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Measuring the Volatility of Foreign Exchange Market in India

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Abstract

In the current era of globalization till date there has not been any perfect model to predict the volatility present in foreign exchange market because of the independent factors increasing the complexity of the forex market. There is immense need to manage the risk effectively and efficiently. Therefore, this paper analyzes the behaviour of foreign exchange rate with respect to time in context of Indian foreign exchange market and identifies the correlation between foreign exchange rate movements.

Keywords: keywords, foreign exchange rates, volatility, us dollar, Japanese, yen. euro, Indian rupee

1. Introduction

An economy is linked to the world economy through two broad channels: trade and finance. India's economic policy reforms of 1991 sought to globalize the hitherto relatively closed Indian economy by opening up both these channels. The changes in both trade and the financial sector have been slow giving the economy time to adjust. Despite restrictions, the trade channel between India and the rest of the world was far more open than financial markets. Not only was the financial sector closed to international agents, the price of capital (interest rate) or of the domestic currency (exchange rate) was not market determined. The nineties saw a twin development in financial markets - prices was allowed to be determined by the market, and the domestic financial market was integrating with international financial markets.

At the same time, India moved from a fixed to a floating exchange rate. However, the economy continued to have features of the closed economy and fixed exchange rate regime that had prevailed for a long period, even after rates were supposed to be market determined. Capital controls continue. While current account convertibility for both inflows and outflows by residents and non-residents was established as early as August 1994, controls continue on the ability of resident individuals and corporate to send capital abroad.

Over the last three decades the foreign exchange market has become the world's largest financial market, with over $1.5 trillion USD traded daily. Forex is part of the bank-to-bank currency market known as the 24-hour interbank market. The Interbank market literally follows the sun around the world, moving from major banking centers of the United States to Australia, New Zealand to the Far East, to Europe then back to the United States.

Until recently, the forex market wasn't for the average trader or individual speculator. With the large minimum transaction sizes and often-stringent financial requirements, banks, hedge funds, major currency dealers and the occasional high net-worth individual speculator were the principal participants. These large traders were able to take advantage of the many benefits offered by the forex market vs. other markets, including fantastic liquidity and the strong trending nature of the world's primary currency exchange rates.

1.1 Need of Foreign Exchange

Let us consider a case where a Japanese company exports electronic goods to USA and invoices the goods in US Dollars. The American importer will pay the amount in US Dollars, as the same as his home currency. However the Japanese exporter requires Yen means his home currency for procuring raw materials and for payment to the labour charges, etc. this he would need exchanging US dollars for Yen. If the Japanese exporters invoice his goods in Yen, then importer in USA will get his dollars converted in Yen and pay the exporter.

From the above example we can infer that in case goods are bought or sold outside the country, exchange of currency in necessary. Sometimes it also happens that transaction between two countries will be settled in the currency of the third country. That case both the countries, which are transacting will require converting their perspective currencies in the currency of the third country. For that also the foreign exchange is required. For example, an Indian exporter, exporting goods to Singapore may rise an invoice for the goods sold in US dollars and as the importer in Singapore has to make payment in US Dollars, he will have to exchange his Singapore dollars into US dollars. The Indian exporter on receipt of US dollars will exchange them into Indian rupees. Thus, the transaction will give rise to exchange of currencies in the exporter's country as well as importer's country. Such transaction may give rise to conversation of currencies at two stages.

1.2 Why Trade Foreign Exchange?

Foreign Exchange is the prime market in the world. Take a look at any market trading through the civilized world and you will see that everything is valued in terms of money. Fast becoming recognized as the world's premier trading venue by all styles of traders, foreign exchange (forex) is the world's largest financial market with more than $1.5 trillion USD traded daily. Forex is a great market for the trader and it's where "big boys" trade for large profit potential as well as commensurate risk for speculators.

Forex used to be the exclusive domain of the world's largest banks and corporate establishments. For the first time in history, it's barrier-free offering an equal playing-field for the emerging number of traders eager to trade the world's largest, most liquid and accessible market, 24 hours a day.

Trading forex can be done with many different methods and there are many types of traders -from fundamental traders speculating on mid-to-long term positions to the technical trader watching for breakout patterns in consolidating markets. The methods for trading foreign exchange are many.

2. Forex Market in India

2.1 The Rupee's Exchange Rate: A Brief History

As already stated in chapter 1, India was a founder member of the IMF. During the existence of the fixed exchange rate system, the intervention currency of the Reserve Bank was the British pound; the RBI ensured maintenance of the exchange rate by selling and buying pounds against rupees at fixed rates. The interbank rate therefore ruled within the RBI band. During the fixed exchange rate era, there was only one major change in the parity of the rupee- devaluation in Junel996.

After the collapse of the fixed exchange rate system in 1971 also, the RBI continued to maintain the parity with the pound, with some minor changes; the exchange rates against other currencies were determined through their cross rate against the pound.

This link with the pound continued until September 1975. By then, in recognition of the fact that India's trade had substantially diversified in terms of both currencies and destinations and that, therefore, the link

with the pound was no longer very logical the rupee's exchange rate was linked to a basket of currencies. The composition of this basket was kept secret and the pound continued as the intervention currency. Its exchange rate against the rupee was so fixed by the RBI daily, and sometimes changed intra-day, as to ensure that the value of the (secret) basket of the currencies remained reasonably steady in the rupee terms.

It is a well known fact that forex market in India is moderated by RBIs intervention from time to time whenever it was warranted in the view of RBI. Intervention by Central Banks in foreign exchange markets is nothing new. Central banks intervene in the forex market in line with their policy to moderate the exchange rate whenever it wanders away from a comfortable level objective. The stated objective in the Indian case is to reduce the volatility in the forex market. The workmanship of RBI in moderating the exchange rate is well acclaimed world over.

Historically, the Indian forex market, which is basically the market for USD-INR, has been within 1 to 4 percent monthly volatility. The exchange rate was broadly maintained between 39 to 45 in last one year. Though there were some high volatile times, the exchange rate in India has shown a stable character. The exchange rate has shown some of those characters which are booked for in an ideal financial market such as unpredicted ability, two ways movement and moderate volatility. Critics have largely given credit to RBI for this well behaved exchange rate.

2.2 Theoretical Frame work

Under the IMF classification of exchange rate regimes, Indian exchange rate management is classified as "managed floating" regime. Under such regime, the exchange rate is closely watched and the movements are assessed against the fundamentals of the economy and the developments in the rest of the world. Based on its view, RBI resorts to moderate the exchange rate through intervention in the market. The intervention takes the form of either buy or sell of USD in spot or swap markets. It is unknown what level of exchange rate or volatility exactly trigger the intervention action by RBI and by how much of intervention.

The exchange rate in India under the current regime is by and large market determined. Even while intervening, RBI takes care that through its operations, the basic market forces are not out of place. The market players, while always keeping an eye on what could be the possible move by RBI, broadly agree that the exchange rate moves based on the demand and supply forces. Therefore, the Indian forex market could perhaps be studied by the regular supply- demand models o f price determination .The basic principle of price determination is that at any point of time, at the market clearing exchange rate, the amount of forex purchased is exactly equal to the amount of forex.

3. Review of Literature

The following studies have been conducted on the subject:

Bekaert (1995) analyzes the time variation in conditional means and variances of monthly and quarterly excess dollar returns on Eurocurrency investments. All results are based on a vector auto regression with weekly sampled data on exchange rate changes and forward premiums of three currencies. Both past exchange rate changes and forward premiums predict future forward market returns. Moreover, past forward premium volatilities predict the volatility of exchange rates. He says that expected forward market returns are very variable and persistent and exhibit marked co-movements. These results carry over to cross-rate investments as well. Non-normality is a feature of many financial time-series. According to him if the predictability is due to risk, the VAR results imply that the risk premiums on forward-market investments are very variable and persistent, and they change sign quite often. The standard deviation of the risk premium on all three investments is around 10%. On average, the premiums on cross-rate investments

are somewhat less variable. Using a nonlinear Wald test, the hypothesis that expected forward-market returns move perfectly together pair wise could never be rejected. Bekaert (1995) deduced that traditional latent-variable tests fail to pick up such subtle but economically significant differences in co-movements of expected returns.

Batten (1999) says that many of the valuation models also require an annualized risk coefficient. However, under the random walk model, the temporal dimension of risk is irrelevant with the risk of the asset at any time interval being estimated by the linear rescaling of the risk from other time periods. That is, the convention is for risk to be scaled at the square root of time. This crucial assumption has rarely been tested and may be inappropriate for many valuation techniques .However he argues that many market valuation models assume normality or attempt to adjust for the non-normality of price distributions. The correct estimation of financial asset risk has important implications for investors using standard asset pricing models. As of his study under the usual assumptions of independent and Gaussian distributed increments, traditional methods of estimating risk have required using an annualized risk coefficient which is calculated by linear rescaling of the variance from shorter time intervals. Only when the returns series under observation is independent, will rescaling provide correct estimates of the underlying level of risk associated with an investment. Results of Batten (1999) show that dependence between increments in the returns series will conversely lead the investor to underestimate or overestimate their exposure to risk. The higher the underlying levels of dependence, the greater the possibility of error in the estimation process. While estimating scaling relationships between the volatility of returns at different time intervals, he produced some evidence of dependence not found using traditional techniques. While the exponent values were not significantly large enough to conclude in favour of statistical long-term dependence in the currency returns series, the economic implications of the exponent values were significant. Using a simple Black-Scholes foreign currency option pricing model, linearly rescaled volatility estimates were shown to misprice the option value by as much as 25.5% for at-the-money contracts. These results are significant, since they demonstrate that even small deviations from independence in asset returns can result in significant economic benefits or costs. Investors should therefore exercise caution when using short term returns to estimate longer-term risk, so as to avoid underestimating their real exposure to risk.

Bertram (2006) says that the second order properties of financial data, such as volatility and correlation, have been the focus many recent studies investigating the presence of long-memory, power-law tails, non-stationarity and scaling behaviour in financial data. It is becoming increasingly apparent from these studies that time dependence and non-stationarity are major features of financial data.

Hodrick (1992, 1993) deduced that the vector auto regressive approach as several advantages over the by-now standard method of using overlapping high-frequency data on monthly or quarterly variable estimates of the conditional variance of monthly and quarterly forward-market returns. It is well known that the forward rate is not an unbiased predictor of the future spot rate. One implication of the vast literature on the subject is that returns from investing in the forward market are predictable by the forward premium as shown in the research work of Bekaert.

Johnson (2002) introduced a model to explore the connection between realized trends and changes in volatility. Foreign exchange returns exhibit the surprising and consistent property that volatility increases when trends continue and decreases when they reverse. Equivalently, the volatility spot covariance, and hence finite-horizon skewness, behaves like a lagged momentum indicator.

Solano (2004) says that modeling the unconditional distribution of returns on exchange rate and measuring its tails area are issues in the finance literature that have been studied extensively by parametric and non-parametric estimation procedures. However, a conflict of robustness is derived from them because the time series involved in this process are usually fat tailed and highly peaked around the center.

Vergni and Vulpiani (1999) have shown the presence of long term anomalies like the structure functions and a generalization of the usual correlation analysis in the foreign exchange market. They say that the available information strongly depends on the kind of investment the speculator has in mind.

Zumbach (2002) introduces a new family of processes that include the long memory (power law) in the volatility correlation. This is achieved by measuring the historical volatility on a set of increasing time horizons and by computing the resulting effective volatility by a sum with power law weights. Using hourly data, the empirical properties of the new models are compared to existing models (GARCH, FIGARCH,), in particular log-likelihood estimates and volatility forecast errors.

The studies mentioned above have no doubt made the literature on Foreign Exchange Market .These studies have extensively helped the present study.

4. Need for the Study

Till date there has not been any perfect model to predict the volatility present in the Forex market because of the interdependent factors increasing the complexity of the forex market. There is immense need to manage the risk effectively and efficiently. Going through the vast literature on this topic, we found

1. The need to analyze the behavior of Foreign Exchange Rate with respect to time in context of Indian Foreign Exchange Market.
2. The need to identify any correlation between Foreign Exchange rate movements

5. Objectives of the Study

There are basically four objectives of this study:-

1. To measure the volatility of 3 currencies US Dollar, EURO and Japanese Yen.
2. To know a relative measure of the co-movement of Foreign Exchange Returns of Euro, Japanese Yen and US Dollar in Indian Forex Market.
3. To find the volatility distribution in these 3 currencies in Indian FOREX market.
4. To measure the skewness and kurtosis of the volatility distribution for the 3 currencies.

6. Research Design

6.1 Hypothesis of study

Hypothesis is being tested for 5 percent of significance level.
For testing the normality of the volatility of FOREX in Indian Market

1. HO: The Volatility of the YEN, USD and EURO is normally distributed.
2. HI: The Volatility of the YEN, USD and EURO is skewed.

6.2 Source of Data

The main data required for the study is the exchange rate of US Dollars, EURO and Japanese YEN in INR in the Indian Foreign Exchange Market. All this data is available from RBI bulletin published monthly. The same source also publishes monthly data on RBI's intervention in the forex market. Therefore, the study is done on the daily data. The daily average of bid and ask rates are taken as reference.

6.3 Scope of the Study

The data set consists of daily observations on spot exchange rates of the US dollar (USD) and Euro (EURO) and Japanese Yen (YEN) versus Indian Rupee (INR) for the period of 13 years, i.e. January 1, 1996 to 31 December, 2008.

7 Research Methodology;

7.1 Measure the volatility

Volatility is a measure of how far the current prices of an asset deviate from its average past prices. Here we measure volatility in Forex market for USD, EURO and YEN by measuring the mean and the variance in logarithm of change in their daily exchange rate. The greater the deviation, the greater is the volatility. Volatility can indicate the strength or conviction behind the price move.

The same process would be repeated for 5 day rate movements and 15 day price movements for the given 3 currencies.

7.2 Calculate the Skewness and Kurtosis of the given currencies volatility distribution

Skewness quantifies how symmetrical the distribution is. A distribution that is symmetrical has a skewness of 0. If the skewness is positive, that means the right tail is 'heavier' than the left tail. If the skewness is negative, then the left tail of the distribution is dominant.

Kurtosis quantifies whether the shape of the data distribution matches the Gaussian distribution. A Gaussian distribution has a kurtosis of 0. A flatter distribution has a negative kurtosis, and a more peaked distribution has a positive kurtosis. It is sometimes referred to as the "volatility of volatility."

7.3 Now apply JARQUE - BERA test for testing the normal distribution.

JARQUE - BERA - The Jarque-Bera test is used to check hypothesis about the fact that a given sample .x^ is a sample of normal random variable with unknown mean and dispersion. As a rule, this test is applied before using methods of parametric statistics which require distribution normality.

This test is based on the fact that skewness and kurtosis of normal distribution equal zero. Therefore, the absolute value of these parameters could be a measure of deviation of the distribution from normal. Using the sample Jarque-Bera statistic is calculated:

(There n is a size of sample), then p-value is computed using a table of distribution quantiles. It should be noted that as n increases, JB-statistic converges to chi-square distribution with two degrees of freedom, so sometimes in practice table of chi-square distribution quantiles is used. However, this is a mistake -convergence is too slow and irregular.

For example, even if n = 70 (which is rather big value) and having JB = 5 chi-square distribution quantiles gives us p-value^? = 0.08, whereas real p-value equals 0.045. So, we can accept the wrong hypothesis. Therefore it's better to use the specially created table of Jarque-Bera distribution quantiles. Now find the coefficient correlation of the Forex movement for the pair of USD/INR to USD/EURO and USD/INR to USD/YEN.

$$JB = \frac{n}{6}\left((Skew\ x_s)^2 + \frac{(Kurt\ x_s)^2}{4} \right)$$

8. Analysis and Interpretation of Data

8.1 Analysis of Volatility for US Dollar-INR

8.1.1) For daily volatility

mean of %age change in dollar	Skewness of dollar %age change	kurtosis	Jasque bera test
0.009509942	2.20329865	4.832197	5705.995

Table 8.1.1

From the results depicted in the Table 8.1.1 it can be inferred that:-

- The average of the percentage change in variation is approximately equal to 0 which reinforces the theory that when the time span is a very large period as in the above study equal to 13 years then the average of the variation in exchange price comes out to be 0.
- Skewness and kurtosis values for the daily variation in USD-INR exchange returns suggest that it is far from normal distribution which ideally should be 0 in case of Normal Distribution.
- The value of Jasque Bera = 5705.99 is clearly greater than the critical value of 5.99 for 95% for a = .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that the null hypothesis that the returns of USD-INR is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that the returns of • USD -INR are not normally distributed for the given time period of 13 years between 1996 to 2008.

8.1.2) For 5 daily volatility of USD

Mean of 5 day Volatility for USD	skewness of volatility distribution kurtosis	kurtosis	
0.078479025	1.512849857	2.00739	329.6124

Table 8.1.2

From the results depicted in the Table 8.1.2 it can be inferred that:-

- The average of the 5 day volatility in returns of exchange rate of USD-INK equal to 0.07 which is different from the mean of the volatility of daily returns.
- Skewness and kurtosis values for 5 day volatility in returns of exchange rate of USD-INR suggest that it is far from normal distribution which ideally should be 0 in case of Normal Distribution.
- The value of Jasque Bera — 329.16 is clearly greater than the critical value of 5.99 for 95% for a — .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that the null hypothesis that the returns of USD-INR is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that

the returns of USD -INR are not normally distributed for the given time period of 13 years between 1996 to 2008.

8.1.3) For 15 daily volatility of USD

mean of 15 day USD volatility	Skewness	Kurtosis	Jasque Bera test
0.151096018	1.361639212	1.630934	81.02938

Table 8.1.3

From the results depicted in the Table 8.1.3 it can be inferred that:-

- The average of the 15 day volatility in returns of exchange rate of USD-INR equal to 0.15 which shows an increase in the volatility compared to the weekly volatility and the daily volatility returns.
- Skewness and kurtosis values for 15 day volatility in returns of exchange rate of USD-INR suggest that it is far from normal distribution which ideally should be 0 in case of Normal Distribution.
- The value of Jasque Bera = 81.1 is clearly greater than the critical value of 5.99 for 95% for a = .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that the null hypothesis that the returns of USD-INR is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that the returns of USD -INR are not normally distributed for the given time period of 13 years between 1996 to 2008.

8.2 Analysis of Volatility for EURO-INR

8.2.1) For daily volatility

mean of daily returns in EURO	skewness	kurtosis	Jasque Bera test
0.010182663	0.121778276	-1.207102753	198.461

Table 8.2.1

From the results depicted in the Table 8.2.1 it can be inferred that:-

- The average of the percentage change in variation of EURO returns is approximately equal to 0 which reinforces the theory that when the time span is a very large period as in the above study equal to 13 years then the average of the variation in exchange price comes out to be 0.
- Skewness and kurtosis values for the daily volatility in EURO-INR exchange returns suggest that it is far from normal distribution which ideally should be 0 in case of Normal Distribution.
- The value of Jasque Bera = 198.46 is clearly greater than the critical value of 5.99 for 95% for a = .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that the null hypothesis that the returns of EURO-INR is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that the returns of EURO-INR are not normally distributed for the given time period of 13 years between 1996 to 2008.

8.2.2) For 5 daily volatility of EURO

Mean of 5 day Euro volatility	Skewness	Kurtosis	Jasque bera test
0.281424077	-0.096920754	-1.394408039	51.53066

Table 8.2.2

From the results depicted in the Table 8.2.2 it can be inferred that:-

- The average of the 5 day volatility in returns of exchange rate of EURO-INR equal to 0.28 which is 4 times the volatility of the returns of the USD weekly returns.
- Skewness and kurtosis values for 5 day volatility in returns of exchange rate of EURO-INR suggest that it is far from normal distribution which ideally should be 0 in case of Normal Distribution. The weekly volatility in EURO-INR exchange returns appear to be positively skewed and not normally distributed but in spite of its appearance its skewness is approximately equal to 0 but still its far from being normally distributed because of the large sample size and high value of kurtosis coefficient
- The value of Jasque Bera = 51 is clearly greater than the critical value of 5.99 for 95% for (X = .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that the null hypothesis that the returns of EURO-INR is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that the returns of EURO-INR are not normally distributed for the given time period of 13 years between 1996 to 2008.

8.2.3) For 15 daily volatility of EURO

mean of 15 day Euro volatility	Skewness	Kurtosis	Jasque Bera test
0.478703097	0.366110565	-1.07426424	14.50748

Table 8.2.3

From the results depicted in the Table 8.2.3 it can be inferred that:-

- The average of the 15 day volatility in returns of exchange rate of EURO-INR equal to 0.47 which is almost twice the volatility of the returns of the EURO weekly returns.
- Skewness and kurtosis values for 5 day volatility in returns of exchange rate of EURO-INR suggest that it is far from normal distribution which ideally should be 0 in case of Normal Distribution the weekly volatility in USD-INR exchange returns appear to be positively skewed and not normally distributed but in spite of its appearance , its skewness ,kurtosis and smaller number observations makes the Jasque Bera value of it very less and takes it very near to being a normal distribution
- The value of Jasque Bera = 14 is clearly greater than the critical value of 5.99 for 95% for a = .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that the null hypothesis that the returns of EURO-INK is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that the returns of EURO-INR are not normally distributed for the given time period of 13 years between 1996 to 2008

8.3 Analysis of Volatility for YEN-INR

8.3.1) For daily volatility

Mean of daily %age variation in return in YEN	skewness	Kurtosis	Jasque bera test
0.013663787	0.711247557	0.938488293	402.239

Table 8.3.1

From the results depicted in the Table 8.3.1 it can be inferred that:-

- The average of the percentage change in variation of EURO returns is approximately equal to 0 which reinforces the theory that when the time span is a very large period as in the above study equal to 13 years then the average of the variation in exchange price comes out to be 0.
- Skewness and kurtosis values for the daily volatility in YEN-INR exchange returns suggest that it is far from normal distribution which ideally should be 0 in case of Normal Distribution.
- The value of Jasque Bera = 402.23 is clearly greater than the critical value of 5.99 for 95% for a = .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that the null hypothesis that the returns of YEN-INR is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that the returns of YEN-INR are not normally distributed for the given time period of 13 years between 1996 to 2008.

8.3.2) For 5 daily volatility of YEN

mean of 5 day volatility of YEN	skewness	kurtosis	Jarsque bera test
0.002331595	0.165158735	1.54708	65.27545

Table 8.3.2

From the results depicted in the Table 8.3.2 it can be inferred that:-

- The average of the 5 day volatility in returns of exchange rate of EURO-INR equal to 0.002 which is approximately equal to 0 and is much less volatile compared to USD and EURO.
- Skewness and kurtosis values for 5 day volatility in returns of exchange rate of YEN-INR suggest that it is far from normal distribution which ideally should be 0 in case of Normal Distribution. The weekly volatility in YEN-INR exchange returns appear to be positively skewed and not normally distributed but in spite of its appearance its skewness is approximately equal to 0 but still its far from being normally distributed because of the large sample size and high value of kurtosis coefficient .
- The value of Jasque Bera = 65 is clearly greater than the critical value of 5.99 for 95% for a = .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that (.he null hypothesis that the ruiurus of YEN-INR is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that the returns of YEN-INR are not normally distributed for the given time period of 13 years between 1996 to 2008.

8.3.3) For 15 daily volatility of EURO

mean of 15 days volatility of yen	skewness of volatility	kurtosis	Jarque Bera test
0.003955885	0.241636394	1.12544	13.06399

Table 8.3.3

From the results depicted in the Table 8.3.3 it can be inferred that:-

- The average of the 15 day volatility in returns of exchange rate of YEN-INR equal to 0 approximately which makes it the least volatile for the weekly returns among the 3 currencies.
- Skewness and kurtosis values for 15 day volatility in returns of exchange rate of YEN-INR suggest that it is. close to normal distribution which ideally should be 0 in case of Normal Distribution. The weekly volatility in YEN-INR exchange returns appear to be positively skewed and not normally distributed but in spite of its appearance , its skewness ,kurtosis and smaller number observations makes the Jasque Bera value of it very less and takes it very near to being a normal distribution.
- The value of Jasque Bera = 13 is clearly greater than the critical value of 5.99 for 95% for a = .05 for 2 degrees of freedom obtained from Chi Square Distribution Table. This means that the null hypothesis that the returns of YEN-INR is normally distributed for the time period between 1996 and 2008 is rejected for the given confidence interval of 95% and we accept the alternate hypothesis that the returns of YEN-INR are not normally distributed for the given time period of 13 years between 1996 to 2008.

9. Analysis of Correlation between Exchange Rates of EURO and US Dollar

correlation of price movement of EURO and US Dollar	correlation of daily volatility in returns of EURO and US Dollar	correlation of volatility for 5 days of EURO and US Dollar	correlation of volatility For 15 days of EURO and US Dollar
0.202740428	0.35992	0.5108	0.5466995

Table 9.1

From the results depicted in the Table 9.1 it can be inferred that:-

- It's clearly visible from the above result that there is very weak form of positive correlation shown for the exchange rate movements of USD-INR and EURO-INR. We can say that there is hardly any correlation between the price movements of the given currencies under the preview of the study conducted for the exchange rates between the period i.e. jan, 1996 and dec,2008.
- Similarly there is a weak form of correlation between the daily volatility of the returns of USD-INR and EURO-INR. The correlation coefficient is not strong to give any particular inference.
- In case of 5 day and 15 day volatility in the return of the USD-INR and EURO-INR currencies, it is of semi strong form ranging between .50 to .55 which still is not concrete enough to form an opinion. Another important observation is that for the given set of currencies the correlation coefficient shows an increasing trend as the longer period volatility is considered.

10 Analysis of Correlation between Exchange Rates of Japanese YEN and US Dollar

correlation of price movement of US Dollar and YEN	correlation of volatility in return of US Dollar and YEN	correlation of 5 day volatility of US Dollar and YEN	correlation of 15 day volatility of US Dollar and YEN
0.752759422	0.3889306	0.436405202	0.423741363

Table 10.1

From the results depicted in the Table 10.1 it can be inferred that:-

- It's clearly visible from the above result that there is very strong form of positive correlation with correlation coefficient equal to .75 shown for the exchange rate movements of USD-INR and YEN-INR. We can say that the result is strong enough to deduce that the exchange rate movements of YEN and USD are much more strongly correlated as compared to the exchange rate movement of EURO and USD, under the preview of the study conducted for the exchange rates between the period i.e. jan,1996 and dec,2008.
- But in the case of correlation of daily volatility of USD and Yen exchange rate, there is a weak form of correlation between the daily volatility of the returns of USD-INR and YEN-INR. The correlation coefficient is not strong to give any particular inference.
- In case of 5 day and 15 day volatility in the return of the USD-INR and YEN-INR currencies, it is of semi strong form ranging between .40 to .45 which still is not concrete enough to form an opinion. Another important observation is that for the given set of currencies the correlation coefficient shows an increasing trend as the longer period volatility is considered.

11. Conclusion

From the results obtained from the analysis done in the study of foreign risk management we can conclude that the exchange rate of EURO is much more volatile than the YEN and US Dollar in the Indian foreign exchange market when comparing their daily volatilities. For all the 3 currencies under this study, we find generally an increasing trend in volatility when volatility is compared along the different time span taken into consideration such as from daily to weekly to monthly.

Similarly for the average returns in the Indian foreign exchange market for all the 3 currencies studied comes out to be 0 , which reinforces the theory in longer period the average return is equal to 0.

As far as correlation between the price movements of a pair of currency is concerned, we conclude that the price movement of YEN - USD is very strongly correlated but apart there is no other striking result could be concluded.

12. Limitations of the study

a) Exchange rate currencies chosen for the above study is based not on the importance of the currency but on the volumes traded in the foreign exchange market of India.
b) The time span of 13 years has been assigned for the research because of the non availability of the data on exchange rate of EURO.
c) The Exchange rate used for the is the average of the ask and bid rate for that given day, so the results may vary in actual.

d) The data collected is from the website of RBI, so it may vary from the actual rate prevalent in the foreign exchange market of India.
e) The Jasque Bera test applied in this study is still not widely acclaimed by Researchers so the reliability of the results is not guaranteed.
f) It does not permit progression of formulating research question to designing methods for answering that question.
g) The Secondary researcher can not engage in making observations and developing concepts.

13. Abbrevations

INR	Indian rupee
USD	United States Dollar
YEN	Japanese Yen
EURO	European currency
IMF	International Monetary Fund
RBI	Reserve Bank of India
USA	United States of America
VAR	Vector auto regression

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