Chapter 5
High Frequency Data in Foreign Exchange Markets: An Appraisal

The research on the macro models in exchange rate determination has taken place since the collapse of the Bretton Woods system in 1972. As is explained in the introduction chapter and the quotation of Frankel & Rose on the first page of this thesis, the purpose of these models was to track the changes in the exchange rate, which was very important for understanding the behaviour of other macro variables in the open economy macro economics. Until the publication of Meese and Rogoff study in 1983, where they showed that the exchange rate follows a random walk, these macro models are much debated, both empirically and theoretically, by the academia and the practitioners. Even after 1983 also, there were studies that tried to improve the performance of macro models against the random walk. But till today the improvements over the random walk model have been slight and in general not statistically significant. The main reason for the neglect of macro models is due to their failure in predicting the short-term behaviour in the exchange rate market, which is very important from the traders' point of view. Macro models are helpful only for the macro economic policy makers who design the policy for the long-term purpose. These models may be of little use for the bankers when they plan their finances for long-term purposes. Hence, the
failures of macro models led the researchers to search for alternative explanations of the exchange rate changes that will be more helpful for the traders and the policy makers.

Given this situation, changes had taken in the exchange rate trading process through the institutions like central banks that made the foreign exchange market more active and efficient. The major change is that of trading the foreign exchange through the electronic broking systems like Reuters and Telerates. This change in the trading process has brought the traders nearer and the space problem became negligible. It reduced the transaction costs and made the traders to react sharply to the information (both public and private) available. For the researchers in exchange rate economics and the technical analysts, the electronic broking system provides the exchange rate data at the level of each deal that is taken place in the market. Since it is established in the literature that foreign exchange market is the biggest market and functions round the clock, we get the data at a high frequency and also huge data set (It is told that in the New York inter bank foreign exchange market, there will be totally 40,000 deals of different exchange rates taking place in an hour). The introduction of these broking systems in the late 1980s has made available of data at extremely high frequency, researchers in the exchange rate economics shifted from the macro modeling to that of micro modeling. From this we can conclude that the
availability of high frequency data in the foreign exchange market has influenced more to shift the focus from macro approach to micro approach. Given this, it is worth studying the nature of high frequency data in the foreign exchange market. In this chapter, we try to explain the process of trading in foreign exchange market through electronic broking system and also explain the character of these data. We also review some of the papers that studied the nature of high frequency data.

The question that is generally asked in the financial economics is that why foreign exchange market is different from other financial markets? This is very important which is to be answered. There are basically three issues that make foreign exchange market quite different from the other financial markets. They are: (1) trading process (2) space of the market and (3) timing. Unlike trading process in other financial markets, in the foreign exchange market, the trading will take place non-synchronously. That is, the market works continuously and is a decentralised market. In contrast to the centralised markets like stock markets, where the trades are carried out at publicly announced prices and all traders have access to the same trading

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1 For more thorough understanding of the nature of high frequency data in foreign exchange market one can refer the special issue on High Frequency Data in Finance brought out by Journal of Empirical Finance, and also Goodhart et al. (1996).

2 Before explaining these concepts, we would like to mention, in the foreign exchange markets itself, there are two separate auction structures for the same commodity: the inter bank direct market and the brokered market. Here we concentrate only on the inter bank direct market as the number and the volume of transactions in these market is very much high and can be observable than the brokered market, which mainly deals with the small volumes. It is also quoted by the Reuters
opportunities, in the foreign exchange market prices are quoted and transactions are concluded in private meetings among the agents. In other words, there is no 'spatial consolidation' in foreign exchange market as in the centralised markets like stock markets. In the foreign exchange market, a dealer can trade with another dealer through electronic mechanism. The dealer has to find a potential player to sell/buy his asset for his quoted price. Electronic broking systems like Reuters and Telerates exactly do the same.

Initially, Reuters D2000-2 electronic broking system was introduced just to help the dealer to find out a potential dealer anywhere in the market irrespective of the space. Once, the potential dealer is found, then the dealers have to correspond over phone and enter into contract. This arrangement made the dealers closer and, hence, reduced the cost of searching for the potential dealer. Over a period, these systems were further advanced and now the dealing can be done over these systems itself. In the Indian foreign exchange market also, initially, it was used just to find out the potential dealers.

3 (Reuters D2000-2 electronic broking system, which was launched in 1992 with twenty-three subscribers in two countries, is a system that caters only for the dealers from the major banks, which are the main participants in the wholesale spot foreign exchange market. Limit orders input by some participants are automatically matched with the market orders of others, yielding data on the best current bid and ask quotations and the inside spread. The limitation of this system is that inter-dealer trades can also be carried out via conventional brokers or via direct dealer-dealer or via dealer-to-customer where spread is the choice variable for which D2000-2 cannot provide any information. As noted in the previous footnote that 90% of the inter-dealer transactions take place through the Reuters system, we can take the prices that are quoted on the Reuters screen as the representative foreign exchange market as a whole. For better understanding on the working of the Reuters D2000-2 broking system refer Goodhart, et.al (1996)).
buyer/seller of the asset. Only at the end of 1999, Reserve Bank of India has allowed the dealers to enter into contract through these electronic broking systems. About the timing of the foreign exchange market, unlike in other financial markets, the trading will take place round the clock. (There is a saying that Sun will not set in the foreign exchange market). A thorough look at the high frequency data of YEN/USD and USD/EURO that is used in this study, we can find that the data is available through out twenty-four hours in any trading day. Even on the weekends it is found that some transactions have taken place elsewhere in the market.

As is shown in the table on Daily timing in foreign exchange market (P.126), unlike in the auction type markets like any other financial markets, the day in the inter bank foreign exchange market will have three rounds of transactions. In the first round, the dealer takes the starting exchange rate, \( r_t \), as given and quotes the same price to the public. In the next stage, he receives the orders from the public, either buy or sell, for the purpose of trading. In the second round, based on the demand and supply from the public, the dealer quotes his price in the inter bank trading. This price may not necessarily same as \( r_t \) that he/she quoted for public in the first round. In this stage, the inter dealer transactions take place. At the end of this round, the dealer will arrive at the order flow, net of buyer initiated orders and seller initiated orders (in other words net of buying and selling of the financial
This stage is very important for other dealers in the market as order flow reveals the private information to the market. If order flow is positive, that is demand for the foreign currency is more than the supply of it, the competitors will jack up the price of the foreign currency in the next round and vice versa. In the third and last round, it is the duty of the dealer to clear off his burden. In this process he/she will try to reduce risk of holding the foreign currency, which is known as 'hot potato trading'. Hence, he/she quote a price to customers and, hence, tries to split the risk among all the customers. Here, typical auction oriented transactions can be observed as the dealer will be trying to minimise risk and the customers will be trying to maximise their profits. In this process, both the dealer and the customer will try to invent a new price for the foreign currency at which the market will clear off. Hence, in a day, the dealer has to face three prices: two for the customers and one for the inter bank dealers. This trading process in foreign exchange market is sufficient to say that it is entirely different from other centralised financial markets. In the next paragraph we review some of the papers that are concentrated on the nature and characteristics of the high frequency data in foreign exchange market.

The basic paper that studied the behaviour of high frequency data in foreign exchange market and set the pace for studying the implication of microstructures in the foreign exchange rate is by Goodhart & Figlinoli (1991).
Their paper titled "Every minutes counts in financial markets" was the beginning for any serious study on the application of market microstructure theory in the foreign exchange market. In their paper, they examined the statistical properties of all the spot foreign exchange rates except the Italian Lira taken at a frequency of one minute from Reuters for three days in 1987 (14-15 of September and 21st October). The study reported that exchange rates exhibited first order negative autocorrelation. The correlation coefficients that are used to calculated the impact of jumps found that there is abnormally high negative autocorrelation not just following the jumps but also preceding it. One more interesting result revealed from this study is that the time aggregation, i.e., at five and ten minutes interval, helps to reduce the first-order negative autocorrelation that was strong in the minute to minute frequency. They also studied the multivariate relationships between exchange rate changes and their lagged changes in both own and other currencies. It was found that the market is inefficient as dealers in other than the deutsche mark have taken the pressure of deutsche mark on the other currencies. With the help of variance ratio test, the study concluded that there exist transitory movements, implying negative autocorrelation, at ultra high frequencies. But, though the issues covered in this study are of preliminary one, this study generated more interest in the exchange rate researchers and made to shift their focus from the macro economic approach to exchange rate behaviour to microstructure theory. Since then, the research on microstructures in
exchange rate behaviour has taken driver's seat in the exchange rate economics.

Another paper by Goodhart & Payne (1996) also examined the microstrucural dynamics in the high frequency exchange rate data. The study covered the transaction-based day for deutsche mark/dollar spot rte for seven hours in June 16th 1993 taken from the Reuters screen and studies the relationship between the spreads, quotations and transactions cost in the foreign exchange market. The results of the study show that current transaction price and its first lag has strong and significant impact on the spread. It was found that the spread widens when a deal occurs and that this widening persists through time. The studied on the behaviour of bid and ask separately, it was found that revisions in bid were clearly affects by spreads but not on ask side. For this phenomena, the study explains that much of the ask activity occurred in the latter part of the data set, at a time when the ask was rapidly rising towards a new equilibrium and the response from bid was not instantaneous. It was also found that the revisions in bid has positively and significantly affected the ask side, but not vice versa. The study also examine the 'thin market hypothesis'. The study found the support for the 'thin market hypothesis' from the same data and it attributed the presence of

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*Thin market hypothesis explains that if there is any sharp jump that takes the quotes too far off the 'true' market price level, then there will normally be a rebound towards the 'fundamental' valuation.
inherent negative autocorrelation in the quote returns due to this hypothesis. The removal of thin market effect from the data is found to drop the explanatory power of the autoregressions. Further the study concluded that though the thin market hypothesis appears to have validity from the sample data and responsible for much of the observed negative autocorrelation, it does not appear to be the only explanation for the presence of negative autocorrelation.

From the above observations one can infer that the study on the 'confusion' in foreign exchange market was made easier with the availability of high frequency data from Reuters electronic broking system, which was introduced in early '90s. Since then, quite a few studies have taken place in studying the microstructural behaviour in the major foreign exchange markets. The present study also try to examine the microstructural hypothesis in the Indian and Euro foreign exchange market, which was not taken place till now, with the help of high frequency data.