Chapter - 6

Empirical Results: Discussion and Interpretation

As discussed in the previous chapters, the present study tries to examine the microstructural aspects of foreign exchange markets with the help of high frequency data. From the literature survey (in chapter 3), the study finds that this theory was basically applied to three major currencies, i.e., deutsche mark/dollar, Yen/dollar and pound/dollar. There are no studies that dealt with the Indian rupee/US dollar and the US dollar/Euro, which are currently major currencies of developing and developed countries respectively. Hence, the present study tries to fill the gap in the literature by concentrating on these exchange rates. The study also considers the Yen/dollar exchange rate to re-examine the microstructural effects with the help of the recent data set.

The objectives of the study are:

1. To examine the volatility of USD/EURO, INR/USD and YEN/USD by using the methodologies developed by Zhou (1996) and Bollerslev & Ghysels (1996).

2. To examine the impact of public information, which is available to all the market participants through Reuters screen, on the quote arrival in these exchange rates.
(3) To examine the impact of private information, which only few people pose, on the quote arrival in the short-run.

(4) To examine the relative explanatory power of macro and micro variables in explaining the exchange rate volatility of these three exchange rates. For this objective, we follow the methodology developed by Evans & Lyons (1999).

To study these objectives that are specified above, we have used the high-frequency data of three bilateral exchange rates that were arranged by Olsen & Associates (Switzerland). The data covers 22 working days in August 1999 (all set to GMT). The present study uses the high frequency data (tick-by-tick data) in the case of Indian rupee/US dollar (INR/USD), US dollar/Euro (USD/EURO) and Japanese Yen/US dollar (YEN/USD) in examining the above stated objectives. The period for which the data used in this study is for the whole month of August 1999 in the case of INR/USD and the number of observations being 4981 points (including holidays); from August 5th to 6th, 1999 in the case of YEN/USD and the observations being 8158; and in the case of USD/EURO we have taken for one day, i.e., on August 2nd 1999 with 13318 observations.

Though we have data for the whole month of August 1999 in the case of all the three exchange rates, we could not utilise as the software could not deal with the huge data sets of these currencies. Hence, we restricted the period for
two days in the case of YEN/USD and for one day in the case of USD/EURO. The choice of days in the case of YEN/USD is basically to examine the effect of employment report of US that will be released on every Friday at 8.30 EST (at 12.30 GMT) (Friday falls on August 6th). And in the case of USD/EURO, the choice of August 2nd is was inevitable, as we could not process the data set for more than one day. One more reason for choosing this day is to examine the impact of macro economic report that will be released on every Monday at 8.30 EST. These data are collected from the Reuters screen that exhibits the bid, ask (both high and low) and the timing of the trading. We will examine the above said objectives separately under different headings. Before going to the discussion of the estimated results, we will try to understand the nature of the sample data sets through their summary statistics that are provided in Table-1.

It was found from the summary statistics of all the three exchange rates that the average bid-ask spread, which is widely accepted as a proxy for the transaction cost, in EURO/USD is very small (0.0005) compared to the other two exchange rates. It shows that the EURO/USD market is very active and that the volumes are very high in these markets (It is established in the finance literature that the spreads and volumes are strongly negatively correlated). The coefficient of kurtosis is very high in INR/USD market compared with the other two markets, indicating that INR/USD market's spreads are not in tune with the 'true' market values. The participants in this market may be 'defensive players'. If we look at the variance of these exchange rates, it gives a clear picture that
USD/EURO has shown negligible variance comparing to other two exchange rates. This may be due to the huge difference in the number of observations considered. It is also found from the variance of spreads that USD/EURO has zero variance compared to the other two exchange rates. For the better understanding of the trends in bid-ask prices and spreads, we have plotted the line graph for all the three exchange rates (see charts from 1 to 6). It is clear from the charts that unlike in the case of INR/USD, spreads in USD/EURO and YEN/USD exchange rates were consistently fluctuating between 0.0002 to 0.001 and between 0.05 to 0.1 respectively. In the case of INR/USD we can see the high variation in the spreads as the graph shows many 'pillars' indicating defensiveness and low volumes of the Indian dealings.

Information effects on the exchange rates:

The study examines the effect of 'news' on the exchange rate behaviour. For this purpose, the study considers the news of employment report on every Friday at 8:30 a.m. of EST (at 12.30 GMT) released by the US Government (i.e. on August 6, 1999 which is Friday) and examines its impact on the short-term dealings in YEN/USD market. It also considers the impact of federal banks' macroeconomic report, which is released every Monday at 8:30 a.m. (EST), on the EURO/USD dealings (i.e., August 2nd is Monday). In the case of INR/USD, we try to study the impact of both the reports on the returns. Here we try to estimate the impact of these news items with the help of GARCH-M model and
the simple OLS model. This is because, it is established in the literature that news will have to distinct effects: (1) news may affect the level of the exchange rate directly as an independent news effect; (2) news may affect the variance of the exchange rate. Both these problems can be probed within the GARCH-M model, first by including specific news variables in the simple ARCH process that is specified below.

\[ Y_t = \alpha' x_t + \delta h_t^2 + \varepsilon_t / \Omega_{t-1} \sim N(0, h_t^2) \]

Where

\[ h_t^2 = \gamma_0 + \sum_{i=1}^{n} \gamma_i \varepsilon_{t-i} \] + \varepsilon'_t z_t,

And the second by including the similar effects in the GARCH model that is specified below.

\[ Y_t = \alpha' x_t + \delta h_t^2 + \varepsilon_t / \Omega_{t-1} \sim N(0, h_t^2) \]

Where

\[ h_t^2 = \gamma_0 + \sum_{i=1}^{n} A_i \varepsilon_{i-t}^2 + \sum_{i=1}^{p} B_i h_{t-i}^2 + x' z_t, \]

were \( x_t \) and \( z_t \) are vectors of weakly exogenous conditioning variables.

The above ARCH and GARCH \((n,p)\) processes are similar to equation 4.1 and 4.5 in chapter 4.
We have estimated the equation 4.13 without news variable, i.e., $\gamma=0$, through a conventional OLS procedure. The second is a GARCH-M model (equation 4.14) where GARCH is assumed to be (1,1). Table 8 provides the results for all the three exchange rates with one lagged difference term. The OLS results suggest that exchange rate is non-stationary in the ease of USD/EURO and YEN/USD and stationary in the case of INR/USD. It is interesting to find that the coefficients of lagged difference terms are highly significant in the case of all exchange rates. The GARCH(1,1) estimation results show that there exists a very well determined autoregressive effect in the conditional variance in the case of YEN/USD and INR/USD (indicated by $B$, parameter). The GARCH term '6' is found to be insignificant in the case of USD/EURO exchange rate only. This result indicates that there is no effect of conditional variance on the USD/EURO and in the case of other two exchange rates, the conditional variance seems to have influence on the future volatility.

In the next step we included the news item also in the equation 4.13 by using a dummy variable $...0,0,1,-1,1,0,...$ which allows for a considerable rebound after the initial news stock and this rebound is quickly reversed. The estimated results that are specified in Table 9 show that, except in the case of INR/USD exchange rate, the news variable is highly significant in the case of all the other two exchange rates (specified by the coefficients of 'r'). This result shows that efficient market hypothesis is rejected in the Indian foreign exchange market. But in the case of INR/USD it is found that $\alpha_1$ is significant denoting the presence
of autoregressive effect. The estimated GARCH model shows that, except in USD/EURO exchange rate, the conditional variance has impact on the exchange rate. Since, the market knows the date and time of announcement of news, there is a possibility that an anticipated increase in uncertainty could occur in advance of the news announcement itself. To condition this anticipation, we use news dummies in the GARCH model. The news event is simply represented by a single dummy 'r', which equals to -1 as the news announced and 0 elsewhere. The second dummy is represented by 'r2', which equals one as the news is announced, and 'r3', which equals 1 and followed by -1, which allows for a dynamic response to the announcement. The result reported in the second half of the table 9 show that the effect of news will be eroded after some hours (which is indicated by highly significant coefficients of 'r' in the case of USD/EURO and YEN/USD). INR/USD exchange rate is found to be insensitive to any type of news and hence we can infer that the Indian foreign exchange market is 'inefficient'. The study conclude that irrespective of the nature of the news, the outcomes in the market will include the impact of these reports and will continue to depend on this news for a short period in YEN/USD and USD/EURO exchange rate market.

**Micro-Macro divide**

Finally, the study tries to examine the superiority of micro variables on macro variables with the help of daily order flows in the market. Order flows, which are synonymous with the concept of effective demand in micro economic
literature, are defined as the net of buyer-initiated trades and seller-initiated trades in a day. Since the information on buyer-initiated trades and seller-initiated trades are not publicised, the present study considers the daily turnover of INR/USD in the Indian foreign exchange market that are available in the Reserve Bank of India Monthly Bulletin. For macro variables, the study considers the Indian daily call money rates and the US federal fund rates. In the case of YEN/USD, the study considers the total number of transactions in a day through the electronic broking system as a proxy for the order flow. The regression results, including the regression specification, are presented in page 120.

The study concludes that order flows have a significant negative impact on the INR/USD exchange rate corroborating to the results of Evans & Lyons (1999). It is also found, interestingly, that both Indian and US interest rates are not found significant in explaining the INR/USD exchange rate. This result supports the disclaimers of macro theories on exchange rate determination models. Further, it was found that comparing to US federal fund rate, total number of transactions has a positive and significant impact on the YEN/USD exchange rate. The view of Hans Stoll that number of transactions in the market will be the most important variable in predicting the short term changes in the asset markets. In the case of USD/EURO exchange rate, it is found that the US federal fund rate plays a significant role in explaining the short-run changes in its rate.
Volatility of Exchange rates

To test the volatility of exchange rates, as specified in the methodology chapter, we have used the method of Periodic Generalized Autoregressive Conditional Heteroscedastic model developed by Bollerslev & Ghysels (1996) and the model developed by Zhou (1996). The results are presented in Table 6 & 7.

For the purpose of studying the volatility of exchange rates, we have calculated the returns on USD/EURO at five minutes interval (288 observations); in the case of YEN/USD at fifteen minutes interval (192 observations); and in the case of INR/USD at half an hour interval (352 observations). In the case of INR/USD we considered only eight trading hours of each day in Indian foreign exchange market as the transactions are almost nil in non-trading hours.

First we consider the methodology developed by Zhou (1996). We have estimated the equation 4.11 (see p.71 of chapter 4) and presented in Table -7. It is observed by Zhou that observation frequency is very important in estimating the volatility of the high frequency data and there is a need for identifying the optimal observation frequency \( k \) that will optimise the variance of \( \hat{\sigma} \) (equation 4.12). We also find the optimal observation frequency \( k \) given by
which is nothing but the signal to noise ratio. We found that optimal k for USD/EURO as three and for YEN/USD and INR/USD as two (See Table-7). It is found that USD/EURO has very strong negative correlation in the noises than the other two exchange rates. This may be due to the presence of noise component. This corroborates to the view of the market participants that in a high frequency data of major exchange rates, the presence of noise component is very high and most influential.

Further, we estimated the P-GARCH (1,1) model whose estimable equation that includes the seasonal dummy variable is given below:

\[ \tilde{\sigma}_t^2 = \omega + \omega_{s(t)} - (\omega + \omega_{s(t-1)})(\alpha_1 + \beta_1 + \alpha_{s(t)}) + (\alpha_1 + \alpha_{s(t)})\tilde{e}_{t-1}^2 + \beta_1 \tilde{e}_{t-1}^2 \]

where by definition \( \omega_0 = 0 \) and \( \alpha_{10} = 0 \)

This expression is same as the equation 4.7 in chapter 4.

The estimated P-GARCH(1,1) model results are presented in Table 6. From the results it can be observed that \( \alpha_{11} \) which is the autoregressive parameter, is found to be significant in USD/EURO and YEN/USD market. But not in the INR/USD market. This result indicates that the seasonality has affected the conditional variance of the two markets. INR/USD is insensitive for any seasonality shocks in the returns. In other words, we can infer that in the case of INR/USD market, periodic structure shocks to the conditional variance appears to provide less information about the future volatility.
**Conclusion**

From the above results, we can conclude that the micro issues are very important in understanding the movements in the short-term exchange rates. Public information, irrespective of the type of information, has indeed explained the changes in two markets except in Indian market. This may be due to inefficiency of the Indian market. But the private information, for which we have taken order flow and number of transactions as proxy, has shown a significant influence on the exchange rate movements. Hence, the private information, if at all present in the market, will play a major role in the high frequency transactions of the market. One can also conclude that the dealers in the Indian foreign exchange market are not willing to take the risk of trading at high volumes and thin spreads. Comparing to Indian dealers, the dealers in Euro and Yen market are smart as they can trade at thin spreads and ready to take risk. From the results it can be inferred that the high volatility will be present in the inefficient markets like Indian market. But the results may be sensitive to the methodologies adopted.

Against this back drop, as a policy measure, it is suggested to all the international banking divisions of all the banks to have research wings for the proper predictions in the intra day and short term forecasting of the exchange rate movements that will help the dealers. Most of the dealing rooms in India have a mix of both stock trading and foreign exchange trading activities where
foreign exchange dealings will be playing a second fiddle to the stock trading. To have fair play in the markets it is necessary to have separate trading rooms. Providing 'proper atmosphere' for the dealers may help them to trade even in thin market and with small spreads that make them 'macho traders'. There is a need for a statutory body for the foreign exchange market (like SEBI for the Indian stock market), which will help in lessening the uncertainties in the market. As in the stock market, it should be made mandatory that all the dealers (or banks) to furnish the details of their transactions, including the volumes, within a stipulated date. This step might help the researchers in this area to probe further the causes of the currently unexplained changes in exchange rates. Further, the data on volume of transactions will help the researchers in microstructure theory to apply the inventory models, which is the most important branch of microstructure theory.