A Study of Efficiency of The Indian Stock Market

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PART-I
INTRODUCTION

Market efficiency is examined in three forms: weak form, semi-strong form and strong form and each one deals with a different source of information. 1. Weak form efficient market - the prices of securities fully reflect all historical information and no excess returns can be earned by utilising historical share prices. 2. Semi-strong form - securities prices adjust instantaneously to available new information such as earnings announcements, bonus issue, merger and acquisition, etc. so that no excess returns can be earned by trading on that information. 3. Strong form efficient market - securities prices fully reflect all information, including inside or private information.
The paper is organised into six sections. The first part is introduction: part 2 deals with review of literature; part 3 deals with objectives and hypotheses of the study; part 4 presents sample, data and methodology; empirical results are analysed in part 5 and part 6 presents summary and conclusions.

PART-II
REVIEW OF LITERATURE

Patell and Wolfson (1984) investigated the intra-day speed of adjustment of stock prices to earnings and dividend announcement. The overall results of the study suggested that stock market responds very quickly to publicly available information. Woodruff and Senchack (1988) also investigated intra-day price adjustment of stock prices to unexpected earnings in NYSE. The results of the empirical study revealed that the reaction started approximately 15 minutes after the earnings announcement.
However, there are many empirical studies that questioned the semi-strong form of efficient market hypothesis. In efficient market hypothesis literature, these results are commonly called 'anomalies'. The drift in the market response was first observed by Ball and Brown (1968) using annual earnings. They found that after earnings are announced, estimated cumulative abnormal returns continue to drift up for "good news" firms and down for "bad news" firms. Watts (1978) concluded that significant abnormal returns exist after the earnings announcement and it is because of the fact that stock market inefficiencies cannot be attributed to deficiencies in the capital asset pricing model. Bernard and Thomas (1989) examined post-earnings announcement drift to ascertain whether it is delayed stock price response or premium for the risk undertaken by the investors. They concluded that post earnings announcement abnormal returns are not premium for the risk but it was due to delayed response by the stock prices.
The studies on semi-strong form of efficient market hypothesis in Indian stock market yielded mixed results. Rao (1994) examined the stock price responses to some of the corporate financial policy announcements such as dividend increase, bonus issue and equity rights and found that Indian stock market is semi-strong form efficient. Srinivasan (1997) studied the impact of right related events on stock prices and concluded that the market is semi-strong form of efficiency. However, there are many studies which found contradictory results. Chaturvedi (2000, 2001a, b) found that abnormal returns persist after the half yearly earnings announcements. Manickaraj (2004) found that the quarterly earnings announcements have information relevant for security valuation and the stock market uses this information and it is immediately reflected in stock prices. The market reacts positively to positive information and negatively to negative information. Thus, he concluded that Indian stock market is semi-strong efficient. However, Mallikarjunappa and Iqbal (2003), Mallikarjunappa (2004 a, b) and Iqbal (2005) found that the Indian stock market does not react immediately to quarterly earnings announcements and they concluded

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that the Indian stock market is not efficient in the semi-strong form.

PART-III
OBJECTIVES AND HYPOTHESES

OBJECTIVES

This study is conducted with the following objectives:

1. To test whether the semi-strong form of efficient market hypothesis holds in the Indian stock market.
2. To empirically investigate adjustment of stock prices to earnings information.

HYPOTHESES

The hypotheses being tested are:

1. The responses of stock prices to the quarterly earnings announcements are complete on the day of the announcement.

2. The investors cannot earn abnormal returns by trading in the stocks after the quarterly earnings announcements.

3. The average abnormal returns and the cumulative average abnormal returns are close to zero.

4. The average abnormal returns occur randomly.

5. There is no significant difference between the number of positive and negative average abnormal returns.

PART-IV
SAMPLE, DATA AND METHODOLOGY

SAMPLE

We have selected the companies based on the criteria of foreign holdings. All the companies that have 20 percent foreign holdings and are traded on the Stock Exchange, Mumbai (famously called BSE) for more than 40 percent of the trading days during the year come under this criterion. Further, companies should have announced the quarterly earnings during the December 2000 quarter (quarter selected for this study). Companies that have any price sensitive information during the event (event period-30 days to +30 days) are eliminated. This resulted in 146 companies being selected as a sample for the study.

DATA

According to the requirements, three sets of data are used in this study. The first set of data consists of quarterly earnings announcement, second set of data consists of daily-adjusted closing prices, and third set consists of the BSE-200 index of ordinary share prices. Data were obtained from the Centre for Monitoring Indian Economy (CMIE), BSE website and Economic Times (financial daily).

METHODOLOGY

In this study, the date of quarterly earnings announcement is defined as day 0 or 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).

We used the market model to measure the returns of stock that is related to market movement. Mathematically, the market model can be expressed as:

$$E\left(R_{it}\right)=\alpha_i+\beta_i R_{mt}+e_{it} \qquad \text{for } i=1,\ldots N \qquad (1)$$

Where, $E(R_{it})$ = Expected return on security 'i' during time period 't'

$\propto_i$ = Intercept of a straight - line or alpha coefficient of i^{th} security.

β_i = Slope of a straight - line or beta coefficient of i^{th} 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'. We used both raw returns and log returns.

We need the values of $\propto_i$ and β_i 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}.

$$\text{Expected Return} = E(R_{it}) = \propto_i + \beta_i R_{mt} \qquad (2)$$

The abnormal returns are computed using the following model:

$$AR_{it} = e_{it} = R_{it} - E(R_{it}) \qquad (3)$$

Where, R_{it} = Actual Returns

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):

$$AAR_{it} = \frac{\sum_{i=1}^{N} AR_{it}}{N} \qquad (4)$$

Where, i = 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 has to be released 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. It gives an idea about average stock price behaviour over time. Generally, if the market is efficient, the CAAR should be close to zero [Brown and Warner (1980, 1985), Fuller and Farrell, Jr., (1987, p.105), Mallikarjunappa and Iqbal (2003), Mallikarjunappa (2004a, b)]. The model used to ascertain CAAR is:

$$CAAR_t = \sum_{t=-30}^{K} AAR_{it} \quad \text{Where } t = -30,...0, ... +30. \qquad (5)$$

Beta is calculated using following equation:

$$\beta_i = \frac{N\sum_{t=1}^{N} R_{mt}R_{it} - \left(\sum_{t=1}^{N} R_{mt}\right)\left(\sum_{t=1}^{N} R_{it}\right)}{N\left(\sum_{t=1}^{N} R_{mt}^2\right) - \left(\sum_{t=1}^{N} R_{mt}\right)^2} \qquad (6)$$

Where, β_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'

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 asses 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:

$$t = \frac{AAR}{\sigma(AAR)} \quad (7)$$

Where, AAR = Average abnormal return

σ (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:

$$t = \frac{CAAR}{\sigma(CAAR)} \quad (8)$$

Where, CAAR = Cumulative average abnormal return

σ (CAAR) = Standard error of cumulative average abnormal return

The standard error is calculated by using following formula:

$$S.E = \frac{\sigma}{\sqrt{n}} \quad (9)$$

Where, S.E. = Standard Error

σ = Standard Deviation

n = Number of Observations

NON-PARAMETRIC SIGNIFICANCE TEST

To avoid the restricted assumption of a particular distribution, which a parametric test makes, we have used the non-parametric test and sign test in addition to t test.

RUNS TEST

Runs test has been used to analyse the randomness in the behaviour of AARs. 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 that 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 to be computed using the following method:

$$\mu_r = \left(\frac{2n_1 n_2}{n_1 + n_2}\right) + 1 \quad (10)$$

Where, μ_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 following formula:

$$\sigma_r = \sqrt{\frac{2n_1 n_2 (2n_1 n_2 - n_1 - n_2)}{(n_1 + n_2)^2 (n_1 + n_2 - 1)}} \quad (11)$$

A standardised variable 'Z' as under can express the difference between actual and expected number of the runs:

$$Z = \frac{r - \mu_r}{\sigma_r} \quad (12)$$

SIGN TEST

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 (σ_p)

$$\sigma_p = \sqrt{\frac{pq}{n}} \quad (13)$$

Where, σ_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:

$$Z = \frac{\bar{p} - p_{Ho}}{\sigma_p} \quad (14)$$

Where, $\bar{p}$ = Actual proportion of AARs in the respective quarters having positive signs

P_{Ho} = Hypothesised proportion = 0.5

PART-V

EMPIRICAL RESULTS AND DISCUSSION

The results of the study are given in Tables 1 to 3. The average abnormal returns (AARs) and cumulative average abnormal returns (CAARs) for each day are calculated by using above-mentioned methodology and the results are shown in Table 1.

TABLE 1: AARs AND CAARs SURROUNDING THE EVENT FOR THE QUARTER

	Market Model with Raw Returns		Market Model with Log Returns	
Days	AAR	CAAR	AAR	CAAR
-30	-0.53727	-0.53727	-0.00575	-0.00575
-29	0.92310	0.38583	0.00920	0.00345
-28	0.08233	0.46817	0.00029	0.00374
-27	-0.43412	0.03404	-0.00460	-0.00086
-26	0.59160	0.62564	0.00516	0.00430
-25	0.13894	0.76457	0.00104	0.00535
-24	0.56528	1.32986	0.00534	0.01069
-23	0.34684	1.67670	0.00370	0.01439
-22	-0.49389	1.18281	-0.00548	0.00891
-21	0.21483	1.39764	0.00169	0.01059
-20	-0.56747	0.83018	-0.00607	0.00452
-19	0.68943	1.51961	0.00665	0.01117
-18	0.08773	1.60734	0.00121	0.01238
-17	-0.36992	1.23741	-0.00369	0.00868
-16	0.02257	1.25999	-0.00047	0.00822
-15	-0.34701	0.91298	-0.00338	0.00484
-14	-0.00579	0.90719	-0.00047	0.00438
-13	-0.43287	0.47432	-0.00458	-0.00021
-12	-0.30716	0.16716	-0.00321	-0.00342
-11	-1.25449	-1.08733	-0.01335	-0.01677
-10	0.29698	-0.79035	0.00291	-0.01386
-9	0.02517	-0.76518	-0.00005	-0.01391
-8	0.15542	-0.60976	0.00158	-0.01233
-7	-0.76667	-1.37642	-0.00771	-0.02004
-6	-0.03538	-1.41180	-0.00029	-0.02034
-5	-0.53553	-1.94733	-0.00569	-0.02602
-4	0.65987	-1.28745	0.00683	-0.01919
-3	0.25931	-1.02814	0.00214	-0.01705
-2	0.10156	-0.92658	0.00059	-0.01646

-1	-0.08965	-1.01623	-0.00169	-0.01816
0	0.71891	-0.29732	0.00682	-0.01134
1	-0.63239	-0.92971	-0.00667	-0.01801
2	-1.24988	-2.17959	-0.01265	-0.03066
3	-0.41719	-2.59678	-0.00455	-0.03521
4	0.72660	-1.87019	0.00683	-0.02839
5	-0.04541	-1.91560	-0.00103	-0.02941
6	-0.00879	-1.92439	0.00018	-0.02923
7	-0.09592	-2.02031	-0.00138	-0.03062
8	0.14147	-1.87884	0.00062	-0.02999
9	-0.69976	-2.57859	-0.00737	-0.03736
10	0.35473	-2.22386	0.00322	-0.03414
11	-0.57402	-2.79788	-0.00578	-0.03992
12	-0.04250	-2.84037	-0.00110	-0.04103
13	-0.07497	-2.91534	-0.00089	-0.04191
14	0.59383	-2.32151	0.00540	-0.03651
15	-0.35493	-2.67644	-0.00524	-0.04175
16	0.72677	-1.94967	0.00546	-0.03629
17	-0.49858	-2.44825	-0.00581	-0.04210
18	0.90126	-1.54699	0.00803	-0.03407
19	-0.86640	-2.41339	-0.00942	-0.04349
20	0.38269	-2.03070	0.00323	-0.04026
21	-0.60903	-2.63973	-0.00718	-0.04745
22	-0.06985	-2.70958	-0.00188	-0.04932
23	-1.31208	-4.02166	-0.01433	-0.06366
24	-0.15468	-4.17634	-0.00248	-0.06613
25	0.07098	-4.10537	-0.00089	-0.06702
26	-0.20548	-4.31085	-0.00377	-0.07079
27	0.59924	-3.71161	0.00501	-0.06578
28	-0.15487	-3.86649	-0.00278	-0.06856
29	0.35878	-3.50771	0.00252	-0.06604
30	-0.55400	-4.06171	-0.00628	-0.07232

Notes:

1. AARs show the values of average abnormal returns.
2. CAARs show the cumulative average abnormal returns, which are computed for days -30 through 30.
3. Day -30 to -1: The days before the quarterly earnings announcement.
4. Day 0: The day of the quarterly earnings announcement.
5. Day 1 to 30: The days after the quarterly earnings announcement.

Column 2 of Table 1 shows that AARs are negative for 14 days (45.16%) and positive for 17 days (54.84%) before the event day under market model with raw returns. Under the same model, AARs are negative for 19 days (63.33%) and positive for 11 days (33.67%) after the event day. Whereas, Column 4 of Table 1 indicates that AARs are negative for 16 days (51.61%) and positive for 15 days (48.39%) before the event day and negative for 20 days (66.67%) and positive for 10 days (33.33%) after the event day under market model with log returns. The results presented in Table 1 show that under market model with raw returns during the event window of 61 days, AARs are negative for 34 days (55.74%) and positive for 27 days (44.26%); whereas column 4 of Table 1 shows that the returns are negative and positive for 36 days (59.02%) and 25 days (40.98%) respectively, under market model with log returns.

It is observed from Column 3 of Table 1 that before the event day, out of the 30 days, for 12 days (40%), CAARs are negative and for the remaining18 days (60%) CAARs are positive under market model with raw returns. Under the same model, after the event day, CAARs are negative for 31 days (100%) and the interesting observation of Table 1 is that CAARs are negative continuously from 11^{th} day before the event day till the end of the event window i.e. + 30 th day. For the event window of 61 days, CAARs are negative for as high as 43 days (70.49%) and positive for as low as 18 days (29.51%) under market model with raw returns. Column 5 of Table 1 shows that CAARs are negative for 15 days (50%) and positive for 15 days (50%) before the event day and after the event day for all the 31 days (100%), CAARs are negative under market model with log returns. CAARs are consecutively negative from 13th day prior to the event day till the last day of the event window i.e. +30 th day. This suggests that the market expected negative information from the quarterly earnings announcement and the same expected bad news was conveyed to the market and negative response continued even 30 days after the announcement of quarterly earnings. During the event window, CAARs are negative for as high as 46 days

(75.41%) and positive for as low as 15 days (24.59%). This indicates that the numbers of negative AARs are thrice the number of positive CAARs for the entire period of 61 days.
Runs test and sign test statistics on AARs for the quarter is detailed in Table 2. It is clear from the Table 2 that the observed runs are not significantly different from the expected number of runs before the announcement of quarterly earnings (i.e. calculated Runs statistics is less than the critical value of ±1.96 and therefore, we accept the null hypothesis that AARs occurred randomly before the event day and for the entire event window. However, after the event day, calculated Runs statistics 2.7243 is greater than the critical value of ±1.96 and it is significant at 5% level of significance. Therefore, we reject the null hypothesis that AARs occur randomly and conclude that after the event day, AARs do not occur randomly.

TABLE 2: RUNS AND SIGN TEST STATISTICS FOR THE QUARTER

	Market Model with Raw Returns			Market Model with Log Returns		
	Runs	Runs Statistics	Sign Statistics	Runs	Runs Statistics	Sign Statistics
Before	15	-0.3484	0.3651	15	-0.3484	-0.3651
After	22	2.7243	-1.6164	22	2.7243	-1.6164
Overall	37	1.5447	-0.8963	37	1.7337	-1.4084

Note: If the computed runs and sign test statistics are greater than ±1.96, the relevant values are statistically significant at 5% level of significance.

We calculated sign test statistics to test whether there is any significant difference between the number of positive and negative AARs. Column 4 and 7 of the Table 2 shows that the calculated sign test statistics are less than ±1.96 and therefore, not significant at 5% level. This confirms that there is no significant difference between the number of positive and negative AARs.
Table 3 presents the summary of t-test statistics on AARs and CAARs for the quarter.

TABLE 3: T-TEST STATISTICS ON AARs AND CAARs FOR THE QUARTER

	Market Model with Raw Returns				Market Model with Log Returns			
	AAR	%	CAAR	%	AAR	%	CAAR	%
Bef-RT	2	50.00	15	57.69	2	50.00	13	52.00
Bef-LT	2	50.00	11	42.31	2	50.00	12	48.00
Aft-RT	0	0.00	0	0.00	0	0.00	0	0.00
Aft-LT	3	100.00	31	100.00	3	100.00	31	100.00
Tot-RT	2	28.57	15	26.32	2	28.57	13	23.21
Tot-LT	5	71.43	42	73.68	5	71.43	43	76.79

Note: If the t-test statistics are greater than ±1.6552, the relevant values are statistically significant at 5% level.

A glance at Table 3 indicates that in the case of AARs under both the models, out of 61 t-values, only 7 t-values (11.48%) fall in the rejection region (i.e. calculated t-test statistics are greater than the critical value of ±1.6552) and remaining 54 t-values (88.52%) are within the acceptance region (i.e. less than the critical value of ±1.6552). From this we infer that AARs are approximately zero for almost 89% of the days and therefore, no trader could earn a profit if he trades on a daily basis for the majority of the days.
The t-values on CAARs show that under market model with raw returns out of 61 t-values, 57 (93.44%) and under market model with log returns 56 (91.80%), t-values fall in the rejection region (i.e. greater than the critical value of ±1.6552). Therefore, we cannot accept the null hypothesis that CAARs are close to zero. This shows the presence of CAARs after the quarterly earnings announcement. Thus, we conclude that there is no empirical evidence to support that Indian stock market is semi-strong form efficient.

PART-VI
CONCLUSIONS

The results of the study show that the sign test statistics are not significant for the event window and we accept hypothesis that there is no significant difference between the number of positive and negative AARs for the event window. The Runs test statistics are not significant before the event day and therefore, AARs occur randomly. But after the event day, they are significant and therefore, we conclude that after the event day, AARs do not occur randomly. However, for the event window of 61 days, Runs test statistics on AARs are not significantly different from the expected number of runs and therefore, it is inferred that AARs occur randomly. The t-test statistics on

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