be very cautious with running down the reserves in defense of falling rupee.
- Around US$ 170 billion, which constitutes more than 50% of current reserve holdings, has been accumulated within a short span of thirty months; coinciding with the incident of stock market boom. This gives an impression that major part of accumulated reserves is just absorption of speculative capital flows into the stock market. Such intervention operation may not be an avoidable one in the context of
minimizing exchange rate volatility, but the RBI needs to minimize absorbing speculative capital flows as it would be more fragile.

- There is clear evidence of asymmetry in exchange rate intervention and such asymmetry is found to be more visible when there are excessive capital inflows. The RBI has been penalizing rupee appreciation more severely and defending rupee value only in times of excessive pressure on rupee to depreciate. This seems to reflect that fact that the RBI is concerned about export. However, it is pertinent to examine the extent to which our export is elastic to exchange rate depreciation. In case export is price inelastic, aggressive intervention to prevent rupee appreciation will yield little or no benefit to the exports and on the other hand the cost associated with accumulation of reserve tends to increase.

- Unfortunately, intervention seems to have triggered volatility of exchange rate. This can be justified on the ground that any secret intervention tends to create ambiguous expectation in the market which will enhance the volatility. In this regard, the RBI needs to gain more credibility through proper communication to the market participants about intervention.

5.4 Directions for Future Research

- The empirical analysis has been conducted using the observed ex-post exchange rate data which could have already received the impact of intervention. This could be one of the reasons why the coefficient on intervention in an exchange rate equation turns out to have wrong sign. The best way is to construct a measure of exchange market pressure which is basically a measure of exchange rate that would have prevailed in the absence of official intervention. Use of such exchange market pressure in the place of observed exchange rate would be an ideal approach to capture the impact of intervention on exchange rate.
For the same reason, it is wise to construct volatility of total exchange market pressure rather than using volatility of observed exchange rate. This would eliminate the bias in the estimates of volatility and such bias free estimates would provide reliable evidence regarding the efficacy of intervention policy in terms of minimizing exchange rate volatility.