Chapter 1

The Issues, Objectives, and Methodology

1.1 Introduction

There are three types of exchange rate regimes: (i) fixed exchange rate regime; (ii) floating exchange rate regime; and (iii) managed float. Under fixed exchange rate regime, the exchange rate is fixed by the authority or a band of upper and lower limit for exchange rate is fixed within which the exchange rate is allowed to fluctuate. Under free float, the exchange rate is determined by demand and supply forces and there is no official intervention in exchange rate determination. What is, at large, put in practice is managed float or dirty float that lies between these two extremes of fixed rate and clean float. Under managed float, the authority needs to intervene in the foreign exchange market either to stabilize the exchange rate or to minimize the exchange rate volatility.

Official intervention in the foreign exchange market is inevitable when there is market failure or the authority is vested with some intentions to which the intervention policy is tuned. For instance, the RBI kept maintaining adequacy of reserves as the prime objective following the balance of payment crises that surfaced in the year 1990-1991. It is in these contexts the official demand for reserve arises because exchange rate intervention is largely conducted in the form of buying and selling of reserves in the market for which the authority needs to maintain adequate amount of reserves. Further, the demand for reserves tend to inversely related to the flexibility of managed float; more rigid is the system more reserve is required.

Apart from direct exchange rate intervention in the form of buying and selling of foreign exchange in the market, the authorities often resort to supplement exchange rate
intervention policy with number of other policy instruments and administrative measures to ensure orderly condition in the foreign exchange market. For instance, the Reserve Bank of India (RBI) often manipulated instruments such as cash reserve ratio, bank rate, repo and reverse repo rate etc. The open market operation is also conducted in line with the conditions in the foreign exchange market. More importantly, there are number administrative measures deployed by the authority to prevent sudden withdrawal of capital as it would bring sharp fall in rupee or lead to speculative attack.

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 interventions 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.

1.2 What drives accumulation 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.
The recent surge in reserve holding of emerging countries is largely attributed to increase in the volatility of cross-border capital flows, subject to sudden stops/reversal (Calvo, 1998; Edwards, 2004; and Aizenman and Marion, 2004). The available empirical evidence derived from panel data support the view that rising volatility of external transactions and increased frequency and intensity of banking and financial crises experienced by emerging countries in the 1990s have significantly increased the precautionary demand for reserves (see Flood and Marion, 2002; Aizenman and Lee, 2007 among others).

However, the empirical studies estimate reserve demand equation using panel data and assess the importance of precautionary motive by examining the magnitude and statistical significance of elasticity coefficient on volatility measures of external transactions\(^1\). The volatility tends to be larger as country is more open. If external transactions are highly liberalized then the country is more vulnerable to unforeseen external shocks; hence, demand for reserves as precautionary balance tends to be larger. Hence, the crucial question is whether countries with large stockpile of reserves are more vulnerable to sudden stops or flight of foreign capital.

What is more intriguing is the observation that the large reserve holding of Asian emerging countries such as China, Taiwan, South Korea, India 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

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\(^1\) Using panel data Flood and Marion (2002) have shown that the buffer stock model explains only 10 – 15 percent of the reserve holding while a larger part of reserve holding is explained by the country-specific fixed effect.
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.

Moreover, prudent administration of capital flows tends to reduce volatility; hence, the coefficient on volatility may not be large and statistically significant. The study by Ramachandran (2004) and Ramachandran and Srinivasan (2007) have shown that volatility coefficient is upwardly biased due to measurement errors and established that the bias free estimates do not support the growing importance of precautionary demand in the India context.

If it is not precautionary motive what lies behind the large stockpile of reserves? The significant fall in the opportunity cost of holding reserves especially in emerging countries appeared to be another reason behind reserve accumulation. A recent study by Ramachandran and Srinivasan (2007) documents empirical evidence for India to support the view that asymmetric exchange rate intervention is one of the important reasons for large stockpile reserves. Such asymmetry is triggered by concern over export competitiveness in the sense that the authority was aggressively buying to prevent rupee appreciation while being lenient with rupee depreciation; hence there has been continuous accumulation of reserves in response to net capital inflows.

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2 See Ramachandran and Srinivasan (2007) for further evidence on insignificant role of precautionary demand for reserves.
1.3 The adequacy of reserves

One of the important issues to be addressed under managed float is to determine the optimal level of reserves to be maintained, because excess reserve holdings increases the cost without much benefit at margin and inadequate reserves complicates the exchange rate management. 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 (1960). 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. If not conventional adequacy indicator what were the developments that brought significant change in the criteria based on which official reserves has been built up.

The notable change during the last two decades that significantly affected the attitudes of policy makers in matters relating to reserve accumulation seems to be the sharp rise in the cross-border capital flows in response to financial liberalization all over the world. The free 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. In India too, 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.

The intermittent excessive capital inflows followed by episodes of ebbing put strain on exchange rate stability; hence, the RBI had to formulate its foreign exchange market intervention policy with main objectives of maintaining orderly condition in the foreign exchange market without any target or band for exchange rate, enhancing the intervention capacity and avoiding undue overvaluation of rupee. In this context, the committees (High Level Committee on Balance of Payments, 1993; Committee on Capital Account Convertibility, 1997) and policy makers often reiterated that the reserve adequacy norms must be broadened to include transactions on capital account rather than restricting to transactions on current account. Adhering to these suggestions, the RBI has erected its reserve management policy upon the changing composition of balance of payments, liquidity risks associated with different types of capital flows, unanticipated pressure on balance of payments due to external shocks and movement of repatriable foreign currency deposits of non-resident Indians (Annual Report, RBI, 1999–2000).

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. There is no dispute on broadening of reserve adequacy measures in the era of growing financial liberalization and its attendant consequences on exchange rate and on balance of
payment. Whether these developments have influenced the attitudes of the RBI in maintaining the reserve level? We examine some of the reserve adequacy level in the Indian context.

Fig. 1.1 Reserve to GDP ratio (percent)

One of the reserve adequacy indicators is the proportion of reserve to GDP ratio. Increase in national income implies growing demand for goods and services; hence, there will be corresponding rise in demand for imports. The growing import demand tends to increase the reserve requirements. Thus, the level of reserves must keep pace with expansion of the economy. In this respect, the plots in Fig. 1.1 indicate that there was a steady rise in the ratio of reserves to GDP from 10% in the year 1990-91 to 70% in the year 2007-08. However, there is a sharp decline in this ratio in the subsequent years which coincides with the financial turmoil surfaced in the US.
Another widely used indicator is import cover of reserves as growing import requires larger amount of reserves to meet the external payment. This in a way reflects the growing transaction demand for reserves. The quantum of reserves as months of import cover is produced in Fig. 1.2. The level of reserves which was equivalent to two months of import in the beginning of 1990s steadily increased to touch its peak of 17 months of import in the year 2007. Subsequently, there was a decline in the import cover of reserves. The reason behind fall in import cover of reserves is that the level of reserves is being maintained at around US$ 300 billion during the recent years while there was a steady rise in the value of import. By this measure of reserve adequacy, we learn that the current level of reserves do not reflect the problem of plenty as it was the scenario in the early 2000s. If this trend continues the RBI may not be in a position to defend the rupee value when it has to decline in response to capital flight.

Fig 1.2 Import cover in months
Another indicator of reserve adequacy that gained importance due to growing cross-border capital flows is the level of reserve holding against outstanding external debt position. As the external payment obligation increases, the demand for reserve tends to increase to service the growing external debt. In this respect, the plots in Fig. 1.3 shows that there was a steady rise in the reserves as percentage of external debt from around 14% in the year 1990-91 to more than 100% in the middle of the last decade. However, as other indicators reflected, there is a decline in reserves as percentage of debt during the later part of the last decade. Although there is a decline in this ratio, the reserve still constitutes around 80% of outstanding external liabilities.
What is more important is the maturity composition of external debt and not the level of external debt that should be linked with quantum of reserve holdings. Hence, the ratio of
reserves to short-term external debt is chosen as one of the most important indicators to determine the reserve adequacy. This ratio reflects the repaying capacity of external debt which is due to be paid within a short span of time; normally one year is considered as short-term. The plots in Fig. 1.4 clearly indicate that reserve position was very comfortable till 2003-04. Since then there is a sharp fall in this ratio due to growing trade credit and other retail debt. Although there is a sharp decline in this ratio, it indicates that reserve position does not reflect a great deal of vulnerability as it is more than the external payment obligation which is due in the next 12 months.

It is often argued that reserve holding must be judged on the basis of domestic monetary base, because growing domestic money supply might trigger currency depreciation; hence, there will be larger need for reserves to defend the value of domestic currency. In this respect, the plots produced in Fig. 1.5 indicates that the reserves as percentage of M3 money stock grew from 20 in the year 1990-91 to 78 in the year 2007-08. However, during the recent crises period, there is a sharp decline in this ratio. Overall, the reserve adequacy indicators consistently suggest that the reserve holdings do keep in pace with the recent developments in the economy. Nonetheless, it was a problem of plenty in the past and also reserve holding incurs a huge opportunity cost and therefore, current reserve holdings do not reflect any vulnerability of our external payment position.

Apart from adequacy indicators, there is voluminous empirical literature that attempt to determine the optimal level of international reserves to be held. 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 of adjustment cost and opportunity cost is minimized.

1.4 How does intervention work?

The official intervention in the foreign exchange market in the form of buying and selling foreign currency assets can be of two types: sterilized intervention and non-sterilized intervention. Official intervention is sterilized if the authority takes action to offset the impact of intervention on the domestic monetary base. For instance, the domestic monetary base tends to increase in response to net official purchase of foreign exchange from the market. Such expansion in money supply can be offset by conducting open market sale of securities or by resorting to other monetary instruments that would reduce monetary base. On the contrary, non-sterilized intervention occurs when the authority buys foreign exchange against its own currency without taking offsetting action. Thus, non-sterilized intervention affects domestic money supply which in turn affects exchange rate. However, to what extent exchange rate responses to non-sterilized intervention depends upon the extent to which change in money supply affects the exchange rate. Better understanding of the issue that how does intervention work can be had from various theories that explain the transmission mechanism between intervention and exchange rate variations.

Broadly speaking, the official purchase or sale of foreign exchange affects the exchange rate through three different channels: (i) portfolio channel; (ii) signaling channel or expectation channel; and (iii) noise trading channel. We present a brief introduction
about these channels through which intervention can have its possible impact on exchange rate.

**Portfolio balance channel**

The portfolio balance model of Kenen (1982) Branson and Henderson (1985) and Taylors (1995) among others are well known in the literature that documents how does portfolio channel affects exchange rate. According this model, investors optimize their portfolio by maximizing their expected return on assets of various currency denominations. In case of sterilized intervention, there is no corresponding change in the domestic money supply; hence, there is no change in interest rate. However, there is a change in composition of asset portfolio which would affect the exchange rate. For instance, when RBI buys foreign denominated assets from the public and sells rupee denominated assets in order to sterilize the intervention operation there is a change in the relative position of assets. Such change tends to dip the price of rupee denominated assets which in turn affects the exchange rate. However, this works only if domestic and foreign assets are not perfect substitutes. In case they are perfect substitutes, change in the composition of assets hardly matters for the investors are they are indifferent; hence, there will be little or no effect on exchange rate.

**Signaling channel**

Under this approach, agent might view intervention as a signal about the future stance of policy about exchange rate. Since exchange rate is a forward looking variable, intervention affects exchange rate through altering the expected future exchange rate (Mussa, 1981). Even if intervention is sterilized and assets are perfect substitutes, intervention tends to affect spot rate as it would alter agent’s perception about future
exchange rate. Indeed, agents in the market view intervention provide additional information under the assumption that the authority has information superior to other market participants.

However, the efficacy of such signaling effect is contingent on how well the authority communicates to the market participants about the course of action. Official intervention is expected to be effective as unsuccessful intervention is very costly. This is the reason why the authorities must clearly communicate to the agents in the market about the course of action with regard to exchange rate management. In this context, Fratzscher (2006) based on empirical evidence concludes that oral intervention in the foreign exchange market is substantially more effective and suggests that systematic change in exchange rate volatility can minimize trader risk. Subsequently Baillie and Osterberg (1997) suggested that oral intervention reduce the exchange rate uncertainty whereas actual interventions keep the information secret leading to an increased uncertainty in the foreign exchange rate.

**Noise trading channel**

There are noise traders in the market and they act as a group to influence the asset prices to move away from their long run equilibrium path. The decisions of buying/selling of assets by noise traders are often influenced by faith and sentiments which are not consistent with economic fundamentals. The best example for noise traders are chartists who are influenced by market movements in the short run, which results in buying when price rises and selling when price falls.

There are two assumptions under noise trading channel. First, there is always a possibility of noise trading to occur. Second, the exchange rate is continuously determined in the market through flow market equilibrium. Under such assumptions, the
authorities can influence the noise traders through a well-defined intervention strategy to influence the exchange rate in the desired directions even if the intervention is sterilized. Indeed, when there is noise trading, official intervention tends to revert the prevailing trend in the exchange rate. Such reversal in the direction of exchange rate might persist for long.

However, noise trading channel can be effective only if the authority is familiar with noise traders’ reaction to intervention and has the capability to intervene secretly in the sense that traders should not come to know about the source of fluctuations in quantum of foreign exchange. For instance, if the RBI sells foreign exchange without publicly announcing in the market then chartist will not know the source of foreign exchange and any change in exchange rate will be considered by them as early signal from the market with regard to future change in exchange rate. Because chartist gives more weight to the recent trend in the exchange rate and has the practice of buying when price of currency rises and selling when currency price falls intervention that breaks the trend in exchange rate tends to be more effective. There are empirical evidences to show that the noise trading channel works and authorities prefer to intervene in thin market to influence the exchange rate (Goodhart and Hesse, 1993; Hung, 1997).

1.5 Exchange rate management in India

After independence India’s exchange rate policy has undergone a shift from a par value to a managed float exchange rate system. Under the managed float, the central bank attempts to use large-scale sterilized exchange rate interventions to alter the exchange rate volatility which is determined by the market forces. It is widely held that the managed float system of exchange rate suits those countries which are mainly export oriented; China and India are good examples for this.
India had framed its foreign exchange regulation act (FERA) in 1947 and this legalization enacted by the British regime remained as a temporary measure for 5 years and later this act was extended till January 1974. The objectives of FERA are: (i) to control payments obligations outside and inside the country; (ii) export and import of currency notes and bullion; (iii) transfers of securities between residents and non-residents; and (iv) acquisition of foreign securities. The prime motive of the foreign exchange policy was to manage imports and exports and second to restrict unofficial influx of foreign currencies inside the country through the Reserve Bank of India. During the period from 1950-1951 to mid-December 1973, India followed an exchange rate system that liked rupee with pound sterling except during the period of devaluation that occurred in 1966 and 1971. Following this, the rupee was pegged against a basket of currencies until early 1990s.

In 1991, India had to face a severe balance of payment crisis and the RBI had to adjust the exchange rate downwards twice once to 9 percent and again to 11 percent. To be specific, the official reserve holding was sufficient to meet only two weeks of imports. In order to bail out this situation, the RBI wanted to improve the export competitiveness of domestic goods so as to install confidence among the investors to invest. Further a sort of liberalized exchange rate management system (LERMS) was planted in March 1992. Subsequently, the dual exchange rate system was replaced with a unified exchange rate system in March 1993. The episode of exchange rate volatility necessitated the intervention of the RBI to manage the volatility in the foreign exchange market. Since March 1993, Reserve Bank of India has been following a market based exchange rate system. India dismantled restrictions on interest rate, the stock market and other financial
instruments, capital account and current account in order to encourage capital inflows and discourage capital outflows to minimize the exchange rate volatility.

The exchange rate management policy during the last two decades largely aims at ensuring realistic and credible external value of rupee, to reduce current account deficit and to maintain adequate amount of foreign exchange reserves. The exchange rate policy is guided by the following objectives:

(i) to eliminate lumpy demand and supply in the foreign exchange market without reference to any target of exchange rate;

(ii) to prevent speculative attack; and

(iii) to maintain adequate amount of reserves.

The conduct of monetary policy in this respect largely involves a package of measures that embraces sales and purchase of currency in both the spot and the forward segments of the foreign exchange market, a wide array of administrative measures, and adjustment of domestic liquidity by manipulating monetary policy instruments such as Bank Rate, CRR, repo rate, etc. The intention is not to target exchange rate at any specified level but to even out lumpy demand or supply in the foreign exchange market.

Moreover, the RBI often adjusted the domestic liquidity to stabilize exchange rate. For instance, the RBI announced a hike in CRR from 10 to 11% and a raise in repo rate from 5 to 8% during August 1998 when the rupee was under pressure to depreciate due to the Russian crisis and the fear of devaluation of Chinese Reminbi. The excess demand condition during April–June 2000 was softened by raising the surcharge of lending rate on import finance by 50% and imposing a penal rate of 25% per annum on overdue export bills apart from the net sales of US$ 1,948 million. In July 2000, the pressure on
the exchange rate was moderated by a raise in the Bank Rate from 7 to 8%; in the CRR from 8 to 8.5%; and a reduction in the limit available to banks for all refinance facilities.

Apart from fine-tuning policy instruments, the RBI has been resorting to several administrative measures to facilitate the inflow of foreign capital and thereby, ease the situation in the market. These measures on the external front included, among others, the provision of automatic approval for priority industries, 100% foreign participation in the infrastructure sector including ports, road and telecommunication, special provision for NRI investments and removal of CRR requirement of 10% on liabilities under the FCNR (B) scheme. Overall, these measures provided tax concessions, repatriation benefits and larger freedom in deploying funds to encourage capital inflows.

The external funds were mobilized through schemes like Resurgent India Bonds to the tune of US$4.23 billion and India Millennium Deposits to the tune of US$5.51 billion. These policy measures, coupled with downward rigidity of domestic interest rates and persistent fall in foreign interest rates, have contributed to a larger inflow of foreign capital, putting pressure on the exchange rate to appreciate. Such pressure, often absorbed by the direct intervention of the RBI in the foreign exchange market, resulted in accumulation of official reserves. The foreign exchange reserve has steadily grown from US$5.8 billion as on 31 March 1990 to around US$76.0 billion up to March 2003. With this high level of reserves, India stood among the top reserve-holding emerging-market countries. The RBI in its Credit Policy for the year 2002–2003 claimed that, “it is a matter of satisfaction that the recent international research on viable exchange rate strategies in emerging markets has lent considerable support to the exchange rate policy followed by India. A number of countries (including those in East Asia) are now following similar policies.”
Considering the growing appreciation of the RBI strategy regarding exchange rate management, this study intends to frame the following objectives.

1.6 Objectives

1. To examine whether the accumulation of foreign exchange reserves by the Reserve Bank of India (RBI) reflects growing precautionary demand in India. If it is not precautionary motive what lies behind the large stockpile of reserves?

2. To analyze the time varying nature of RBI’s reaction to exchange rate movements and in response to other developments in the foreign exchange market.

3. To evaluate the impact of intervention on the volatility of exchange rate and examine whether there is any asymmetric impact of intervention on volatility.

1.7 Methodology

To investigate the above mentioned issues, the study uses weekly data for the sample period from 20th December 1996 to 25th March 2011. This sample is chosen to cover the market based exchange rate regime introduced in March 1993. The exchange rate is measured as rupee per US$ since US$ is used as a reference currency for intervention purposes. Intervention is measured as percentage change in foreign currency assets, as data on official purchase/sale of foreign exchange are available only at monthly frequency. The interest rate on 91 days treasury bills is used as opportunity cost of international reserve and volatility of reserve increment is constructed from appropriate GARCH model. The BSE Sensex has been used as an additional variable in the model to examine how stock market developments have affected the reserve accumulation. The data on all the variables 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 empirical examination of this issue is carried out using the buffer stock of model (Frankel and Jovanovic, 1981). The long run relationship among the variables that figure in the buffer stock model is examined using the cointegration test. However, the variables that appear in the buffer stock model are combinations of I (1) and I (0) process and as result, the conventional methods such as Engle-Granger (1985) or Johansen and Juselius (1990) methodologies cannot be used. Therefore, we chose the bounds test approach of (ARDL) Pesaran et. al. (1996) and Pesaran and Shin (1998) 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.
1.8 Organization of the study

The thesis is organized as five chapters. Chapter 2 deals with identifying the cause for large stockpile of official reserves in India and the chapter is presented in five sections. Section 2.1 throws some light on various reasons for reserve accumulation which are widely discussed in the literature. Section 2.2 presents the theoretical framework of the buffer stock model and some of the defects relating to the measurement of reserve increment volatility. Section 2.3 discusses the consequences of such measurement errors in variables and provides an alternative method to construct volatility of reserve increment which is free from measurement bias. Section 2.4 provides the empirical results and documents evidence against the use of volatility measures using conventional method such as rolling standard deviation. The construct of bias free volatility measure and a detailed discussion on the estimates of reserve demand equation derived from the ARDL approach is also presented in this section. Section 2.5 provides the concluding remarks of the results.

Chapter 3 deals with changing characteristics of the intervention policy in the foreign exchange market and this chapter is organized as four sections. Section 3.1 briefly discusses the theoretical literature on estimates of time varying parameters of the models and its relevance to the issue of estimating the exchange rate intervention reaction function. Section 3.2 provides the theoretical framework of flexible least square model for the estimation of reaction function. Section 3.3 presents different variants of intervention reaction function to be estimated using the flexible least square approach and a thorough discussion of the empirical results. Section 3.4 summarizes the major inferences drawn from the empirical results.
Chapter 4 deals with the success of RBI’s exchange rate intervention policy and this chapter is organized as four sections. Section 4.1 presents the emergence of new ideas with regard to exchange rate management policy of the RBI and various empirical approach used in examining such issues. Section 4.2 deals with the theoretical superiority of APARCH model to capture the impact of official intervention on exchange rate volatility. Section 4.3 presents the empirical results and section 4.4 provides the major inferences emerge from the empirical evidences.

Chapter 5 presents the summary of findings, policy suggestions and discusses further scope for research in this field. This chapter is produced in four sections: section 5.1 presents a brief review of the issues undertaken in the present study, the objectives and methodological issues; section 5.2 presents the summary of findings; section 5.3 discusses the policy implications of the empirical evidences generated in the study; and 5.4 presents some directions for further research.

1.9 Limitations of the study

1. We had no option other than using weekly percentage change in foreign currency assets as a proxy for intervention as data on intervention on intra-day/daily frequency is not available in the public domain. This is not an appropriate measure of official intervention, because change in foreign currency assets can reflect valuation changes arising out of exchange rate fluctuations, interest earned out of official investment of reserves etc. Hence, the inference might suffer from the consequence of measurement errors in variables.

2. The RBI has used several other policy instruments and often resorted to administrative measures to ensure orderly condition in the foreign exchange
market. We are ignoring the impact of those factors on exchange rate and on its volatility for the reason that high frequency data on many important variables are not available.

3. One of the serious lacunas in this study is the use of ex-post data on exchange rate. This data already contains the influence of intervention in the past and this could be the reason behind the wrong sign of coefficient on intervention in the exchange rate equation. Instead of ex-post data on exchange rate one should use aggregate market pressure on exchange rate. Since no published data on such measure is available, we need to construct a measure of exchange market pressure, which is beyond the scope of this study.

4. Number of important variables which would have influenced the behaviour of exchange rate and the characteristics of monetary policy were ignored in this study mainly on account of lack of high frequency data on such variables.