Chapter 2

Review of Literature

2.1 Introduction
Balance of payments disequilibrium and exchange rate determination are very old problems of any open economy and have been recorded quite early in the literature. Several attempts have been made to find out an appropriate theoretical framework to understand balance of payments adjustment and exchange rate determination. The first of these was the purchasing power parity theory, which made its appearance very early and has continued till today. Prior to 1930s, there was no comprehensive theory of balance of payments as such. Under gold standard, the exchange rate between the two currencies was determined by the relative weights of the gold content of the coin. It was fluctuating within a well-defined narrow limit set by the cost of shipping gold between the countries concerned. An automatic balance of payments adjustment was operating through price changes. This system continued up to the outbreak of the World War I in 1914. The attempts made by the leading countries to return to the gold standard in the mid-1920s proved unsuccessful and finally it collapsed with the advent of the ‘great depression’ of 1930s. Some theories have been developed since then to understand the determinants of balance of payments and exchange rates under different exchange rate systems.

Balance of payments disequilibria and exchange rate variations are seen to be two sides of the same coin. Under fixed exchange rate system the adjustment takes place in balance of payments whereas under floating exchange rate system the exchange rate tends to adjust. However, under intermediate regimes of managed floats, where both balance of payments (as captured through official reserve changes) and exchange rate can vary simultaneously, a new problem comes up as to how to arrive at a cardinal measure of the exchange market conditions. Once such a measure is notionally obtained, different frameworks can be used to explain it. Recent contributions to the literature have looked at this problem. This chapter reviews first the different theoretical frameworks of the exchange market, and then the more current literature on measuring exchange market pressure. It ends by
looking at some of the empirical studies made in the Indian context on exchange market pressure.

2.2 Theoretical Approaches to Exchange Rate Determination

2.2.1 Purchasing Power Parity Theory

One of the oldest and most widely used frameworks for assessing long-term movements of exchange rates is derived from purchasing power parity (PPP) theory advocated by Cassell (1918). It simply asserts the relationship between exchange rates and prices. Any variation of PPP relies on the 'law of one price', which states that the price of any tradable good is the same in any place when the price is quoted in terms of the same currency under the assumption that there are competitive free markets, and no tariffs, no transport costs, and non-tariff barriers. There are two variants of this theory: the absolute version and relative version. The absolute version of PPP states that the exchange rate between the currencies of the two countries is equal to the ratio of price levels in the two countries. That is, \( E_t = \frac{P_t}{P_t^*} \),

where \( E_t \), \( P_t \), and \( P_t^* \) are the exchange rate, domestic price level and foreign price level respectively at time \( t \). The PPP theory therefore predicts that when the domestic price level increases (decreases) relative to the foreign price, domestic currency depreciates (appreciates) proportionally. The basic idea is that goods markets are integrated, and hence if there is price differential across the countries then arbitrage takes place and finally the price levels get equalised.\(^1\)

However, in reality, most of the traded goods are differentiated products and the consumption baskets across countries differ. This questions the empirical validity of the absolute version of PPP theory at aggregate level. This problem is overcome by reverting to the relative version of PPP, which states that the percentage variation in the exchange rate equals the percentage variation in the ratio

\(^1\) It is to be noted that, if the law of one price holds for every commodity in the commodity basket then PPP holds automatically but the reverse may not be necessarily true.
of the price levels of the two countries. It can be written as:

\[ \frac{E_t - E_{t-1}}{E_{t-1}} = \frac{P_t - P_{t-1}}{P_{t-1}} - \frac{P_t^* - P_{t-1}^*}{P_{t-1}^*}. \]

Another major problem with the PPP as stated is that it is supposed to hold for all types of goods. A more general version distinguishes between traded and non-traded goods. Arbitrage being possible only with traded goods, the PPP would hold only for these. Since the aggregate price index is a weighted average of traded and non-traded goods' prices, PPP does not necessarily hold for it. In fact, the relative price of non-traded to traded goods in each country can be shown to influence the exchange rate. Changes in the real prices and hence the exchange rate could be caused by differing rates of productivity in the traded and non-traded sectors, and changing consumption demand patterns.

Empirically, there has not been any clear-cut evidence for the PPP theories in any form. Some of the reasons advanced for this are differences in inflation rates, impediments to trade, the effect of exchange market intervention, etc. This has led to the developments of other models of exchange rate determination, which also look at the balance of payments.

2.2.2 Balance of Payments Approach

The balance of payments approach was motivated by the question of what happens to current account balance when a country devalues its exchange rate. It asserts, basically, that the equilibrium exchange rate is determined when the net inflow (outflow) of foreign exchange arising from current account transactions equals the net outflow (inflow) of foreign exchange arising from capital account transactions. This approach built upon Keynesian models of the economy, and came into existence initially in an era of limited capital mobility. In trying to explain the balance of payments/exchange rate changes, they view the current account items as autonomous, and the capital account items as accommodating. So these models try to explain factors behind current account deficit. This gave rise to the well-known elasticity approach (Robinson, 1937) and absorption approach (Alexander, 1952). According to the first, the exchange rate necessary to correct a balance of payments
imbalance will depend on price elasticities of supply and demand for imports and exports, and particularly on the critical value of the sum of the demand elasticities, known as the Marshall-Lerner condition.

The elasticity approach, however, can be considered to be only a partial equilibrium approach as it ignores other variables that affect the balance of payments. This was taken into account in the absorption approach developed by Alexander. This approach portrays a deficit in current account balance as arising out of an excess of absorption over income. The basic criticism against this approach is that it neglects relative prices of exports and imports, which are taken to be constant.

Different versions of balance of payments flow model, keeping the Marshall-Lerner conditions inbuilt, were developed during the Bretton Woods regime. Of these, the Mundell-Fleming model (Mundell, 1962, 1963; Fleming, 1962) was widely used in theoretical and empirical studies. The Mundell-Fleming model extends the standard closed economy Keynesian IS-LM model to incorporate the role of the balance of payments in an open economy. The model shows that the changes in monetary and fiscal policy, by changing domestic money supply or interest rate, lead to changes in output that cause temporary balance of payments surpluses or deficits. The Keynesian Mundell-Fleming model assumes that price is fixed in the short run. So this leads to changes in exchange rate, which in turn work to restore the balance of payments equilibrium.

While the Mundell-Fleming model took into account international capital flows, the emphasis remained on the current account balance. As such the exchange rate was taken to equilibrate the flows of foreign exchange passing through the exchange market. This aspect came in for criticism in the 1970s. It was argued that this flow supply and demand was relevant only for determining the price of non-durable goods, while the exchange rate was determined by the stock equilibrium in the asset market. Hence, the actual volume of domestic and foreign currencies that changes hands in foreign exchange transactions is not relevant for the determination of the equilibrium exchange rate. What is relevant is that, once the exchange rate has
changed, the outstanding stock of domestic and foreign currencies is willingly held by the market participants at the new market price.

2.2.3 Monetary Approach

This is an alternative approach to the balance of payments framework, first propounded by Frenkel and Johnson (1976). The basis of this approach is that monetary flows in the exchange market are a consequence of disequilibrium in stock demand and supply of money. Thus balance of payments disequilibrium is essentially a monetary phenomenon, reflecting disequilibrium in the money market. In a fixed exchange rate system, a balance of payments surplus, measured by a fall in the official reserves, reflects an excess demand for money. In a floating exchange rate system, the balance of payments is always in balance, with the excess demand/supply of money leading to a rise/fall in the exchange rate.

The simplest version of the monetary model has a few key assumptions. These are a stable money demand function based on the Quantity Theory of Money, an exogenous money supply assumed to be completely controlled by the central bank, a vertical aggregate supply curve, and PPP holding continuously. Prices are taken to be flexible even in the short run, keeping the economy at full employment. So any disequilibrium in the money market affects aggregate demand and hence the domestic price level. The consequent arbitrage in goods leads to a flow of money through exchange market, which affects exchange rate in case of flexible exchange rate regime or the balance of payments in case of a fixed exchange rate regime. In equilibrium, price level is determined by money supply; and given the PPP relationship, the exchange rate is determined by the relative supply of and demand for the different national money stocks.

This simple model, based upon PPP theory, is concerned with arbitrage in goods alone, and does not say anything about international capital movements. However, the second half of the twentieth century saw tremendous growth of money and capital markets, which allows investors to transfer large amounts of money from one currency to another very quickly. This results in arbitrage in assets denominated in different currencies, based on the expected rate of return on each currency. This
has led to the development of sophisticated variants of the monetary model. One major modification is to allow arbitrage in financial assets as well as goods. This is brought in through the interest parity condition that states that the domestic interest rate is equal to the foreign interest rate plus the expected appreciation of the exchange rate. This allows for foreign bonds to be held, but under the assumption that domestic and foreign bonds are perfect substitutes. That is, there is perfect capital mobility and foreign and domestic bonds are equally risky. The other assumption of the simple monetary model are retained except that the money demand function here is taken to be a stable function of interest rate and price. In this version, disequilibrium in the money market affects the domestic interest rate and price level, and therefore the demand for foreign goods and assets leading to monetary flows through the exchange market. Equilibrium is re-established through changes in the exchange rate, till both the interest parity and PPP conditions hold.

This framework, in its simple and more sophisticated versions, has certain implications. In a flexible exchange rate system, the exchange rate is determined entirely by the money market disequilibrium. In a fixed exchange rate regime, money market disequilibrium causes a temporary change in the balance of payments, which results in a change in the official reserves that corrects the original disequilibrium. It does not matter how the disequilibrium occurs. So if the central bank wants to set some exchange rate level, it must change money supply consistently with that objective. In other words, it loses its monetary autonomy. This gives rise to Mundell’s (1963) ‘Impossible Trinity’ argument, which posits the incompatibility of free capital movements, fixed exchange rate and monetary independence. Also, since domestic and foreign bond markets are regarded as a single market, foreign exchange policy conducted through foreign exchange intervention and through domestic credit expansion has exactly the same effect. Yet another implication is that sterilised foreign exchange interventions will have no effect on the exchange rate, since they leave the money supply unchanged. Finally, real variables affect the exchange rate only indirectly through changes in the demand for money.
The fundamental assumptions of the monetary approach have been criticised. One criticism has been that the PPP does not hold continuously. This has given rise to 'sticky price' monetary models (Dornbusch, 1976), which give up this assumption in the short-run, though holding on to it in the long run. Other criticisms are that it is misleading to regard balance of payments imbalances/exchange market disequilibrium as arising exclusively due to monetary decisions, since the causation could be from elsewhere. However, the monetary approach to exchange rate determination does not claim that exchange rate is determined only in money market but it emphasises stock rather than flow variables as being relevant for determining the exchange rate. It claims that whatever the direction of causation, the disequilibrium in the exchange market is ultimately a reflection of money market disequilibrium, and that monetary policy is the only effective means of influencing the exchange rate.

There are however some noticeable omissions in the monetary approach. These are, first, the absence of an explicit role for the current account to influence the exchange rate, and second, the lack of recognition that domestic and foreign bonds may not be perfect substitutes. These are taken into account in the portfolio balance approach to the exchange market.

2.2.4 Portfolio Balance Approach
The monetary approach is essentially an asset market approach. The exchange rate in it is viewed as an asset price that depends on current and expected future values of domestic as well as foreign financial assets. But apart from money, the only assets considered are bonds, with foreign and domestic bonds being considered perfect substitutes. The portfolio balance approach is another version of asset market model, which is a development over monetary approach to exchange rate determination in that it recognises the presence of assets different from money and bonds. In fact the distinguishing feature of this class of models is that it differentiates between domestic and foreign bonds mainly due to the presence of country risk. Given that investors are risk averse, they will require a higher expected return on more risky assets. Thus, the uncovered interest parity is no longer taken to hold, but a risk
premium is allowed to drive a wedge between the rate of return on domestic and foreign bonds. Equilibrium in these models requires that participants in the markets should willingly hold the stock of all financial assets.

The basic idea behind portfolio models is that individuals hold their wealth in the form of a portfolio of different financial assets (which, for the present purposes can be thought of as money, domestic and foreign bonds). The demand for these assets depends upon wealth, the real rate of return on all the assets and the risk characteristics of the different assets. The asset market as a whole is in equilibrium when market for each individual asset clears. In practice, this requires the domestic rate of interest and the exchange rate to be at levels that make the expected rate of return on the foreign assets equal to the domestic rate of interest, up to the risk premium. A disequilibrium in any asset market leads first to a change in the rate of return on that asset, which in turn affects demand for other assets and thence their rate of return. Since, a change in the total value of the portfolio (i.e., wealth), or in its composition entails an initial disequilibrium in some asset market, it affects the demand for money and other assets, leading to changes in rates of interest and the exchange rate. One implication of the framework is that the current account plays a prominent role in exchange rate determination, since a change in current account balance implies a change in the holding of net foreign assets. This changes the composition of the portfolio, leading to changes in all asset prices and exchange rate till equilibrium is once again reached.

In the portfolio balance approach, as in the monetary approach, an increase in money supply would lead to exchange rate changes. However, in contrast to the monetary approach, where exchange rate is a purely monetary phenomenon, non-monetary assets and the goods market also play important roles in determining the equilibrium exchange rate in the portfolio approach. Changes in risk perceptions of domestic bonds can also change the demand for foreign assets, and so affect the exchange rate. Finally, in complete contrast to monetary models, a given change in the money stock can have different effects depending on how it is carried out. In particular, intervention in the foreign exchange market through sale or purchase of
reserves could affect exchange rate differently from an equivalent change in money supply through open market operations. This is because the two operations affect the composition of the portfolio in different ways. This implies that sterilised intervention can also have an effect. Portfolio balance models allow two channels through which this can happen. One is the signalling effect, which can change market participants’ expectations and risk perceptions. The other channel works through a change in the composition of asset portfolio.

2.3 Measures of Exchange Market Pressure and Index of Intervention Activity

The different theoretical approaches to the exchange rate determination discussed in the earlier section give rise to different structural models of the open economy. These models may be applied to explain the exchange rate in a flexible exchange rate regime and the balance of payments (or changes in official reserves) in fixed exchange rate regimes. However, in intermediate regimes of managed floats, changes in exchange rates and foreign exchange reserves occur simultaneously as a result of the policy followed. So exchange market conditions are not captured fully by changes in either of these variables taken alone.²

This points to the need for a single quantitative measure to characterise conditions in the exchange market, which takes into account changes in both exchange rate and foreign exchange reserves. One of the earliest and best-known measures in this context is given by Girton and Roper’s exchange market pressure formula, which is the simple difference of percentage changes in exchange rate and official foreign exchange reserves. Girton and Roper used the term 'exchange market pressure' to refer to the extent of money market disequilibrium that must be removed through reserve or exchange rate changes. They specified a simple monetary model with the assumption that policy authorities do not employ net

² It is of interest to look at empirical studies that have attempted to study the relevance of the different structural models to different economies. In earlier periods, different studies have claimed support for one or the other of the structural models. But in the post-Bretton Woods era, the general conclusion is that all structural models explain little of the observed changes in exchange rate or in balance of payments (see Meese and Rogoff, 1983 and Macdonald and Taylor, 1992). This is true of studies in India as well. Joshi, Sahadevan and Kamaiah find that models using some measure of exchange market pressure perform better.
domestic credit changes to influence exchange rate levels. In the context of this model, their exchange market pressure formula measures the magnitude of external imbalance. Later, Roper and Turnovsky used a different model specification, and allowed intervention in the form of domestic credit changes as well as changes in reserves. They found that in this model the excess demand for money is given by a linear combination, with unequal weights, of changes in exchange rate and monetary base. Given their assumptions, this measures the magnitude of international excess demand for domestic currency. They also called this exchange market pressure.

Both the studies mentioned above were not primarily concerned with a general measure of exchange market pressure per se. Girton and Roper were interested in investigating the extent to which monetary policy can be formulated independently, while Roper and Turnovsky focused on optimal stabilisation policy in a small open economy. In fact, a general definition of the concept of exchange market pressure is not given by either of them, and the measure each study calls the exchange market pressure was obtained in the context of the specific models and purpose of the study.

Weymark (1995, 1998) uses the formulae derived by Girton and Roper, and Roper and Turnovsky as a starting point to develop a general approach to measure exchange market pressure. She introduced a general definition of exchange market pressure as "exchange market pressure measures the total excess demand for a currency in international markets as the exchange rate change that would have been required to remove this excess demand in the absence of exchange market intervention, given the expectations generated by the exchange rate policy actually implemented." This definition has two important features. First, unlike the Girton and Roper measure, which implicitly defines exchange market pressure as the excess demand for money in the domestic money market, Weymark's measure defines exchange market pressure as the excess demand for domestic currency in international markets. Consequently, the definition of exchange market pressure introduced here can be used to obtain model consistent measures of exchange market pressure from models that do not emphasise the monetary approach to
exchange rate determination as well as from those that do. Second, Weymark’s definition measures the excess demand for currency associated with the expectations held under the policy actually implemented by the policy authority. Consequently, her definition of exchange market pressure measures the actual external imbalance experienced by the economy rather than the external imbalance that would have occurred under a pure float.

This general definition can be applied to a structural model to yield indices of exchange market pressure specific to the model, which can then be calculated through observed data. For example, when intervention takes only the form of purchases and sales of foreign exchange reserves, the exchange market pressure, \( EMP_r \), formula, for a log-linear open economy model takes the form:

\[
EMP_r = \Delta e_r + \eta_1 \Delta r
\]

where \( \Delta e_r \) is the percentage change in exchange rate and \( \Delta r \) is the change in official reserves expressed as a percentage of inherited monetary base. The formula will be modified for other forms of intervention policy. If the intervention in the foreign exchange market is sterilised, then,

\[
EMP_r = \Delta e_r + \eta_1 (1 - \lambda) \Delta r
\]

where \( \lambda \) is the sterilisation coefficient, i.e., the proportion of foreign exchange inflows that are sterilised. Sometimes policy authorities use domestic credit changes to influence exchange market conditions, i.e., indirect intervention. In this case, exchange market pressure is relieved partly by a change in the domestic money base, and the formula would then be:

\[
EMP_r = \Delta e_r + \eta_1 [\Delta d_r + \Delta r]
\]

where \( \Delta d_r \) is the percentage change in domestic monetary base carried out for the purpose of indirect intervention in the exchange market.

In each case, \( \eta_1 \) converts the observed changes in monetary base carried out for the purpose of intervention in the exchange market, into equivalent exchange rate
units. The conversion factor, $\eta$, is not directly observable but must be calculated on the basis of the structural parameters of the model. It is therefore model specific, for the effect of a change in reserves on the exchange rate works itself out through all the other markets in the economy. Weymark (1998) shows that the formulae given by Girton and Roper and Roper and Turnovsky may be obtained by applying her general definition to the specific models they use.

Weymark stresses the model specific nature of the measure of exchange market pressure. But there is an alternative view that argues against model dependence, given the well-known difficulties of finding a structural model that explains the relationship between exchange rate and economic fundamentals. Eichengreen, Rose and Wyplosz (1995) argue that an operational index should be model-independent. They suggest an index to measure exchange market pressure that is a linear combination of the interest rate differential and the percentage changes in exchange rate and foreign exchange reserves. The weights of the components are chosen to equalise their conditional volatilities. This is felt necessary because of the problem of widely differing volatilities of the components of the measure. The components included in the index are chosen because they represent the channels through which exchange market disequilibrium is removed.

Model independence might appear to be a desirable characteristic, but Weymark points out that the magnitudes of the different components required to relieve disequilibrium in fact depend upon the structure of the economy, and this is reflected in their relative volatilities. So any model independent measure, like the Eichengreen, Rose and Wyplosz index, cannot really be used as a cardinal measure of exchange market pressure, and one has to derive a model dependent measure.

The exchange market pressure measure characterises conditions in the exchange market in the presence of intervention. A related measure, required in order to evaluate intervention policies, is one that allows a characterisation of the extent of intervention. Weymark has proposed an index of intervention activity as the proportion of exchange market pressure relieved by exchange market
intervention. This would take the following formulae under different forms of intervention:

\[ II_A_i = \frac{\eta \Delta r_i}{EMP_i} \text{ when only direct intervention is in operation,} \]

\[ = \frac{\eta (1 - \lambda) \Delta r_i}{EMP_i} \text{ when sterilised intervention is in operation,} \]

\[ = \frac{\eta [\Delta d_i + \Delta r_i]}{EMP_i} \text{ when direct and indirect intervention are used in tandem.} \]

This index of intervention activity is based on the measure of exchange market pressure obtained through a model of the economy, and is therefore specific to that model.

There have been other measures of intervention proposed in the literature. One of these is the index of managed float proposed by Frenkel (1980) and Frenkel and Aizenmann (1982). The Frenkel and Aizenmann index characterizes exchange rate policy in terms of the ratio \( \mathcal{G}_i = \frac{\Delta e_i}{\Delta e_i (\text{float})} \), where \( \Delta e_i (\text{float}) \) is the exchange rate that would have been observed in the absence of intervention. They used this in the context of looking for optimal intervention policies. This index is conceptually similar to that of Weymark. However, it has a problem from an operational standpoint. The denominator of this index is counterfactual, and cannot be directly observed. It must therefore be imputed on the basis of an analytical model. This problem does not arise in Weymark’s index, since, in that, exchange market pressure itself is obtained from observed values.

2.4 Empirical Studies on Exchange Market Pressure

The concept of exchange market pressure being relatively new, empirical studies on it are scanty, particularly in the Indian context. Most studies follow the Girton and Roper formulation, but a few recent studies have applied the Weymark definition.
The studies in the Girton-Roper tradition are generally not all concerned with the measurement of exchange market pressure as such. A number of them use the Girton-Roper measure to test the monetary model of the open economy, in various modified forms, to different countries. Some of these are briefly reviewed here.

Girton and Roper (1977), as noted, defined exchange market pressure as the simple sum of the percentage changes in exchange rates and official reserves obtained from a simple monetary model. This study estimated the model using annual data for the period 1952-74, to obtain a bilateral estimate of exchange market pressure for Canada vis-à-vis the US in the context of monetary autonomy. The model specification implies that the sum of the two components is independent of the composition. This was independently tested, and the test of sensitivity shows that exchange market pressure is not sensitive to its components. This implies that the sum of these two variables as a measure of exchange market pressure provides potential information, which could be used to determine the volume of intervention required to meet the exchange rate targets.

Hodgson and Schneck (1981) examined the relationship between monetary variables and exchange market pressure in the framework of standard monetary model for seven advanced countries using quarterly data. The sample period for six of the countries: Canada, France, West Germany, Belgium, the Netherlands and Switzerland is 1959-II to 1976-I, and for United Kingdom is 1964-II to 1976-I. They found that the relationship between the demand for money and exchange market pressure was not stable, especially during the period of disruptive international monetary relations. The relationship between monetary variables and exchange market pressure is more consistent with a weak rather than a strong version of the monetary approach, indicating that the factors other than monetary variables may be important as well to explain the variations in exchange market pressure.

Modeste (1981) examined the external imbalance of Argentina under a managed float system for the period 1972-1978 based on quarterly data. A modified version of the Girton and Roper model due to Connolly and Silveira (1979) was used to test the hypothesis that an excess demand for money will cause a
combination of currency appreciation and/or an inflow of international reserves. The
applicability of Girton and Roper model of exchange market pressure to Argentina
in the seventies is justified on the grounds that a large proportion of exchange
market pressure in the 1970s was absorbed by depreciating the Argentine peso, and
the Argentine economy can be regarded as a small economy in the sense that world
monetary conditions and world prices for goods, services, and capital are considered
to be given. The empirical analysis suggests that during 1970s Argentina alleviated
the imbalance in the external sector by combining changes in both reserves and
exchange rates.

Goldsbrough and Zaidi (1989) estimated a monetary model of exchange
market pressure for Philippines. The results suggest that even after the adoption of a
floating exchange rate system, the authorities allowed changes in foreign reserves to
continue to absorb most of the exchange market pressure.

Costa-Fernandes (1990) derived and empirically tested a modified version
of the monetary model, with exchange market pressure in the Girton and Roper
formulation as the independent variable. Lags in the adjustment process were
incorporated both with respect to the balance of payments and to exchange rate and
prices were taken to be fixed in the short-run. Furthermore, given the embryonic
character of the Portuguese capital markets and all sorts of government controls,
great importance is attached to exchange rate expectations. The model performs
reasonably well when tested and the study concludes that domestic credit growth
should be kept under strict control, and the absence of well developed capital
markets may lead to a deterioration of the balance of payments and to exchange rate
problems through speculation in foreign currency.

Wohar and Lee (1992) applied a refined and expanded version of the Girton
and Roper model to the Japanese economy using yearly data for the period 1959
through 1991. This paper develops and estimates a less restrictive and more
expanded version of the models previously estimated. The evidence clearly indicates
that their unrestricted model performs significantly better than the restricted models
used in previous works. On the basis of the estimated signs, and significance of the
price, income, and interest rate variables and other tests, they conclude that the monetary approach is favoured over the Keynesian alternative.

**Thornton (1995)** applied the Girton-Roper monetary model of exchange market pressure to the economy of Costa Rica during the period 1986-92. The results provide strong evidence of a negative relation between domestic credit creation and exchange market pressure and indicate that the central bank absorbed most of the exchange market pressure by adjustments in foreign reserves.

**Burdekin and Burkett (1990)** examined the performance of Girton and Roper model for Canada/US using quarterly data for the period 1963:I-1988:I. The results supported the hypothesised negative impact of domestic credit growth on exchange market pressure. Also the result strongly favoured the overall policy relevance of the short-run monetary model that gave unitary trade-off between exchange rate and foreign exchange reserve movements for Bank of Canada.

There have also been some studies in the Indian context, using the Girton-Roper framework. **Pradhan et al (1989)** examined the applicability of the monetary approach to exchange rate determination for India along the lines of Girton and Roper model of exchange market pressure, using quarterly data for the period 1976-85. The results strongly support the monetarists’ hypothesis that an increase in money supply leads to reserve losses and exchange rate depreciation. However exchange market pressure was found to be sensitive to its composition. In other words, the policy authorities in India do make a choice between changes in reserves and exchange rates in response to any disequilibrium in the money market. This does raise questions about the applicability of the model.

**Joshi (1990)** empirically tested three models of the monetary approach to balance of payments and exchange rate determination for India under different exchange rate regimes. The tested models include standard reserve flow equation with annual data for the period 1953-72, standard exchange rate equation based on purchasing power parity doctrine for the period 1970-82 with annual data, and the exchange market pressure equation using quarterly data for the period 1976 II – 1983 I. The results show that the performance using exchange market pressure is
better compared to others. It was also found that exchange market pressure is sensitive to its composition. It is pointed out that, among other things, the absence of well-developed money market, exogeneity assumption of the variables, long-run nature of monetary approach, arbitrary nature of rupee rates management might be the reasons for weak results.

Sahadevan and Kamaiah (1995) examined the monetary approach to the balance of payments separately under fixed exchange rate regime (1950-75) and managed floating regime (1976-90) using annual data. Under the fixed exchange rate regime, they estimated the reserve flow and sterilisation equations in a simultaneous equation framework using 3SLS procedure. The results do not support the monetarist proposition, implying that the monetary model cannot explain India’s reserve movements. The possible reasons, according to them, are low degree of openness of the Indian economy, controlled foreign exchange policy and a relatively inflexible financial market. The estimated results of the exchange market pressure equation show that it fits reasonably well to the Indian data over the period under consideration. Further, the exchange market pressure is not sensitive to its distribution unlike in Pradhan et al (1989).

Mathur (1999) used a modified version of the Girton and Roper model to explain both exchange rate movements and official intervention and evaluated the measures of the degree of monetary autonomy within the framework of a bilateral model comprising India and rest of the world over the period 1980:01 to 1998:06. Expected exchange rate was generated by using three forecasting techniques — the random walk model, Box-Jenkins methodology and the VAR procedure and was incorporated as a new independent variable to the Girton and Roper original model. It was found that inclusion of the new variable gives a better result than the original Girton and Roper model in explaining exchange market pressure.

Sahadevan (1999) analysed the impact of monetary policy on the behaviour of rupee exchange rate and international reserves during the period 1992:04 to 1999:03. The study analysed how the RBI offsets the pressure that monetary shocks exert on exchange rate and reserves. Based on the estimates of Girton-Roper model
of exchange market pressure the study examined the RBI’s policy of maintaining exchange rate and reserves over the study period. The values of the offset coefficient ranging between −0.81 to −0.93 signify that the pressure on exchange rate is not completely offset by the domestic monetary expansion (contraction) either by depreciation (appreciation) of rupee or by running down (accumulating) foreign exchange reserves or by some combination of both, but is partially being neutralised by some other means. The controls on international trade and capital flows do provide significant insulation from exchange market pressure. When exchange rate and reserve levels are considered to be the indicators of government’s performance and when they are being maintained at ‘politically correct’ levels, the economic reasoning underlying the model becomes irrelevant. The statistically significant intercept term as against the postulation of the model is a manifestation of these institutional realities.

Studies using the Weymark conceptualisation have been fewer. These studies are directly concerned with measuring exchange market pressure and the index of intervention activity in the context of specific models. These measures are then used to evaluate exchange rate management policy. Weymark (1995) used a simple monetary model with unsterilised intervention to obtain a model consistent expression for exchange market pressure. A bilateral model, using quarterly data over the period 1975:II 1990:IV, was estimated and used for calculating exchange market pressure and an index of intervention activity for Canada and the US. A multilateral version was also estimated. The results show that the weight attached to the change in official reserves was as high as −3.089 for the bilateral, and −7.9189 for the multilateral case. Thus, the Girton and Roper measure, with a unitary trade-off between exchange rate changes and official reserves, would have given a misleading picture. Both the bilateral and multilateral estimates of exchange market pressure show that there was sustained downward pressure on the Canadian dollar over the period 1975:II-1984:IV. But 1985 onwards, 18 out of 24 quarterly estimates have negative signs indicating that there was pressure for the Canadian dollar to appreciate. The large positive values obtained for 1989:II and 1990:I are taken to be
evidence of speculation against the Canadian dollar. The results also show that, the Bank of Canada responded strongly to counteract the speculative attack on Canadian dollar.

**Weymark (1997)** elaborated the general discussion of the index of intervention activity. This is illustrated in the context of a small open economy model, different from the one used in her 1995 study. The exchange market pressure and index of intervention activity are calculated using quarterly data for the same period as the earlier study, for both the bilateral and multilateral models. The coefficient attached to a fall in official reserves is now lower (-2.0860 for the bilateral and -1.8370 for the multilateral case) than was obtained with the earlier model. This highlights the model specificity of these measures, and raises the question of sensitivity of the results to model specification.

**Spolander (1999)** adapted the Weymark definition to a monetary model that explicitly brought in the impact of monetary policy through a money supply function. Monetary policy is taken to be conducted through changes in the monetary base, and foreign exchange interventions are partly sterilised. The model is estimated for Finland, from September 1992 to October 1996 with monthly data, using 2SLS method and model-consistent measures of exchange market pressure and index of intervention activity are derived. The weights attached to official reserves in this case too are very different from the unitary weights of the Girton and Roper measure. The results show that neither depreciation nor appreciation pressure was clearly dominant. Exchange market pressure decreased over time during the markka's float, but the Bank of Finland was seen to actively intervene in the exchange market.

**Patra and Pattanaik (1998)** carried out an empirical evaluation of exchange rate management in India. They adopted the monetary model used by Weymark (1995), over the period 1990-98 with monthly data. The calculated values of exchange market pressure show that there was market pressure on exchange rate to depreciate and appreciate at different points of time. The results also show that the index of intervention activity values were close to one, which suggests that the
exchange rate regime was highly managed and the observed exchange rates would have been quite different in the absence of intervention. They claim that the exchange rate policy in India has been actively supportive of the external sector target in terms of sustainable level of current account deficit. It is however, to be noted that, there is a measurement error in the conversion factor.

Baig et al (1999), using a similar monetary model to Weymark (1995), estimated exchange market pressure, and index of intervention activity for India over the period 1975-98 using annual data. The findings show that during the study period the exchange market pressure has fluctuated with positive (negative) values indicating upward (downward) pressure from the US dollar. The RBI was found to counter this pressure by intervening extensively in the foreign exchange market as indicated by large index of intervention activity values. From 1991 onwards, when the exchange market is supposedly free from controls, the RBI has been intervening even more in the foreign exchange market as indicated by higher index of intervention activity values. It is reasoned that with the removal of controls from foreign exchange market RBI has had to intervene strongly to counteract the speculation in the market, and protect rupee from appreciation because of large inflows. A cross check was also carried out by calculating a monetary conditions index for this period. The values of the monetary conditions index suggest that monetary authorities seem to intervene in the market through monetary policy in response to exchange market pressure.

2.5 Concluding Remarks
The discussion in this chapter shows that there are several approaches to studying the exchange market, and within each approach many specific structural models may be constructed. Further, the discussion also brought out the need for arriving at a model specific measure of the exchange market pressure. Obviously, the credibility of the measure depends upon how good the model is. Most of the studies in Indian context have used Girton and Roper measure; a few have used the Weymark definition. As we noted, the Girton and Roper measure itself is specific to a simple monetary model. The studies using the Weymark definition have also used a simple
monetary model, where monetary authorities do not use domestic credit changes, which have concentrated on the money market only. This suggests that there is a need and a scope for constructing a suitable model of the Indian economy to get a measure of exchange market pressure.