Chapter 5

Research Methodology
5.1 Sample

The study period ranges over 20 years from 1992 to 2011. The sample of IPOs and FPOs (Follow-on Public Offerings) and the relevant data, especially the issue opening and closing dates, issue price, issue size and the listing dates, are compiled from two main databases.

The formation of the first main database is as under:

First, for the period 1992 to 1999, the 'New Issue Monitor' column of various issues of the Capital Market magazine is referred. This source provides information about IPOs and FPOs that are going to be floated during the forthcoming fortnight along with information like face value, issue price, number of shares offered, issue size, and issue opening and closing dates. Second, starting from the year 2000 to 2011, another data source is maintained using the archives of Hindu Business Line newspaper. The soft copy of various IPO and FPO-related news items that have been published in different issues are collected. This source, again, gives information about various IPOs and FPOs that are floated along with other relevant information including the listing day and listing day trading information. A third source of data is developed starting from the year 2006 to 2011 from the website http://www.chittorgarh.com/ipo/ipo_detail.asp. This website provides detailed information about each IPO as well as FPO including the issue size, issue method, issue opening date and closing date, issue price, listing date, and listing day trading information. Data from these three sources are compiled to arrive at the first database containing various issue-related information, along with their BSE scrip code, for both IPOs as well as FPOs. The total number of issues, both IPOs and FPOs, for which various issue-related details are available from this first database, is 3,855 issues. However, this database lacks the listing dates of IPOs, especially for issues during the period 1992 to 1999, which is very important to compute IPO underpricing as well as post-listing aftermarket performance.

The second main database is formed as under:

Data from the 'Changes in Debt and Equity Capital' section of the Prowess, the corporate database of CMIE (Centre for Monitoring Indian Economy) is obtained, relating to both IPO and FPO issues for the period 1992-2011. This database provides information mainly about the listing day or the first trading day on BSE and NSE along with BSE scrip code. However, first trading date on BSE is not available for some of these public issues (both for IPO and FPO issues) either because the issue is withdrawn (in the case of IPOs) or because the data is not available with Prowess. The total number
of such cases reported is 1,540 (for 801 issues 'first trading date on BSE' appears as 'NA', for 25 issues, it is '0', and for 714 issues it is blank) The remaining issues are the IPOs and FPOs for which listing date on BSE is available. The number of such public issues is 3,626. However, the major drawback of this second database is that it lacks the issue price or the offering price for both IPOs and FPOs.

Finally, using the above two databases, a comprehensive database is developed for both IPOs as well as FPOs that are compulsorily listed on BSE. The information from the two main databases is matched on the basis of the BSE scrip code. In case the name of the issuing company is changed over time, this problem is taken care of by the use of BSE scrip code as this code remains the same even when the name is changed. Such a matching of the two databases provides a final sample of 2,934 IPOs and 162 FPOs for the study period of 1992 to 2011. The total IPO sample of 2,934 is further divided into IPOs belonging to two sub-periods: sub-period I ranging from 1992 to 2000 and sub-period II ranging from 2001 to 2011. The number of sample IPOs belonging to these two sub-periods are 2,470 and 464, respectively.

Soon after the abolition of Controller of Capital Issue (CCI) and the introduction of free pricing in India, the Indian IPO market saw hectic IPO activity. When CCI was regulating the public issue market in India, it did not allow freely companies in 'unproductive' areas such as finance, leasing, and entertainment activities to come out with public issues. Therefore, during the post-CCI period, a large number of finance companies came to the market with their initial public offering. In the year 1992-1993, finance companies accounted for only 6 percent of the total number of public issues made, while in 1994-1995, this proportion increased to 33 percent (Karmakar (2002)).

Also, a large number of small and medium sized companies from different sectors visited the primary market with their IPOs, especially during the period 1993-1996, to take advantage of the abolition of CCI and the introduction of free pricing of issues. However, many of these companies that issued IPOs, later proved to be fly-by-night companies, either they did not get listed on the stock exchanges, or even though they got listed, their shares were not traded regularly and frequently, and eventually, they got delisted. Therefore, the sample of IPOs for sub-period I is further divided into three subcategories: IPOs that are regularly traded (with a sample size of 1,835 IPOs), IPOs that are infrequently traded and/or got delisted within 300 trading days (with a sample size of 524 IPOs), and IPOs that got listed on BSE with a gap of one year or more from the issue opening date (with a sample size of 111 IPOs).
Using the Prowess database of CMIE, study follows each IPO issuing firm from its listing date until the earlier of its delisting date or June 30, 2012. For FPOs, the FPO issue opening date is taken as the 0th day. Daily prices are collected for FPO issues considering a window period of -31 to +31 (61 days event window surrounding FPO issue opening) and an estimation period of 250 trading days i.e., -31 to -280 days prior to FPO issue opening.

5.2 Methodology to Evaluate IPO Performance

5.2.1 Initial Return or Underpricing

Returns from IPOs are computed for two intervals: the initial return, known as either underpricing or overpricing of IPOs, and the aftermarket return, known as long-run performance of IPOs. IPO initial return is computed from the offer price to the first trading day/listing day price. The vast majority of researchers have computed initial return from IPOs, popularly known as underpricing in IPO literature, using the offer price and the closing price on the first trading day as under

\[ IR = \frac{P_{cl} - P_{o}}{P_{o}} \]

Where \( IR \) is the IPO subscriber’s initial raw return from security \( i \), \( P_{cl} \) is the closing price of the IPO scrip on the first day of trading, and \( P_{o} \) is the offer/issue price of the IPO scrip. Benchmark-adjusted underpricing or abnormal initial return is computed as the initial raw return from the IPO minus the return on the market benchmark over the same period which is computed as under

\[ AIR = \frac{P_{cl} - P_{o}}{P_{o}} - \frac{P_{ml} - P_{m0}}{P_{m0}} \]

Where \( AIR \) is the benchmark-adjusted abnormal initial return from IPO stock \( i \), \( P_{ml} \) denotes the closing level of the benchmark index on the listing day of the IPO scrip and \( P_{m0} \) is the closing level of the benchmark index on the IPO offering day. The average underpricing, both raw and market-adjusted, for the whole sample is computed as under

\[ R_t = \frac{\sum_{i=1}^{n} R_{it}}{n} \]

Where, \( R_t \) is the average raw/benchmark-adjusted underpricing for the sample of IPO firms, \( R_{it} \) is the raw/benchmark-adjusted underpricing of stock \( i \), and \( n \) is the sample size. To test the significance of average underpricing of the sample, following parametric \( t \)-test is employed.
Where,

\[ R_t = \text{The average benchmark-adjusted underpricing for the sample,} \]

\[ SE(R_t) = \text{Standard Error of average benchmark-adjusted underpricing and is calculated as} \]

\[ SE(R_t) = \frac{\sigma(R_t)}{\sqrt{n}} \]

Where, \( SE(R_t) = \text{Standard Error of average benchmark-adjusted underpricing,} \)

\( \sigma(R_t) = \text{Standard Deviation of average benchmark-adjusted underpricing,} \)

\( n = \text{Number of observations in the sample or sample size} \)

Apart from using closing price on the listing day as most researchers did, the present study also computes IPO initial return using opening price, high price, and low price on the listing day. Abnormal initial return or market-adjusted underpricing on the basis of the closing price on the listing day is computed using BSE 100, BSE 200, Sensex, and Nifty returns. However, due to non-availability of data on market indices, market-adjusted underpricing on the basis of opening price, high price, and low price on the listing day is restricted to BSE 100 and Sensex. For the sample of IPOs belonging to sub-period II (2001-2011), in addition to the above mentioned market-adjusted underpricing measures, study also computes BSE 500-adjusted underpricing measure using all the four prices—opening, high, low, and closing—on the listing day. Therefore, market-adjusted underpricing for this sub-sample and also for the sub-sample of book-built issues are computed using five market indices and four prices on the listing day. For some IPOs, the issue opening day market indices are not available. The total number of such cases reported is 196. In such cases, the market indices on the immediate next available date are considered for the computation of market-adjusted underpricing.

5.2.2 Long Run Performance

Under event-study methodology, to evaluate the long run performance of IPOs, two measures are widely used: (1) buy-and-hold-abnormal returns and (2) cumulative average abnormal returns. Buy-and-hold return assumes a buy-and-hold investment strategy. This investment strategy presumes that an IPO stock is purchased at the first closing market price after going public and is assumed to be held by the investor for a definite period of time or its delisting, whichever is earlier. This buy-and-hold return that the investor earns by holding the IPO stocks for up to a definite period of time is adjusted for the market return for the contemporaneous period to arrive at the buy-and-hold-abnormal return.
Positive buy-and-hold abnormal return demonstrates better performance of IPO stocks compared to the benchmark. The return on a buy-and-hold investment in the sample firm less the return on a buy-and-hold investment in an asset/portfolio with an appropriate expected return (BHAR) is computed as

$$BHAR_{t} = \prod_{t=1}^{T} [1 + R_{t}] - \prod_{t=1}^{T} [1 + E(R_{t})]$$.

The mean buy-and-hold-abnormal return is computed as the arithmetic average of abnormal returns on all IPOs in the sample of size N as under

$$BHAR_{\text{mean}} = \frac{1}{N} \sum_{i=1}^{N} BHAR_{i}$$

The second measure, cumulative average return (CAR) is computed with daily/monthly portfolio rebalancing and the cumulative average abnormal returns (CAARs) are computed after adjusting for the contemporaneous benchmark return. Barber and Lyon (1997) note that the convention in much of the research that analyses abnormal returns has been to sum either daily or monthly abnormal returns over time.

Ritter (1991) was among the first to argue that CAARs and BHARs can be used in evaluating the long-run performance of securities. Barber and Lyon (1997) note that the differences between the CAARs and BHARs result from the effect of monthly compounding, CAARs ignore compounding, while BHARs include the effect of compounding. If individual security returns are more volatile than the returns on the market index, they note that CAARs would be greater than BHARs in case the BHAR is less than or equal to zero. As the annual BHAR becomes increasingly positive, the difference between the CAAR and BHAR will approach zero and eventually become negative. They also find that CAARs (summed monthly abnormal returns) yield positively biased test statistics, while BHARs (the compound return on a sample firm less the compound return on a reference portfolio) yield negatively biased test statistics.

The present study uses cumulative average abnormal return (CAAR) to evaluate the long-run performance of IPOs. Excluding the initial return which is based on the offer price and listing day closing price, daily returns are computed using the adjusted closing price starting from the listing day until the earlier of its delisting date, or June 30, 2012. The daily raw return for security i, is computed as under

$$R_{t} = \frac{P_{t} - P_{t-1}}{P_{t-1}}$$.
Where, $R_u$ is the raw return on security $i$ for day $t$, $P_t$ is the adjusted closing price of security $i$ on day $t$, and $P_{t-1}$ is the adjusted closing price of security $i$ on day $t-1$.

The market return for the same period is computed as under

$$R_{mt} = \frac{I_t - I_{t-1}}{I_{t-1}}$$

Where, $R_{mt}$ is the market return on day $t$, $I_t$ is the closing index level on day $t$, and $I_{t-1}$ is the closing index level on day $t-1$.

Daily benchmark-adjusted returns are calculated as daily raw return on the security minus the daily benchmark return for the corresponding day. Using return on BSE 200 as the market return, the benchmark-adjusted return (abnormal return) for stock $i$ on day $t$ is defined as

$$AR_t = R_u - R_{mt}$$

Where, $AR_t$ is the benchmark-adjusted return for stock $i$ on day $t$, $R_u$ is the raw return for stock $i$ on day $t$, and $R_{mt}$ is the return on BSE 200 used as the benchmark return for the same period. The average benchmark-adjusted return (average abnormal return) on a portfolio of $n$ stocks for day $t$ is the equally-weighted arithmetic average of the benchmark-adjusted returns

$$AAR_t = \frac{1}{n} \sum_{i=1}^{n} AR_t$$

Where, $AAR_t$ is the average abnormal return (benchmark-adjusted) on a portfolio of $n$ stocks for day $t$, $n$ is the number of stocks in the portfolio on day $t$, and $AR_t$ is the benchmark-adjusted abnormal return for stock $i$ on day $t$. The cumulative benchmark-adjusted aftermarket performance (cumulative average abnormal return) from day $q$ to day $s$ is the summation of the average benchmark-adjusted returns or $AAR_t$

$$CAAR_{q,s} = \sum_{t=q}^{s} AAR_t$$

Where $CAAR_{q,s}$ is the cumulative average abnormal return or the cumulative benchmark-adjusted aftermarket performance from day $q$ to day $s$, and $AAR_t$ is the average abnormal return on a portfolio of $n$ stocks for day $t$. When a firm in portfolio $p$ is delisted from the BSE, the portfolio return for the next day is an equally-weighted average of the remaining firms in the portfolio. The cumulative market-adjusted return for various days, thus, involves daily rebalancing of the portfolio with the proceeds of a delisted firm.
equally allocated among the surviving members of the portfolio $p$ for each subsequent day.

Out of the whole sample of 2,934 IPOs, for 9 IPOs (all belonging to sub-period I, 7 to ‘Frequently Not Traded’ sub-category, and 2 to “Delayed Listing” sub-category) data on daily prices are not available from Prowess database beyond the first trading day post-listing. This reduces the size of the portfolio for the whole sample as well as for various sub-samples proportionately. For example, the post-listing return computation for the whole sample begins with $n=2,925$, while for sub-period I, $n=2,461$, for ‘Delayed Listing, $n=109$, and for ‘Frequently Not Traded’ sub-sample, $n=517$.

5.2.3 Parametric Significance Test

In testing the long run performance of IPOs in the aftermarket, the cumulative average abnormal return provides information about the average price behaviour of securities during the post-listing period. 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 percent level of significance with appropriate degree of freedom is used to test the null hypothesis of no significant abnormal returns post-listing. The conclusions are based on the results of $t$-values on AARs and CAARs for the post-listing period. The $t$-test statistics for AAR for each day during the post-listing period is calculated as under

$$ t(AAR_t) = \frac{AAR_t}{SE(AAR_t)} $$

Where $AAR_t$ is the average abnormal return on day $t$, and $SE(AAR_t)$ is the standard error of average abnormal return on day $t$ which is computed as under

$$ SE(AAR_t) = \frac{SD(AAR_t)}{\sqrt{n}} $$

Where, $SD(AAR_t)$ is the standard deviation of average abnormal return on day $t$, and $n$ is the number of stocks in portfolio $p$ on day $t$.

The $t$-test statistics for CAAR for each day during the post-listing period is calculated by using the following formula

$$ t(CAAR_t) = \frac{CAAR_t}{SE(CAAR_t)} $$

Where, $CAAR_t$ is the cumulative average abnormal return on day $t$, and $SE(CAAR_t)$ is the standard error of cumulative average abnormal return on day $t$ which is computed as under.
$SE(CAAR_t) = \frac{SD(CAAR_t)}{\sqrt{n}}$  

$SD(CAAR_t)$ is the standard deviation of cumulative average abnormal return on day $t$ which is computed as under  

$SD(CAAR_t) = SD(AAR_t) \times \sqrt{N}$  

Where, $N$ is the total number of days for which $AAR$ is cumulated

5.3 Methodology to Evaluate FPO Performance

5.3.1 FPO Underpricing

Underpricing/overpricing of FPOs is measured using two methodologies in FPO literature. While, Corwin (2003) uses close-to-offer ($R_o$) measure, and Kim and Park (2006) use offer-to-close ($R_l$) measure, Safieddine and Wilhelm (1996), and Ghosh et al (2000) use both these measures in computing FPO underpricing. The present study uses both these measures to compute FPO underpricing which are as under

**Close-to-offer ($R_o$) measure of FPO underpricing**

$R_o = \frac{P_{o}-P_{c-1}}{P_{c-1}}$

Where, $R_o$ is the close-to-offer measure of FPO underpricing for security $i$, $P_{o}$ is the FPO offering price, and $P_{c-1}$ is the closing price of the FPO security on the day previous to FPO opening. Market-adjusted measure of FPO underpricing ($AR_o$) is computed as under

$AR_o = \frac{P_{o}-P_{c-1}}{P_{c-1}} - \frac{P_{m_0}-P_{m-1}}{P_{m-1}}$

Where, $P_{m_0}$ is the opening market index on the FPO opening day, and $P_{m-1}$ is the closing market index on the day previous to FPO opening

**Offer-to-close ($R_l$) measure of FPO underpricing**

$R_l = \frac{P_{c}-P_{o}}{P_{o}}$

Where $R_l$ is the offer-to-close measure of FPO underpricing for security $i$, $P_{c}$ is the closing price of security $i$ on the FPO opening day, and $P_{o}$ is the FPO offering price. The market-adjusted measure of underpricing ($AR_l$) is computed as

$AR_l = \frac{P_{c}-P_{o}}{P_{o}} - \frac{P_{m_0}-P_{m_0}}{P_{m_0}}$
Where, $P_{mo}$ is the opening index of the market on the FPO opening day, and $P_{mi}$ is the closing index of the market on the FPO opening day. Market-adjusted underpricing under both the measures are computed using BSE 100 and Sensex returns. The average raw and market-adjusted FPO underpricing under both the measures for the whole sample is computed separately, as under

$$R_t = \frac{1}{n} \sum_{i=1}^{n} R_{it}$$

Where, $R_t$ is the average underpricing for the sample of FPO firms, $R_{it}$ is the underpricing of stock $i$, and $n$ is the sample size.

To test the statistical significance of average FPO underpricing under both the measures, the same t-test which is used to test the significance of IPO underpricing is employed, which is as under

$$t(R_t) = \frac{R_t}{SE(R_t)}$$

Where, $R_t$ is the average FPO underpricing for the sample, and $SE(R_t)$ is the standard error of average FPO underpricing which is computed as under

$$SE(R_t) = \frac{SD(R_t)}{\sqrt{n}}$$

Where, $SD(R_t)$ is the standard deviation of average FPO underpricing for the whole sample, and $n$ is the number of observations in the sample.

### 5.3.2 Abnormal Returns surrounding FPO Issue Opening

We follow event study methodology to analyse the abnormal returns on stock prices surrounding the opening of FPO issues. The event period is centered on the issue opening date of the FPOs. The FPO issue opening date is designated as the $t^{th}$ day for the event period. Prior studies have considered different event window periods to study the impact of a given corporate event on its stock returns. For example, Brown and Warner (1985) use eleven day event window (-5 to +5) to analyse daily stock returns. In the present study, we use an event window of 61 days, 30 days before the opening of FPO issue and 30 days after the opening of FPO issue, zero being the FPO issue opening day. To test the significance of abnormal returns surrounding the FPO issue opening during the window period, we use an estimation period of 250 days starting from day -31 up to day -280 from FPO issue opening date ($0^{th}$ day).

The initial sample consists of 162 FPOs for the study period of 1992 to 2011. However, for 10 FPOs, no data was available during the estimation period from Prowess database.
Further, for another 34 FPOs only partial data were available during the estimation period. Data for the full 250-days estimation period was not available. Therefore, excluding these two sets of FPOs, the sample of FPO firms for which daily adjusted BSE closing price is available for the whole of estimation period and event period is reduced to 118.

The effect of stock prices is measured in an event period using the abnormal return associated with this event. Study computes the expected returns (ER), abnormal returns (AR), average abnormal returns (AAR), and cumulative average abnormal returns (CAAR) to examine the stock price reaction. To measure the stock price response to the event of FPO issue opening, it is necessary to segregate the returns attributed to the market movement and those that are not attributed to the market movement, but to FPO issue opening. This adjustment is made using the market-adjusted model. Therefore, standard market model is used with BSE 200 market return for the computation of expected returns and eventually the abnormal returns on FPO securities during the event window.

Out of 118 FPO firms, we could not compute BSE 200 market returns for some of the days during the estimation period for 4 FPOs due to non-availability of data reducing the final sample to 114.

The market model determines the expected return on specific asset, given the return on market and the two parameters of the market model (alpha and beta of the security).

Market model is based on the fact that the most important factor affecting stock returns is market factor and it is captured in the market model in the form of the parameters. It is a model to analyse the riskiness of stocks in terms of systematic risk and unsystematic risk. In market model, return on a security is regressed against returns of the market index.

The market model is given by the following regression equation:

\[ E(R_{jt}) = \alpha_j + \beta_j R_m + e_j \]

Where,
- \( \alpha \) is intercept (Mean return over the period not explained by the market),
- \( E(R_{jt}) \) is the expected return on security \( j \),
- \( R_m \) is the expected market return,
- \( \beta_j \) is the slope of the regression and,
- \( e_j \) is the error term (with a zero mean and constant standard deviation).

The slope, \( \beta_j \), of the regression measures the variability of the security’s returns relative to the market returns, and it is the security’s beta. Beta is the ratio of the covariance between the security’s returns and the market returns to the variance of the market.
returns. Alpha ($\alpha$) indicates the return on the security when market return is zero. It could be interpreted as return on the security on account of unsystematic risk. Over a long period of time, $\alpha$ should be zero given the randomness of unsystematic risks.

The predicted return represents the return that would be expected if no event took place. The predicted return for a firm for a day in the event period is given by the following market model:

$$E(R_{jt}) = \alpha_j + \beta_j R_{mt}$$

Where $R_{mt}$ is the return on the market index for day ‘t’ in the event period.

Abnormal return ($AR$) is the part of the return on a security on day $t$ that is not predicted, and therefore, it is an estimate of the change in firm’s share price on that day which is caused by the event. The residual is calculated for each day and for each firm. The residual is the actual return for that day for the firm minus the predicted return.

The log returns during the estimation window and also during the event window is calculated using the following equation:

$$R_{jt} = \log(P_{jt} / P_{j,t-1})$$

Where,

$R_{jt}$ is the daily return on security ‘j’ on day ‘t’,

$P_{jt}$ is the daily adjusted price of the security ‘j’ at the end of period ‘t’,

$P_{j,t-1}$ is the daily adjusted price of the security ‘j’ at the end of period ‘t-1’.

The market return is given by the following equation:

$$R_{mt} = \log(I_t / I_{t-1})$$

Where,

$R_{mt}$ is the daily return on market index on day ‘t’.

$I_t$ and $I_{t-1}$ are the closing index values on day ‘t’ and day ‘t-1’, respectively.

The abnormal return is the difference between the actual return on day $t$ and the predicted return by the market model using the parameters from the estimation window.

$$AR_{jt} = R_{jt} - E(R_{jt})$$

The residual $AR_{jt}$ represents the abnormal return, i.e., the part of the return that is not predicted and is, therefore, an estimate of the change in firm’s share price on that day which is caused by the FPO issue opening.

Abnormal returns are averaged across firms ($j=1$ to $N$) to produce average abnormal return for day $t$ using the following formula,
\[ AAR_t = \frac{\sum_{i=1}^{N} AR_{it}}{N} \]

Where, \( AAR_t \) is the average abnormal return on event day \( t \) and \( N \) is the number of firms in the sample. Using the \( AAR \), study computes cumulative average abnormal return (\( CAAR \)) for the event period. The cumulative average abnormal return represents the average total effect of the event across all firms for different time periods in the event window. \( CAAR \) is given by

\[ CAAR = \sum_{t=-30}^{30} AAR_t \]

To examine the statistical significance of the average abnormal returns (\( AARs \)) and the cumulative average abnormal returns (\( CAARs \)), Z-statistic is constructed and the hypothesis that the abnormal returns surrounding the event is zero is tested.

### 5.3.3 Testing the Significance of the AARs and the CAARs

The excess returns are standardized before they are aggregated and the standardized aggregates form the basis of the test statistics. For each security \( 'j' \), the excess return (\( AR_{jt} \)) or the prediction error (\( PE_{jt} \)), for each of the days in the event window is standardized by dividing the \( AR_{jt} \) by the standard deviation, \( (S_{jt}) \) of the abnormal returns during the estimation period to yield a standardized excess return, \( SER_{jt} \).

The standardized excess return (\( SER \)) is computed as

\[ SER_{jt} = AR_{jt} / S_{jt} \quad \text{where} \]

\[ S_{jt} = \sqrt{\frac{\sum_{i=1}^{T} (AR_{it} - \overline{AR}_j)^2}{T-1}} \]

Where, \( T \) is the number of days in the estimation period.

\[ \overline{AR}_j = \frac{1}{T} \sum_{i=1}^{T} AR_{jt} \]

In the present study, the number of days in the estimation period is 250 (-31 to -280).

The test statistic for any given day for \( N \) companies would be

\[ Z = \frac{\sum_{j=1}^{N} SER_{jt}}{\sqrt{N}} \]

Where,

\( N \) denotes the number of companies in the study,

\( SER_{jt} \) is the standardized prediction error for firm \( 'j' \) on day \( 't' \).
The standardized cumulative excess returns for firm \( j \) is the sum of the \( SPE_j \) between any periods of interest, adjusted for the number of days \( (M) \) being considered, starting at \( t_1 \) and ending at \( t_2 \) and is computed as under

\[
SCER_j = \left( \sum_{t=t_1}^{T} SER_{jt} \right) / \sqrt{M}
\]

Where, \( t = -30 \) to \(+30\) days

The test statistic for \( N \) firms is the sum of the \( SCER_j \) divided by the square root of the number of firms

\[
Z = \left( \sum_{j=1}^{N} SCER_j \right) / \sqrt{N}
\]

Where, \( N \) is the number of firms