Chapter 5

Research Methodology

In the previous chapters, evidence for and against the efficient market hypothesis in foreign and Indian stock market has been reviewed. This chapter deals with the methodology employed in this study to investigate the stock price responses to quarterly earnings announcements. In this chapter, we discuss the investigation method, procedure used for data collection, criteria for sample selection, data source, research design, selection of market index as a proxy to market portfolio, method used for classification of companies into portfolio, the choice of model, method employed to calculate residuals, and choice of interval. The problem of infrequent trading and method used to adjust infrequent trading are also discussed.

The semi-strong form of the efficient market hypothesis asserts that stock prices adjust instantaneously and in an unbiased fashion to new information and it is not possible to earn consistently abnormal return by trading on that information, except by chance. Therefore, empirical studies on the semi-strong form of efficient market hypothesis examine the speed and accuracy of adjustment of stock prices to publicly available information. Publicly available information in quarterly earnings announcements is measured by the changes in the quarterly earnings. Therefore, empirical studies on the semi-strong form of efficient market hypothesis is concerned with whether stock prices ‘fully reflect’ all the publicly available information immediately. If the stock price adjustments to quarterly earnings announcements are instantaneous, then there should not be any scope to earn abnormal returns. Consequently, testing of the efficient market hypothesis with respect to quarterly earnings announcements requires estimation of changes in quarterly earnings and the abnormal returns following the announcement of those earnings. Over the years, a number of methods have been used to investigate the stock price responses to earnings announcements. All of these methods can be broadly classified into two categories. The first category called ‘event study methodology’ is based on the identification of price sensitive specific events such as earnings announcements, stock splits, issue of bonus shares, rights issue, buyback of shares, mergers and acquisitions, etc, common to all the firms. That is why Fama (1991) referred to tests concerning semi-strong form as ‘event studies’.

Cumulative average abnormal returns for the sample firms are
calculated either on a daily, weekly or monthly basis both before and after the event day. Presence of cumulative average abnormal returns rejects semi-strong form of efficient market hypothesis and vice versa. The second category of method directly tests whether an investment strategy such as investing in stock with low price earning (P/E) ratio or having small market capitalisation formulated on the basis of publicly available information produces returns in excess of those warranted by the portfolio. If a strategy based on publicly available information enables an investor to beat the market, then there is evidence against the semi-strong form of market efficiency. However, if no such strategy can be formulated, then the market is considered to be efficient in the semi-strong form.

In this study, each stock is analysed in pre- and post-announcement periods. Date of quarterly earnings announcement is defined as day 0 or event day. If event day is non-trading day, immediate next trading day is considered as day 0 or event day. Pre-announcement period includes 30 trading days prior to the quarterly earnings announcement date, i.e., days -30 to -1. Post announcement period includes 30 trading days after the quarterly earnings announcement date, i.e., days +1 to +30. Since this study is concerned with measuring abnormal returns around the date of quarterly earnings announcement, 'an event' it is also called 'event study'.

5.1 Data Collection

Researchers, over the years have used monthly, weekly or daily data to study the impact of price sensitive information on stock prices. However, use of monthly or weekly data does not provide precise evidence of time of adjustment of stock prices to the new information. Therefore, daily-adjusted stock returns are used in this study to fulfill the need of the 'precise evidence'.

According to the requirements, three sets of data are used in this study. The first set of data consists of quarterly earnings announcement made by the sample companies. This includes the dates on which the Board of Directors meets and approves quarterly financial results of the company. The second set of data consists of daily-adjusted closing prices of the stocks selected for the study at the Bombay Stock Exchange for the period covered by this study. Daily-adjusted closing prices are used in the study as these are assumed to reflect the consensus of the market participants regarding price of the stock at the end of the trading. The third set consists of the BSE-200 index of ordinary share prices compiled and published by the Bombay Stock Exchange.
Exchange on daily basis with 1989-90 as the base year. Though several other stock price indices are also available to represent market movement, BSE-200 index is preferred over these indices for three reasons. First, it is compiled on daily basis, secondly, it is a market value weighted index number, and thirdly, it is a broad based index with 200 stocks. A detailed discussion regarding the selection of BSE-200 index as proxy to market portfolio is given later in the chapter.

5.2 Sample Selection and Data Sources

The sample of stocks selected for the study is selected from the stocks listed on the Bombay Stock Exchange and which meet the following criteria:

1. The firm should have at least 20 percent foreign holdings for the quarter ended March 31, 2004.
2. The firm should have been continuously listed and traded on the Bombay Stock Exchange for the period from June 2000 to June 2004.
4. The dates on which quarterly financial results were announced are available either from www.bseindia.com, www.capitalmarket.com, or from the press release/advertisement by the companies in The Economic Times, magazines like Capital Market and Dalal Street.
5. The company has no price sensitive news announcement other than the publication of quarterly financial results during the event window, i.e., 30 trading days before and 30 trading days after the date of announcement of quarterly financial results.

The first criterion of only those companies, which have at least 20 percent of foreign holdings have been chosen because these companies ensure that there are considerable activities in these shares. The second criterion of continuously listing at the stock exchange ensures data comparability across firms. The third criterion ensures availability of quarterly financial results for all the sample companies for all the quarters covered in the study. The fourth criterion helps in the determination of time of arrival of quarterly financial results to the market, a critical factor in this type of study. The fifth criterion is to ensure that the price sensitive information other than the quarterly earnings information do not affect the conclusions of the study.
this period the company has price sensitive news announcement such as bonus issue, rights issue, public issue, stock split, buy back of shares, mergers, takeover, and demerger, etc then for that quarter that particular company is excluded from the study.

The study covers the earnings announcements of seventeen quarters, from June 2000 to June 2004. Majority of the companies are included for all the 17 quarters except a few companies, which declared price sensitive information other than quarterly earnings within the event window, are excluded from that quarter. However, in the case of Infosys Technologies Ltd, mergers and takeover are common phenomenon for almost all the quarters, these events are ignored. The announcement of quarterly financial results was made mandatory by incorporating it as a clause in the listing agreement in 1998. However, many companies took time to abide by the new requirement. In several cases, exchange authorities had to issue notices to those companies, which did not announce their quarterly financial results as per listing agreement as to why action should not be taken against them for not adhering to the new regulation. In view of the non-announcement of quarterly financial results by several companies in time initially, that period was excluded from the study. Quarterly financial results and the dates of their announcements have been taken from the websites like www.bseindia.com, and www.capitalmarket.com. In a few cases where this information was not available we scanned The Economic Times, Capital Market and Dalal Street to obtain the required information. Similar procedure was adopted for the non-result related price sensitive information announced during the event window i.e. 30 days before and 30 days after the announcement of quarterly financial results.

Though initially the sample size was 317 companies having foreign holdings of 20 percent or more, at the end only 156 companies met the selection criteria and considered as sample size. Of the 317 companies, in the case of 123 companies the gap between two board meetings was less than 30 trading days, 2 companies were delisted from the BSE during the study period, 22 companies were merged or taken over by some other companies, in the case of 4 companies no proper records were found, in the case of 2 companies consecutive zero returns were more than 20 percent of total zero returns, and 8 companies traded less than 40 percent of total trading days. However, care is taken to have a wide representation of all the important industries, companies with low and high price earnings ratios, both big and small companies on
the basis of market capitalisation as well as companies included in the indices like BSE sensex, BSE 100 and BSE 200. Of the 156 companies, 62 companies (39.73 percent) belong to A group, 91 companies (58.32 percent) belong to B-1 group, and 3 companies (1.96 percent) belong to B-2 group.

5.3 Research Design

In the study of semi-strong form of efficient market hypothesis the time at which the quarterly financial results are released to the market is a critical factor. The listing agreement requires each company to make an announcement of its quarterly financial results within 48 hours of the conclusion of the meeting of the Board of Directors. The announcement is to be made in at least one national English language daily newspaper as well as in a newspaper published in the language of the region where the registered office of the company is situated. In this study with a view to maintain comparability across companies, the results are assumed to have been conveyed to the market on the date the Board of Directors meets to finalise and take the results on record to release these to the market. The date of conveying of quarterly financial results to the market is called the ‘event day’ and is defined as day 0. The event day or day 0 is not the same date for all companies. Even for the same quarter day 0 may correspond to different dates for different companies depending upon the date on which Board of Directors meet to consider the quarterly financial results of the company. Day +1 is defined as the trading day immediately following the event day and day −1 is trading day immediately preceding the event day. The period of 61 trading days, i.e., 30 trading days before, 30 trading days after the event day and the event day is the ‘event window’ during which the stock price responses to the event is examined. The market may start anticipating quarterly financial results, or the information regarding the quarterly financial results may leak out well before these are officially conveyed to the market leading to revision of the estimates of probability distribution of stock prices. Thus, stock prices may start responding well before the official announcement of quarterly financial results. That is why, the responses of the stock prices are examined 30 trading days before the event day. Though the choice of the ‘event window’ i.e., 30 trading days before and 30 trading days after the event day is arbitrary, a period of 30 trading days before the announcement of quarterly financial results is considered appropriate to capture the effect of leakages of information regarding financial performance of the firm or their
anticipation by the market. Similarly, post-announcement period of 30 trading days are considered sufficient to absorb fully the information contained in the quarterly financial results.

5.4 Selection of Market Index

Stock market index is a single figure that sums up a number of factors in each time period, thereby facilitating the measurement of change that may have occurred since an earlier period. There is a mushroom growth in the number of stock price indices in India. Stock price indices have become significant because of introduction of index based derivative products. Market index numbers are constructed to represent and to know the movement in the stock market. The percentage change in the stock index represents the market rate of return. In order to indicate the movement in the stock market in an unbiased manner, the index should be well designed. The sample of firms selected for the purpose of compilation of the index should be representative of all the listed firms and the industries. At present many agencies compile and publish index numbers of stock prices in India. Prominent of them are index numbers published by the Bombay Stock Exchange, National Stock Exchange, The Economic Times and the Reserve Bank of India. These index numbers can be differentiated on the basis of their coverage and method of compilation. The Bombay Stock Exchange compiles indices based on the “Free float Market Capitalisation” methodology, which is globally accepted and considered as the best method. Free float market capitalisation refers to an index construction methodology that takes into consideration that proportion of total shares issued by the company, which are readily available in the market for trading. It generally excludes shares held by promoters, government, strategic holding and other locked in shares, which will not come to the market for trading in the normal course. The Economic Times compute indices as the simple arithmetic mean of price relatives without considering weights. The advantages of free float market capitalisation methodology are such that it not only reflects the market trends in a more rational manner, but also helps both active and passive investing styles. It also assists active managers by enabling them to benchmark their fund returns vis-à-vis an investable index. Free-float index is best suited for the passive managers as it enables them to track the index with the least tracking error. The Economic Times indices being computed without assigning weight to its constituent firms that is why it is not considered appropriate for...
measuring the performance of the market. Even though the RBI made several modifications in the computation of the stock prices indices in the form of shifting of base year, increasing of coverage of stocks and industries, etc., it is not a popular index. Therefore, the choice was restricted to the index numbers compiled and published by the Bombay Stock Exchange (BSE).

The Bombay Stock Exchange compiles and publishes five categories of indices of stock prices. They are: (i) BSE Sensitive Index of Equity Prices comprising 30 stocks from specified and non-specified categories of the companies listed on the Bombay Stock Exchange with 1978-79 as the base year. Bombay Stock Exchange started compiling and publishing the BSE sensex from January 2, 1986. The sensex was initially calculated based on the “Full Market Capitalisation” methodology, in which the total market capitalisation of a company, irrespective of how many shares are readily available for trading in the market, is taken into consideration for computation of index. But with effect from September 1, 2003, it was shifted to free float market capitalisation. (ii) BSE 100 index comprising of 100 stocks from the specified and non-specified groups with 1983-84 as the base year. The criteria for selection of stocks have been market activity, representation of various industry groups and frequency of trading. Bombay Stock Exchange started compilation and publication of BSE-100 from January 3, 1989. The method of computation of free float index and determination of free float factor is similar to the BSE Sensex. (iii) On May 27, 1994, Bombay Stock Exchange launched BSE-200 broad-based index to reflect the overall market trends in a more effective manner and to provide more representation to the newly emerged industry groups. The ‘BSE-200’ includes a total number of 200 shares. The ‘BSE-200’ index is computed with 1989-90 as the base year. The shares have been selected from the specified and non-specified groups of stocks listed at the BSE. The selection of companies has been made on the basis of market capitalisation, volume of turnover, and on the basis of certain other fundamental factors of the companies. The method of computation is similar to BSE Sensex. (iv) The Bombay Stock Exchange has constructed BSE 500, consisted of 500 stocks by taking into consideration the changing pattern of the economy and that of the market. This index came into existence with effect from August 9, 1999, and represents nearly 97 percent of the total market capitalisation on the BSE and 20 major industries of the economy. The base year for this index is 1998-99. (v) With effect from August 23, 2004, BSE also started “Sectoral Series (90/FF)” indices with a
view to provide quality sector benchmarks in India. Here “90/FF” implies that the index covers 90 percent of the sectoral market capitalisation and is compiled based on free float capitalisation methodology. BSE sector series are: BSE Auto Index, BSE BANKEX, BSE Capital Goods Index, BSE Consumer Durables Index, BSE FMCG Index, BSE Healthcare Index, BSE IT Index, BSE Metal Index, BSE Oil & Gas Index. All these sectoral indices are calculated on the basis of free float methodology and displayed on the BOLT system on the real time basis.

A comparison of all the indices explained above revealed that theoretically BSE 500 is the most comprehensive index. It is based on the 500 stocks as compared to 200 stocks used for the BSE-200 and 100 stocks for the BSE-100. The BSE sensitive index is based on only 30 shares some of which are having a very large market capitalisation. Therefore, its movements are sensitive to only 30 shares included in the sample, which may not represent the true market movement. On the other hand, BSE-500 represents approximately 97 percent of the total market capitalisation. However, BSE-500 Index data is available only from August 9, 1999, the day when it was implemented, which limits its usefulness for the present study. The next choice is the BSE-200 index. It is a broad based index and is expected to follow closely the BSE-500 index. Hence, it can be used as a proxy to the market movement. Therefore, BSE-200 Index is used in this study to proxy the market movement.

5.5 Classification of Companies into Portfolio

In this study an attempt has been made to test the semi-strong form of efficient market hypothesis by examining stock price responses to quarterly earnings announcement. It is believed that earnings numbers convey a lot of information to investors, and the price changes induced by them would be in opposite direction for positive and negative unexpected earnings. Efficient market hypothesis holds that the reaction of stock prices subsequent to the earnings announcements is instantaneous and is in the right direction. If actual earnings were less than expected earnings, negative abnormal returns would result. Conversely, when actual earnings are more than expected, positive abnormal returns should occur.

In the present study two variables - net profit and net sales – are taken as a base for the construction of portfolio. The method used for the classification of companies into portfolio consists of dividing the companies into two portfolios on the
basis of percentage changes in quarterly earnings (net profit) and net sales. The percentage changes in net earnings in the current quarter over corresponding quarter in the previous year is ascertained in the following way:

\[
\text{Current quarter net earnings - Corresponding quarter net earnings in the previous year} \times 100
\]
\[
\text{Corresponding quarter net earnings in the previous year}
\]

The percentage changes in net sales in the current quarter over corresponding quarter in the previous year is ascertained in the following way:

\[
\text{Current quarter net sales - Corresponding quarter net sales in the previous year} \times 100
\]
\[
\text{Corresponding quarter net sales in the previous year}
\]

Thus, on the above basis we classified companies into three portfolios. The first portfolio includes firms with positive percentage change in net earnings (net profit) and net sales, "good news" portfolio. The second portfolio contains firms with negative percentage change in net earnings (net profit) and net sales, "bad news" portfolio. The third is the overall portfolio, which includes all the firms selected as sample for the study. In case a particular firm's percentage changes in net profit is positive and net sales is negative and vice versa, in that situation the sign of percentage change in the net profit is considered as a criterion to include that firm in the portfolio. If the percentage changes in net profit are zero, though such cases are very rare, the criteria used is the change in the net sales. If the changes in the net sales are positive, it is considered as good news, and positive and the firms are included in the good news portfolio. If the changes in the sales are negative, it is considered as bad news, and the firms to be included in the bad news portfolio. In the present study there are three companies with zero percentage difference in net profit. Out of these three companies, for two companies percentage changes in net sales are positive and for one company it is negative. Of the three companies, two companies are included in the good news portfolio and one is included in the bad news portfolio. In this process the same company may not be included in the same portfolio for all the quarters. If in the subsequent quarters the sign of percentage changes in net profit and net sales of the company changes, it is included in the appropriate portfolio. The same procedure is followed for all the quarters throughout the study. In other words, the
portfolio to which a particular stock in a particular quarter belongs depends upon the sign of its percentage changes in net profit and net sales in that quarter.

The number of companies included in the positive percentage changes in net profit and net sales, good news portfolio, negative percentage changes in net profit and net sales, bad news portfolio and all the companies selected for the study, and overall portfolio for each quarter are presented in the Table 5.1, 5.2 and 5.3 respectively.

**Table 5.1: Number of Companies Included in the Good News Portfolio**

<table>
<thead>
<tr>
<th>Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter</td>
<td>No of Companies</td>
<td>No of Companies</td>
<td>No of Companies</td>
<td>No of Companies</td>
</tr>
<tr>
<td>March</td>
<td>77</td>
<td>70</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>74</td>
<td>100</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>66</td>
<td>81</td>
<td>106</td>
<td>------</td>
</tr>
<tr>
<td>December</td>
<td>71</td>
<td>91</td>
<td>100</td>
<td>------</td>
</tr>
</tbody>
</table>

Notes:
1. The good news portfolio includes firms with positive percentage change in net earnings and net sales. That is why in the case of good news portfolio the study covers a period from June 2001 to June 2004.
2. March quarter indicates the period from January to March, June quarter indicates the period from April to June, September quarter indicates the period from July to September, December quarter indicates the period from October to December.
3. For March 2001 quarter percentage change in net earnings and net sales were not available for all the selected companies, that is why it is excluded from the study.
4. September and December 2004 quarters are not included in the study.

**Table 5.2: Number of Companies Included in the Bad News Portfolio**

<table>
<thead>
<tr>
<th>Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter</td>
<td>No of Companies</td>
<td>No of Companies</td>
<td>No of Companies</td>
<td>No of Companies</td>
</tr>
<tr>
<td>March</td>
<td>------</td>
<td>76</td>
<td>75</td>
<td>48</td>
</tr>
<tr>
<td>June</td>
<td>76</td>
<td>78</td>
<td>55</td>
<td>61</td>
</tr>
<tr>
<td>September</td>
<td>83</td>
<td>67</td>
<td>45</td>
<td>------</td>
</tr>
<tr>
<td>December</td>
<td>81</td>
<td>62</td>
<td>53</td>
<td>------</td>
</tr>
</tbody>
</table>
Notes
1. The bad news portfolio includes firms with negative percentage change in net earnings and net sales. That is why in the case of bad news portfolio the study covers a period from June 2001 to June 2004.
2. For March 2001 quarter percentage change in net earnings and net sales were not available for all the selected companies, that is why it is excluded from the study.
3. September and December 2004 quarters are not included in the study.

Table 5.2: Number of Companies Included in the Overall Portfolio

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>----</td>
<td>150</td>
<td>153</td>
<td>145</td>
<td>144</td>
</tr>
<tr>
<td>June</td>
<td>150</td>
<td>150</td>
<td>152</td>
<td>155</td>
<td>155</td>
</tr>
<tr>
<td>September</td>
<td>151</td>
<td>149</td>
<td>148</td>
<td>151</td>
<td>----</td>
</tr>
<tr>
<td>December</td>
<td>146</td>
<td>152</td>
<td>153</td>
<td>153</td>
<td>----</td>
</tr>
</tbody>
</table>

Notes
1. In the case of overall portfolio the study covers a period from June 2000 to June 2004.
2. For March 2000 quarter earnings announcements were not available for all the selected companies that is why it is excluded from the study.
3. September and December 2004 quarters are not included in the study.

5.6 The Choice of Model

Different researchers have used different variants of the basic residual analysis methodology to study efficient market hypothesis. In all the studies, they have calculated abnormal returns by subtracting the expected rate of return from the actual rate of return (actual returns - expected returns). The level of abnormal returns depends upon the return-generating model used to predict the stock’s expected rate of return, the market factors and the parameters like alpha and beta. Even though there are several variants of the market and risk adjusted returns, market models are used in different studies by different researchers to ascertain abnormal return. The commonly used models and the researchers who used these models are given below:

\[ \Delta R_t = R_t - R_{mt} \]  \hspace{1cm} (1)


\[ A_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \] (2)


\[ A_{it} = R_{it} - \bar{R}_i \] (3)

Marsh (1979), Chaturvedi (2001) used the above model

\[ AR_{it} = R_{it} - \left( (1 - \beta_i) R_{ft} + \beta_i R_{mt} \right) \] (4)


\[ AR_{it} = R_{it} - \left( \alpha_i + \beta_i + R_{mt} \right) \] (6)

Choosing between these models is a difficult task. While selecting the model from among alternative models, the relative merits and deficiency of each model is to be considered Brown and Warner (1980) in a comparison of different methodologies, which have been used in the event studies, concluded thus

"Beyond a simple, one factor market model, there is no evidence that more complicated methodologies convey any benefit In fact, we have presented evidence that more complicated methodologies can actually make the researcher worse off." (p 249)

In this study, market model developed by Sharpe (1963) and subsequently used by many researchers is used to calculate expected returns Further, in addition to raw returns we also used log returns
5.7 Residual Analysis Methodology

We have used a two-stage approach to test the stock price responses to quarterly earnings announcement. The first stage consists of estimation of parameters like alpha, beta based on the ex-post returns on stocks and market index, and expected returns on each of the stocks based on the market model. In the second stage, these estimated parameters are used to calculate abnormal returns around the event day. In this study, the date of quarterly earnings announcement is defined as day 0 or event day. If event day is a non-trading day then the immediate following trading day is considered as event day. Pre-announcement period includes 30 trading days prior to the earnings announcement date, i.e., days -30 to -1. Post announcement period includes 30 trading days after the earnings announcement, i.e., days +1 to +30. Thus, we have taken the event window of 61 trading days (including day 0 as the event day). The estimated abnormal returns are averaged across securities to calculate average abnormal returns (AARs) and average abnormal returns are then cumulated over time in order to ascertain cumulative average abnormal returns (CAARs).

The returns of each security are divided into two parts. These are those returns, which can be attributed to market movement and those, which cannot be attributed to market movement but to quarterly earnings announcement. In order to measure the stock price responses to the quarterly earnings announcement or the event, market influence in stock’s observed rate of return is to be eliminated. The methodology employed for the purpose is called the ‘Residual Analysis Methodology’ since it involves calculation of residuals defined as that part of stock’s returns which is not explained by movement of the market. These residuals are explained by the event-related news of a particular company for which these are calculated. As transaction costs have become insignificant after the introduction of dematerialisation and online trading in the Indian stock market, they have been ignored in this study while calculating the expected returns (ER), abnormal returns (AR), AAR and CAAR.

Market model is used to measure the returns of stock that is related to market movement. Market model was developed and suggested by Sharpe (1963). Many researchers, cited above, to determine the expected return on stock, have extensively used this model. The market model is based on the fact that the most important factor affecting stock’s returns is market factor and it is captured in the market model in the form of beta (β). It is a simple model to analyse the risk component of stocks in terms of systematic and unsystematic risks. Thus, the market model relates the return on any
stock or portfolio of securities to the return on the 'market portfolio' in a linear fashion. The actual tests are not performed on the daily prices of securities and stock index but on the first differences, which are termed as returns in these types of studies. Mathematically, the market model can be expressed as:

$$E(R_{it}) = \alpha_i + \beta_i R_{mt} + e_{it}$$

for \( i = 1, N \)

- \( E(R_{it}) \) = Expected return on security 'i' during time period 't'
- \( \alpha_i \) = Intercept of a straight-line or alpha coefficient of 'i' security
- \( \beta_i \) = Slope of a straight-line or beta coefficient of 'i' security
- \( R_{mt} \) = Expected return on index (BSE 200 Index in this study) during period 't'
- \( e_{it} \) = Error term with a mean zero and a standard deviation which is a constant during time period 't'. This term captures the variations that are not captured by the market index. It is assumed that this term satisfies the usual assumptions of Ordinary Least Square (OLS) regression line.

Thus, the market model divides a security return into two components, a systematic component (\( \beta_i R_{mt} \)) and an unsystematic component (\( e_{it} \)). The systematic component measures the impact of general market movement, and unsystematic component, also called the error term, measures the impact of micro event on the rate of return of individual security. Thus, the error term is a firm-specific component. In this study, quarterly earnings announcements is a firm-specific component. The market model is not as sophisticated conceptually as the CAPM but is consistent with the CAPM because it also assumes a linear relationship between return and risk of a security, which is measured by beta coefficient. Market model does so without incorporating unrealistic assumptions of the CAPM.

The logarithmic form of the model, which was used, by Fama, Fisher, Jensen and Roll (1969) is also used in this study in addition to the above model to ascertain that our results do not arise because of use of simple general equilibrium model. The model used in this is as follows:

$$\log_e R_{it} = \alpha_i + \beta_i \log_e L_t + u_{it}$$

Where,
- \( R_{it} \) = Price relative of security 'i' during time period 't'
- \( \alpha_i \) = Intercept of a straight-line or alpha coefficient of 'i' security
- \( \beta_i \) = Slope of a straight-line or beta coefficient of 'i' security
- \( L_t \) = Index relatives (BSE 200 Index in this study) during period 't'
\( u_t = \) Error term with a mean zero and a standard deviation which is a constant during time period 't'. This term captures the variations that are not captured by the market index. It is assumed that \( u_t \) satisfies the usual assumptions of the linear regression model. That is, (a) \( u_t \) has zero expectation and variance independent of 't', (b) the \( u_t \) are serially independent, and (c) the distribution of \( u_t \) is independent of \( \log_e L \).

The natural logarithm of the security price relative is the rate of return with continuous compounding for the day in question; similarly, the log of the market index relative is approximately the rate of return on a market portfolio. The formula for calculating the returns using the log normal distribution is given subsequently in this chapter. Thus, the above model represents the daily rate of return on an individual security as a linear function of the corresponding return for the market. The actual tests are not performed on the daily prices of securities and stock index but on the natural logarithms of their price relatives. According to Fama (1965)

"There are three main reasons for using changes in log price rather than simple price. First, the change in log price is the yield, with continuous compounding, from holding the security for that day. Secondly, the variability of simple price changes for a given stock is an increasing function of the price level of the stock and logarithms seem to neutralise most of this price level effect. Thirdly, for changes less than ±15 percent the change in log price is very close to the percentage price change, and for many purposes it is convenient to look at the data in terms of percentage price changes." (p 45-46)

We need the values of \( \alpha \), and \( \beta \), to estimate the expected returns. Therefore, the following simplified model of regression is used for estimating the returns on each security by taking the actual returns on market, \( R_{mt} \):

\[
\text{Expected Return} = E(R_{it}) = \alpha_t + \beta_t R_{mt}
\]

Calculation of abnormal returns is necessary to know the existence of market efficiency. Abnormal returns are defined as the excess of actual returns of a security over the expected returns. The expected returns are related to the market movement as per the market model used above. The error term \( e_t \) in the market model represents the residual, or abnormal return, for the security 'i' at time 't', which is equal to the realised return \( R_{it} \) minus expected rate of return. The abnormal returns are computed using the following model:

\[
AR_{it} = e_{it} = R_{it} - E(R_{it})
\]
Where,

\[ R_t = \text{Actual Returns} \]

These excess returns can be used to test whether individual securities have earned abnormal returns or not. This method of estimating abnormal returns is referred to as "residual analysis", since the regression equation represents a normal return and the residuals in the equation represent the abnormal returns (Fuller and Farrell, Jr., 1987, p 105). Abnormal returns indicate the existence of market inefficiency. But very often, individual security returns are affected by external factors and may not give an indication of trends in other securities. Therefore, in order to avoid the effect of any one or any group of securities on the abnormal returns; the abnormal returns are averaged over the number of securities in each portfolio. The abnormal returns of individual security are averaged for each day surrounding the event day (i.e., 30 days before and 31 days after the event day). The AAR is the average deviation of actual returns of a security from the expected returns.

The following model is used for computing the average abnormal returns (AARs):

\[
\text{AAR}_{it} = \frac{\sum_{t=1}^{N} AR_{it}}{N} \quad \text{For} \quad 1 = 1 \quad N, \quad t = -30 \ldots +30
\]

Where,

1 = the number of securities in the study

N = total number of securities

t = the days surrounding the event-day

Since the security's overall reaction to the quarterly earnings announcement or the event will not be captured instantaneously in the average abnormal return behaviour for one specific day, it is necessary to accumulate the abnormal returns over a long period. The cumulative average abnormal return (CAAR) is chosen as a measure of cumulative abnormal performance. Cumulative average abnormal returns (CAAR) are to be calculated for the 30 days before and 30 days after the event. The CAAR is calculated by adding the average abnormal returns (AARs) for each time period beginning 30 days before the event day and ending 30 days after the event day. It gives an idea about average stock price behaviour over time. Generally, if market is efficient, the CAAR should be close to zero [Brown and Warner (1980, 1985), Fuller...
5.8 Parametric Significance Test

The cumulative average abnormal return provides information about the average price behaviour of securities during the event window. If markets are efficient, the AARs and CAARs should be close to zero. Parametric ‘t test’ is used to assess significance of AARs and CAARs. The 5% level of significance with appropriate degrees of freedom was used to test the null hypothesis of no significant abnormal returns after the event day. The conclusions are based on the results of t values on AARs and CAARs for the event window. The t test statistics for AAR for each day during the event window is calculated as

\[ t = \frac{AAR}{\sigma(AAR)} \]

Where,

- \( AAR \) = Average abnormal return
- \( \sigma(AAR) \) = Standard error of average abnormal return

The t statistics for CAAR for each day during the event window is calculated by using following formula

\[ t = \frac{CAAR}{\sigma(CAAR)} \]

Where,

- CAAR = Cumulative average abnormal return
- \( \sigma(CAAR) \) = Standard error of cumulative average abnormal return

The standard error is calculated by using following formula

\[ SE = \frac{\sigma}{\sqrt{n}} \]

Where, \( SE \) = Standard Error

\( \sigma \) = Standard Deviation

\( n \) = Number of Observations
5.9 Non-Parametric Significance Test

Brown and Warner (1985) showed that the parametric t test is well specified under the null hypothesis of no abnormal performance. However, t test makes the assumption that security returns are normally distributed. If such an assumption is not met, then the sampling distribution of test statistics assumed for the hypothesis tests could differ from actual distribution, and false inferences could result. Moreover, if the distribution of the test statistics is misspecified, then the null hypothesis, when true, could be rejected. Therefore, to avoid the restricted assumption of a particular distribution, which a parametric test makes, we have used the non-parametric runs test and sign test in addition to t test.

5.9.1 Runs Test

Runs test has been used to analyse the randomness in the behaviour of AARs. According to Levin and Rubin (2002) “A run is a sequence of identical occurrences preceded and followed by different occurrences or by none at all” (p 813). Runs test is performed to test the null hypothesis that AARs occur randomly. If the observed runs are not significantly different from the expected number of runs, then it is inferred that AARs occur randomly. On the other hand, if this difference were statistically significant, it would be regarded, as AARs do not occur randomly. We carried out runs test on AARs before and after the event day and also for the event window.

Mean number of runs computed using the following method:

\[ \mu_r = \left( \frac{2n_1n_2}{n_1+n_2} \right) + 1 \]

Where,

- \( \mu_r \) = Mean number of runs
- \( n_1 \) = Number of positive AARs
- \( n_2 \) = Number of negative AARs
- \( r \) = Number of runs (actual sequence of counts)

The standard error of the expected number of runs can be computed by using the following formula:

\[ \sigma_r = \sqrt{\frac{2n_1n_2(n_2-n_1-n_2)}{(n_1+n_2)(n_1+n_2-1)}} \]
A standardised variable 'Z' as under can express the difference between actual and expected number of the runs.

\[ Z = \frac{r - \mu_r}{\sigma_r} \]

The null hypothesis (AARs occur randomly) will be accepted (or rejected) at 5% level of significance against (or in favour of) the alternative hypothesis (AARs do not occur randomly) depending on whether computed values of Z is within the range of critical value of ±1.96.

### 5.9.2 Sign Test

In this study we also used non-parametric 'sign test' which do not make the restrictive assumption that security returns are normally distributed. In the sign test positive or negative signs are used instead of quantitative values. We carried out sign test on AARs to test the null hypothesis that there is no significant difference between the number of positive and negative AARs

First we have to calculate the standard error of the proportion (\( \sigma_p \))

\[ \sigma_p = \sqrt{\frac{pq}{n}} \]

Where,

- \( \sigma_p \) = Standard error of the proportion
- \( P \) = Expected proportion of positive AARs = 0.5
- \( q \) = Expected proportion of negative AARs = 0.5
- \( n \) = Number of AARs

To compute the value of sign test we used the following equation:

\[ Z = \frac{\bar{P} - P_{Ho}}{\sigma_p} \]

Where,

- \( \bar{P} \) = Actual proportion of AARs in the respective quarters having positive signs
- \( P_{Ho} \) = Hypothesised proportion = 0.5

We calculated sign test statistics before and after the event day and also during the event window.

The null hypothesis that there is no significant difference between the number of positive and negative AARs will be accepted (or rejected) at 5% level of significance against (or in favour of) the alternative hypothesis that there is a
significant difference between the number of positive and negative AARs depending on whether computed values of $Z$ is within the acceptance region given by critical value of $\pm 1.96$

### 5.10 Choice of Interval

Alpha ($\alpha$) and beta ($\beta$) values for each stock can be calculated by regressing the security's rate of return against the market rate of return. The performance of regression requires a number of paired observations in the form of returns for particular security and returns for a market index over the same time interval. Alpha and beta become systematically biased if the choice of the estimation period and the differencing interval is not appropriate. Estimation period refers to the total time period over which the alpha and betas are to be estimated. Differencing interval refers to the length of the individual time periods over which returns are computed. Use of an appropriate estimation period i.e., neither too long nor too short evens out any unusual behaviour in security prices and produces more reliable estimate of parameters. Use of too long estimation period carries the risk of using outdated data and too short period results in less number of observations. The sensitivity of stocks to the market movement and characteristics of the companies' risks change over time. A study by Breen and Lerner (1972) revealed that betas change significantly with the changes in the estimation period. In many cases it is observed that extreme high-risk stocks turn into low-risk stocks and vice-versa. That is why, the recent rather than old data were found to be more appropriate for the estimation of alpha and beta. Accordingly, in this study daily returns on BSE 200 index and on stock prices are taken from January 1, 1997 for the first quarter of the study i.e., June 2000 quarter.

Similarly, the reliability of estimation of returns, which is required to compute alpha and beta, is affected by differencing interval used for the estimation. The choices are between daily, weekly, monthly, and yearly intervals since stock prices are reported at the end of the day, week, month, and year. Therefore, the choice is between using shorter and longer differencing intervals. The shorter the differencing intervals more will be the number of observations within a particular estimation period. For instance, there would be only 52 weekly and 12 monthly returns as against approximately 250 daily returns in the estimation period of one year. Regression is used to estimate securities alpha and beta from a sample of observations and in general, larger the observations, more reliable the estimate. Therefore, we used, daily
interval since within the shortest estimation period, this will provide more observations. In this study, 750 daily returns are used within an estimation period of approximately three years. The larger numbers of observations in the estimation of parameters are sufficient to reduce the standard error of the estimate. In case the daily returns for any company are less than 750, those numbers of daily returns, as available, are used for estimating the parameters of the market model. Moreover, to minimise the problems associated with non-stationarity of beta over time, beta was re-estimated each quarter for all the stocks in the portfolio, which was used, by Ball (1972), Mandelker (1974) and Bathke and Lorek (1984). In this study, ordinary least square (OLS) regressions were run using 750 daily returns of each individual stock, \( R_t \) for approximately three years immediately preceding each event window corresponding to each earnings announcement as the dependent variable and index returns, \( R_{mt} \) for corresponding periods as an independent variable to estimate the beta. The market rate of return is represented by returns on BSE-200 index, compiled and published by the Bombay Stock Exchange on daily basis.

In empirical studies on semi-strong form of efficient market hypothesis, researchers have used either monthly, weekly or daily returns data to calculate ARs, AARs and CAARs during the event window. If monthly or weekly prices are used, it is difficult to pin point the exact time when adjustment in stock prices to the event takes place. Opong (1994) observed:

"Price sensitive information contained in the earnings announcement will be reflected in monthly or weekly prices. The use of monthly or weekly prices does not however, provide precise evidence of the time of adjustment of prices to the new information. Much more precise evidence is therefore, provided by the use of daily prices (p 270).

Therefore, in order to get a better idea about the time period in which the information contained in the quarterly earnings announcement is reflected in the stock prices, daily prices during the event window have been used in this study.

The following methodology is used for computing returns and beta:

Returns on stock price are given by:

\[
R_t = \frac{P_t - P_{t-1}}{P_{t-1}}
\]

Where,
\[ R_{lt} = \text{Return on security 'i' during time period 't'} \]
\[ P_{t} = \text{Closing price of security 'i' for time period 't'} \]
\[ P_{t-1} = \text{Closing price of security 'i' for time period 't-1'} \]

Returns on market index are given by:
\[
R_{mt} = \frac{I_{t} - I_{t-1}}{I_{t-1}}
\]

Where,
\[ R_{mt} = \text{Return on market index m during time period 't'} \]
\[ I_{t} = \text{Closing value of market index corresponding to the period of security 'i' for time 't'} \]
\[ I_{t-1} = \text{Closing value of market index corresponding to the period of security 'i' for time 't-1'} \]

The following methodology is used to compute price relative and index relative.

Stock price relatives are given by
\[
R_{it} = \log_{e} \left( \frac{P_{t}}{P_{t-1}} \right)
\]

Where,
\[ \log_{e} = \text{Natural log} \]
\[ R_{it} = \text{Price relative of the security 'i' during time period 't'} \]
\[ P_{t} = \text{Closing price of the security 'i' for time period 't'} \]
\[ P_{t-1} = \text{Closing price of the security 'i' for time period 't-1'} \]

Index relatives on market index are given by
\[
L_{t} = \log_{e} \left( \frac{I_{t}}{I_{t-1}} \right)
\]

Where,
\[ \log_{e} = \text{Natural log} \]
\[ L_{t} = \text{Index relatives on market index 'm' during time period 't'} \]
\[ I_{t} = \text{Closing value of market index corresponding to the period of security 'i' for time 't'} \]
\[ I_{t-1} = \text{Closing value of market index corresponding to the period of security 'i' for time 't-1'} \]

Beta is calculated using following equation.
\[ \beta_i = \frac{N \sum_{t=1}^{N} R_{mt} - R_{it}}{N \left( \sum_{t=1}^{N} R_{mt}^2 \right) - \left( \sum_{t=1}^{N} R_{mt} \right)^2} \]

Where,

- \( \beta_i \): Slope of a straight line or beta coefficient of security ‘i’
- \( N \): Number of observations
- \( R_{mt} \): Return on market index ‘m’ during time period ‘t’
- \( R_{it} \): Return on security ‘i’ during time period ‘t’

The same equation is used to estimate beta of log model. But, instead of \( R_{mt} \) (Return on market index ‘m’ during time period ‘t’) and \( R_{it} \) (Return on security ‘i’ during time period ‘t’), \( L_t \) (Index relatives on market index ‘m’ during time period ‘t’) and \( R_{it} \) (Price relative of the security ‘i’ during time period ‘t’) are respectively used to calculate beta of log model.

### 5.11 Adjustment for Infrequent Trading

Infrequent trading also known as ‘nonsynchronous trading’ is one of the serious problems of developing stock markets of the world including India. When the stocks are not traded at the end of each return interval, the problem of infrequent trading or nonsynchronous trading arises. While estimating beta this creates serious problems. Scholes and Williams (1977) mentioned that nonsynchronous trading of securities creates downward bias to the estimated beta. Dimson (1979) also argued that infrequent trading of stocks biases beta estimates and predicts a downward bias for infrequently traded stocks and an upward bias for frequently traded stocks. The direction of bias will depend on the relative trading frequency of the sample firms versus the constituents of the market index. Roll (1981) stated that since the stocks of small firms are generally the most infrequently traded and the stocks of large firms are the most frequently traded, the betas for small firms are downward biased (under estimated) while the betas of the large firms upward biased (over estimated).

Therefore, estimation of abnormal returns using beta that are not adjusted for nonsynchronous trading may yield the observed size effect. However, Remganum (1982) and Keim (1983) reported that the direction of the bias in beta estimation is consistent with Roll (1981)’s argument, i.e., the risk (beta) of small firms has been underestimated. However, they found that even after adjusting beta for infrequent...
trading, portfolio of small firms still provided abnormal returns, although the amount of small firm effect was reduced after adjusting for nonsynchronous trading.

Two methods have been proposed, one by Scholes and Williams (1977) and the other by Dimson (1979) to estimate beta correctly when there is infrequent trading. In the aggregated co-efficient method, Scholes and Williams (1977) and Dimson (1979) suggested a nonsynchronous adjustment that required summation of coefficients pertaining to the lagged, coincident and leading market return variables that provide an unbiased estimate of the stock's systematic risk. These coefficients are estimated from multiple regressions of stock returns on lagged, coincident and leading market returns.

The alternative method for solving the problem of infrequent or nonsynchronous trading is suggested by Marsh (1979). In the alternative method, betas are estimated on the basis of variable rather than fixed length periods and each period is defined as the time between two adjacent recorded trades. That is why this method is known as 'trade-to-trade' method, and does not involve making the adjustment in the systematic risk. The market rate of return represented by an appropriate index and stock's rate of return are calculated over the same period. These paired observations are used to estimate the value of beta.

In this study we used 'trade-to-trade' method to estimate reliable beta for infrequently traded stocks even though the problem arose in less number of cases/occasions. This method is considered better than aggregated co-efficients method because in aggregated co-efficients method it is difficult to decide an appropriate number of leads and lags to be included in the model. Further, according to Marsh (1979):

"although this method (aggregate co-efficient method) is suitable for beta estimation, the use of trade-to-trade returns is effectively the only way of handling the non-trading problem in the second stage of the two-stage methodology" (p 847)

Two-stage methodology is the methodology used by Fama, Fisher, Jensen and Roll (1969). The first stage consists of estimation of parameters like alpha, beta, etc depending on the particular form of the model being used. In the second stage, these estimated parameters are used to calculate abnormal returns around the event. Therefore, we used 'trade-to-trade' method in this study.
In this study we followed matching process to match daily-adjusted closing prices of stocks with closing values of BSE 200 index. We arranged date, daily adjusted closing prices of stocks, and closing values of BSE 200 index in the chronological order starting from January 1, 1997. In case on a particular date the index is available and stock price is not available and vice versa, that date and adjusted closing price of stock or index whichever is available is automatically deleted. This process results in retaining only those dates for which both adjusted closing stock prices and index are available and dates for which either index or stock prices are not available is automatically eliminated. From these paired data, returns on stock and market index are calculated. These pairs of returns are used to calculate of alpha and beta.